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United States Nuclear Regulatory Commission

Protecting People and the Environment

NUREG-1437
Supplement 44

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 44

Regarding Crystal River Unit 3 Nuclear Generating Plant

Draft Report for Comment

Office of Nuclear Reactor Regulation

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Draft Report for Comment

Manuscript Completed: May 2011
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Office of Nuclear Reactor Regulation

Proposed Action	Issuance of a renewed operating license, DPR-72, for Crystal River Unit 3 Nuclear Generating Plant in the city of Crystal River, Citrus County, Florida.
Type of Statement	Draft Supplemental Environmental Impact Statement
Agency Contact	Daniel Doyle U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Mail Stop O-11F1 Washington, D.C. 20555-0001 Phone: 301-415-3748 E-mail: Daniel.Doyle@nrc.gov
Comments	Any interested party may submit comments on this supplemental environmental impact statement. Please specify NUREG-1437, Supplement 44, draft, in your comments. Comments must be received by July 25, 2011. Comments received after the expiration of the comment period will be considered if it is practical to do so, but assurance of consideration of late comments will not be given. Comments may be submitted electronically by searching for docket ID NRC-2009-0039 at the federal rulemaking website, http://www.regulations.gov. Comments may also be mailed to: Cindy Bladey, Chief Rules, Announcements, and Directives Branch Division of Administrative Services Office of Administration Mail Stop: TWB-05-B01M U.S. Nuclear Regulatory Commission Washington, D.C. 20555-0001 Please be aware that any comments that you submit to the NRC will be considered a public record and entered into the Agencywide Documents Access and Management System (ADAMS). Do not provide information you would not want to be publicly available.

ABSTRACT

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Florida Power Corporation, doing business as Progress Energy Florida, Inc., to renew the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3) for an additional 20 years.

This draft SEIS includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from a new supercritical coal-fired plant, a new natural gas-fired combined-cycle plant, a combination of alternatives that includes some natural gas-fired capacity and energy conservation, and not renewing the license (the no-action alternative).

The U.S. Nuclear Regulatory Commission's (NRC's) preliminary recommendation is that the adverse environmental impacts of license renewal for CR-3 are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on: (1) the analysis and findings in NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*; (2) the environmental report submitted by Florida Power Corporation; (3) consultation with Federal, State, and local agencies; (4) the NRC's environmental review; and (5) consideration of public comments received during the scoping process.

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BACKGROUND

By letter dated December 16, 2008, Florida Power Corporation (FPC), doing business as Progress Energy Florida, Inc., submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to issue a renewed operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3) for an additional 20-year period.

Pursuant to Title 10 of the *Code of Federal Regulations*, Section 51.20(b)(2) (10 CFR 51.20(b)(2)), the NRC notes that a renewal of a power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c) states that the NRC shall prepare an EIS which is a supplement to NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC, 1996), (NRC, 1999a).

Upon acceptance of FPC's application, the NRC staff (Staff) began the environmental review process, described in 10 CFR Part 51, by publishing a Notice of Intent to prepare a supplemental environmental impact statement (SEIS) and conduct scoping. In preparation of this SEIS for CR-3, the Staff performed the following actions:

- conducted public scoping meetings on April 16, 2009, in Crystal River, Florida
- conducted a site visit at the plant in July 2009
- reviewed FPC's environmental report (ER) (Progress Energy, 2008) and compared it to the GEIS
- consulted with other agencies
- conducted a review of the issues following the guidance set forth in NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC, 1999b)
- considered public comments received during the scoping process

PROPOSED ACTION

FPC initiated the proposed Federal action—issuing a renewed power reactor operating license—by submitting an application for license renewal of CR-3, for which the existing license, DPR-72, will expire on December 3, 2016. The NRC's Federal action is the decision whether to renew the license for an additional 20 years.

PURPOSE AND NEED FOR ACTION

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of the current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by other energy-planning decisionmakers. This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review required by the Atomic Energy Act or findings in the National Environmental Policy Act (NEPA) environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions such as those of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, the appropriate energy-planning decisionmakers and FPC will ultimately decide if the plant will continue to operate based on factors such as the need for power or other energy-planning matters. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, December 3, 2016.

ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL

The SEIS evaluates the potential environmental impacts of the proposed action. The environmental impacts from the proposed action are designated as SMALL, MODERATE, or LARGE. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- The environmental impacts associated with the issue are 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.
- 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.
- Mitigation of adverse impacts associated with the issue is 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 Category 1 issues, no additional site-specific analysis is required in this SEIS unless new and significant information is found. Chapter 4 of this SEIS presents the process for finding and evaluating new and significant information. Site-specific issues (Category 2) are those that do not meet one or more of the criteria for Category 1 issues; therefore, a site-specific review is required, and the results are documented in the SEIS.

