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

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

Ctenophores

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

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

2.2.6 Terrestrial Resources

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

2.2.6.1 Description of Site Terrestrial Environment

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

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

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

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

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

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

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

2.2.6.2 Threatened and Endangered Terrestrial Species

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

Federally Listed Species

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

Indiana Bat

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

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

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

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

Bog Turtle

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

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

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

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

New England Cottontail Rabbit

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

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

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

State-Protected Species

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

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

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

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

Table 2-6 (continued)

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

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

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

2

Table 2-6 (continued)

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

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

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

2

Table 2-6 (continued)

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

Table 2-6 (continued)

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

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

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

2

Table 2-6 (continued)

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

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

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

2

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

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

2

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

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

2

Table 2-6 (continued)

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

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

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

2

Table 2-6 (continued)

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

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

2.2.7 Radiological Impacts

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

Radiological Environmental Impacts

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

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

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

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

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

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

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

2006 REMP Results

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

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

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

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

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

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

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

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

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

2009 REMP Results

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

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

Direct Radiation

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

Airborne Particulates and Radioiodine

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

Hudson River Water

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

Drinking Water

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

Hudson River Shoreline Soil

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

Broad Leaf Vegetation

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

Fish and Invertebrates

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

Aquatic Vegetation

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

Hudson River Bottom Sediment

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

Precipitation

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

Soil

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

Groundwater

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

Land Use Census

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

Conclusion

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

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

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

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

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

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

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

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

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

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

Groundwater Contamination and Monitoring

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

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

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

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

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

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

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

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

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

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

New York State Groundwater Investigations

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

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

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

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

Dose Impacts to the Public

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

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

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

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

2.2.8 Socioeconomic Factors

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

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

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

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

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

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

Source: Entergy 2007a

2.2.8.1 Housing

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

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

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

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

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

2.2.8.2 Public Services

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

<u>Water Supply</u>

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Education

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

Transportation

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

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

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

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

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

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

Source: NYSDOT 2005

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

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

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

2.2.8.3 Offsite Land Use

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

Dutchess County

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

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

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

Orange County

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

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

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

Putnam County

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

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

Westchester County

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

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

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

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

2.2.8.4 Visual Aesthetics and Noise

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

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

2.2.8.5 Demography

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

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

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

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

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

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

— = No data available.

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

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

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

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

Source: USCB 2008c

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

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

Source: USCB 2008c

Transient Population

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

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

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

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

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

Migrant Farm Workers

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

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

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

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

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

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

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

Table 2-15 (continued)

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

Source: USDA 2002e, "Census of Agriculture," County Data, Table 7. Hired Farm Labor—Workers and Payroll: 2002
[a] Counties within 50 mi of IP2 and IP3 with at least one block group located within the 50-mi radius

2.2.8.6 Economy

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

Employment and Income

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

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

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

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

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

Source: The Journal News 2006

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

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

Source: USCB 2008c

Unemployment

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

Taxes

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

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

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

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

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

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

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

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

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

Source: NYSOSC 2008; ENN 2007c

2.2.9 Historic and Archeological Resources

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

2.2.9.1 Cultural Background

Prehistory

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

Table 2-19. Cultural Sequence and Chronology

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

Paleo-Indian Period

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

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

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

Archaic Period

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

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

Woodland Period

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

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

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

European Contact, 1524–1608

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

Historic Period

The Colonial Period, 1608–1776

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

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

The Revolutionary War, 1776–1783

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

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

19th Century Development

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

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

20th Century Development

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

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

2.2.9.2 Historic and Archeological Resources at the IP2 & IP3 Site

Previously Recorded Resources

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

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

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

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

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

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

Results of Walkover Survey

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

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

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

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

Potential Archeological Resources

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

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

2.2.10 Related Federal Project Activities and Consultations

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

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

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

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

New York/New Jersey/Philadelphia Airspace Redesign

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

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

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

Hudson River PCBs Site

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

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

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

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

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

Coastal Zone Management Act

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

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

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

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

2.3 References

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

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

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

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

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

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

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

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

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

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

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

3.1 Potential Refurbishment Activities

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

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

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

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

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

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

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

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

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

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

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

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

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

3.2 Refurbishment Impacts

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

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

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

Category 1 Issues for Refurbishment Evaluation

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

Provided below are the results of the NRC staff reviews and a brief statement of GEIS conclusions, as codified in Table B-1 of 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Subpart A, "National Environmental Policy Act—Regulations Implementing Section 102(2)," Appendix B, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," for each of the Category 1 refurbishment issues listed in Table 3-1. For each Category 1 issue, the NRC staff has not identified any new and significant information during its review of the Entergy ER (Entergy 2007), its site audit, the SEIS scoping process, public comments on the draft SEIS, and its evaluation of other available information, including Entergy's May 14, 2008, RAI response (Entergy 2008b).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

  No significant impacts are expected during refurbishment.

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

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

Table 3-2. Category 2 Issues for Refurbishment Evaluation

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

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

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

3.2.1 Terrestrial Ecology—Refurbishment Impacts

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

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

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

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

3.2.2 Threatened or Endangered Species—Refurbishment Impacts

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

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

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

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

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

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

3.2.3 Air Quality During Refurbishment (Nonattainment and Maintenance Areas)

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

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

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

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

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

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

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

3.2.4 Housing Impacts—Refurbishment

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

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

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

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

3.2.5 Public Services: Public Utilities—Refurbishment

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

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

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

3.2.6 Public Services: Education—Refurbishment

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

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

3.2.7 Offsite Land Use—Refurbishment

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

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

3.2.8 Public Services: Transportation—Refurbishment

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

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

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

3.2.9 Historic and Archeological Resources—Refurbishment

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

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

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

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

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

3.2.10 Environmental Justice—Refurbishment

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

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

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

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

3.4 Summary of Refurbishment Impacts

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

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

3.5 References

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

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

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

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

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

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

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

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

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

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

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

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

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

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

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

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

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

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

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

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

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

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

4.1 Cooling System

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

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

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

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

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

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

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

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

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

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

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

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

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

- <u>Eutrophication</u>. Based on information in the GEIS, the Commission found the following:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

term.

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

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

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

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

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

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

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

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

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

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

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

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

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

  Stimulation of nuisance organisms has been satisfactorily mitigated at the single

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

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

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

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

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

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

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

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

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

NYSDEC administrative proceedings continue.

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

Applicant Assessment

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

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

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

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

<u>NYSDEC Assessment</u>

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

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

NYSDEC (2003a) also stated that, while the changes to the IP2 and IP3 cooling system, including the use of dual-speed and variable-flow pumps and the installation of modified Ristroph traveling screens, “represent some level of improvement compared to operations with no mitigation or protection, there are still significant unmitigated mortalities from entrainment and impingement at all three of the Hudson River Settlement Agreement (HRSA) facilities.” NYSDEC (2003a) concluded that the millions of fish killed by impingement, entrainment, and thermal effects at the HRSA power plants represent a significant source of mortality and stress on the Hudson River’s fish community and must be taken into account when assessing the observed fish population declines. To help mitigate such losses, the NYSDEC (2003b) fact sheet for the draft SPDES permit states that “This permit does not require the construction of cooling towers unless: (1) the applicant seeks to renew its NRC operating licenses, (2) the NRC approves extension of the licenses, and determines that the installation and operation of closed-cycle cooling is feasible and safe, and (3) all other necessary Federal approvals are obtained.” Furthermore, NYSDEC states that if the NRC grants extensions of the operating licenses, Indian Point would have to submit for NYSDEC approval a revised construction schedule for closed-cycle cooling.

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

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

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

<u>NRC Assessment</u>

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

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

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

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

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

4.1.1 Impingement of Fish and Shellfish

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

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

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

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

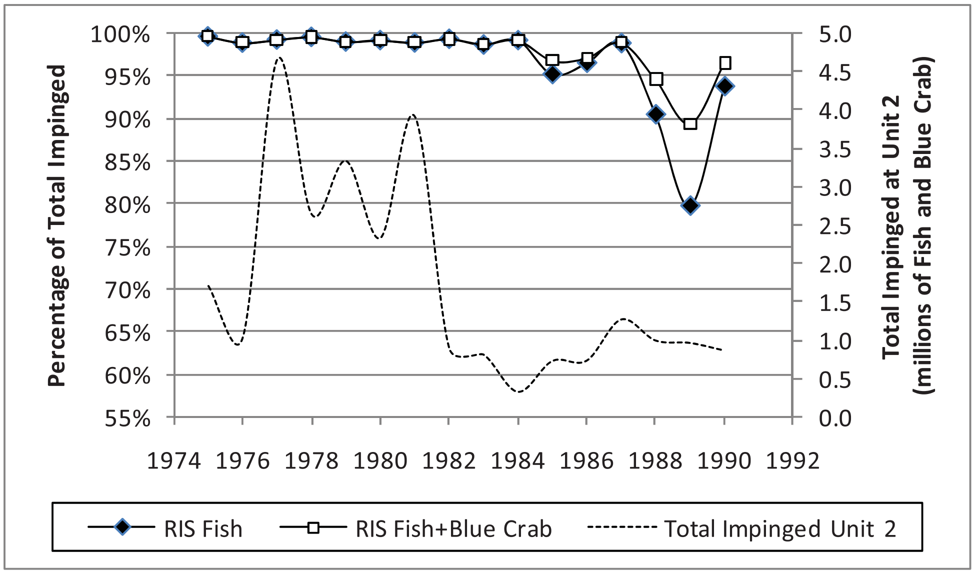


Figure 4-5. Percentage of impingement of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP2 (data from Entergy 2007b and 2009)

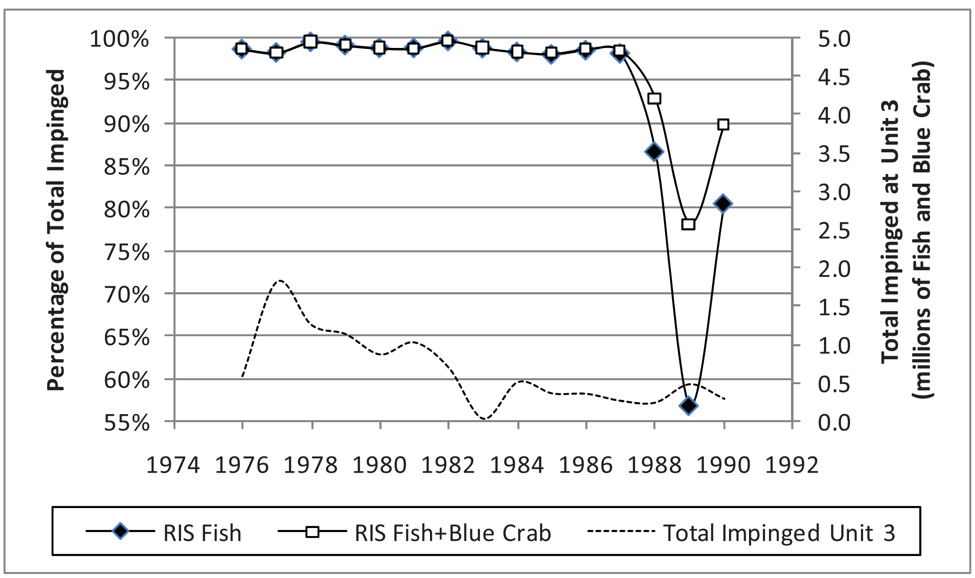


Figure 4-2. Percentage of impingement composed of RIS fish and RIS fish plus blue crab relative to the estimated total impingement at IP3 (data from Entergy 2007b and 2009)

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

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

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

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

Source: Fletcher 1990

Based on Fletcher's assessment, the NRC staff concludes that the IP2 and IP3 cooling system continues to impinge RIS of the lower Hudson River and that impingement mortality for 4 of the 10 species exceeds 25 percent. Monitoring data (Entergy 2007b and 2009), reviewed by NRC staff) also showed that impingement was greater at IP2 than at IP3 and that impingement has generally declined since 1976. Although IP2 and IP3 currently employ modified Ristroph screens and fish return systems to increase the survival rates of impinged organisms, since impingement monitoring was required by NYSDEC after 1990, the actual improvements in fish survival after installation of these systems at IP2 and IP3 have not been established (impingement monitoring last occurred in 1990). In Section 4.1.3 of this SEIS, the NRC staff includes impingement results in a weight-of-evidence (WOE) analysis to evaluate the overall impacts of the IP2 and IP3 cooling system on lower Hudson River RIS.

4.1.2 Entrainment of Fish and Shellfish in Early Lifestages

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

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

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

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

The entrainment monitoring data provided Entergy (2007b) contained 66 taxa. Blue crabs, shortnose and Atlantic sturgeon, and gizzard shad were not present in the 1981–1987 entrainment data. Some RIS data included taxa identified only to family or genus (e.g., anchovy family, *Alosa* spp., and *Morone* spp.) because the identification of early life stages for these groups is difficult. As shown in Figure 4-3, RIS fish represented greater than 70 percent of all entrainment, except for 2 weeks in 1984 and 1985 (1 week in May and 1 in June) for which amphipods (*Gammarus* spp.) were present. The total number of identified fish entrained has decreased at a rate of 187 billion fish per year since 1984. This result is consistent with the decrease observed in the number of fish impinged (Figures 4-1 and 4-2).

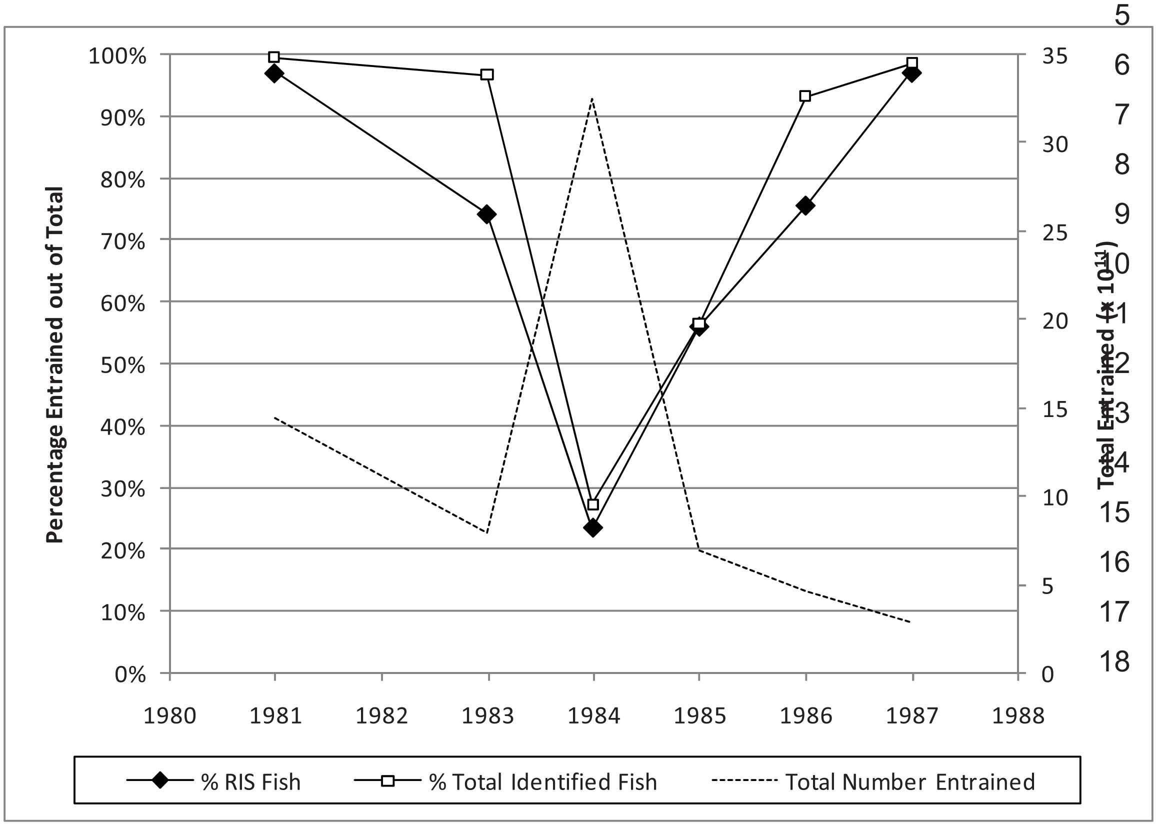
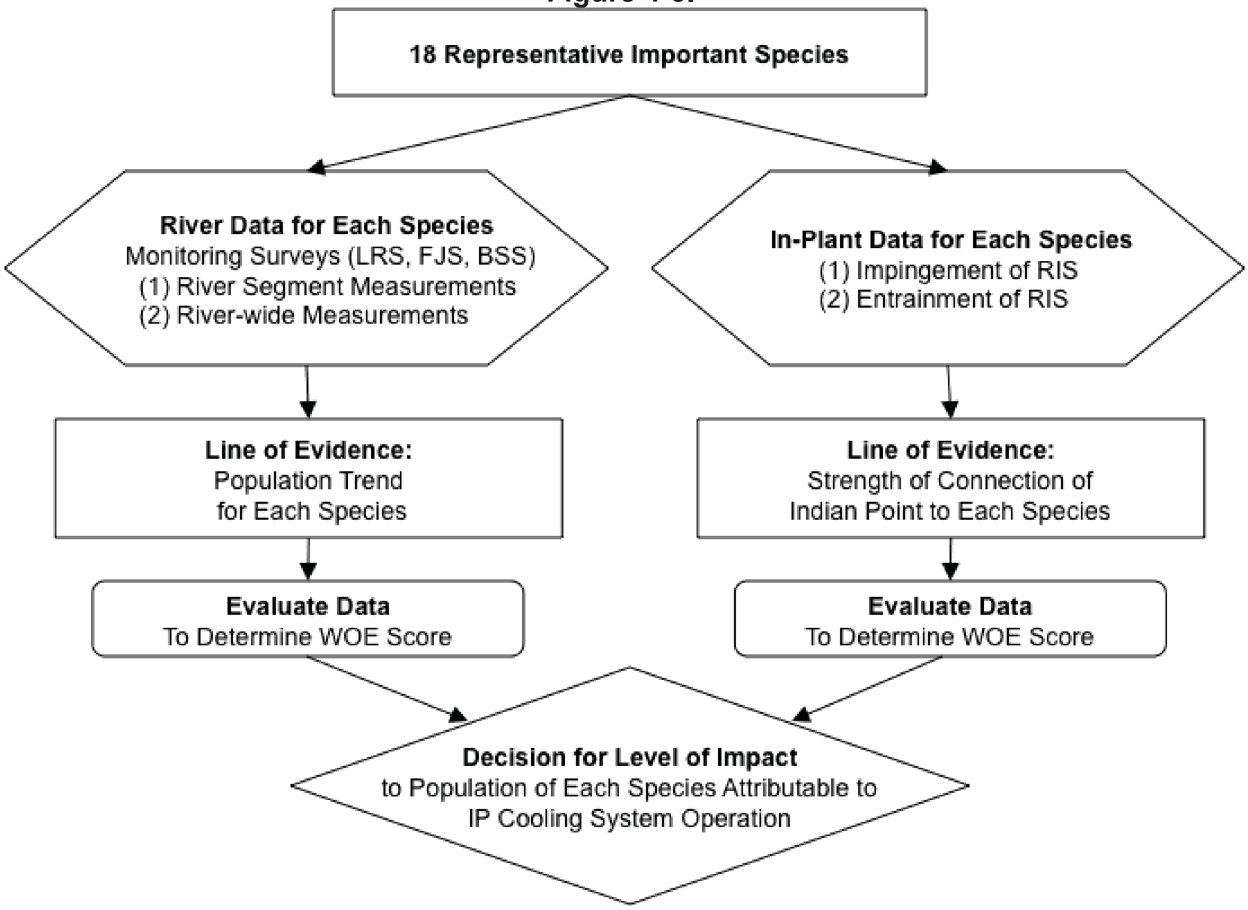


Figure 4-3. Percentage of entrainment of RIS fish and total identified fish relative to the estimated total entrainment at IP2 and IP3 combined (data from Entergy 2007b)

4.1.3 Combined Effects of Impingement and Entrainment

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

Figure 4-5.



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

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

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

Step 2: Identify Lines of Evidence and Quantifiable Measurements

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

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

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

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

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

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

The NRC staff developed decision rules for the first LOE to determine the historical trends in lower Hudson River RIS populations. The NRC staff used a mathematical approach to integrate the regression results (e.g., detected population decline) from each field survey to produce a single conclusion for a given RIS population trend. Appendices H and I provide detailed discussions of how the decision rules were developed and used in the environmental assessment. The possible outcomes of this analysis are as follows:

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

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

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

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

Step 5: Integrate the Results and Assess Impact

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

> SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE: Environmental effects are sufficient to alter noticeably—but not to destabilize—any important attributes of the resource.
>
> LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

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

4.1.3.1 Assessment of Population Trends—The First Line of Evidence

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

The NRC staff assessed YOY population trends in river segment 4 (the region of the lower Hudson River where IP2 and IP3 are located) and the lower Hudson River from the Troy Dam to the Battery (river-wide). The final WOE score reflects an integrated result for both measurements (Table 4-4). The analysis showed that YOY American shad, Atlantic tomcod, blueback herring, bluefish, hogchoker, spottail shiner, and white perch populations were declining, and that bay anchovy and striped bass populations were not declining. Alewife, rainbow smelt, weakfish, and white catfish exhibited variable population trends, meaning some data showed detectable declines, whereas other data did not. Atlantic menhaden, Atlantic sturgeon, gizzard shad, shortnose sturgeon, and blue crab showed unresolved population trends because Hudson River monitoring programs did not collect enough of these species to support statistically significant trend analyses. The impact on these species resulting from IP2 and IP3 operation under a renewed license is discussed in section 4.1.3.3 of the SEIS.

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

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

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

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

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

4.1.3.3 Impingement and Entrainment Impact Summary

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

Based on the WOE assessment (Table 4-4), the NRC staff concludes that impacts to American shad, Atlantic menhaden, Atlantic sturgeon, Atlantic tomcod, bay anchovy, bluefish, gizzard shad, shortnose sturgeon, striped bass, white catfish, and blue crab are SMALL. The NRC staff concludes impacts to alewife, rainbow smelt and weakfish are MODERATE. The staff concludes that impacts to blueback herring, hogchoker, spottail shiner, and white perch are LARGE. The NRC staff used the river-wide abundance and CPUE data, and river segment 4 (Indian Point) density and CPUE information from FSS, BSS, and LRC studies for each RIS to support population trend analysis. Section 4.1.3.4 provides a discussion of the uncertainty associated with the impact analysis, and Section 4.1.3.5 presents the final integrated assessment of the impact of the IP2 and IP3 cooling system for all RIS combined.

Large Impacts

Blueback Herring

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

Hogchoker

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

Spottail Shiner

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

White Perch

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

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

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

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

Moderate Impacts

Alewife

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

Rainbow Smelt

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

Weakfish

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

4.1.3.4 Discussion of Uncertainty

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

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

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

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

4.1.3.5 Overall Impingement and Entrainment Impact

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

4.1.4 Heat Shock

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

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

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

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

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

4.1.4.1 Potential Effects of Heated Water Discharges on Aquatic Biota

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

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

4.1.4.2 Historical Context

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

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

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

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

4.1.4.3 Thermal Studies and Conclusions

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

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

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

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

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

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

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

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

4.1.4.4 Assessments of Thermal Impacts

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

<u>Applicant's Assessment</u>

The IP2 and IP3 ER (Entergy 2007a) discusses the potential environmental impacts of thermal discharges from IP2 and IP3. The conclusions provided in the ER indicate that the current owners of IP2 and IP3 hold a NYSDEC SPDES permit (NY-0004472) and that the station is complying with the terms of this permit. The conclusions of the ER also describe the current mitigation required under the terms of the Fourth HRSA Consent Order that include flow reductions to limit aquatic impacts and extensive studies in the Hudson River to evaluate temporal and spatial trends. The applicant concludes that “continued operation in the manner required by the current SPDES permit and the associated agreement to continue implementation of the fourth Consent Degree ensures that thermal impacts will satisfy the requirements of CWA 316(a) and will thus remain SMALL during the license renewal term. Therefore, no further mitigation measures are warranted” (Entergy 2007a).

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

NYSDEC Assessment

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

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

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

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

4.1.4.5 NRC Staff Assessment of Thermal Impacts

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

4.1.5 Potential Mitigation Options

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

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

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

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

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

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

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

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

<u>Additional Flow Reductions or Shutdowns</u>

As discussed in Section 4.1.1.1 of this SEIS, under the conditions of HRSA and the subsequent consent orders, the operators of IP2 and IP3 developed programs to employ flow-reduction measures and scheduled outages to reduce impingement and entrainment impacts. Because flow rates were dependent on water temperature, greater flows were required during the months of May through October when river water temperatures were above 15°C. It may be possible to further reduce flows or increase the length or frequency of scheduled outages, though these options will cause the plant operator to lose revenue from operating IP2 and IP3. In the 1999 DEIS, CHGEC et al. estimated that outages could cost between $14 million and $73 million per year.

<u>Wedgewire or Fine-Mesh Screens</u>

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

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

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

<u>Barrier Systems</u>

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

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

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

Behavioral Deterrent Systems

Behavioral deterrent systems such as noncontact sound barriers or the use of light sources to reduce impingement have been evaluated at a variety of power generating stations in marine, estuarine, and freshwater environments (EPA 2008a). At present, a sonic deterrent system is being used at the Danskammer Point fossil energy plant on the Hudson River, and a similar system has been evaluated at Roseton. The advantage to these systems is that they can be configured and deployed at a variety of locations at costs that are not prohibitively high for simple system configurations. The disadvantages of the systems are that pneumatic air guns, hammers, and fishpulser systems are not considered reliable, the cost of sophisticated acoustic sound-generating systems can be high, and the use of high-technology equipment requires maintenance at the site (EPA 2008a). EPA (2008a) further states that, although many studies have been conducted to evaluate the feasibility of sound and light to reduce impingement and entrainment, the results "have either been inconclusive or shown no tangible reduction in impingement or entrainment" (EPA 2008a). There is, however, evidence that the use of acoustic sound barriers at a site in Pickering, Ontario, did appear to reduce the impingement and entrainment of alewife, but no benefits were realized for rainbow smelt or gizzard shad. At the Roseton facility, the use of sound barriers provided little or no deterrence for any species (EPA 2008a). In its review, the EPA concluded that it may be possible to employ acoustic or light barrier systems in conjunction with other technologies to reduce impingement or entrainment, but further studies are likely necessary to evaluate the feasibility of various technology combinations. The 1999 DEIS from CHGEC et al. indicated an unknown cost associated with implementing behavioral deterrence systems.

4.2 Transmission Lines

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.2.1 Electromagnetic Fields—Acute Effects

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

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

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

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

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

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

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

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

4.2.2 Electromagnetic Fields—Chronic Effects

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

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

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

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

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

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

4.3 Radiological Impacts of Normal Operations

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

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

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

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

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

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

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

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

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

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

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

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

4.4 Socioeconomic Impacts of Plant Operations during the License Renewal Term

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

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

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

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

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

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

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

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

  Only impacts of small significance are expected.

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

  No significant impacts are expected during the license renewal term.

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

  No significant impacts are expected during the license renewal term.

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

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

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

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

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

4.4.1 Housing Impacts

Appendix C to the GEIS presents a population characterization method based on two factors, sparseness and proximity (see Section C.1.4). Sparseness measures population density within 20 miles (mi) (32 kilometers (km)) of the site, and proximity measures population density and city size within 50 mi (80 km). Each factor has categories of density and size (see Table C.1 of the GEIS). A matrix is used to rank the population category as low, medium, or high (see Figure C.1 of the GEIS).

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

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

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

4.4.2 Public Services—Public Utility Impacts

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

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

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

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

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

4.4.3 Offsite Land Use—License Renewal Period

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

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

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

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land use impacts during the license renewal term should consider (1) the size of the plant's payments relative to the community's total revenues, (2) the nature of the community's existing land use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant's tax payments are projected to be small relative to the community's total revenue, tax-driven land use changes during the plant's license renewal term would be SMALL, especially where the community has preestablished patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be SMALL. If the plant's tax payments are projected to be medium to large relative to the community's total revenue, new tax-driven land use changes would be MODERATE. If the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land use changes would be LARGE. This would be especially true where the community has no preestablished pattern of development or has not provided adequate public services to support and guide development.

4.4.3.1 Population-Related Impacts

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

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

4.4.3.2 Tax-Revenue-Related Impacts

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

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

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

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

4.4.4 Public Services: Transportation Impacts during Operations

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

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

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

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

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

4.4.5 Historic and Archeological Resources

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

4.4.5.1 Site-Specific Cultural Resources Information

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

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

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

4.4.5.2 Conclusions

Entergy has proposed no specific new facilities, service roads, or transmission lines for the IP2 and IP3 site associated with continued operation and refurbishment (which does not include the installation of cooling towers). However, Entergy indicated that it plans to replace the IP2 and IP3 reactor vessel heads and CRDMs during the license renewal period. This activity could involve ground-disturbing activities associated with the construction of a storage building for the existing reactor vessel heads and CRDMs. Ground-disturbing activities would be reviewed in accordance with Entergy nuclear fleet procedures, which are designed to ensure that investigations and consultations are conducted as needed, and that existing or potentially existing cultural resources are adequately protected by Entergy such that the applicant can meet State and Federal expectations (Enercon 2007). The NRC staff considers the potential impacts to historic and archaeological resources on the IP2 and IP3 site that may result from installation of cooling towers, should such towers be required by the NYSDEC, in the discussion of alternatives in Chapter 8 of this SEIS.

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

4.4.6 Environmental Justice

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

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

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

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

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

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

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

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

Minority Population in 2000

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

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

Low-Income Population in 2000

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

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

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

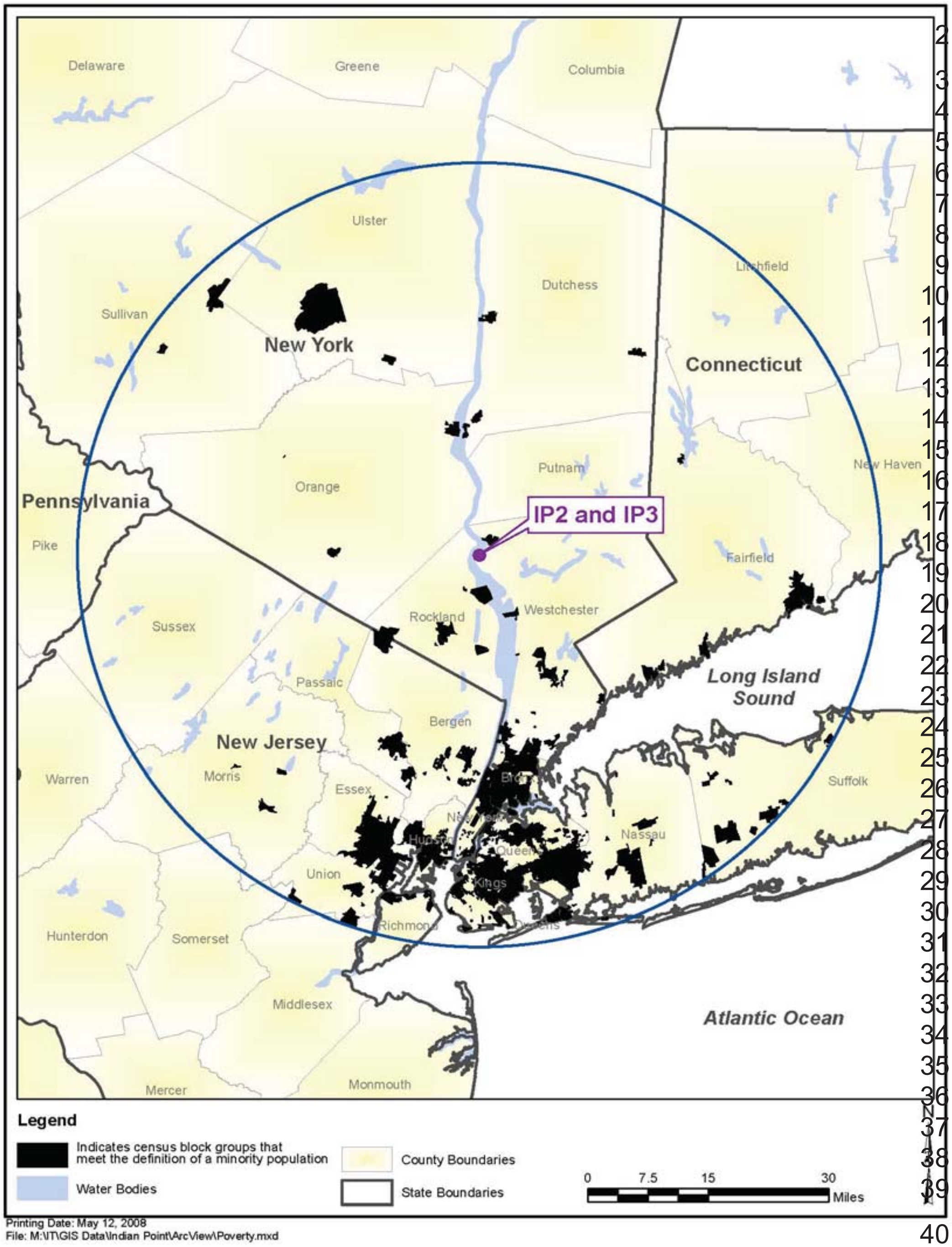


Figure 4-5. Minority block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

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

Analysis of Impacts

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

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

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

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

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

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

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

Subsistence Consumption of Fish and Wildlife

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

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

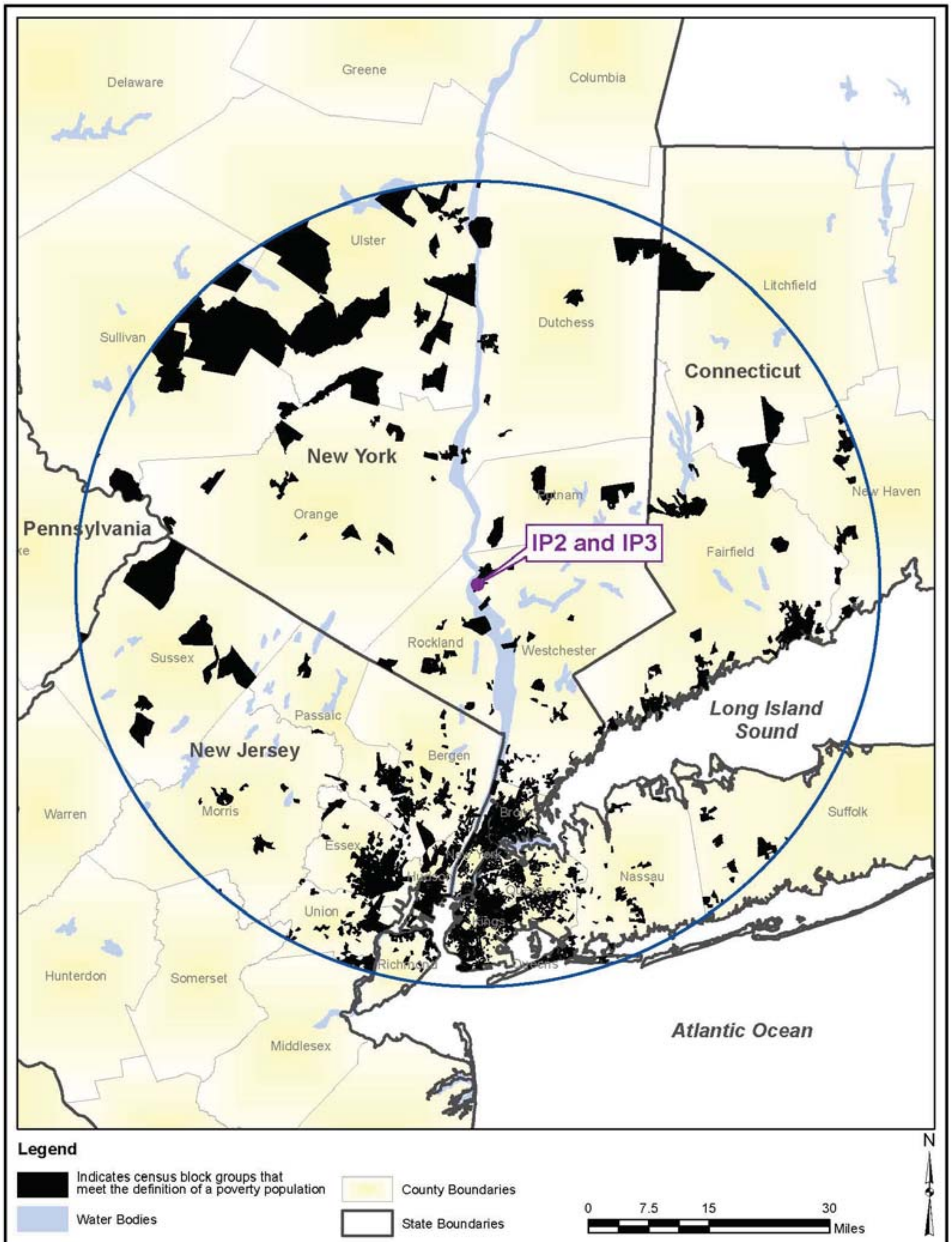


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Figure 4-6. Low-income block groups in 2000 within a 50-mi radius of IP2 and IP3 (USCB 2008)

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

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

4.5 Ground Water Use and Quality

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

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

4.6 Threatened or Endangered Species

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

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

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

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

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

4.6.1 Aquatic Special Status Species

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

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

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

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

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

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

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

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

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

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

The NRC staff reviewed information from the site audit, Entergy's ER for the IP2 and IP3 site, other reports, and information from NMFS. Based on the WOE information presented in Table 4-4, The NRC staff concludes that the impacts associated with the IP2 and IP3 cooling system are Small for both Atlantic and shortnose sturgeon. The population trend LOE evaluation was unresolved because the Hudson River monitoring programs were not designed to catch either species. The NRC staff was also unable to determine the strength of connection for either species using the Monte Carlo simulation modeling. Because historical impingements of sturgeon have been relatively low, especially for shortnose sturgeon, the NRC staff concluded that the strength of connection was low. Based on the WOE analysis described above, a determination of Moderate or Large impact is not supported, and the NRC staff concludes that the impacts of an additional 20 years (beyond the current term) of operation and maintenance of the site on aquatic species that are Federally listed as threatened or endangered is SMALL.

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

4.6.2 Terrestrial Threatened or Endangered Species

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

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

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

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

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

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

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

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

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

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

4.8 Cumulative Impacts

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

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

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

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

4.8.1 Cumulative Impacts on Aquatic Resources

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

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

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

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

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

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

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

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

Continued Water Withdrawals

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

Invasive and Nuisance Species

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

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

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

<u>Fishing Pressure</u>

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

<u>Habitat Loss</u>

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

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

Water and Sediment Quality

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

Climate Change

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

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

Final Assessment of Cumulative Impacts on Aquatic Resources

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

4.8.2 Cumulative Impacts on Terrestrial Resources

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

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

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

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

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

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

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

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

4.8.3 Cumulative Radiological Impacts

The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of the IP2 and IP3 site was included. The radiological environmental monitoring program conducted by Entergy in the vicinity of the IP2 and IP3 site measures radiation and radioactive materials from all sources; therefore, the monitoring program measures cumulative radiological impacts. Within the 50-mi (80-km) radius of the IP2 and IP3 site there are no other nuclear power reactors or uranium fuel cycle facilities. The NRC staff reviewed the 1993 and 1994 radiological environmental monitoring data from the area around IP2 and IP3 reported by New York State; the data showed no adverse environmental impact. For the new issue identified by Entergy concerning the tritium leak into the Hudson River, the NRC staff also reviewed the information reported by Entergy, the NYSDEC and NYSDOH, and by the NRC. No adverse impacts were identified (Entergy 2007b, NYSDEC and NYSDOH 2008, NRC 2006b, NRC 2007b).

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

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

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

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

4.8.4 Cumulative Socioeconomic Impacts

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

Entergy has indicated that it may replace the IP2 and IP3 reactor vessel heads and CRDMs, Entergy estimates that this replacement activity would require an increase in the number of refueling outage workers for up to 60 days during two separate refueling outages, one for each unit, 12 months apart (Entergy 2008b). These additional workers would create short-term increases in the demand for temporary (rental) housing, increased use of public water and sewer services, and transportation impacts on access roads in the immediate vicinity of IP2 and IP3. Given the short amount of time needed for this replacement activity, the cumulative effects of these replacement activities on socioeconomic conditions in the vicinity of IP2 and IP3 would not likely be noticeable. Also, there would be no long-term cumulative socioeconomic impacts after the reactor vessel heads and CRDMs are replaced.

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

4.8.5 Cumulative Impacts on Ground Water Use and Quality

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

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

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

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

4.8.6 Conclusions Regarding Cumulative Impacts

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

4.9 Summary of Impacts of Operations during the Renewal Term

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

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

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

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

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

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

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

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

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

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

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

5.1 Postulated Plant Accidents

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

5.1.1 Design-Basis Accidents

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

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

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

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

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

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

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

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

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

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

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

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

5.1.2 Severe Accidents

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

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

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

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

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

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

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

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

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

5.2 Severe Accident Mitigation Alternatives

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

5.2.1 Introduction

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

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

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

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

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

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

5.2.2 Estimate of Risk

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

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

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

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

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

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

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

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

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

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

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

5.2.3 Potential Plant Improvements

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

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

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

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

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

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

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

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

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

5.2.5 Cost-Benefit Comparison

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

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

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

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

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

- SMA 62 – Provide a hard-wired connection to a safety injection (SI) pump from the alternate safe shutdown system (ASSS) power supply. This modification would reduce the CDF from events that involve loss of power from the 480V vital buses.
- SAMA 65 – Upgrade the alternate safe shutdown system to allow timely restoration of reactor coolant pump seal injection and cooling from events that cause loss of power from the 480-V ac vital buses.