The NRC has reviewed FPC's established process for finding and evaluating new and significant information on the environmental impacts of renewing the CR-3 operating license. The CR-3 ER, scoping comments, and other available data records on CR-3 were reviewed by the NRC and evaluated for new and significant information. However, no new and significant information on Category 1 issues was identified during this review that would change the conclusions presented in the GEIS. Therefore, for these Category 1 issues, impacts during the renewal term are not expected to exceed those discussed in the GEIS.

LAND USE

SMALL. The NRC did not note any Category 2 issues for land use, nor did the Staff find any new and significant information during the environmental review. Therefore, for plant operation during the license renewal term, there are no land use impacts beyond those discussed in the GEIS. For these issues, the NRC concludes in the GEIS that the impacts are SMALL.

AIR QUALITY

SMALL. The NRC did not note any Category 2 issues for air quality impacts, nor did the Staff find any new and significant information during the environmental review. Therefore, for plant operation during the license renewal term, there are no air quality impacts beyond those discussed in the GEIS. For these issues, the NRC concludes in the GEIS that the impacts are SMALL.

GROUNDWATER USE AND QUALITY

SMALL. The NRC evaluated the direct and indirect impacts due to groundwater use conflicts during the license renewal term and concluded that the impacts would be SMALL. The GEIS considers this a Category 2 issue. All other groundwater issues are considered Category 1. The NRC did not find any new and significant information during the environmental review regarding these Category 1 issues. Therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS. For these Category 1 issues, the NRC concludes in the GEIS that the impacts are SMALL.

SURFACE WATER USE AND QUALITY

SMALL. All surface water issues are considered Category 1. The NRC did not find any new and significant information during the environmental review. Therefore, for plant operation during the license renewal term, there are no surface water impacts beyond those discussed in the GEIS. For these issues, the NRC concludes in the GEIS that the impacts are SMALL.

AQUATIC RESOURCES

SMALL to MODERATE. The NRC evaluated the direct and indirect impacts of entrainment, impingement, and heat shock from continued operations during the license renewal term on fish and shellfish and concluded that the impacts would be SMALL to MODERATE. The GEIS considers these Category 2 issues. All other aquatic ecology issues are considered Category 1. The NRC did not find any new and significant information during the environmental review regarding these Category 1 issues.

TERRESTRIAL RESOURCES

SMALL. With the exception of threatened or endangered species (discussed below), all terrestrial ecology issues are considered Category 1, and, for these, the NRC did not find any new and significant information during the environmental review. Therefore, for plant operation during the license renewal term, there are no impacts to terrestrial resources beyond those discussed in the GEIS. For these Category 1 issues, the NRC concludes in the GEIS that the impacts are SMALL.

THREATENED AND ENDANGERED SPECIES

SMALL. The NRC evaluated the direct and indirect impacts of continued operations during the license renewal term on terrestrial and aquatic threatened and endangered species and concluded that the impacts would be SMALL. The GEIS considers this a Category 2 issue.

HUMAN HEALTH

SMALL. With regard to Category 1 human health issues during the license renewal term—microbiological organisms (occupational health), noise, radiation exposures to public, and occupational radiation exposures—the NRC did not identify any new and significant information during the environmental review. In addition, the NRC's review of the historical data on radiation doses from radioactive releases from CR-3 demonstrates that it is operating in compliance with Federal radiation protection standards. Continued compliance with regulatory requirements is expected during the license renewal term. Therefore, for plant operations during the license renewal term, there are no impacts beyond those discussed in the GEIS for these Category 1 issues, and the NRC concludes in the GEIS that the impacts are SMALL.

Microbiological organisms (public health) and electromagnetic fields – acute effects (electric shock) are Category 2 human health issues. The issue of microbiological organisms does not apply to CR-3. Based on its review of relevant information, the NRC concludes that the potential impacts from electric shock during the renewal term would be SMALL. For chronic effects of electromagnetic fields, the NRC considers the GEIS finding of "uncertain" still appropriate and will continue to follow developments on this issue.

SOCIOECONOMICS

SMALL. For Category 1 issues (public services and aesthetic impacts), no new and significant information was found during the environmental review. Therefore, there would be no impacts beyond those discussed in the GEIS. Category 2 socioeconomic impact issues include housing impacts, public services (public utilities), offsite land use, public services (public transportation), and historic and archaeological resources.