The potentially cost-beneficial SAMAs for IP3 include the following:

- SAMA 7 – Create a reactor cavity flooding system. This modification would enhance core debris cooling and reduce the frequency of containment failure due to core-concrete interaction.
- SAMA 18 – Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove fission products.
- SAMA 19 – Install additional pressure or leak monitoring instrumentation to reduce the frequency of interfacing system loss of coolant accidents.
- SAMA 30 – Provide a portable diesel-driven battery charger to improve dc power reliability. A safety-related disconnect would be used to change a selected battery. This modification would enhance the long-term operation of the turbine-driven AFW pump on battery depletion.
- SAMA 52 – Proceduralize opening the city water supply valve for alternative AFW system pump suction to enhance the availability of the AFW system.
- SAMA 53 – Install an excess flow valve to reduce the risk associated with hydrogen explosions inside the turbine building or primary auxiliary building.
- SAMA 55—Provide the capability of powering one safety injection pump or RHR pump using the Appendix R diesel (MCC 312A) to enhance reactor cooling system injection capability during events that cause loss of power from the 480-V ac vital buses.
- SAMA 61 – Upgrade the alternate safe-shutdown system to allow timely restoration of reactor coolant pump seal injection and cooling from events that cause loss of power from the 480-V ac vital buses.
- SAMA 62 – Install a flood alarm in the 480-V ac switchgear room to mitigate the occurrence of internal floods inside the 480-V ac switchgear room.

In response to an NRC staff inquiry regarding estimated benefits for certain SAMAs and lower cost alternatives, Entergy identified one additional potentially cost-beneficial SAMA (regarding a dedicated main steam safety valve gagging device for SGTR events in both units; this was unnumbered for each unit because the applicant did not initially identify them) (Entergy 2008b); and Entergy determined that one SAMA that was previously identified as potentially cost beneficial was no longer cost beneficial based on correction of an error in the ER (IP3 SAMA 30) (Entergy 2008a, Entergy 2009).

Based on its review of Entergy's SAMA analysis, as revised, the staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than their associated benefits.

5.2.6 Conclusions

The NRC staff reviewed Entergy's analysis, as revised, and concludes that the methods used, and the implementation of those methods, were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by Entergy are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process and inclusion of a multiplier to account for external events.

Based on its review of the SAMA analysis, as revised, the staff concurs with Entergy's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all or a subset of potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the staff considers that further evaluation of these SAMAs by Entergy is appropriate. However, none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of IP2 and IP3 license renewal pursuant to 10 CFR Part 54.

In a decision issued on June 30, 2010, the Atomic Safety and Licensing Board ("Board") admitted two contentions for litigation, which had been filed by the State of New York in the Indian Point Units 2 and 3 license renewal adjudicatory proceeding. Entergy Nuclear Operations, Inc. (Indian Point Nuclear Generating Units 2 and 3), LBP-10-13, 71 NRC __ (2010). These contentions generally assert that the NRC staff must reach a final determination of the cost-beneficial SAMAs, from the slate of SAMAs that have been found to be potentially cost-beneficial, and that (a) the cost-beneficial SAMAs must be imposed as a "backfit" on the plants' current licensing basis ("CLB"), as a condition for license renewal, or (b) the staff must provide a sufficient explanation for not imposing such a license renewal condition. In this regard, the NRC staff has provided a detailed discussion of SAMA costs and benefits in this SEIS, which satisfies the NRC's obligation, under NEPA and related case law, to consider SAMAs in a license renewal proceeding such as the IP2 and IP3 proceeding. Indeed, as the Board found, while NEPA requires consideration of environmental impacts and alternatives, it does not require that SAMAs be imposed to redress environmental impacts. LBP-10-13, slip op. at 29.

Moreover, the NRC staff has determined that none of the potentially cost-beneficial SAMAs are related to the license renewal requirements in 10 CFR Part 54 (i.e., managing the effects of aging) (SEIS § 5.2.6). Under the NRC's regulatory system, any potentially cost-beneficial SAMAs that do not relate to 10 CFR Part 54 requirements would be considered, to the extent necessary or appropriate, under the agency's oversight of a facility's current operating license in accordance with 10 CFR Part 50 requirements, inasmuch as such matters would pertain not just to the period of extended operation but to operations under the current operating license term as well. Thus, there is no regulatory basis to suggest that potentially cost-beneficial SAMAs that are unrelated to Part 54 requirements must be imposed as a backfit to the CLB, as a condition for license renewal.

Finally, the NRC staff notes that SAMAs, by definition, pertain to severe accidents – i.e., those accidents whose consequences could be severe, but whose probability of occurrence is so low that they may be excluded from the spectrum of design basis accidents ("DBAs) that have been postulated for a plant (see GEIS §§ 5.3.2, 5.3.3, 5.4); this is consistent with the conclusions reached in § 5.2.2 of this SEIS concerning severe accidents at IP2 and IP3. The Commission has previously concluded, as a generic matter, that the probability-weighted radiological consequences of severe accidents are SMALL. GEIS § 5.5.2; 10 CFR Part 51, App. B, Table B

1. As stated in §§ 5.1.1 and 5.1.2 above, no significant new information has been identified that would remove IP2 and IP3 from these generic determinations. Thus, there is no regulatory basis to impose any of the potentially cost-beneficial SAMAs as a condition for license renewal of IP2 and IP3 – even if those potentially cost-beneficial SAMAs are “finally” found to be cost-beneficial.

5.3 References

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

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

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

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

Atomic Safety and Licensing Board Panel (ASLBP). *Entergy Nuclear Operations, Inc.* (Indian Point Nuclear Generating Units 2 and 3), LBP-10-13, 71 NRC __ (2010).

Consolidated Edison (Con Ed). 1992. Letter from Stephen B. Bram to U.S. Nuclear Regulatory Commission, Subject: Generic Letter 88-20, Supplement 1: Individual Plant Examination (IPE) for Severe Accident Vulnerabilities—10 CFR 50.54, Indian Point Unit No. 2, August 12, 1992.

Consolidated Edison (Con Ed). 1995. Letter from Stephen E. Quinn to U.S. Nuclear Regulatory Commission, Subject: Final Response to Generic Letter 88-20, Supplement 4: Submittal of Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities, Indian Point Unit No. 2, December 6, 1995.

Entergy Nuclear Operations, Inc. (Entergy). 2007a. “Applicant's Environment Report, Operating License Renewal Stage.” (Appendix E to Indian Point, Units 2 and 3, License Renewal Application; Attachment E: Severe Accident Mitigation Alternatives). April 23, 2007. Agencywide Documents Access and Management System (ADAMS) Accession No. ML071210562.

Entergy Nuclear Operations, Inc. (Entergy). 2007b. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Indian Point Energy Center License Renewal Application, NL-07-039, April 23, 2007. ADAMS Accession No. ML071210512.

Entergy Nuclear Operations, Inc. (Entergy). 2008a. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Reply to Request for Additional Information Regarding License Renewal Application—Severe Accident Mitigation Alternatives Analysis, NL-08-028, May 22, 2008. ADAMS Accession No. ML080420264.

Entergy Nuclear Operations, Inc. (Entergy). 2008b. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: Supplemental Reply to Request for Additional Information Regarding License Renewal Application—Severe Accident Mitigation Alternatives Analysis, NL-08-086, May 22, 2008. ADAMS Accession No. ML081490336.

Entergy Nuclear Operations, Inc. (Entergy). 2009. Letter from Fred Dacimo to U.S. Nuclear Regulatory Commission, Subject: License Renewal Application – SAMA Reanalysis Using Alternate Meteorological Tower Data, NL-09-165, December 11, 2009. ADAMS Accession No.

ML093580089.

New York Power Authority (NYPA). 1994. Letter from William A. Josiger to U.S. Nuclear Regulatory Commission, Subject: Indian Point 3 Nuclear Power Plant Individual Plant Examination for Internal Events, June 30, 1994.

New York Power Authority (NYPA). 1997. Letter from James Knubel to U.S. Nuclear Regulatory Commission, Subject: Indian Point 3 Nuclear Power Plant Individual Plant Examination of External Events (IPEEE), September 26, 1997.

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

Nuclear Regulatory Commission (NRC). 1997. "Regulatory Analysis Technical Evaluation Handbook." NUREG/BR-0184, Washington, DC.

Nuclear Regulatory Commission (NRC). 1999. "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report," Section 6.3, "Transportation," Table 9.1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, DC.

Nuclear Regulatory Commission (NRC). 2004. "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission." NUREG/BR-0058, Rev. 4, Washington, DC. ADAMS Accession No. ML042820192.

6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE, SOLID WASTE MANAGEMENT, AND GREENHOUSE GAS EMISSIONS

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

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

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

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

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

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

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management that are listed in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) and are applicable to the Indian Point Nuclear Generating Unit Nos. 2 and 3 (IP2 and IP3). The generic potential radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor." The U.S. Nuclear Regulatory Commission (NRC) staff also addresses the impacts from radon-222 and technetium-99 in the GEIS.

6.1 The Uranium Fuel Cycle

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

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to IP2 and IP3 from the uranium fuel cycle and solid waste management are listed in Table 6-1.

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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1; 6.2.2.1; 6.2.2.2; 6.2.3; 6.2.4; 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8;
	6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.4
Mixed waste storage and disposal	6.1; 6.4.5; 6.6
Onsite spent fuel	6.1; 6.4.6; 6.6
Nonradiological waste	6.1; 6.5; 6.6
Transportation	6.1; 6.3, Addendum 1; 6.6

Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and significant information associated with the renewal of the IP2 and IP3 operating licenses, though it did identify leaks to ground water as a potential new issue. The NRC staff addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant). The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the NRC staff concluded in the GEIS that the impacts are SMALL (except for the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, as discussed below) and that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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

- Off-site radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste). Based on information in the GEIS, the Commission found the following:

  Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part (10 CFR 51.51(b)). Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (individual effects) of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Off-site radiological impacts (collective effects). Based on information in the GEIS, the Commission found the following:

  The 100 year environmental dose commitment to the United States (U.S.) population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U.S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next one thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits and even smaller fractions of natural background exposure to the same populations.

  Nevertheless, despite all of the uncertainty, some judgement as to the National Environmental Policy Act of 1969, as amended (NEPA) implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts (collective effects) from the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Offsite radiological impacts (spent fuel and high-level waste disposal). Based on information in the GEIS, the Commission found the following:

  For the high-level waste (HLW) and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for off-site releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards" (NAS 1995), and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem (mrem) (1millisevert [mSv]) per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 mrem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 mrem (1 mSv) per year. The lifetime individual risk from 100 mrem annual dose limit is about 3×10^{-3}.

  Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the U.S. Department of Energy (DOE) in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980 (DOE 1980). The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of

> potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR Part 191 protect the population by imposing "containment requirements" that limit the cumulative amount of radioactive material released over 10,000 years. Reporting performance standards that will be required by EPA are expected to result in releases and associated health consequences in the range between 10 and 100 premature cancer deaths with an upper limit of 1,000 premature cancer deaths world-wide for a 100,000 metric ton (MT) repository.
>
> Nevertheless, despite all of the uncertainty, some judgement as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgement in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered Category 1.

On February 15, 2002, based on a recommendation by the Secretary of the DOE, the President recommended the Yucca Mountain site for the development of a repository for the geologic disposal of spent nuclear fuel and HLW. The U.S. Congress approved this recommendation on July 9, 2002, in Joint Resolution 87, which designated Yucca Mountain as the repository for spent nuclear waste. On July 23, 2002, the President signed Joint Resolution 87 into law; Public Law 107-200, 116 Stat. 735 designates Yucca Mountain as the repository for spent nuclear waste. The staff notes that, on March 3, 2010, the U.S. Department of Energy (DOE) submitted a motion to the Atomic Safety and Licensing Board to withdraw with prejudice its application for a permanent geologic repository at Yucca Mountain, NV. The NRC is currently considering DOE's request. Nevertheless, the NRC has evaluated the safety and environmental effects of spent fuel storage and, as set forth in 10 CFR 51.23, "Temporary Storage of Spent Fuel after Cessation of Reactor Operation—Generic Determination of No Significant Impact" (known as the Waste Confidence Rule).

> The Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation (which may include the term of a revised or renewed license) of that reactor at its spent fuel storage basin or at either onsite or offsite independent spent fuel storage installations. Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the

> first quarter of the twenty-first century, and sufficient repository capacity will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time.

That rule is the subject of an ongoing rulemaking proceeding, as discussed in "Waste Confidence Decision Update," 73 F.R. 59551 (Oct. 9, 2008).

In 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," onsite spent fuel storage is classified as a Category 1 issue that applies to all nuclear power reactors. While the Commission did not assign a single level of significance (i.e., SMALL, MODERATE, or LARGE) in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51 for the impacts associated with spent fuel and HLW disposal, it did conclude that the impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion that for any plant, the option of extended operation under 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," should be eliminated.

The GEIS for license renewal (NUREG-1437) evaluated a variety of spent fuel and waste storage scenarios, including onsite storage of these materials for up to 30 years following expiration of the operating license, transfer of these materials to a different plant, and transfer of these materials to an ISFSI. During dry cask storage and transportation, spent nuclear fuel must be "encased" in NRC-approved casks. An NRC-approved cask is one that has undergone a technical review of its safety aspects and been found to meet all of the NRC's requirements, as specified in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste" (for storage casks), and 10 CFR Part 71, "Packaging and Transportation of Radioactive Material" (for transportation casks). For each potential scenario involving spent fuel, the GEIS determined that existing regulatory requirements, operating practices, and radiological monitoring programs were sufficient to ensure that impacts resulting from spent fuel and waste storage practices during the term of a renewed operating license would be small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no offsite radiological impacts related to spent fuel and high-level waste disposal during the renewal term beyond those discussed in the GEIS.

- <u>Nonradiological impacts of the uranium fuel cycle</u>. Based on information in the GEIS, the Commission found the following:

  > The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the NRC staff's site visit, the scoping process, or its evaluation of other available information pertaining to the IP2 and IP3 license renewal application. Therefore, the NRC staff concludes that there are no nonradiological impacts of the uranium fuel cycle during the renewal term beyond those discussed in the GEIS.

- Low-level waste storage and disposal. Based on information in the GEIS, the Commission found the following:

  The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of low-level waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Mixed waste storage and disposal. Based on information in the GEIS, the Commission found the following:

  The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of mixed waste storage and disposal associated with the renewal term beyond those discussed in the GEIS.

- Onsite spent fuel. Based on information in the GEIS, the Commission found the following:

  The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

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

  No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no nonradiological waste impacts during the renewal term beyond those discussed in the GEIS.

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

  The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 megawatt-days per metric ton of uranium (MWd/MTU) and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4—Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in 10 CFR 51.52.

IP2 and IP3 meet the fuel-enrichment and burnup conditions set forth in Addendum 1 to the GEIS. The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site audit, the scoping process, or evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts of transportation associated with license renewal beyond those discussed in the GEIS.

There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.2 Greenhouse Gas Emissions

6.2.1 Introduction

The NRC staff received many comments during the scoping period from individuals and groups regarding the impact of the proposed relicensing of IP2 and IP3 on the release of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions relative to potential alternative energy sources, including fossil fuels, renewable energy sources, and conservation programs.

6.2.2 IP2 and IP3

The NRC staff has not identified any studies specifically addressing GHGs produced by IP2 and IP3 or their fuel cycles. Although Entergy developed a study identifying gas emissions that would result if IP2 and IP3 were to be decommissioned and their generating capacity replaced with fossil-fuel based sources (Entergy Nuclear Northeast 2002), Entergy did not evaluate GHG emissions related to the existing facility. This study evaluated emissions of CO_2, sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulates (i.e., particulate matter, 10 microns or less in diameter [PM_{10}]), carbon monoxide (CO), and volatile organic compounds (VOCs). The study was intended as an evaluation of the impact of IP2 and IP3 shutdown on air quality in the local New York City area, rather than an evaluation of the impact of IP2 and IP3 shutdown on global GHG emissions.

6.2.3 GEIS

The GEIS provided only qualitative discussions regarding the GHG impacts of the nuclear fuel cycle. In the analysis of potential alternatives to nuclear power plant relicensing, the GEIS referenced CO_2 emissions as one of the substantial operating impacts associated with new coal-fired and oil-fired power plants, although no direct quantitative assessment of GHG emissions was presented. The GEIS also did not address GHG impacts of the nuclear fuel cycle relative to other potential alternatives, such as natural gas, renewable energy sources, or conservation programs.

6.2.4 Other Studies

Since the development of the GEIS, extensive further research into the relative volumes of GHGs emitted by nuclear and other electricity generating methods has been performed. In support of the analysis for this SEIS, the NRC staff performed a survey of the recent literature on the subject. Based on this survey, the NRC staff found that estimates and projections of the carbon footprint of the nuclear power lifecycle vary widely, and considerable debate exists regarding the relative impacts of nuclear and other electricity generation methods on GHG emissions. These recent studies take two different forms:

(1) qualitative discussions of the potential use of nuclear power to address GHG emissions and global warming

(2) technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle

6.2.4.1 Qualitative Studies

The qualitative studies primarily consist of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, and/or politically feasible means of achieving global GHG reductions. Examples of the studies that commenters referenced during the scoping period or that the NRC staff identified during the subsequent literature search include the following:

- Studies conducted to evaluate whether investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider 2000; International Atomic Energy Agency [IAEA] 2000; NEA 2002; and Nuclear Information and Resource Service and World Information Service on Energy [NIRS/WISE] 2005). Ultimately, the parties did not approve nuclear power as a component under the Clean Development Mechanism (CDM), but not because of concerns about GHGs from the nuclear fuel cycle (NEA 2002). Instead, it was eliminated from consideration for the CDM because it was not considered to meet the criterion of helping developing nations achieve sustainable development because of safety and waste disposal concerns (NEA 2002).

- Analyses developed to assist governments (including the U.S. Government) in making long-term investment and public policy decisions in nuclear power (Keepin 1988; Hagen et al. 2001; Massachusettes Institute of Technology [MIT] 2003).

Although the qualitative studies sometimes reference and critique the rationale contained in the existing quantitative estimates of GHGs produced by the nuclear fuel cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are not directly applicable to the evaluation of GHG emissions that will be associated with the proposed relicensing of IP2 and IP3.

6.2.4.2 Quantitative Studies

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature. Examples of these studies include Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), Paliamentery Office of Science and Technology (POST; 2006), AEA (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparison of the different studies is difficult because the assumptions and components of the lifecycles included within each study vary widely. Examples of differing assumptions that make comparability between the studies difficult include the following:

- the type of energy source that may be used to mine uranium deposits in the future
- the amount of reprocessing of nuclear fuel that will be performed in the future
- the type of energy source and process that might be used to enrich uranium in the future
- different calculations regarding the grade and volume of recoverable uranium deposits in the world
- different estimates regarding the GHG emissions associated with declining grades of recoverable coal, natural gas, and oil deposits
- the release of GHG gases other than CO_2, including the conversion of the masses of these gases into grams of CO_2 equivalents per kilowatt-hour (g C_{eq} /kWh)

- the technology to be used for future fossil fuel power systems, including cogeneration systems
- the projected capacity factors assumed for the different generation alternatives
- the different types of nuclear reactors used currently and in the projected future (light water reactor, pressurized-water reactor, Canadian deuterium-natural uranium reactor, breeder)

In addition, studies are inconsistent in their application of full lifecycle analyses, including plant construction, decommissioning, and resource extraction (uranium ore, fossil fuel). For instance, Storm van Leeuwen and Smith (2005) present comparisons of GHG emissions from nuclear versus natural gas that incorporate GHG emissions associated with nuclear plant construction and decommissioning in the values used for comparison.

In the case of the proposed IP2 and IP3 relicensing, the relicensing action will not involve additional GHG emissions associated with construction because the facility already exists. In addition, the proposed relicensing action will not involve additional GHG emissions associated with facility decommissioning, because that decommissioning must occur whether the facility is relicensed or not. In many of these studies, the contribution of GHG emissions from facility construction and decommissioning cannot be separated from the other lifecycle GHG emissions that would be associated with IP2 and IP3 relicensing. Therefore, these studies overestimate the GHG emissions attributed to the proposed IP2 and IP3 relicensing action.

In an early study on the subject, Dr. Nigel Mortimer conducted an analysis of the GHG emissions resulting from the nuclear fuel cycle in 1990 (Mortimer 1990). In this study, Mortimer stressed that the GHG implications of the nuclear fuel cycle were substantially related to the ore grade of uranium that must be mined to support nuclear power generation. Using ore grades that were current as of 1990, this study concluded that nuclear power offered a dramatic reduction in GHG emissions over conventional coal-fired power plants over an estimated 35-year lifecycle. The analysis estimated that a nuclear power plant would generate 230,000 tons (209,000 metric tons (MT)) of CO_2 over a 35-year life span, or about 3.9 percent of the 5,912,000 tons (5,363,000 MT) that an equivalent coal-fired plant would generate (Mortimer 1990). The study also projected that most of this 230,000 tons (209,000 MT) of CO_2 resulted from the use of a coal-fired plant to perform uranium enrichment by gaseous diffusion, and that using nuclear power and alternative enrichment methods in the future could reduce the amount to 21,000 tons (19,000 MT) (Mortimer 1990).

Mortimer's study went on to demonstrate that the GHG impact of the nuclear fuel cycle would increase as the grade of uranium ore mined dropped, and that the net emissions of CO_2 from the nuclear and coal-fired alternatives would become equal once uranium ore grades reached 0.01-percent uranium oxide. However, Mortimer does not address differences in energy consumption from future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements. Based on his cutoff ore grade and projections of ore reserves, Mortimer estimated GHG emissions of nuclear and natural gas generation would be similar after a period of 23 years (Mortimer 1990). The analysis also compared GHG emissions associated with the nuclear fuel cycle with other electricity generation and efficiency options, including hydroelectric, wind, tidal power, and new types of insulation and lighting (but not including natural gas). The conclusion was that nuclear power had lower GHG emissions compared to coal, but that GHG emissions associated with the nuclear fuel cycle still exceeded those for renewable generation and conservation options (Mortimer 1990).

The Mortimer (1990) study is not presented here to support a definitive conclusion regarding whether nuclear energy produces fewer GHG emissions than other alternatives and similar discussions will not be presented in this SEIS for each of the available studies. Instead, the NRC staff presents the Mortimer (1990) study to provide an example of the types of considerations underlying the calculations and arguments presented by the various authors. Almost every existing study has been critiqued, and its assumptions challenged, by later authors. Therefore, no single study has been selected to represent definitive results in this SEIS. Instead, the results from a variety of the studies are presented in Tables 6-2, 6-3, and 6-4 to provide a weight-of-evidence argument comparing the relative GHG emissions resulting from the proposed IP2 and IP3 relicensing compared to the potential alternative use of coal-fired plants, natural gas-fired plants, and renewable energy sources.

6.2.5 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Because coal is the fuel most commonly used to generate electricity in the United States, and the burning of coal results in the largest emissions of GHGs for any of the likely alternatives to nuclear power, most of the available quantitative studies have focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent coal-fired plant, are presented in Table 6-2.

Table 6-2. Nuclear GHG Emissions Compared to Coal

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade
Andseta et al. 1998	Nuclear energy produces 1.4 percent of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).

Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Coal—264 to 357 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Authors did not evaluate nuclear versus coal.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Coal—950 g C_{eq}/kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Coal—>1000 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq} /kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90 percent.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Coal—950 to 1250 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones 2007	Author did not evaluate nuclear versus coal.

6.2.6 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to an equivalent natural gas-fired plant, are presented in Table 6-3.

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

Source	GHG Emission Results
Mortimer 1990	Author did not evaluate nuclear versus natural gas.
Andseta 1998	Author did not evaluate nuclear versus natural gas.
Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Natural Gas—120 to 188 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Nuclear fuel cycle produces 20 to 33% of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.

Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Cogeneration Combined Cycle Natural Gas—150 g C_{eq}/kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Natural Gas—500 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90%.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Natural Gas—440 to 780 g C_{eq}/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones 2007	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15 to 27% of the GHG emissions of natural gas.

6.2.7 Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6-4. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because the efficiencies of the different energy sources vary so much by location. For instance, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved. Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources.

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

Source	GHG Emission Results
Mortimer 1990	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.

Andseta 1998	Author did not evaluate nuclear versus renewable energy sources.
Spadaro 2000	Nuclear—2.5 to 5.7 g C_{eq}/kWh Solar PV—27.3 to 76.4 g C_{eq}/kWh Hydroelectric—1.1 to 64.6 g C_{eq}/kWh Biomass—8.4 to 16.6 g C_{eq}/kWh Wind—2.5 to 13.1 g C_{eq}/kWh
Storm van Leeuwen and Smith 2005	Author did not evaluate nuclear versus renewable energy sources.
Fritsche 2006 (values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Solar PV—125 g C_{eq}/kWh Hydroelectric—50 g C_{eq}/kWh Wind—20 g C_{eq}/kWh
POST 2006 (Nuclear calculations from AEA 2006)	Nuclear—5 g C_{eq}/kWh Biomass—25 to 93 g C_{eq}/kWh Solar PV—35 to 58 g C_{eq}/kWh Wave/Tidal—25 to 50 g C_{eq}/kWh Hydroelectric—5 to 30 g C_{eq}/kWh Wind—4.64 to 5.25 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh.
Weisser 2006 (compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Solar PV—43 to 73 g C_{eq}/kWh Hydroelectric—1 to 34 g C_{eq}/kWh Biomass—35 to 99 g C_{eq}/kWh Wind—8 to 30 g C_{eq}/kWh
Fthenakis and Kim (2007)	Nuclear—16 to 55 g C_{eq}/kWh Solar PV—17 to 49 g C_{eq}/kWh
Dones 2007	Author did not evaluate nuclear versus renewable energy sources.

6.2.8 Conclusions

Estimating the GHG emissions associated with current nuclear energy sources is challenging because of differing assumptions and noncomparable analyses performed by the various authors. The differences and complexities in these assumptions and analyses increase when using them to project future GHG emissions. However, even with these differences, the NRC staff can draw several conclusions.

First, the studies indicate a consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation. Based on the literature review, the lifecycle GHG emissions from the complete nuclear fuel cycle currently range from 2.5 to 33 g C_{eq}/kWh. The comparable lifecycle GHG emissions from the current use of coal range from 264 to 1250 g C_{eq}/kWh, and GHG emissions from the current use of natural gas range from 120 to 780 g C_{eq}/kWh. The existing studies also provided estimates of GHG emissions from five renewable energy sources, based on current technology. These estimates included solar-photovoltaic (17 to 125 g C_{eq}/kWh), hydroelectric (1 to 64.6 g C_{eq}/kWh), biomass (8.4 to 99 g C_{eq}/kWh), wind (2.5 to 30 g C_{eq}/kWh), and tidal (25 to 50 g C_{eq}/kWh). The range of these estimates is very wide, but the general conclusion is that the current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as those for these renewable energy sources.

Second, the studies indicate no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors regarding the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists regarding future GHG emissions associated with coal and natural gas electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources, and are expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur at all.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed IP2 and IP3 relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The NRC staff bases this conclusion on the following rationale:

(1) The current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.

(2) IP2 and IP3 license renewal will involve continued uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not).

(3) Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the IP2 and IP3 periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher grade resource discovery, and technology improvements could extend this timeframe.

With respect to comparison of GHG emissions between the proposed IP2 and IP3 license renewal action and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, and constructing facilities in both areas. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same range. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power, and because most renewable energy sources lack a fuel component, it is likely that GHG emissions from renewable energy sources would be lower than those associated with IP2 and IP3 at some point during the period of extended operation.

6.3 References

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

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

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

10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy,* Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste."

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7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in NUREG-0586, Supplement 1, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors" (NRC 2002). The U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, identifies a range of impacts for each environmental issue.

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are discussed in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[(1)] The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria for Category 1; therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

7.1 Decommissioning

Category 1 issues in Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51) that are applicable to IP2 and IP3 decommissioning following the renewal term are listed in Table 7-1. Entergy Nuclear Operations, Inc. (Entergy), stated in the IP2 and IP3 environmental report (ER) (Entergy 2007) that it is not aware of any new and significant information regarding the environmental impacts of IP2 and IP3 license renewal, though it did identify leaks from spent fuel pools as a potential new issue. The NRC staff

(1) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

addressed this issue in Sections 2.2.7, 4.3, and 4.5 of this supplemental environmental impact statement (SEIS). In Section 4.5, the NRC staff concludes that the abnormal liquid releases (leaks) discussed by Entergy in its ER, while new information, are within the NRC's radiation safety standards contained in 10 CFR Part 20 and are not considered to have a significant impact on plant workers, the public, or the environment (i.e., while the information related to spent fuel pool leakage is new, it is not significant).

The NRC staff has not identified any information during its independent review of the IP2 and IP3 ER (Entergy 2007), the site visit, the scoping process, or its evaluation of other available information that is both new and significant. Therefore, the NRC staff concludes that there are no impacts related to the Category 1 issues applicable to the decommissioning of IP2 and IP3 beyond those discussed in the GEIS. For all of these issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 7-1. Category 1 Issues Applicable to the Decommissioning of IP2 and IP3 Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation doses	7.3.1
Waste management	7.3.2
Air quality	7.3.3
Water quality	7.3.4
Ecological resources	7.3.5
Socioeconomic impacts	7.3.7

A brief description of the NRC staff's review and the GEIS conclusions, as codified in Table B-1, 10 CFR Part 51, for each of the issues follows:

- Radiation doses. Based on information in the GEIS, the Commission found the following:

  Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no radiation dose impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Waste management. Based on information in the GEIS, the Commission found the following:

  Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts from solid waste associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Air quality. Based on information in the GEIS, the Commission found the following

  Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on air quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Water quality. Based on information in the GEIS, the Commission found the following:

  The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on water quality associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Ecological resources. Based on information in the GEIS, the Commission found the following:

  Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts on ecological resources associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

- Socioeconomic Impacts. Based on information in the GEIS, the Commission found the following:

> Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.

The NRC staff has not identified any new and significant information during its independent review of the IP2 and IP3 ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no socioeconomic impacts associated with decommissioning following the license renewal term beyond those discussed in the GEIS.

7.2 References

10 CFR Part 20. Code of Federal Regulations, Title 10, *Energy*, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

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8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES TO LICENSE RENEWAL

This chapter examines the potential environmental impacts associated with (1) a closed-cycle cooling system alternative to replace the Indian Point Nuclear Generating Unit No. 2 (IP2) and Unit No. 3 (IP3) existing once-through cooling-water systems, (2) denying the renewal of both operating licenses for IP2 and IP3 (i.e., the no-action alternative), (3) replacing the electric generation capacity of both units with alternative electric-generation sources or energy conservation, (4) importing electric power from other sources to replace power generated by IP2 and IP3, and (5) combinations of generation and conservation measures to replace power generated by IP2 and/or IP3. In addition, this chapter briefly discusses other alternatives that were deemed unsuitable to replace power generated collectively by IP2 and IP3.

As NRC staff indicated in its 1996 statements of consideration in promulgating the final license renewal environmental rules (61 FR 28467; June 5, 1996), NRC staff evaluates alternative energy sources as direct alternatives to license renewal, and not simply as consequences of the no-action alternative. Many comments received by the staff after the publication of the draft SEIS appear to conflate energy alternatives with the no-action alternative. Whether NRC renews a license or not, all alternatives to license renewal are available to energy planning decision makers. Continued operation, however, is only an available option if NRC grants renewed licenses. NRC evaluates, in this chapter, likely environmental impacts from alternatives in order to provide a comparison that allows NRC to determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable (NRC's "decision standard" from 10 CFR 51.95(c)(4)).

This chapter contains a number of updated or revised discussions in response to comments on the draft SEIS. First, NRC staff no longer considers a restoration-based alternative for complying with New York State Department of Environmental Conservation (NYSDEC) determinations on aquatic impacts from IP2 and IP3. As indicated in several comments NRC staff received on the draft SEIS, the U.S. Second Circuit Court of Appeals has held that habitat restoration is an impermissible means of complying with 316(b) (in *Riverkeeper I* and *Riverkeeper II*). Because the restoration alternative relied on habitat restoration to meet 316(b) goals, and would not be capable of meeting 316(b) goals in the absence of the restoration portion, the NRC staff has removed the restoration alternative from this SEIS.

The NRC staff has also removed the coal-fired alternative from the range of alternatives considered in depth (though staff has retained the discussion from the draft SEIS in Section 8.3.4, Alternatives Dismissed from Individual Consideration, based partly on comments regarding greenhouse gas and permitting restrictions in New York State, as well as on indications from the U.S. Department of Energy that coal use in New York State power generation is markedly declining. The Staff has also updated its combination alternatives, recognized that a gas-fired facility could also be a repowering project at an existing power plant, and upgraded its consideration of energy conservation to a full alternative given projections from New York State's energy efficiency (here used interchangeably with energy conservation) programs.

As in the draft SEIS, the NRC staff considered an alternative to the existing IP2 and IP3 cooling-water systems because the New York State Department of Environmental Conservation

(NYSDEC) identified closed-cycle cooling (e.g., cooling towers) as the best technology available (BTA) to reduce fish mortality in the draft New York State Pollutant Discharge Elimination System (SPDES) discharge permit (NYSDEC 2003a). This alternative is described in Section 8.1 of this SEIS. IP2 and IP3 have been operating under timely renewal provisions of the New York SPDES permit process since 1992. In 2004, NYSDEC issued a revised draft SPDES permit, including the BTA determination. The requirements, limits, and conditions of the draft SPDES permit had not been finalized at the time the NRC staff performed the assessment presented in this SEIS, and are subject to ongoing adjudication.

The environmental impacts of alternatives are evaluated using the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—developed based on the Council on Environmental Quality (CEQ) guidelines and set forth in the footnotes to Table B-1 of Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51). The following definitions are used for each category:

> SMALL—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

> MODERATE—Environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource.

> LARGE—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999)[(1)] with the additional impact categories of environmental justice and transportation.

8.1 Alternatives to the Existing IP2 and IP3 Cooling-Water System

IP2 and IP3 currently use once-through cooling-water systems that withdraw water from and discharge water to the Hudson River as described in Section 2.1.3 of this SEIS. The circulating water systems for IP2 and IP3 include two intake structures, each containing seven pumps. The maximum flow rate for the facility is 6,553,000 lpm (1,731,000 gpm) IP2 uses dual-speed pumps and IP3 uses variable-speed pumps.

Warm discharge water from IP2 and IP3 flows from the condensers through six pipes that are 2.4 meters (m) (94 inches (in.)) in diameter and exits beneath the water surface into a discharge canal 12 m (39 feet (ft)) wide. Water flows from the discharge canal to the Hudson River through an outfall structure located south of IP3 at a discharge velocity of about 3.7 meters per second (mps) (12 feet per second (fps)). The design of the outfall is intended to reduce the thermal impact the warm water may potentially have on the river. An assessment of the impacts

(1) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addendum 1.

of the current cooling-water system on the environment is presented in Section 4.1 of this SEIS.

Surface water withdrawals and discharges at IP2 and IP3 are regulated under the New York SPDES permit program. In 1975, the U.S. Environmental Protection Agency (EPA) issued National Pollutant Discharge Elimination System (NPDES) permits for the facility. Subsequently, the NYSDEC issued an SPDES permit for the facility in 1987. In 1992, a timely renewal application was filed with the NYSDEC, and terms of the 1992 SPDES have been continued under provisions of the NY State Administrative Procedure Act. Petitioners commenced proceedings in 2002 to mandate that the NYSDEC act on the SPDES permit renewal application. On April 8, 2003, the NYSDEC proposed to modify the SPDES permit to require that IP2 and IP3 reduce the impacts to aquatic organisms caused by the once-through cooling systems and that Entergy Nuclear Operations, Inc. (Entergy), complete a water quality review. NYSDEC published a draft SPDES permit in 2003 (NYSDEC 2003), and then issued a revised draft SPDES permit on March 2, 2004 (NYSDEC 2010a). The 2003 draft and 2004 revised draft identified closed-cycle cooling as the BTA. NYSDEC affirmed this perspective in its April 2, 2010, Notice of Denial of Entergy's Clean Water Act Section 401 Water Quality Certification (NYSDEC 2010b), indicating that closed cycle cooling would minimize aquatic impacts (the denial itself is currently subject to further state-level adjudication). Also, NYSDEC has published a draft policy on BTA (NYSDEC 2010c) indicating that "Wet closed-cycle cooling or its equivalent" is the "minimum performance goal for existing industrial facilities that operate a CWIS [cooling water intake system] in connection with a point source thermal discharge. . ." The policy is in draft form and NYSDEC received public comments through July 9, 2010.

The revised draft SPDES permit requires that immediate and long-term steps be taken to reduce the adverse impacts on the Hudson River estuary once the permit is issued (NYSDEC 2004). The short-term steps include mandatory outage periods, reduced intake during certain times, continued operation of fish-impingement mitigation measures, the payment of $24 million to a Hudson River Estuary Restoration Fund, and various studies. In the long term, IP2 and IP3 will have to implement the BTA to minimize environmental impacts to the aquatic ecology. Should the BTA determination in the revised draft SPDES permit go into effect, final implementation of the BTA is subject to NRC's approval only insofar as the NRC oversees the plant's safety performance and ability to cool itself.).

Specifically, the revised draft SPDES permit states the following:

> Within six months of the effective date of this permit, the permitee must submit to the NYSDEC…its schedule for seeking and obtaining, during its permit term, all necessary approvals from the NRC, Federal Energy Regulatory Commission (FERC), and other government agencies to enable construction and operation of closed-cycle cooling at Indian Point.

NYSDEC (2004) has also indicated that any alternative technology or technologies may be proposed for IP2 and IP3 within 1 year of the permit's effective date. These technologies must be able to minimize the adverse environmental impacts to a level equivalent to that achieved by a closed-cycle cooling system at IP2 and IP3 (NYSDEC 2004).

The NYSDEC identified construction and operation of a closed-cycle cooling system at IP2 and IP3 as its preferred alternative to meet current national performance standards for impingement and entrainment losses. Entergy indicates that Entergy or its predecessors have proposed and

NYSDEC has rejected the following alternative cooling technologies as described in the IP2 and IP3 ER (Entergy 2007). As a result, these options are not discussed further in this SEIS.

- Evaporative ponds, spray ponds, or cooling canals all require significantly more land area than exists at the site.
- Dry cooling towers, which rely totally on sensible heat transfer, lack the efficiency of wet or hybrid towers using evaporative cooling, and thus require a far greater surface area than is available at the site. Additionally, because of their lower efficiency, dry towers are not capable of supporting condenser temperatures necessary to be compatible with IP2 or IP3 turbine design and, therefore, are not a feasible technology.
- Natural draft cooling towers, while potentially feasible, would be 137 to 152 m (450 to 500 ft) above ground level with significant adverse aesthetic impacts in an important viewshed corridor. This option also would raise water vapor plume-related and sound effects concerns. In the original EPA permitting proceeding, New York State opposed natural draft cooling towers on aesthetic grounds.
- Single-stage mechanical-draft wet cooling towers were eliminated for a number of reasons including, but not limited to, the dense water vapor plumes that may compromise station operations (including visual signaling) and equipment over time, and result in increased noise (Enercon 2003).

The EPA has concluded that, in some circumstances, retrofitting a plant to a closed-cycle cooling system lacks demonstrated feasibility or economic practicality (EPA 2004). In addition, Entergy asserts that retrofitting facilities the size and configuration of IP2 and IP3 with a closed-cycle cooling system is neither tried nor proven (Entergy 2007). Entergy also considers mitigation measures currently implemented to protect aquatic wildlife as part of the once-through cooling system to be adequate in terms of minimizing impacts from current operations and operations during the license renewal period (Entergy 2007).

Entergy expressed a number of concerns regarding financial or technical issues related to a closed-cycle cooling retrofit (Entergy 2007), including high cost, a lengthy forced outage, and lost power output due to parasitic losses from new cooling system components

Entergy notes that replacement power during the outage may carry negative air quality impacts, and that the outage may have negative impacts on electric-system reliability and market pricing.

Finally, Entergy indicates that closed-cycle cooling would result in a loss of generating capacity due to lowered thermal efficiency and parasitic loads related to cooling system pumps and auxiliary systems (an average annual loss of 88 megawatts electric [MW(e)], per unit) because of power demands of the closed-cycle system (Entergy 2010).

In the following chapter, the NRC staff will evaluate the environmental impacts associated with installing a closed-cycle cooling system at Indian Point, as well as the environmental impacts associated with a potentially-equivalent combination of plant modifications and restoration activities. Regardless of the NRC staff's findings, the NRC does not have the regulatory authority to implement the requirements of the Clean Water Act (CWA), and it is not up to the NRC staff to judge the validity of Entergy's or others' claims in the ongoing NYSDEC SPDES permit process.