Since FPC has no plans to add additional outage and non-outage employees during the license renewal period, employment levels at CR-3 would remain relatively constant with no additional demand for permanent housing during the license renewal term. Based on this information, there would be no impact on housing during the license renewal term beyond what has already been experienced.

For the same reason, demand for public water services will remain relatively unchanged with no additional demand. Public water systems in the region would be adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no additional impact to public water services during the license renewal term beyond what is currently being experienced.

Since non-outage employment levels at CR-3 would remain relatively constant during the license renewal period, there would be no land use impacts related to population or tax revenues and no transportation impacts. Therefore, offsite land use and transportation issues would remain relatively unchanged.

No impacts to known historic and archaeological resources are expected from the continued operation of CR-3 during the license renewal term. This conclusion is based on the results of archaeological surveys done on the property before initial plant and transmission line construction; a review of Florida State Historic Preservation Office Master Site Files, published literature, and information supplied by FPC; and verified use of existing environmental procedures by CR-3.

With respect to environmental justice, the NRC also finds 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 water, local food, fish, and wildlife.

SEVERE ACCIDENT MITIGATION ALTERNATIVES

Since FPC had not previously considered alternatives to reduce the likelihood or potential consequences of a variety of highly uncommon but potentially serious accidents at CR-3, NRC regulation 10 CFR 51.53(c)(3)(ii)(L) requires that FPC evaluate severe accident mitigation alternatives (SAMAs) in the course of the license renewal review. SAMAs are potential ways to reduce the risk or potential impacts of uncommon but potentially severe accidents and may include changes to plant components, systems, procedures, and training.

The NRC reviewed the ER's evaluation of potential SAMAs. Based on the review, the NRC concluded that none of the potentially cost-beneficial SAMAs relate to managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

ALTERNATIVES

The NRC considered the environmental impacts associated with alternatives to renewing the CR-3 operating license. These alternatives include other methods of power generation and not renewing the CR-3 operating license (the no-action alternative). Replacement power alternatives considered were supercritical coal-fired generation, natural gas combined-cycle generation; and a combination alternative that includes natural gas and conservation. The no-action alternative and the effects it would have were also considered by the NRC. The NRC evaluated each alternative using the same impact areas that were used in evaluating impacts from license renewal. Where possible, the NRC considered the existing infrastructure at the CR-3 site (e.g., transmission facilities, water intakes, and discharges) and whether it could be used by new alternative power plants. The results of this evaluation are summarized in Table ES-1.

The NRC also considered a number of replacement power alternatives to renewing the CR-3 operating license; these were later eliminated from detailed study due to technical, resource availability, or commercial limitations that currently exist and are likely to continue to exist when the existing CR-3 license expires. Replacement power alternatives considered but eliminated from detailed study include: offsite coal- and gas-fired capacity, coal-fired integrated gasification combined-cycle generation, new nuclear, energy conservation/energy efficiency, purchased power, wind power (onshore/offshore), solar power, wood waste, hydroelectric power, wave and ocean energy, geothermal power, municipal solid waste, biofuels, oil-fired power, fuel cells, and delayed retirement.

COMPARISON OF ALTERNATIVES

The supercritical coal-fired generation alternative is not an environmentally preferable alternative due to impacts to air quality from nitrogen oxides, sulfur oxides, particulate matter, polycyclic aromatic hydrocarbons, carbon monoxide, carbon dioxide, and mercury (and the corresponding human health impacts), as well as construction impacts to aquatic, terrestrial, and potential historic and archaeological resources.

The natural gas combined-cycle generation alternative would have slightly lower air emissions, and waste management and socioeconomic impacts would be lower than the coal-fired alternative. The combination alternative would have lower air emissions and waste management impacts than both the gas-fired and coal-fired alternatives.

In conclusion, the environmentally preferred alternative in this case is the license renewal of CR-3. All other alternatives capable of meeting the needs currently served by CR-3 entail potentially greater impacts than the proposed action of license renewal of CR-3. Because the no-action alternative necessitates the implementation of one or a combination of alternatives, all of which have greater impacts than the proposed action, the no-action alternative would have environmental impacts greater than or equal to the proposed license renewal action.

Table ES-1. Summary of Environmental Impacts of Proposed Action and Alternatives

Alternative	Impact Area						
	Air Quality	Groundwater	Surface Water	Aquatic and Terrestrial Resources	Human Health	Socioeconomics	Waste Management
License renewal of CR-3	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL
Supercritical coal-fired generation	MODERATE	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	MODERATE
Natural gas combined-cycle generation	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Combination alternative	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
No-action alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

RECOMMENDATION

The NRC's preliminary recommendation is that the environmental impacts of license renewal for CR-3 are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on the following:

- the analysis and findings in the GEIS (NRC, 1996), (NRC, 1999)
- the ER submitted by FPC (Progress Energy, 2008)
- consultation with Federal, State, and local agencies
- the NRC's environmental review
- consideration of public comments received during the scoping process

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."