In 2004, EPA issued regulations for reducing impingement and entrainment losses at existing electricity-generating facilities (EPA 2004). These regulations, known as the Phase II rule, established standards for compliance with the requirements of Section 316(b) of the CWA, which calls for intake structures to reflect the BTA for minimizing adverse environmental impact. The EPA's Phase II rule established two compliance alternatives that reduce impingement mortality by 80 to 95 percent of baseline and reduce organism entrainment by 60 to 90 percent of baseline (EPA 2004). These regulations supported the requirements of the draft New York SPDES permit's requirement that immediate and long-term steps be taken to minimize adverse impacts on the Hudson River estuary.

The EPA's rules concerning Phase II of Section 316(b) of the CWA were struck down by the U.S. Court of Appeals in the Second Circuit in January 2007. The Court also mandated the conduct of a cost-benefit analysis under Section 316(b) of the CWA. Specifically, the EPA suspended 40 CFR 122.2(r)(1)(ii) and (5) and Subpart J, "Requirements Applicable to Cooling Water Intake Structures for Phase II Existing Facilities Under Section 316(b) of the Act," of 40 CFR Part 125, "Criteria and Standards for the National Pollutant Discharge Elimination System," with the exception of 40 CFR 125.90(b) (EPA 2007). On April 1, 2009, the Supreme Court ruled that EPA may permissibly use cost-benefit analyses in its Phase II rule, though EPA has yet to reinstate or reissue the rule. Nonetheless, the 1987 SPDES permit remains in effect, pending the conclusion of State-level administrative and legal proceedings.

8.1.1 Closed-Cycle Cooling Alternative

Entergy's preferred close-cycle alternative consists of two hybrid mechanical-draft cooling towers (Enercon 2003, Entergy 2007). IP2 and IP3 would utilize one cooling tower, each, for a total of two towers onsite. Entergy rejected single-stage mechanical draft cooling towers, indicating that the dense water vapor plumes from the towers may compromise station operations (including visual signaling) and equipment over time, and single-stage towers may result in increased noise (Enercon 2003).

Entergy asserts that a hybrid mechanical-draft cooling tower system, also referred to as a "wet/dry" or "plume-abated" mechanical-draft cooling tower, addresses some of the shortcomings of the cooling system types described in Section 8.1 (Entergy 2007). In the ER, Entergy indicates that hybrid towers are "appreciably more expensive" than single-stage towers (Entergy 2007).

A hybrid tower consists of a standard efficiency wet tower segment combined with a dry heat exchanger section above it. The dry section eliminates visible plumes in the majority of atmospheric conditions. After the plume leaves the lower "wet" section of the tower, it travels upward through a "dry" section where heated, relatively dry air is mixed with the plume in the proportions required to achieve a nonvisible plume. Because of the "dry" section, which is on top of the "wet" section, hybrid towers are slightly taller than comparable wet towers and require a larger footprint (Entergy 2007). A potential exists for increased noise from additional fans in the dry section, although Entergy indicates that sound effects can be attenuated (Entergy 2007).

Portions of the site where Entergy could construct cooling towers are heavily forested, with rocky terrain and some steep slopes. Entergy indicates that these areas can be more environmentally sensitive and costly to build on.

The NRC staff has previously assessed closed cycle cooling with a hybrid cooling tower in the license renewal SEIS for Oyster Creek Nuclear Generating Station (OCNGS) (NRC 2006). The NRC staff finds that a hybrid cooling tower system is a reasonable design for the purpose of evaluating potential environmental impacts in a NEPA document. However, the NRC staff does not intend for this analysis to prejudice potential requirements imposed by NYSDEC or other authorities.

8.1.1.1 Description of the Closed-Cycle Cooling Alternative

As described in the Entergy's "Engineering Feasibility and Costs of Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration" (Enercon 2010, prepared for Entergy), new hybrid cooling towers would be large, approximately 160 m (525 ft) in diameter and 50 m (165 ft) high. To provide construction access for tower erection and clearance for air intake, the excavation diameter for each tower would be approximately 215 m (700 ft) (Enercon 2010). The locations for the IP2 and IP3 towers are expected to be approximately 305 m (1000 ft) north of the IP2 reactor and approximately 305 m (1000 ft) south of the IP3 reactor, respectively (Entergy 2007). A detailed description of a round hybrid cooling tower conceptual design is presented in the 2010 engineering feasibility and cost evaluation (Enercon 2010). Crews excavating areas for the cooling tower basins and associated piping will need to blast substantial amounts of rock during the construction process.

As noted in Section 8.1, the closed-cycle cooling alternative would introduce parasitic losses from additional pumps and other equipment. The new circulating pumps would likely be housed in a new pumphouse located along the discharge canal (Enercon 2010). The new, enclosed pumphouse would supply circulating water to the new towers via two concrete-lined steel pipes 3 m (10 ft) in diameter. Flow from the cooling tower basin to the condenser is expected via two pipes 3.7 m (12 ft) in diameter (Enercon 2010).

Enercon also reported that two dedicated substations would likely supply electricity to the closed-cycle cooling system from the 138-kilovolt (kV) offsite switchyard. The substation transformers, switch gear, and system controls for each tower and pumphouse would be housed in prefabricated metal buildings (Enercon 2003).

8.1.1.2 Environmental Impacts of the Closed-Cycle Cooling Alternative

In this section, the NRC staff addresses the impacts that would occur if Entergy constructs and operates the closed-cycle cooling system described in Section 8.1.1.1. The NRC staff summarizes anticipated impacts of the closed-cycle cooling alternative in Table 8-1. In the areas of land use, terrestrial ecology, terrestrial threatened and endangered species, waste, transportation and aesthetics, the environmental impacts of constructing and operating this closed-cycle cooling system would be greater than the impacts associated with the existing once-through cooling system, primarily due to construction-stage impacts. The closed-cycle cooling alternative significantly reduces impacts to aquatic ecology, including impacts from entrainment, impingement, and heat shock. Impacts to aquatic threatened and endangered species – already SMALL – are also likely to further decline. In the following sections, the NRC staff presents the potential environmental impacts of installing and operating a closed-cycle cooling alternative at Indian Point. The NRC staff addresses impacts for each resource area.

- **Land Use**

Construction of two hybrid mechanical-draft cooling towers would entail significant clearing and excavation of the currently timbered areas within the IP2 and IP3 exclusion area. Each cooling tower requires an excavated area of approximately 3.6 hectares (ha) (9 acres (ac)). Ultimately, approximately 16 ha (40 ac), most of which is presently wooded (though previously disturbed; ENN 2007), would need to be cleared for the two cooling towers, access roads, and support facilities (Enercon 2003). The towers would be located within the property exclusion area boundary adjacent to existing facilities as described in Section 8.1.1.1.

Unlike the IP2 tower, the proposed IP3 cooling tower would be located in the permanent right-of-way (ROW) easement granted to the Algonquin Gas Transmission Company (AGTC) for constructing, maintaining, and operating the two natural gas pipelines that traverse the IP2 and IP3 site (Entergy 2007, ENN 2010, Enercon 2010). These pipelines transport natural gas under the Hudson River, across the IP2 and IP3 site, and exit the site between Bleakley Avenue and the Buchanan substation (see Figure 2-3 in Chapter 2 of this SEIS for a graphical representation).

Entergy indicates that roughly 305 m (1000 ft) of river bank would be clear-cut and excavated to allow for the installation of the four large-diameter water pipes (two 3-m-diameter supply pipes and two 3.7-m-diameter pipes to each condenser) required for each tower (Entergy 2007). In addition, Enercon reports that the base of each tower would be constructed on bedrock at an elevation of about 9.1 m (30 ft) above mean sea level. This would entail the removal of approximately 2 million cubic yards (cy) (1.5 million cubic meters (m^3)) of material, primarily rock and dirt, using traditional excavation methods as well as a significant amount of blasting (Enercon 2010). This volume of material includes material excavated to allow rerouting of the Algonquin pipeline. Disposal of 2 million cy (1.5 million m^3) of material from the excavations for the cooling towers would create some offsite land use impacts. Excavated material also may be recycled or reused, which would reduce these impacts.

Entergy indicates that ROW easement agreement calls for AGTC to relocate the pipelines at Entergy's request. The FERC would first have to review and approve any such action. Entergy must also provide a suitable location for the pipeline on its land or land that it has acquired (Entergy 2007). Entergy indicates that pipeline relocation may require blasting and could also require Entergy to purchase additional land adjacent to the IP2 and IP3 site if onsite areas aren't suitable for the pipeline (Entergy 2007). Entergy's 2010 feasibility and cost evaluation indicates that relocation would be feasible, through additional regulatory approvals (Enercon 2010).

The IP2 and IP3 site is within New York's Coastal Zone. As indicated in Chapter 2, the IP2 and IP3 site is located adjacent to a Significant Coastal Fish and Wildlife Habitat, as well as a Scenic Area of Statewide Significance. Construction activities, such as grading, excavating, and filling, would require a coastal erosion management permit. Permitting restrictions would influence the construction of the cooling towers but they would not likely prevent Entergy from building the towers.

Excavation for the cooling towers would cut into the side of the hills east of IP2 and IP3, resulting in the removal of approximately 2 million cy (1.5 million m^3) of material, including mostly rock as well as dirt (Enercon 2010). In areas where the excavation intersects onsite plumes of groundwater contaminated with tritium, strontium-90, and other radionuclides, Entergy expects that excavated material will also be contaminated. The 2010 feasibility and cost evaluation indicates that at least 6350 cy may be contaminated (Enercon 2010). Any contaminated material would require appropriate disposal as radioactive waste. Currently, the only available disposal site for low-level radioactive wastes is in Clive, Utah.

Entergy's 2010 feasibility and cost study indicated that clean spoils from blasting could be marketed as commodity crushed stone for construction projects, used as mine fill. Entergy could also dispose of spoils in artificial reef projects off the New Jersey and New York coasts, though their analysis indicates that additional permitting requirements may result (Enercon 2010). The NRC staff concludes that construction activities associated with cooling tower installation at IP2 and IP3 would likely result in SMALL to LARGE land use impacts, depending largely on how much material Entergy is able to reuse or recycle, and where Entergy disposes of excavated material that cannot be reused or recycled.

- **Ecology**

Aquatic ecology. Land-clearing and construction activities can cause short-term, localized impacts on streams and rivers from increased site runoff. These impacts are generally mitigated through the use of erosion and sediment controls. Because of the size of the construction area needed for the cooling towers at the IP2 and IP3 site, such measures would be necessary to limit erosion and sediment deposition in the Hudson River. Construction impacts, however, would be relatively short-lived, and would be offset to some degree by reduced water consumption during prolonged outages at IP2 and IP3 when Entergy or its contractors would connect the closed-cycle cooling system to the units.

Following construction, the closed-cycle cooling alternative will significantly reduce operational impacts on streams and rivers compared to the current once-through cooling system. During the summer months, when water use is at its highest, service and cooling tower makeup water would be withdrawn at a rate of approximately 314,000 lpm (83,000 gpm) for the combined needs of IP2 and IP3. This would be a 95.2-percent reduction in water use compared to the existing IP2 and IP3 once-through systems, which have a maximum flow rate of 6,553,000 lpm (1,731,000 gpm). Without modifications to the intake screening technologies, the NRC staff assumes that the reduction in water intake results in an equivalent reduction in entrainment and impingement. Entergy's feasibility and cost evaluation indicates that 4 of the existing 6 circulating water intake bays would be used at each unit, and the existing service water intake bays would also remain in service (Enercon 2010). The staff concludes that this significant reduction in water demand would likely result in a similarly significant reduction in entrainment- and impingement-related losses compared to the losses created by the current once-through cooling system.

New circulating-water intake pumps would likely continue to utilize the Ristroph traveling screens and fish-return system currently in operation (Entergy 2007). The greatest impact of the closed-cycle system would be a reduction in entrainment and impingement of aquatic species. As described in Section 4.1.3.3 of this SEIS, the NRC staff has concluded that the once-through cooling system has a MODERATE impact from impingement and entrainment. The reduction in flow may also reduce impingement or entrainment of the endangered shortnose sturgeon (*Acipenser brevirostrum)* and macroinvertebrates, such as small clams and mussels (bivalves), snails, worms, crustaceans, and aquatic insects. In Section 4.6.1, the NRC staff had indicated that the impacts to the shortnose sturgeon are already SMALL, though additional reductions in effects may occur as a result of reduced flow.

Under a closed-cycle cooling system, most discharged blowdown water is unheated. Because the closed-cycle cooling system discharges a smaller volume of water, and because the water is cooler than in a once-through system, the extent of thermal impacts - which could range from SMALL to LARGE for the current once-through system, given uncertainty in the facility's thermal impacts – would be reduced. Thus, the effects of thermal shock also decline. However, the discharge water may be higher in salinity and may contain higher concentrations of biocides, minerals, trace metals, or other chemicals or constituents. To maintain compliance with discharge permits, the water may need to be treated.

Overall, operation of the closed-cycle cooling alternative would produce substantially fewer impacts to the aquatic environment relative to those caused by the existing once-through system. The NRC staff concludes that the aquatic ecological impacts (including those to threatened and endangered species) from the construction and operation of the hybrid mechanical-draft closed-cycle cooling alternative for IP2 and IP3 would be SMALL.

Terrestrial ecology. Construction of the closed-cycle cooling alternative would entail clear-cutting of onsite trees and excavation of areas for the two cooling towers as described in the Land Use section. These activities would destroy fragments of onsite eastern hardwood forest habitat (NYSDEC 2007; NYSDEC 2008a; Enercon 2010). Effects of removing these habitats could include localized reductions in productivity or relocations of some species.

Operation of the cooling towers also could have adverse localized impacts on terrestrial ecology. The cooling towers would be 50 m (165 ft) tall and may produce a visible plume as well as minimal ground fog under certain conditions, though hybrid towers of a round configuration minimize these conditions to the maximum extent possible (Enercon 2010). The potential physical impacts from a cooling tower plume include icing and fogging of surrounding vegetation during winter conditions. Icing can damage trees and other vegetation near the cooling towers. The salt content of the entrained moisture (drift) also has the potential to damage vegetation, depending on concentrations (Enercon 2010), though this is reduced by the higher release height and minimized entrainment inherent in the round, hybrid design. Entergy's feasibility and cost evaluation indicate deposition rates for both towers in the area of highest exposure (between the two towers – an area that includes parking lots, Unit 1, and site infrastructure) is 70 percent of the natural ambient salt deposition rate (Enercon 2010). The hybrid cooling towers evaluated in this section have a drift rate of 0.001 percent (Enercon 2010). This amounts to 26 lpm (7 gpm (0.00001 x 70,000 gpm of water)) drift for both towers. The amount and effects of drift would vary depending on a number of factors, including the concentration of salt in the droplets, the size of the droplets, the number of droplets per unit of surface area, the species of plant affected, and the frequency of local precipitation.

Actual measurements of drift deposition have been collected at only a few nuclear plants. These measurements indicate that, beyond about 1.5 kilometer (km) (about 1 mile (mi)) from nuclear plant cooling towers, salt deposition is generally near natural levels (NRC 1996). The NRC staff reported in the GEIS that the salt-drift rate estimated to cause acute injury to the eastern/Canadian hemlock (a particularly sensitive species) is in excess of 940 kilograms (kg) per square kilometer (km^2) (8.4 pounds per acre) per week (NRC 1996), well above the anticipated deposition rates from the IP2 and IP3 cooling towers. Natural deposition is 160 kg per km^2, while the maximum deposition from both towers is 112 kg per km^2 (Enercon 2010).

The NRC staff does not expect bird collisions with cooling towers to be a significant issue. The NRC staff found in the GEIS that impacts from collisions would be SMALL at all plants with existing cooling towers (NRC 1996).

Section 4.6.2 of this SEIS discusses the effects of license renewal on threatened or endangered terrestrial species. The section identifies the endangered Indiana bat (*Myotis sodalis*), the threatened bog turtle (*Clemmys muhlenbergii*), and the New England cottontail (*Sylvilagus transitionalis*), a candidate species, as being potentially affected. However, because of both the site-specific environment and the lack of evidence of the species existing at the facility, potential impacts to these threatened or endangered species are considered SMALL. Nonetheless, should NYSDEC decide that cooling towers must be installed at the site, then appropriate consultation with Fish and Wildlife Service would need to take place regarding the potential for impacts to these species. Entergy noted in its comments (included in Appendix A of this SEIS) that constructing cooling towers may have an effect on the Indiana Bat or its habitat.

While the effects of this alternative—including onsite land clearing and introduction of cooling tower drift—are greater than the effects of the continued operation of the once-through cooling system and are likely to be noticeable, they are not so great that they will have a destabilizing effect on terrestrial resources in the vicinity of IP2 and IP3. The NRC staff concludes that the overall effect on terrestrial ecology would be SMALL to MODERATE.

- **Water Use and Quality**

During construction of the alternative closed-cycle cooling systems at IP2 and IP3, changes in water usage would likely be negligible. Increases may be seen in potable water demand for construction workers and, if concrete is mixed on site, there would be additional demands. However, these water needs would be short lived and would be at least partially offset by a reduction in water use while IP2 and IP3 are in outages to install the closed-cycle cooling system. For the term of construction, the additional water demands would need to be met by the Village of Buchanan, which supplies water to the site. The Village of Buchanan purchases public drinking water from surface water supplies.

The NYSDEC requires a construction general permit for storm water discharges from a project such as construction of the hybrid cooling towers. In addition, the NYSDEC will require a stormwater pollution prevention plan describing the use of silt fencing and other erosion-control management practices that will be used to minimize impacts on surface water quality. The construction project could also affect ground water as a result of dewatering excavations.

Circulating water makeup (30,000 to 61,000 lpm (7800 to 16,000 gpm) for the cooling towers (Enercon 2010) will have a negligible impact on water flow past the site. The estimated flow 150 m (500 ft) off the shoreline is about 34 million lpm (9 million gpm) in a 150-to-180-m (500-to-600-ft)-wide section (Entergy 2007). Therefore, the evaporation loss would be approximately 0.1 percent of the river flow. Further, the estuarine Hudson River is at sea level, and thus the river's water level would not be affected by the cooling towers' consumptive water use.

To compensate for evaporative and discharge losses, makeup water from the Hudson River would be treated to remove silt, suspended solids, biological material, and debris. Makeup water may also need lime softening, a water treatment process that produces a waste sludge that requires disposal. Biocides, such as hypochlorite, are often added to cooling water to diminish the affects of the biofouling organisms (Entergy 2007). Other chemicals, such as acids, dispersants, scale inhibitors, foam suppressants, and dechlorinators may also be needed for water treatment (NRC 1979).

To manage the chemicals and elevated concentrations of dissolved solids in the discharge water, treatment would likely be necessary in accordance with the IP2 and IP3 site SPDES permit. The use of biocides or any other chemicals would likely require discharge treatment and additional monitoring.

The IP2 and IP3 site does not utilize ground water for cooling operations, service water, or potable water. As such, the continued operation of the site is not expected to affect local ground water supplies (EPA 2008a). Localized dewatering of ground water from excavations will likely be necessary during construction operations, but because this ground water is not used by Entergy or entities off site, and because the ground water discharges to the Hudson River after exiting the IP2 and IP3 site, construction is not likely to affect either ground water quality or ground water use. Any radiologically contaminated groundwater that construction crews encounter on site would need to be treated to meet release criteria before being discharged. As a result of onsite contamination, crews will need to monitor for radionuclides in liquid discharges and in excavations.

Proper controls of runoff and treatment of other site discharges, as well as appropriate treatment of any contaminated groundwater, will not result in significant impacts on the surface water (Hudson River) and evaporation losses are very small. Also, ground water impacts from construction and operation of the cooling towers are expected to be minor. Therefore, the NRC staff concludes that overall impacts to water resources and water quality from the closed-cycle cooling alternative would be SMALL.

- **Air Quality**

The IP2 and IP3 site is located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13, "New Jersey-New York-Connecticut Interstate Air Quality Control Region"). The air quality nonattainment issues associated with the portions of these States located within a 50-mi radius are related to ozone (8-hour standard) and particulate matter less than 2.5 microns (μm) in diameter ($PM_{2.5}$). The entire States of New Jersey and Connecticut are designated nonattainment areas for ozone (8-hour standard). Several counties in Central and Southeastern New York within a 50-mi radius are also in nonattainment status for the 8-hour ozone standard (EPA 2008b). Air quality would be affected by three different factors: replacement power during construction-related outages, construction activities and vehicles (including worker transportation), and cooling tower operations.

Entergy contractors indicate that prolonged outages of IP2 and IP3, such as would be required to install cooling towers (TRC Environmental Corp [TRC] 2002) would require replacement power from existing generating facilities within the New York City metropolitan area. They assert that replacement of IP2 and IP3 energy output during cooling tower installation would result in substantial increases in regulated air pollutants. To the extent that coal- and natural-gas-fired facilities replace IP2 and IP3 output, the NRC staff finds that some air quality effects would occur. The NRC staff finds that these effects would largely cease when IP2 and IP3 return to service, with the exception of any output lost to lower efficiency and new parasitic loads from the closed-cycle cooling system (an average of approximately 88 MW, with peak losses of 157.6 MW). Additional air quality impacts could result from power that replaces these parasitic and efficiency losses.

Air quality at or near IP2 and IP3 during the construction of the IP2 and IP3 cooling towers would be affected mostly by exhaust emissions from internal combustion engines. These emissions would include carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur oxides (SO_x), carbon dioxide (CO_2), and particulate matter 10 μm or less in diameter (PM_{10}) from operation of gasoline- and diesel-powered heavy-duty construction equipment, delivery vehicles, and workers' personal vehicles (these vehicles would also produce or contribute to production of $PM_{2.5}$). The amount of pollutants emitted from construction vehicles and equipment and construction worker traffic would likely be small compared with total vehicular emissions in the region.

As noted in Section 3.3 of the GEIS, a conformity analysis is required for each pollutant when the total direct and indirect emissions caused by a proposed Federal action would exceed established threshold emission levels in a nonattainment area. In the GEIS, the NRC determined that a major refurbishment activity may increase the facility workforce by up to 2300 construction, refurbishment, and refueling personnel during a significant refurbishment outage period. The construction of two new cooling towers at IP2 and IP3 could approximate such conditions; however, Entergy estimates that the construction activities would require an average workforce of 300 additional workers with a maximum of about 600 workers (Enercon 2003). Because IP2 and IP3 are in a nonattainment area for ozone, and emissions from vehicles of the additional workforce may exceed the ozone air quality thresholds, a conformity analysis would be required before construction.

Fugitive dust, a contributor to PM_{10}, would be generated from site clearing and construction traffic, blasting, and excavation. Given the size of the disturbed area that would be involved (about 16 ha (40 ac)), and assuming that dust management practices would be applied (e.g., watering, silt fences, covering soil piles, revegetation), the fugitive dust impacts generated during construction should be minor. Furthermore, the amount of road dust generated by the vehicles traveling to and from the site transporting workers or hauling rock and dirt would contribute to PM_{10} concentrations. Construction stage impacts, though significant, would be relatively short lived.

Operation stage impacts could be more significant. As previously discussed, the cooling towers would emit tower drift consisting of water, salt, and suspended solids. These emissions would be considered PM_{10}, and some portion may include $PM_{2.5}$. Because IP2 and IP3 are located in a nonattainment area for $PM_{2.5}$, a conformity analysis for the cooling towers would be necessary and may result in additional restrictions on emissions, additional compensatory measures, or further control of drift from the towers. Entergy's feasibility and cost study indicates that particulate emissions would be so great that it may not be possible to obtain construction and air permits (Enercon 2010).

Should operational air quality impacts cause air quality to worsen and thus further exceed limits, the effect would be MODERATE or greater, though some level of emissions trading would limit this impact. During construction, air quality effects would be controlled by site practices and compensatory measures required to maintain compliance with the Clean Air Act (CAA) (should a conformity analysis show the need to take other action). Also, replacement power would be required to comply with CAA requirements (and it would be short lived). Overall, the air quality effects would be driven by operational impacts, and could be SMALL to LARGE, depending on the towers' compliance with CAA requirements and the availability of PM2.5 allowances.

- **Waste**

Construction of the closed-cycle cooling alternative at IP2 and IP3 would generate some construction debris and an estimated 2 million cy (1.5 million m^3) of rock and soil (Entergy

2007). This material may be affected by onsite radiological contamination or by other previous site activities. Depending on the characteristics of the material, it may be possible to reuse or recycle much of it, as discussed in the Land Use portion of this section. If the material cannot be reused or recycled, it will have to be properly managed as a waste. Whether reused, recycled, or disposed of, the material will have to be transported off site. Given the likely size of blasting spoil particles, an onsite crushing operation may be necessary (Enercon 2010).

If disposed of, rather than reused or recycled, the waste may require additional offsite land use. Entergy's feasibility and cost evaluation indicates that at least 6350 cy (4850 m^3; approximately 0.3 percent) is likely to be contaminated, and that contaminated spoils would need to be disposed of as Class A Waste (Enercon 2010). The only current outlet for Class A Waste is in Clive, Utah. Contaminated wastes would need to be appropriately packaged and transported. However, Entergy's feasibility and cost evaluation also indicates that all material, even if it contains low levels of contamination, could possibly be disposed of in the ocean.

Some solid wastes may be generated by water treatment processes. Any such waste would be treated and/or disposed of in accordance with State solid waste regulations. During operation, Entergy will have to maintain release of solids and chemicals to the blowdown water and, subsequently, to the discharge canal and the Hudson River in accordance with IP2 and IP3 SPDES permits. Other solid wastes from tower operation and maintenance (including sludge from the tower basins) would be managed and disposed of in accordance with applicable State regulations at approved offsite facilities. As noted in the Water Quality portion of this section, any contaminated ground water produced by dewatering operations will need to be properly treated before discharge.

Though a large volume of rock and soil would require offsite transportation, at least one disposal option – ocean dumping – would require no additional land.. The NRC staff concludes that waste-related impacts associated with the closed-cycle cooling alternative at IP2 and IP3 could range from SMALL to LARGE, depending on where Entergy disposes of the material, whether the material can be reused or recycled, and the extent to which contaminated spoils require special disposal.

- **Human Health**

Human health impacts for an operating nuclear power plant are identified in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. Potential impacts on human health from the operation of closed-cycle cooling towers at nuclear power plants are evaluated in Section 4.3.6 of the GEIS.

During construction activities there would be risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices.

Depending on the level of contaminated spoils and groundwater removed during the construction process, it is possible that additional occupational exposures to radiation may occur. Crews would need to comply with existing radiation exposure standards. Given the low level of contamination in soil and groundwater, as well as the limited extent of the contamination, this is likely not to be a significant issue at the construction site.

Hybrid cooling towers at IP2 and IP3 would be equipped with sound attenuators (Enercon 2010). The topography of the area would provide additional attenuation of the noise levels. An analysis of potential offsite noise levels resulting from both cooling towers operating continuously indicated that the increase in noise levels at sensitive receptor sites would be 1 decibel or less, a level most likely not noticeable by the residents of the Village of Buchanan (Enercon 2010). These sound levels would comply with Village of Buchanan requirements.

The GEIS evaluation of health effects from plants with cooling towers focuses on the threat to workers from microbiological organisms whose presence might be enhanced by the thermal conditions found in cooling towers. The microbiological organisms of concern are freshwater organisms that are present at nuclear plants that use cooling ponds, lakes, or canals and that discharge to small rivers (NRC 1996). Because the closed-cycle system at IP2 and IP3 would operate using brackish water, and because the Hudson River at Indian Point does not meet the NRC's definition of a small river, thermal enhancement of microbiological organisms is not expected to be a concern.

Furthermore, as described in Section 4.3 of this SEIS, the NRC concludes that continued operation of the facility would not increase the impacts of occupational radiation exposures during the relicensing period. Overall, the NRC staff concludes that human health impacts from the closed-cycle cooling alternative would also be SMALL.

- **Socioeconomics**

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a closed-cycle cooling could affect regional employment, income, and expenditures. Two types of job creation result from this alternative: (1) construction-related jobs, and (2) operation-related jobs, which have the greater potential for permanent, long-term socioeconomic impacts.

Entergy estimates that construction of the cooling towers would require an average workforce of 300 mostly temporary employees or contractors and could take an estimated 62 months. During the outage phase of the effort, the temporary workforce could peak at 600 (Entergy 2007). For comparison purposes, a workforce of approximately 950 additional workers is on site during a routine refueling outage (Entergy 2007).

As previously described, the impacts of relicensing and refurbishing IP2 and IP3 are addressed in a site-specific case study presented in Appendix C (Section C.4.4) to the GEIS. The case study postulated that major refurbishment activities could result in as many as 2300 workers on site. In the case study, the workers were engaged in a variety of component replacement and inspection activities. The case study employment estimate is significantly larger than Entergy's estimate in the previous paragraph and is considered by the NRC staff to be the maximum potential size of the temporary workforce because the GEIS estimate includes a variety of activities that will not be occurring at Indian Point during an outage to install a closed-cycle cooling system. As of June 2006 the site had approximately 1255 full-time workers (Entergy employees and baseline contractors) during normal plant operations (Entergy 2007).

The GEIS case study concluded that, because the surrounding counties are high population density areas as described in Section 4.4.1 of this SEIS, there will be available housing to support the influx of workers. Therefore, the GEIS concluded that any construction-related impact on housing availability would likely be small. With even fewer workers on site than anticipated in the GEIS, impacts would be even less noticeable.

As reported by Levitan and Associates, Inc. (2005), payments-in-lieu-of-taxes (PILOT) are made by Entergy to surrounding taxing jurisdictions. The PILOT amounts would not likely be affected by the construction of new closed-cycle cooling systems or other capital expenditures. In accordance with the PILOT agreements, this payment schedule will remain fixed through the term of the current site licenses (Levitan and Associates, Inc. 2005). Because plant valuation is not likely to change drastically with the installation of closed-cycle cooling (though it may increase), PILOT payments are likely to stay at similar relative levels throughout the renewal term.

Electricity costs and grid reliability are outside of the scope of NRC's review, though many commenters have expressed concern about these two issues. The NRC staff notes that the New York Independent System Operator (NYISO) would continue to monitor grid function and reliability, and prices would be established on New York State's restructured electricity market. Approximately 42 weeks of outage would be necessary to complete construction and implement closed-cycle cooling (Enercon 2010).

The NRC staff concludes that most socioeconomic impacts related to construction and operation of cooling towers at the site would be SMALL.

- **Transportation**

Adverse transportation impacts would be likely during construction of cooling towers. The greatest impacts would occur during site excavation and would decline later in construction. These impacts would return to current levels following construction.

Offsite disposal of approximately 2 million cy (1.5 million m^3) of rock and soil from the excavation of the two cooling tower sites would be expected to have a significant impact on local transportation infrastructure. As indicated by Entergy's feasibility and cost evaluation, the blasting and excavation phase of construction would take approximately four years to complete (Enercon 2010). Given 20 cy dump trucks, approximately 100,000 round trips would be needed to remove the excavated materials. During peak excavation periods, 364 to 518 truck loads would leave the site each day. Much of this material could leave the site on barges in the Hudson River (Enercon 2010). Entergy's feasibility and cost evaluation indicates that barge transportation is the most likely option for reused and recycled blasting spoils (Enercon 2010). Earlier estimates by Entergy indicated that each barge may hold 1000 tons of spoils.

Road traffic in the area is heavy and the additional traffic from construction and site workers would cause increased traffic delays, particularly along US Highway 9 and State Highway 9A (Entergy 2007). Barged material may be transferred to trucks at transshipment points along the Hudson, though this is likely to have markedly lower impacts on transportation than if all spoils were trucked offsite along surface roads near Indian Point. In some cases, though, impacts could still be significant. If barged material were transported out to sea and disposed of there, then NRC staff expects that impacts on transportation would be minor.

During operations, NRC staff anticipates that the closed-cycle cooling system would have little to no effect on transportation, and would likely be limited to occasional shipments of waste cleaned out from cooling tower basins, occasional deliveries of chemicals used to prevent fouling of the towers, and any replacement components necessary throughout the life of the towers. As noted previously, fogging and icing is not expected to be significant.

Based on independent calculations of expected waste volumes from site excavations that were on the same order of magnitude as the Entergy estimates, the NRC staff concludes that impacts from transportation activities, primarily during excavation of the construction site, could be significant and destabilizing, though temporary, during construction and will not be noticeable during operations. Impacts, then, will be SMALL during operations, but SMALL to LARGE during construction.

- **Aesthetics**

IP2 and IP3 are already visible from the Hudson River, scenic overlooks on area highways, and the Palisades Interstate State Park. The property is adjacent to the Scenic Area of Statewide Significance. The addition of the two cooling towers, standing 50 m (165 ft) in height, would make the entire facility more visible as the developed footprint of the facility would be expanded (Entergy's feasibility and cost evaluation includes site renderings to illustrate visual impacts; Enercon 2010. The towers are more aesthetically similar to austere, international-style performance or convention centers than to the hyperbolic natural draft towers many associate with nuclear power plant sites). The clear-cutting of wooded areas for construction of the towers would remove a visual buffer for some site structures. The towers themselves would be clearly visible from offsite vantage points. Entergy has indicated that it would preserve as many trees as possible and that it would plant new trees to reestablish some visual buffers and help attenuate noise (Entergy 2007). Remaining and new trees could act as a partial visual buffer between the construction sites and the river and a visual and noise buffer on land (Entergy 2007).

While the hybrid mechanical-draft cooling towers under consideration are designed to reduce fog and ice production in the local area and minimize presence at ground level, fog and ice produced during operation could still occur. In particular, a visible plume, though attenuated by the hybrid design, may occur under certain meteorological conditions during the year (Enercon 2010). In most cases, these plumes would occur immediately over the towers and Indian Point property, though under worst case conditions, plumes may extend several hundred to thousands of meters (Enercon 2010). Given tower design, it is likely to remain aloft and not occur at ground level thereby reducing the likelihood and severity of fog and ice. Less noticeable moisture and salt deposition from the plume may increase dampness and corrosion on surrounding property, which could affect the visual environment. The circular hybrid design proposed by Entergy disperses remaining drift over a greater area at a lower intensity than a single-stage wet mechanical-draft cooling tower (Enercon 2003).

Given proximity to a Scenic Area of Statewide Significance, Entergy's feasibility and cost evaluation indicates that cooling towers may be incompatible with NYSDEC Visual Policy. From NRC's perspective, this is an issue for Entergy and the State to reconcile, should NYSDEC require cooling towers.

The NRC staff concludes that the impact of construction and operation of a closed-cycle cooling system at IP2 and IP3 on aesthetics would likely be MODERATE to LARGE, given the proximity to important visual resources. Impacts will be greater when atmospheric conditions result in large, visible plumes, and the towers will always be clearly visible.

- **Historic and Archeological Resources**

Should NYSDEC decide that Indian Point must install cooling towers, extensive consultation and further study of onsite historical resources will be necessary. As noted in Section 4.4.5.1 of this SEIS, Entergy's Phase 1b study identified historic and prehistoric resources in the area identified for the south tower (ENN 2009). Based on Entergy's consultation with the New York State Historic Preservation Office, significant additional site study and consultation with other interested groups, particularly Tribal representatives, will be necessary should NYSDEC require cooling tower installation (ENN 2009, NYSHPO 2009). Prior to Entergy's Phase 1b study, a Phase 1A survey was conducted on the property in 2006. The NRC staff identified 76 resources listed on the National Register of Historic Places (NRHP) within 5 miles of IP2 and IP3.

There are registered historically significant buildings and sites within several kilometers of IP2 and IP3 and other nonregistered sites or buildings that may be eligible for registration (NRC 1996). However, the NRC case study presented in the GEIS indicated that some unregistered sites may go unprotected because the sites' significance may be discounted because of their proximity to the IP2 and IP3 facility.

Further studies and consultation with the State Historic Preservation Office and appropriate Native American Tribes, would occur under Section 106 of the National Historic Preservation Act (NHPA) should NYSDEC require that cooling towers be constructed onsite. Any historic or archeological resources are present in previously disturbed areas or in undisturbed areas, they would have to be evaluated for eligibility for listing on the NRHP.

Entergy has procedures for addressing historic and archeological resources (as noted in Section 4.4.5.2), and it has acknowledged the need to survey for unknown resources before construction. As noted in this section, further evaluation and consultation would be necessary prior to cooling tower installation. Historic and archeological resources could be adversely impacted given the potential for historic and prehistoric resources to be discovered on the cooling tower sites. Entergy's early coordination, consultation, and planning could help to reduce or minimize most impacts. . Nonetheless, the NRC staff concludes that the impact from the closed-cycle cooling alternative would likely range from SMALL to MODERATE if historic and archeological resources cannot be avoided.

- **Environmental Justice**

The NRC staff addresses environmental justice impacts of continued operations in Section 4.4.6 of this SEIS. Construction and operation of cooling towers at IP2 and IP3 could have an impact on minority and low-income populations.

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a closed-cycle cooling system at Indian Point. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceeds the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas previously discussed in this section. For example, increased demand for rental housing during construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around IP2 and IP3, and all are exposed to the same hazards generated from constructing and operating a closed-cycle cooling system.

Potential impacts to minority and low-income populations from the construction and operation of a closed-cycle cooling system at Indian Point would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. However, minority and low-income populations residing along site access roads could be affected by increased commuter vehicle traffic during shift changes. Increased demand for rental housing during construction of the closed-cycle cooling system could affect low-income populations in the vicinity of IP2 and IP3. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Since IP2 and IP3 are located in a high population area and the number of available housing units exceeds demand, any increase in employment would have little or no noticeable effect on the availability of housing in the region. Given the close proximity to the New York metropolitan area, most construction workers would commute to the site thereby reducing the potential demand for rental housing.

As noted earlier in this section, replacement power required during a 42-week outage could increase air quality effects in minority and low-income communities, depending on the location and characteristics of generator units used to replace IP2 and IP3 output. These effects are likely to be short-lived (most will be no longer than the outage period), and may vary with time of year, scheduled outages at other facilities, and generator pricing on the New York Independent System Operator (NYISO) grid. Additionally, impacts would occur near existing facilities and would result from incremental increases rather than new effects. As a result, impacts are likely to be small. Nonetheless, some additional power generation may have to come from other sources to make up for parasitic and efficiency losses. These could contribute to additional air quality and human health impacts. However, it is assumed that emissions from these generator facilities would meet air quality standards.

Based on this information and the analysis of human health and environmental impacts presented in this section, the construction and operation of the closed-cycle cooling system would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of IP2 and IP3.

Table 8-1. Summary of Environmental Impacts of a Closed-Cycle Cooling Alternative at IP2 and IP3

Impact Category	Impact	Closed-Cycle Cooling Alternative Comments
Land Use	SMALL to LARGE	Construction of towers requires about 16 ha (40 ac). Waste disposal may require much offsite land.
Ecology: Aquatic	SMALL	Entrainment and impingement of aquatic organisms, as well as heat shock, would be reduced.
Ecology: Terrestrial	SMALL to MODERATE	Onsite forest habitats disturbed with possible effects to endangered species.
Water Use and Quality	SMALL	Releases to surface water would be treated as necessary to meet permit requirements. Runoff from construction activities is likely to be controlled.
Air Quality	SMALL to LARGE	Primary impacts from operational emissions, as well as replacement power. Existing regulations may limit effects.
Waste	SMALL to LARGE	Construction would generate soil, rock, and debris requiring disposal; impacts vary greatly with disposal options.
Human Health	SMALL	Workers experience minor accident risk and may encounter contaminated blasting spoils during construction, though monitoring will limit potential for impacts.
Socioeconomics	SMALL	No impact to offsite housing or public services occurs.
Transportation	SMALL to LARGE	Increased traffic associated with construction (workers and waste disposal) may be significant, though little effect during operations.
Aesthetics	MODERATE to LARGE	Construction of two towers, 165 ft tall, would have a noticeable impact on the aesthetics of the site. Plume may be highly visible on some days.
Historical and Archeological Resources	SMALL to MODERATE	Recent study indicates potential for resources, though existing procedures should help protect resources on the largely-disturbed site.
Environmental Justice	SMALL	Impacts are not anticipated to be disproportionately high and adverse for minority and low-income communities.

8.2 No-Action Alternative

The NRC regulations implementing the National Environmental Policy Act of 1969, as amended (NEPA) (see 10 CFR Part 51, Subpart A, Appendix A, paragraph 4), specify that the no-action alternative will be discussed in an NRC environmental impact statement.

For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the IP2 and IP3 operating licenses and Entergy would then cease operating both units on or before the expiration of their current operating licenses. Following the shutdown of each unit, Entergy would initiate decommissioning of the facility in accordance with the NRC decommissioning requirements in 10 CFR 50.82, “Termination of License.” Full dismantling of structures and decontamination of the site may not occur for up to 60 years after plant shutdown.

Regardless of whether or not the IP2 and IP3 operating licenses are renewed, the facility’s owner will eventually be required to shut down the reactors and decommission the IP2 and IP3 facility. If the operating licenses are renewed, shutdown and decommissioning activities would not be avoided but would be postponed for up to an additional 20 years.