Atomic Energy Act of 1954. § 42 U.S.C. § 2011, et seq.

National Environmental Policy Act of 1969. § 42 U.S.C. § 4321, et seq.

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volumes 1 and 2, Washington, D.C., May 1996, Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML040690705 and ML040690738.

NRC (U.S. Nuclear Regulatory Commission). 1999a. *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, D.C., August 1999, ADAMS Accession No. ML04069720.

NRC (U.S. Nuclear Regulatory Commission). 1999b. *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*, NUREG-1555, Washington, D.C., October 1999, ADAMS Accession No. ML003702019.

Progress Energy (Progress Energy Florida, Inc.). 2008. "Crystal River Unit 3 – License Renewal Application, Applicant's Environmental Report, Operating License Renewal Stage," November 2008, ADAMS Accession No. ML090080731.

ABBREVIATIONS AND ACRONYMS

AADT	annual average daily traffic
ac	acre
AC	alternating current
ACC	averted cleanup and decontamination cost
ACHP	Advisory Council on Historic Preservation
ADAMS	Agencywide Documents Access and Management System
AEC	U.S. Atomic Energy Commission
AFW	auxiliary feedwater
ALARA	as low as is reasonably achievable
AOC	averted offsite property damage cost
AOE	averted occupational exposure
AOSC	averted onsite cost
APE	area of potential effect
AQCR	Air Quality Control Region
AQI	Air Quality Index
APE	averted public exposure
B.P.	before present
BEST	backup engineered safeguards transformer
BTU	British thermal unit
BWST	borated water storage tank
°C	degrees Celsius
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CCP	Coal Combustion Products
CCUD	Citrus County Utilities Division
CDF	core damage frequency

CEQ	Council on Environmental Quality
CET	containment event tree
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CGCC	coal gasification combined cycle
cm	centimeter
CO	carbon monoxide
COE	cost of enhancement
COL	combined license
COLA	combined operating license application
CR-3	Crystal River Unit 3 Nuclear Generating Plant
CRD	control rod drive
CREC	Crystal River Energy Complex
CST	condensate storage tank
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DAW	dry active waste
dBA	decibel
DBA	design-basis accident
dbh	diameter at breast height
DC	direct current
DECON	decontamination and dismantlement
DH	decay heat
DHCC	decay heat closed cooling
DHR	decay heat removal
DHV	decay heat valve
DOE	U.S. Department of Energy
DSM	demand-side management

E.O.	executive order
EAC	Early Action Compact
EDG	emergency diesel generator
EFIC	emergency feedwater initiation and control
EFP	emergency feedwater pump
EFW	emergency feedwater
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
EOP	emergency operating procedure
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EPU	extended power uprate
EPZ	emergency planning zone
ER	environmental report
ESA	Endangered Species Act of 1973
°F	degrees Fahrenheit
F&O	fact and observation
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FERC	Federal Energy Regulatory Commission
FES	final environmental statement
FGD	flue gas desulfurization
FGT	Florida Gas Transmission Company, LLC
FGUA	Florida Government Utilities Authority
FIVE	fire-induced vulnerability evaluation
FL	Florida
FNAI	Florida Natural Areas Inventory
FPC	Florida Power Corporation
FPSC	Florida Public Service Commission

FSAR	final safety analysis report
ft	feet
ft^2	square foot
FTS	failure to start
FWC	Florida Fish and Wildlife Conservation Commission
FWP	feedwater pump
FWS	U.S. Fish and Wildlife Service
gal	gallon
GCRP	U.S. Global Change Research Program
GEIS	generic environmental impact statement
GGC	groundwater guidance concentrations
GIS	geographic information system
GL	generic letter
gpd	gallons per day
gpm	gallons per minute
ha	hectare
HCLPF	high confidence in low probability of failure
HEP	human-error probability
HEPA	high-efficiency particulate air
HIC	high-integrity container
hp	horsepower
HPI	high-pressure injection
hr	hour
HRA	human reliability analysis
HVAC	heating, ventilation, and air conditioning
HX	heat exchanger
Hz	hertz
IPA	integrated plant assessment