The environmental impacts associated with decommissioning, following a license renewal period of up to 20 years or following the no-action alternative, would be bounded by the discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this SEIS, and NUREG-0586, “Final Environmental Impact Statement on Decommissioning of Nuclear Facilities” (NRC 2002). The impacts of decommissioning after 60 years of operation are not expected to be significantly different from those occurring after 40 years of operation.

Table 8-2. Summary of Environmental Impacts of the No-Action Alternative

Impact Category	Impact	Comment
Land Use	SMALL	Impacts are expected to be SMALL because plant shutdown is expected to result in few changes to offsite and onsite land use, and transition to alternate uses is expected over an extended timeframe.
Ecology	SMALL	Negative impacts to aquatic ecology of the Hudson River will cease. The overall impact is SMALL.
Water Use and Quality	SMALL	Impacts are expected to be SMALL as no new impacts occur with plant shutdown.
Air Quality	SMALL	Impacts are expected to be SMALL because emissions related to plant operation and worker transportation will decrease.
Waste	SMALL	Impacts are expected to be SMALL because generation of high-level waste will stop and generation of low-level and mixed waste will decrease.
Human Health	SMALL	Impacts are expected to be SMALL because radiological doses to workers and members of the public, which are within regulatory limits, will be reduced.
Socioeconomics	SMALL to MODERATE	Impacts vary by jurisdiction, with some areas experiencing MODERATE effects.
Socioeconomics (Transportation)	SMALL	Impacts are expected to be SMALL because the decrease in employment would reduce traffic.
Aesthetics	SMALL	Impacts are expected to be SMALL because plant structures will remain after plant shutdown.
Historic and Archeological Resources	SMALL	Impacts are expected to be SMALL because shutdown of the plant will not immediately change land use.
Environmental Justice	SMALL	Impacts are not anticipated to be disproportionately high and adverse for minority and low-income populations.

Impacts from the decision to permanently cease operations are not considered in NUREG-0586, or its Supplement 1.[2] Therefore, immediate impacts that occur between plant shutdown and the beginning of decommissioning are considered here. These impacts will occur when the units shut down regardless of whether the license is renewed (see Table 8-2).

Plant shutdown will result in a net loss of power generating capacity. The power not generated by IP2 and IP3 during the license renewal term would likely be replaced by (1) power supplied by other producers (either existing or new units) using generating technologies that may differ from that employed at IP2 and IP3, (2) demand-side management and energy conservation, or (3) some combination of these options. The environmental impacts of these options are discussed in Section 8.3 of this SEIS. While these options can be alternatives to license renewal (given sufficient resource availability), they also constitute potential consequences of the no-action alternative. Impacts from these options will addressed in their respective portions of this Section.

This SEIS does not assess the specifics of the need for corrections to reactive power that would be required if IP2 and IP3 were shut down. Reactive power (i.e., power stored in magnetic fields throughout the power grid) is essential for the smooth operation of the transmission grid because it helps hold the voltage to desired levels. It may be possible to use the existing generators at IP2 and IP3 as a source of reactive power even if IP2 and IP3 are shut down. As "synchronous condensers," the generators could add reactive power (but not real power) to the transmission system (National Research Council 2006). Because it is assumed that the generators would be operated as synchronous condensers only until the reactive power could be supported by new, real replacement power generation, their operation is not considered as a significant contributor to the impacts described below. Further, as a shut-down nuclear power plant may not be decommissioned for many years after shutdown, the continued operation of IP2 and IP3 generators would not necessarily slow or impede decommissioning activities.

- **Land Use**

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on land use would be SMALL. Onsite land use will not be affected immediately by plant shutdowns. Plant structures and other facilities are likely to remain in place until decommissioning. In the near term, the transmission lines associated with IP2 and IP3 will likely remain in place. In the long term, it is possible that the transmission lines that extend from the onsite switchyard to major transmission corridors will be removed. As a result, the transmission line ROWs will no longer be maintained and the ROW will be available for other uses. Also, as a result of plant shutdowns, there would be a reduction in uranium mining activity on approximately 870 ha (2150 ac), or 405 ha (1000 ac) per 1000 MW(e) (NRC 1996). Therefore, the staff concludes that the impacts on land use from plant shutdown would be SMALL.

(2) Appendix J, "Socioeconomic and Environmental Justice Impacts Related to the Decision to Permanently Cease Operations," to NUREG-0586, Supplement 1, discusses the socioeconomic impacts of plant closure, but the results of the analysis in Appendix J are not incorporated in the analysis presented in the main body of the NUREG.

- **Ecology**

In Chapter 4 of this SEIS, the NRC staff concluded that entrainment and impingement of aquatic species would have MODERATE impacts. The NRC staff also concluded that thermal shock could have a SMALL to LARGE impact. Terrestrial ecological impacts were SMALL. Cessation of operations will eliminate cooling water intakes from and discharges to the Hudson River. The environmental impacts to aquatic species, including threatened and endangered species, associated with these changes are generally positive because entrainment and impingement issues will be eliminated, as would impacts from the plant's thermal plume. The NRC staff expects that impacts to aquatic ecology would decline to SMALL if the plant shuts down.

The impacts of plant closure on the terrestrial ecosystem could be both negative and positive, depending on final disposition of the IP2 and IP3 site. Currently, there is a fragment of eastern deciduous hardwood habitat in the exclusion area of the facility that Entergy indicates has not been previously developed. This fragment could be destroyed by new development once access is no longer restricted. Plant closure will not directly affect this fragment, however, and a prolonged period prior to site decontamination may also provide protection for this fragment. Overall, the NRC staff concludes that ecological impacts from shutdown of the plant would be SMALL.

- **Water Use and Quality**

When the plant stops operating and cooling water is no longer needed, there will be an immediate reduction in water withdrawals from and discharge to the Hudson River. This will reduce evaporation from the river in the vicinity of the plant and will result in decreased discharges of biocides and other chemicals. Therefore, the staff concludes that the impacts on surface water use and quality from plant shutdown would be less noticeable than current operations and would remain SMALL.

Ground water at the IP2 and IP3 site contains elevated concentrations of tritium (EPA 2004). In Sections 2.2.7 and 4.5 of this SEIS, the NRC staff examined available information on leakage to ground water and determined that the issue, while new, is not significant. The source of the contamination is believed to be historical leakage from the IP1 and IP2 spent fuel pools. Since discovering the leaks, Entergy has removed fuel from the IP1 spent fuel pool and drained it. The no-action alternative would not, on its own, affect ground water contamination. Consequently, the NRC staff concludes that ground water quality impacts from shutdown of the plant would be SMALL.

- **Air Quality**

In Chapter 4 of this SEIS, the NRC staff adopted the findings in the GEIS that the impacts of continued plant operation on air quality would be SMALL. When the plant stops operating, there will be a reduction in emissions from activities related to plant operation (e.g., use of diesel generators and vehicles to transport workers to the site). As such, the NRC staff concludes that the impact on air quality from shutdown of the plant would be SMALL.

- **Waste**

The impacts of waste generated by continued plant operation are discussed in Chapter 6 of this SEIS. The impacts of low-level and mixed waste from plant operation are characterized as SMALL. When IP2 and IP3 stop operating, the plant will stop generating high-level waste and generation of low-level and mixed waste associated with plant operation will briefly increase, and then will decline. Therefore, the staff concludes that the impacts of waste generated after shutdown of the plant would be SMALL.

Wastes associated with plant decommissioning are unavoidable and will be significant whether the plant is decommissioned at the end of the initial license term or at the end of the period of extended operation. The no-action alternative will not have an appreciable effect on waste volumes associated with decommissioning.

- **Human Health**

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on human health are SMALL. After cessation of plant operations, the amount of radioactive material released to the environment in gaseous and liquid forms, which are currently within regulatory limits, will be reduced. Therefore, the NRC staff concludes that the impact of plant shutdown on human health also would be SMALL. In addition, the variety of potential accidents at the plant will be reduced to a limited set associated with shutdown events and fuel handling. In Chapter 5 of this SEIS, the staff concluded that impacts of accidents during operation are SMALL. Therefore, the NRC staff concludes that the impacts of potential accidents following shutdown of IP2 and IP3 also would be SMALL.

- **Socioeconomics**

In Chapter 4 of this SEIS, the NRC staff concluded that the socioeconomic impacts of continued plant operation would be SMALL. Should the plant shut down, there would be immediate socioeconomic impacts from loss of jobs (some, though not all, of the approximately 1255 full-time employees and baseline contractors would begin to leave the site); property tax payments to Westchester County may be reduced. These impacts, however, would not be considered significant on a countywide basis because of the large population in the area and because plant workers' residences are not concentrated in a single municipality or county.

PILOT payments and other taxes from IP2 and IP3 are paid directly to the Town of Cortlandt, the Village of Buchanan, and the Hendrick Hudson Central School District. Entergy paid a combined $21.2 million in PILOT payments, property taxes, and other taxes to Westchester County, the Town of Cortlandt, the Village of Buchanan, the Verplanck Fire District, and the Hendrick Hudson Central School District in 2005 (Entergy 2007). PILOT payments, property taxes, and other taxes paid by the site account for a significant portion of revenues for these Government agencies.

The Village of Buchanan, which has over 2100 residents, is the principal local jurisdiction that receives direct revenue from IP2 and IP3. In fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed about 39 percent of the Village of Buchanan's total revenue of $5.08 million (Entergy 2007). The revenues generated from IP2 and IP3 are used to fund police, fire, health, transportation, recreation, and other community services. Additionally in fiscal year 2005, PILOT payments, property taxes, and other taxes from Entergy contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District, which serves approximately 3000 students (Entergy 2007).

The shutdown of IP2 and IP3 may result in increased property values of the homes in the communities surrounding the site (Levitan and Associates, Inc. 2005). This would result in some increases in tax revenues. However, to fully offset the revenues lost from the shutdown of IP2 and IP3, taxing jurisdictions most likely would have to compensate with higher property taxes (Levitan and Associates, Inc. 2005). The combined increase in property values and increased taxes could have a noticeable effect on some area homeowners and business, though Levitan and Associates did not indicate the magnitude of this effect and whether the net effect would be positive or negative.

Revenue losses from Indian Point operation would affect the communities closest to and most reliant on the plant's tax revenue and PILOT. If property values and property tax revenues increase, some of these effects would be smaller. The NRC staff concludes that the socioeconomic impacts of plant shutdown would likely be SMALL to MODERATE (MODERATE effects for the Hendrick Hudson Central School District, Village of Buchanan, Town of Cortlandt, and the Verplanck Fire District). See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of the potential impacts of plant shutdown.

- **Transportation**

In Chapter 4 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on transportation would be SMALL. Cessation of operations will be accompanied by reduced traffic in the vicinity of the plant. Most of the reduction will be associated with a reduction in plant workforce, but there will also be a reduction in shipment of maintenance materials to and from the plant. Therefore, the staff concludes that the impacts of plant closure on transportation would be SMALL

- **Aesthetics**

In Chapter 4 of this SEIS, the NRC staff concluded that the aesthetic impacts of continued plant operation would be SMALL. Major plant structures and other facilities, such as the containment buildings and turbine buildings, are likely to remain in place until decommissioning begins. The NRC staff also anticipates that the overall appearance of the facility and its grounds would be maintained through the decommissioning. Since no significant changes would occur between shut down and decommissioning, the staff concludes that the aesthetic impacts of plant closure would be SMALL.

- **Historic and Archeological Resources**

In Chapter 4 of this SEIS, the staff concluded that the impacts of continued plant operation on historic and archeological resources would be SMALL. Onsite land use will not be affected immediately by the cessation of operations since plant structures and other facilities are likely to remain in place until decommissioning. Following plant shutdown, there would be no foreseeable need for archeological surveys of the area. Therefore, the NRC staff concludes that the impacts on historic and archeological resources from plant shutdown would be SMALL.

- **Environmental Justice**

In Chapter 4 of this SEIS, the NRC staff concluded that the environmental justice impacts of continued operation of the plant would be SMALL because continued operation of the plant would not have a disproportionately high and adverse impact on minority and low-income populations. Although the NRC staff concluded that the socioeconomic impacts of the plant shutdown would be MODERATE for some jurisdictions, the impacts of the plant shutdown are likely to be felt across the entire community and could disproportionately affect some minority and low-income populations. Some minority and low-income populations located in urban areas could be affected by reduced air quality and increased health risks due to the burning of fossil fuel in existing power plants used to replace the lost power generated by Indian Point.

As described in Section 2.2.8.6, the site contributed over 35 percent of the total revenue collected for the Hendrick Hudson Central School District in 2005. The Hendrick Hudson Central School District has only an 18-percent minority population (compared to a 47-percent Statewide average) and only 5 percent of the students are eligible for a free or reduced-price lunch program (compared to a Statewide average of 44 percent). Therefore, the loss of funding to the Hendrick Hudson Central School District would not disproportionately affect minority and low-income populations (GreatSchools 2008).

The site contributed about 39 percent of the Village of Buchanan's total revenue in 2005 (Entergy 2007). In 2000, less than 4 percent of the population were minorities and less than 4 percent of the individuals were below the poverty level (US Census Bureau 2000). Therefore, the loss of funding to the Village of Buchanan would not disproportionately affect minority and low-income populations.

The NRC staff concludes that the environmental justice impacts of plant shutdown would be SMALL. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.3 Alternative Energy Sources

This section discusses the environmental impacts associated with developing alternative sources of electric power to replace power generated by IP2 and IP3. The order of alternative energy sources presented in this section does not imply which alternative would be most likely to occur or which is expected to have the least environmental impacts. The NRC staff notes that discussion of supercritical coal-fired generation has been relocated to Section 8.3.

The following central generating station alternatives are considered in detail in the identified sections of this SEIS:

- natural gas combined-cycle (NGCC) generation at either the IP2 and IP3 site or an alternate site (Section 8.3.1)

The NRC staff considers the following nongeneration alternatives to license renewal in detail in the identified sections of this SEIS:

- purchased electrical power (Section 8.3.2)
- energy conservation and efficiency (Section 8.3.3)

The NRC staff also considers two combinations of alternatives that include new or existing generation along with conservation or purchased power in the identified sections of this SEIS:

- continued operation of either IP2 or IP3, renewable generation, and conservation programs (Section 8.3.5.1)
- repowering a retired facility with a new NGCC power plant, renewable generation, and conservation (Section 8.3.5.2)

Alternatives considered by the NRC staff but dismissed from further evaluation as stand-alone alternatives are addressed in Section 8.3.4 of this SEIS. Several of the alternatives discussed in Section 8.3.4 are included in the combinations addressed in Section 8.3.5.

<u>Alternatives Process</u>

Since IP2 and IP3 have a net electric output of 2158 MW(e), the NRC staff evaluated the impacts of alternatives with comparable capabilities.

Of the alternatives mentioned in this section, the NRC staff expects that only a NGCC generation alternative could be wholly developed at the IP2 and IP3 facility because the site is too small to host other alternatives. As noted elsewhere in this Chapter, the NGCC alternative could also be constructed as part of a repowering operation of another existing but retired power plant.

While the alternate site considered need not be situated in New York State, the availability of transmission line capacity to deliver power from a location outside the New York metropolitan region to current IP2 and IP3 customers could constrain siting choices. The DOE has identified critical congestion areas where it is critically important to remedy existing or growing electrical transmission congestion problems because the impacts of the congestion could be severe. It is conceivable that these transmission congestion patterns would influence selection of an alternate site for generating power that is needed in the New York metropolitan region. For purposes of this analysis, however, the NRC staff assumes that adequate transmission will exist – either through planned, new projects (e.g., the proposed New York Regional Interconnect – NYRI , or the Champlain-Hudson Power Express, Inc. – CHPEI – Project, among others) – or by locating the alternatives near to downstate loads.

All of New York's constrained transmission paths move power from areas to the west, south, and north of the State to the loads in and around New York City and Long Island. The New York City metropolitan area consumes major quantities of electricity with less generation capacity than load. Therefore, the region is dependent on imports. Because of the area's current dependence on local power generation from natural gas and oil fuels, the area has high electricity rates (DOE 2006). The replacement of limited local generation sources with additional imported power would place even more demands on the constrained transmission system moving power into the New York City area, though direct current transmission, like CHPEI, could allow greater flexibility. As noted in Section 8.2, it may be necessary to continue operating the IP2 and IP3 generators as synchronous condensers to supply virtual power to the local transmission system after the IP2 and IP3 reactors shut down.

Finally, the NRC staff notes that an infinite number of potential combination alternatives exists, based on varying the amounts or types of power generation means employed or varying the extent to which alternatives rely on energy conservation. The following alternatives are based on available research and input from the draft SEIS comment process, and represent, in the staff's professional judgment, reasonable examples of combinations that address comments received, ongoing State-level programs, and resource availability in New York State. The staff also notes that none of these combinations are intended to place a limit on available capacities, nor are they intended to supplant State or utility level policy decisions about how to generate electricity, reduce or add to load, set prices, or promote different approaches to generating electricity or managing loads.

<u>EIA Projections</u>

Each year the Energy Information Administration (EIA), a component of DOE, issues an annual energy outlook. In its "Annual Energy Outlook 2010 with Projections to 2035," EIA projects that natural gas-fired plants will account for approximately 46 percent of electric generating capacity additions through 2035 (DOE/EIA 2010), while coal-fired plants will account for approximately 12 percent of generating capacity additions through 2035 (DOE/EIA 2010). EIA projects that renewable energy sources will account for 36 percent of capacity additions through 2035 (DOE/EIA 2010). New nuclear units are expected to account for only 3 percent of additions over the same time period (DOE/EIA 2010).

EIA bases its projections on the assumption that providers of new generating capacity will seek to add generating sources that are cost effective and meet applicable environmental requirements, like air emissions standards. Particularly, uncertainty about future limits on greenhouse gases (GHGs), along with Federal incentives, State energy programs, and rising fossil fuel prices increase competitiveness for renewable and nuclear power (DOE/EIA 2010). Aspects of the American Recovery and Reinvestment Act (ARRA) have also supported renewable capacity growth and will likely continue to do so. EIA notes that regulatory uncertainty also drives capacity decisions. For example, EIA notes that potential future requirements for carbon capture and sequestration (CCS) could result in higher costs for coal generation. Given a smaller future role for coal-fired power, in line with New York State's declining reliance on coal (DOE/EIA 2009) and GHG restrictions imposed by the Regional Greenhouse Gas Initiative (RGGI), the NRC staff has relocated the supercritical coal-fired alternative to Section 8.3.4., Alternatives Dismissed from Individual Consideration. NRC staff addresses the impacts of a new NGCC plant located at either the IP2 and IP3 site or an alternate site in Section 8.3.1 of this SEIS, and considers combinations of alternatives that include substantial amounts of renewable energy sources in Section 8.3.5.

In contrast to many recent AEO editions, EIA no longer indicates, in its overview of future electrical generation capacity, that any new capacity will be fired with oil. NRC staff notes that some gas-fired facilities may fire with oil during periods of high gas demand, but does not consider new oil-fired capacity in this SEIS..

The NRC staff uses EIA's projections to help select reasonable alternatives to license renewal. In the following sections of this chapter, the NRC staff will examine several alternatives in depth, and identify a range of others that staff considered but rejected.

8.3.1 Natural Gas-Fired Combined-Cycle (NGCC) Generation

In this section, the NRC staff examines the environmental impacts of the NGCC alternative at both IP2 and IP3 and at an alternate site. The NRC staff assumed that a natural gas-fired plant would use a closed-cycle cooling system.

This replacement NGCC plant would likely use combined-cycle technology. Compared to simple-cycle combustion turbines, combined-cycle plants are significantly more efficient, and thus provide electricity at lower costs. NGCC power plants also tend to operate at markedly higher thermal efficiencies than other fossil-fuel or nuclear power plants, and require less water for condenser cooling than other thermoelectric alternatives. As such, the NGCC alternative would require smaller cooling towers and substantially less makeup water than the cooling system proposed in Section 8.1.1 of this SEIS. Typically, these plants support intermediate loads but they are capable of supporting a baseload duty cycle; thus they provide an alternative to renewing the IP2 and IP3 operating licenses. Levitan and Associates indicated that gas-fired generation was the most likely alternative to take the place of IP2 and IP3 (Levitan and Associates 2005). Further, New York State is increasingly reliant on natural gas for electrical power.

The NRC evaluated environmental impacts from gas-fired generation alternatives in the GEIS, focusing on combined-cycle plants (NRC 1996). In a combined-cycle unit, hot combustion gases in a combustion turbine rotate the turbine to generate electricity. Waste combustion heat from the combustion turbine is routed through a heat-recovery steam generator, which then powers a steam turbine electrical generator. The combination of two cycles can be as much as 60 percent efficient.

EIA projects that advanced combined-cycle gas turbines can operate at a heat rate as low as 6333 BTU/kWh for units with net output of 400 MW(e) (DOE/EIA 2010b). These units are more efficient than the 408-MW(e) units Entergy considered in its ER, and would consume less fuel, while producing fewer emissions per unit of electrical output. Using five, 400-MW(e) units would slightly underestimate the total impact to some resources, but it provides a useful approximation using more-current technology. .

The NRC staff discusses the overall impacts of the NGCC generating system in the following sections and summarizes them in Table 8-4 of this SEIS. The extent of impacts at an alternate site would depend on the location of the site selected. A third option is that this NGCC alternative could be constructed at an existing, retired or underutilized fossil facility as part of a facility repowering. Impacts would be essentially the same for a repowered facility as for a facility constructed at Indian Point, though available site infrastructure could result in slightly lower or higher impacts at the repowering project. Regardless, a repowered site would already have transmission access, likely access to cooling water, and possible access to gas transmission infrastructure.

- **Land Use**

Existing facilities and infrastructure would be used to the extent practicable if a NGCC complex were to be developed at IP2 and IP3. Specifically, the NRC staff assumed that this alternative would use the existing switchyard, offices, and transmission line ROWs. However, a new mechanical-draft cooling tower would need to be constructed to support the new closed-cycle cooling system.

The GEIS estimated that 45 ha (110 ac) are needed for a 1000-MW(e) natural gas-fired facility. Scaling up for the 2000-MW(e) facility would indicate a land requirement of approximately 90 ha (220 ac). The NRC staff notes that some existing NGCC facilities require less space than the GEIS indicates, and may be more on the order of 16 ha (40 ac) per 1000 MW(e), inclusive of cooling towers. (Entergy's withdrawn proposal for combined-cycle capacity on the IP2 and IP3, for example, required only 2 ha (5 ac) for 330 MW(e) of capacity (as noted in Levitan and Associates 2005)). The IP2 and IP3 site is only 98 ha (242 ac) with some land unsuitable for construction. Also, much of the site is covered by the IP2 and IP3 containment structures, turbine buildings, other IP2 and IP3 support facilities, and AGTC gas pipeline. Land covered by some IP2 and IP3 facilities would not be available until decommissioning, though land covered by some support facilities may be available prior to the end of the current license. The AGTC pipeline ROW would remain unavailable. Based on previous Entergy proposals and experience at other combined-cycle plants, however, the NRC staff finds it possible that a NGCC alternative could be constructed and operated on the IP2 and IP3 site.

As reported by Levitan and Associates, Inc. (2005), the existing Algonquin pipeline that passes through the IP2 and IP3 site may be adequate for a 330-MW(e) simple-cycle plant that would operate in peaking mode during the summer season, when gas supplies are less constrained by winter-season heating demands. Levitan and Associates (2005) concluded that substantial and expensive pipeline upgrades would probably be necessary to supply natural gas to a combined-cycle alternative throughout the winter heating season and for the additional baseload capacity throughout the year. Given firm demand for natural gas during the winter heating season, it is possible that the NGCC alternative may need to burn fuel oil during several weeks of the year, should conditions of limited supply emerge. This practice is common at gas-fired power plants in the northeastern United States. Another option is that future, proposed liquefied natural gas (LNG) facilities in the northeastern United States or Canadian maritime provinces could reduce demands on the Algonquin pipeline system.

The environmental impacts of locating the NGCC facility at an alternate location would depend on the past use of the location. If the site is a previously undisturbed site the impacts would be more significant than if the site was a previously developed site, or if the site is a repowered, existing facility. Construction and operation of the NGCC facility at an undeveloped site would require construction of a new cooling system, switchyard, offices, gas transmission pipelines, and transmission line ROWs. A previously industrial site may have closer access to existing infrastructure, which would help to minimize environmental impacts. A NGCC alternative constructed at the IP2 and IP3 site would have direct access to a transmission system, an existing pipeline ROW, and an existing dock to receive major components. A repowered facility is likely to have similar access to supporting infrastructure as a facility sited at the Indian Point site, and may have other benefits, like existing connections to natural gas pipelines. In some cases, other onsite support structures may also be repurposed to support the repowering operation.

Regardless of where a NGCC alternative is built, the GEIS indicates that additional land would be required for natural gas wells and collection stations. According to the GEIS, a 1000-MW(e) gas-fired plant requires approximately 1500 ha (3700 ac) for wells, collection stations, and pipelines, or about 3000 ha (7400 ac) for a 2000-MW(e) facility (NRC 1996).

Overall, land use impacts of the NGCC alternative are considered SMALL to MODERATE at the IP2 and IP3 site. NGCC land use impacts at a new previously industrial site or a repowered facility are considered to be SMALL to MODERATE; while NGCC generation at a new undeveloped site would have MODERATE to LARGE impacts.

- **Ecology**

At the IP2 and IP3 site, there would be terrestrial ecological impacts associated with siting a

NGCC facility. These impacts would likely be less than those described in Section 8.1.1.2 of this SEIS, which discusses the ecological impacts of the construction of a closed-cycle cooling system to support IP2 and IP3, as existing portion of the site currently used for support structures like parking lots or outbuildings could be redeveloped for a gas fired alternative. Also, substantially less soil and rock removal would be necessary. The duration of impacts from construction would be less.

Improvements to the existing pipeline network would also be necessary, with some impacts along the already-disturbed ROW. Levitan and Associates (2005) indicated that no transmission system improvements would be necessary to accommodate the NGCC alternative at the IP2 and IP3 site. Overall, construction effects are limited in both scope and duration. Impacts to terrestrial ecology of constructing the NGCC alternative on site are likely to be SMALL. In most cases, impacts at a repowering project would be similarly SMALL, depending on the extent to which existing site structures can be reused. Some transmission improvements may be necessary if the repowered site was previously of smaller capacity.

Ecological impacts at an alternate site would depend on the nature of the land used for the plant and the possible needs for a new gas pipeline and/or transmission lines. Construction of the transmission line and construction and/or upgrade of the gas pipeline to serve a new plant at an alternate site, if necessary, would have substantial ecological impacts, though these would be temporary. Ecological impacts to the plant site and in utility ROWs could include impacts on threatened or endangered species, habitat loss or fragmentation, reduced productivity, and a local reduction in biological diversity. Impacts to terrestrial ecology would likely be SMALL to MODERATE, depending on site characteristics.

Operation of the NGCC alternative at the IP2 and IP3 site or another site would likely not introduce noticeable new terrestrial ecological effects after construction.

The NGCC alternative is unlikely to create significant impacts for aquatic ecology during construction, regardless of location. Because the plant has a relatively small footprint, and because crews would likely implement some measures to control site runoff, it is unlikely that impacts to aquatic ecology would be noticeable. Noticeable effects could occur during construction if new transmission line ROWs or gas pipelines would need to cross streams or rivers.

During operations, aquatic ecological resources would experience significantly smaller effects than they would from a comparable nuclear or coal-fired power plant. The combined-cycle gas plant using closed-cycle cooling would require less than half the cooling water of IP2 and IP3 using closed-cycle cooling. Construction of intake and discharge structures at an alternate site could trigger some impacts to aquatic ecology, but because these impacts are very limited in scope and time, they will likely not affect any important resource characteristics. Thus, aquatic ecological impacts of the NGCC alternative are likely to be SMALL.

At an alternate site, impacts to ecology may range from SMALL to MODERATE, while they are likely to be SMALL if constructed at the existing IP2 and IP3 site or a repowered site.

- **Water Use and Quality**

<u>Surface Water</u>: NGCC plants are highly efficient and require less cooling water than other generation alternatives. Plant discharges would consist mostly of cooling tower blowdown, with the discharge having a slightly higher temperature and increased concentration of dissolved

solids relative to the receiving water body, as well as intermittent, low concentrations of biocides (e.g., chlorine). All discharges from a new plant at the IP2 and IP3 site would be regulated through a New York SPDES permit, which would be issued by NYSDEC. Finally, some erosion would probably occur during construction (NRC 1996), though the GEIS indicates this effect would be SMALL. Plant construction crews would employ at least basic runoff control measures. Because crews would likely not have to construct entirely new intake structures, transmission lines, or a gas pipeline, most activities that could affect water use and quality will not occur for an alternative constructed at the IP2 and IP3 site, or at a repowered site. Like the existing IP2 and IP3, a NGCC alternative located on the site would likely not rely on ground water. Overall, impacts to water use and quality at the IP2 and IP3 site from a NGCC alternative would likely be SMALL for both construction and operation.

At an alternate site, a NGCC alternative would likely rely on surface water for cooling makeup water and blowdown discharge. Intake and discharge would involve relatively small quantities of water compared to once-through cooling and less than a nuclear or coal-fired power plant. The impact on the surface water would depend on the volume of water needed for makeup water, the discharge volume, and the characteristics of the receiving body of water. If a NGCC plant discharges to surface water, the plant would have to meet the requirement of a SPDES permit. The NRC staff expects that any new facility would comply with requirements of the discharge permits issued for its operation. Thus discharges from the plant would be legally obligated to conform to applicable water quality standards. Water withdrawals from a small river or cooling pond, however, could lead to potential water use conflicts. The impacts would be SMALL to MODERATE during operations depending on receiving water characteristics, though they would likely be SMALL at a repowered site. During construction, some erosion would probably occur though the GEIS indicates this would have a SMALL effect (NRC 1996).

<u>Ground Water</u>: IP2 and IP3 currently use no ground water. It is likely that a NGCC alternative at the IP2 and IP3 site would also use no ground water. Impacts at the IP2 and IP3 site would thus be SMALL. Ground water impacts from operations at an alternate site or a repowered site may vary widely depending on whether the plant uses ground water for any of its water needs, though it would be unlikely that a plant on an alternate site would use ground water for cooling system makeup water given the quantity of water required. Ground water impacts at an alternate site could range from SMALL to MODERATE, depending on the quantity of ground water used and characteristics of aquifers used. Construction-stage impacts at both the existing site and a new site are likely to be SMALL.

- **Air Quality**

Natural gas is a relatively clean-burning fuel relative to relative to other fossil fuels. The NGCC alternative would release a variety of emissions, however.

The NRC staff calculates that approximate emissions from the five-unit, 2000-MW NGCC alternative with a heat rate of 6333 BTU/kWh would be:

- SO_x—150 MT/yr (164 tons/yr)
- NO_x—493 MT/yr (543 tons/yr)
- CO—103 MT/yr (113 tons/yr)

- Filterable particulates (PM_{10})—83 MT/yr (92 tons/yr)[(3)]

NGCC power plants primarily emit pollutants as a result of combustion conditions. These pollutants include NO_x, CO, and particulates. Regulations in place to reduce potential health effects from air emissions, especially those promulgated in response to the CAA, drive the types of emissions controls this NGCC alternative would use to limit its effects on air quality. CAA mechanisms like new source performance standards, nonattainment areas, State implementation plans, and specialized programs, including one that limited overall NO_x emissions throughout the Eastern United States, all drive emissions control technologies used in this NGCC alternative.

NO_x is typically the pollutant of greatest concern for a NGCC power plant. Given the proper atmospheric conditions, NO_x helps to form ozone, as well as smog. The NGCC alternative in this case relies on selective catalytic reduction (SCR) to reduce NO_x emissions. As previously discussed, IP2 and IP3 are located within the New Jersey-New York-Connecticut Interstate Air Quality Control Region (40 CFR 81.13). All of the States of New Jersey and Connecticut, as well as several counties in Central and Southeastern New York within a 80-km (50-mi) radius of IP2 and IP3, are designated as nonattainment areas for ozone (8-hour standard) (EPA 2008b). Operators or owners of a NGCC power plant constructed in a nonattainment area would need to purchase offsets for ozone precursor emissions. In this case, NOx is the major ozone precursor emitted by the NGCC power plant. In accordance with NYSDEC regulations, "Emission offsets must exceed the net increase in annual actual emissions from the air contamination source project" (NYSDEC, Chapter 3, Parts 231–15). By design, this regulatory requirement should result in a net reduction in ozone emissions in the region.

A new NGCC generating plant located in a nonattainment area (like that at the IP2 and IP3 site) would need a nonattainment area permit and a Title IV operating permit under the CAA. The plant would need to comply with the new source performance standards for such plants set forth in 40 CFR Part 60, Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), SO_2 (40 CFR 60.43(a)), and NO_x (40 CFR 60.44(a)).

In December 2000, EPA issued regulatory findings on emissions of HAPs from electric utility steam-generating units (EPA 2000a). NGCC power plants were found by EPA to emit arsenic, formaldehyde, and nickel (EPA 2000a). Unlike coal- and oil-fired plants, EPA did not determine that emissions of HAPs from NGCC power plants should be regulated under Section 112 of the CAA.

A NGCC plant would have unregulated CO_2 emissions of about 117 pounds per MMBtu (DOE/EIA 2008a). The NRC staff calculates that a five-unit NGCC alternative with technologically advanced turbines rated at 6333 BTU/kWh would emit approximately 5,516,000 MT (6,076,000 tons) of CO_2 per year. Section 6.2 of this SEIS contains a discussion of current and future relative GHG emissions from several energy alternatives including coal, natural gas, nuclear, and renewables. Other emissions and losses during natural gas production or transportation could also increase the relative GHG impact.

Construction activities also would result in some air effects, including those from temporary fugitive dust, though construction crews likely would employ dust control practices to limit this impact. Exhaust emissions also would come from vehicles and motorized equipment used

(3) Additional particulate emissions associated with the cooling towers were not quantified.

during the construction process, though these emissions are likely to be intermittent in nature and will occur over a limited period of time. As such, construction stage impacts would be SMALL.

The overall air quality impact for operation of a new NGCC plant at the IP2 and IP3, at an alternate site, or at a repowered site would be SMALL to MODERATE, depending on air quality in the surrounding airshed. Air quality impacts during construction would be SMALL.

- **Waste**

Burning natural gas fuel generates small amounts of waste. However, a plant using SCR to control NO_x will generate spent SCR catalyst and small amounts of solid waste products (i.e., ash). In the GEIS, the NRC staff concluded that waste generation from gas-fired technology would be minimal (NRC 1996). Waste generation impacts would be minor and would not noticeably alter any important resource attribute.

Constructing a NGCC alternative would generate small amounts of waste, though many construction wastes can be recycled. Construction either at the Indian Point site or at a repowered site would likely require little land-clearing, though some existing on-site structures at either Indian Point or a repowered site may need to be dismantled or demolished. Most of this type of debris would be recycled, transported offsite, or, in the case of demolished concrete, parking lots, and roads, could be reused at road bed material, laydown areas, or for clean fill onsite. Land-clearing debris from construction at an alternate location could be land filled on site. Overall, the waste impacts would be SMALL for a NGCC plant sited at an alternate site or a repowered site.

Cooling towers for a new NGCC alternative would be much smaller than those proposed in 8.1.1, and would not need to be constructed on slopes near the Hudson. Waste generation from plant construction, then, is much less than in 8.1.1.2. The waste-related impacts associated with construction of a five-unit NGCC plant with closed-cycle cooling systems at the IP2 and IP3 site would be SMALL.

- **Human Health**

Human health effects from the operation of a NGCC alternative with SCR emissions controls would likely not be detected or would be sufficiently minor that they would neither destabilize nor noticeably alter any important attribute of the resource.

During construction activities there would be a risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry, and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, complying with worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene protocols, occupational health and safety controls, and radiation protection practices. Fewer workers would be on site for a shorter period of time to construct a NGCC plant than other new generation alternatives, and so exposure to occupational risks tends to be lower than other alternatives.

Overall, the impacts on human health of a NGCC alternative sited at IP2 and IP3, a repowered site, or at an alternate site would be considered SMALL.

- **Socioeconomics**

Construction of a NGCC plant would take approximately 3 years (DOE/EIA 2007b). Peak labor force would be approximately 1090 workers (NRC 1996). The NRC staff assumed that construction of an offsite alternative would take place while IP2 and IP3 continue operation and would be completed by the time the plants permanently cease operations. Entergy indicates that a gas-fired facility could be producing power before IP2 and IP3 shut down (Entergy 2007). Construction time periods and employment figures may vary somewhat a repowering project depending on the extent to which existing structures can be reused.

At the end of construction, the local population would be affected by the loss of as many as 1090 construction jobs. However, this loss would be partially offset by a postconstruction permanent employment. An additional construction workforce would be needed for the decommissioning of IP2 and IP3 which could temporarily offset the impacts of the lost construction and IP2 and IP3 jobs at the IP2 and IP3 site. A new NGCC plant at the IP2 and IP3 site would offset a small portion of lost employment, though, according to Levitan and Associates, it may provide more revenues to the surrounding jurisdictions than IP2 and IP3 do (2005). The large and diverse economic base of the region would help to offset or minimize the significance of job losses.

The NRC staff concludes that the overall socioeconomic impacts from the NGCC alternative could be SMALL to MODERATE during construction and could be SMALL to MODERATE during operation at most sites, depending largely on tax impacts.

- **Transportation**

Impacts associated with transportation of the construction and operating personnel to the plant site would depend on the population density and transportation infrastructure in the vicinity of the site. During the 3-year construction period of the NGCC facility, approximately 1090 construction workers may be working at the site. The addition of these workers would increase traffic on highways and local roads that lead to the construction site. The impact of this additional traffic would have a SMALL to MODERATE impact on nearby roadways, depending on road infrastructure and existing traffic demands. Rural areas would typically experience a greater impact than urban or suburban areas. Impacts associated with plant operating personnel commuting to and from work are considered SMALL at all sites. Because the NGCC alternative relies on pipelined fuel, transportation impacts from natural gas supply are not likely to be noticeable, though plant operators will have to ensure that sufficient gas transportation capacity exists.

- **Aesthetics**

The combustion turbines and the heat-recovery boilers of the NGCC plant would be relatively low structures compared to existing plant facilities, but could be visible from the Hudson River if located at the current IP2 and IP3 site. Some facility structures could be visible from offsite locations as well. The impact on aesthetic resources of a NGCC plant is likely less than the impact of the current nuclear plant, excepting when cooling towers produce noticeable plumes. Overall, aesthetic impacts from a NGCC plant constructed at the IP2 and IP3 site would likely be SMALL. Impacts on a repowered site would be similar to those at the Indian Point site. In some cases, substantial portions of onsite infrastructure may be reused such that the aesthetic impacts of a repowered facility differ little from those of the facility prior to repowering.

At an alternate site, new buildings, cooling towers, cooling tower plumes, and electric transmission lines would be visible off site. Visual impacts from new transmission lines or a pipeline ROW would also be significant, though these may be minimized by building near existing transmission lines or on previously developed land. Additionally, aesthetic impacts would be minimized if the plant were located in an industrial area adjacent to other power plants. Overall, the aesthetic impacts associated with the NGCC alternative at alternate site could be SMALL to LARGE, though LARGE impacts would be expected only in cases where substantial new transmission is necessary, and the lines have a significant effect on important aesthetic values.

- **Historic and Archeological Resources**

As noted in Section 8.1.1.2, Entergy's recent Phase 1b survey revealed additional onsite historic and prehistoric resources.A cultural resource inventory would be needed for any property at a new site or adjacent to the IP2 and IP3 site that has not been previously surveyed. The survey would include an inventory of field cultural resources, identification and recording of existing historic and archeological resources, and possible mitigation of adverse effects from subsequent ground-disturbing actions related to physical expansion of the plant site. The studies would likely be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs).

The impacts to historic and archeological resources for the NGCC alternative at the IP2 and IP3 site would be similar to, or less than those described in Section 8.1.1.2 of this SEIS for the closed-cycle cooling alternative (given that the NGCC alternative would require less than half the cooling tower capacity needed by IP2 and IP3. These impacts can likely be effectively managed, and could range from SMALL to MODERATE if surveys reveal unavoidable conflicts between the new facility and onsite resources. Impacts at a repowered site would likely entail similar impacts of disturbance. At a repowered site, it may be possible to begin construction in power block areas at a repowering site, while such reuse or repurposing would not be possible until after Indian Point structures are no longer needed (and, perhaps, until decommissioning occurs).

Historic and archeological resource impacts can generally be effectively managed on alternate sites and, as such, would be considered SMALL to MODERATE at a new, undeveloped site. For a previously developed site, impact on cultural and historic resources would also be SMALL to MODERATE. Previous development would likely have either removed items of archeological interest or may have included a survey for sensitive resources. Any significant resources identified would have to be handled in accordance with the NHPA.

- **Environmental Justice**

As described in Section 8.1.1.2 of this SEIS, impacts to the environment or community from actions at the IP2 and IP3 site, including the construction of a NGCC plant, are not likely to disproportionately affect minority or low-income populations because these populations in the area around the site are proportionately small compared to the geographical region's population. Therefore, the NGCC alternative constructed at the IP2 and IP3 site would have SMALL impacts on environmental justice. At a repowered site or at an alternate site, impacts would depend upon the site chosen, nearby population characteristics, and economic conditions. These impacts would range from SMALL to LARGE, depending on impacts and the distribution of low-income and minority populations. At a repowered site, impact levels would