IPE	individual plant examination
IPEE	individual plant examination of external events
ISFSI	independent spent fuel storage installation
ISLOCA	interfacing system loss-of-coolant accident
ITS	Incidental Take Statement
kg	kilogram per year
km	kilometer
km^2	square kilometer
kV	kilovolt
kW	kilowatt
L	liter
lb	pound
LERF	large early release frequency
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LOS	level of service
µg/L	micrograms per liter
m	meter
m^2	square meter
m^3	cubic meter
m^3/d	cubic meter per day
MAAP	modular accident analysis program
MACCS2	MELCOR Accident Consequence Code System 2
MBTA	Migratory Bird Treaty Act
mg/L	milligrams per liter
mgpd	million gallons per day
mGy	milligray
mi	mile

MMACR	modified maximum averted cost risk
MOR	model of record
MOV	motor-operated valve
mrad	millirad
mrem	millirem
MSA	Metropolitan Statistical Area
msl	mean sea level
MSO	multiple spurious operation
mSv	millisievert
MSW	municipal solid waste
MTHM	metric ton
MUP	makeup and purification system
MUV	makeup valve
MW	megawatt
MWd/MTU	megawatt days per metric ton uranium
MWe	megawatts-electric
MWt	megawatts-thermal
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NCDC	National Climatic Data Center
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESC®	National Electrical Safety Code®
NHPA	National Historic Preservation Act of 1966
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System

NRC	U.S. Nuclear Regulatory Commission
NRHP	*National Register of Historic Places*
NSSS	nuclear steam supply system
NWS	National Weather Service
O_3	ozone
ODC	ozone depleting compounds
ODCM	offsite dose calculation manual
OTCW	once-through condenser cooling water
OTSG	once-through steam generator
PAH	polycyclic aromatic hydrocarbon
Pb	lead
pCi/L	picocuries per liter
PD&E	project development and environment
PDS	plant damage state
PDWS	primary drinking water standards
PM	particulate matter
PM_{10}	particulate matter, 10 microns or less in diameter
$PM_{2.5}$	particulate matter, 2.5 microns or less in diameter
POD	point of discharge
PORV	power-operated relief valve
ppm	parts per million
ppt	parts per thousand
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
PTE	potential to emit
psu	practical salinity units
PWR	pressurized-water reactor
RAI	request for additional information

rad	radiation absorbed dose
RB	reactor building
rem	roentgen equivalent man
REMP	radiological environmental monitoring program
RFO	refueling outage
RG	regulatory guide
RGWDS	radioactive gas waste disposal system
RICE	reciprocating internal combustion engine
RLE	review level earthquake
RLWDS	radioactive liquid waste disposal system
ROI	region of influence
ROW	right-of-way
RPC	replacement power cost
RRW	risk reduction worth
RWP	raw water pump
s	second
SAFSTOR	safe storage of the stabilized and defueled facility
SAMA	severe accident mitigation alternatives
SAR	safety analysis report
SAV	submerged aquatic vegetation
SCPC	supercritical pulverized coal
SCT	south cooling tower
SDWS	secondary drinking water standards
SEIS	supplemental environmental impact statement
SER	safety evaluation report
SERCC	Southeast Regional Climate Center
SG	steam generator
SGTR	steam generator tube rupture
SHPO	State Historic Preservation Office

SMA	Seismic Margins Assessment
SMITTR	surveillance, monitoring, inspections, testing, trending, and recordkeeping
SO_2	sulfur dioxide
SO_x	oxides of sulfur
SQUG	Seismic Qualification User's Group
Sv	sievert
SFWMD	Southwest Florida Water Management District
TDS	total dissolved solids
TECO	Tampa Electric Company
TLD	thermoluminescent dosimeter
TtNUS	Tetra Tech NUS
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USDOI	U.S. Department of Interior
USGS	U.S. Geological Survey
USI	unresolved safety issue
WRWSA	Withlacoochee Regional Water Supply Authority
WTE	waste-to-energy
WUCA	Water Use Caution Areas
yr	year

1.0 PURPOSE AND NEED FOR ACTION

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51)—which carry out the National Environmental Policy Act of 1969 (NEPA)—issuance of a new nuclear power plant operating license requires the preparation of an environmental impact statement (EIS).

The Atomic Energy Act of 1954 (AEA) originally specified that licenses for commercial power reactors be granted for up to 40 years with an option to renew for another 20 years. The 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility.

The decision to seek a license renewal rests entirely with nuclear power facility owners and, typically, is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC makes the decision to grant or deny license renewal based on whether the applicant has demonstrated that the environmental and safety requirements in the agency's regulations can be met during the period of extended operation.

1.1 PROPOSED FEDERAL ACTION

Florida Power Corporation (FPC), doing business as Progress Energy Florida, Inc., initiated the proposed Federal action by submitting an application for license renewal of Crystal River Unit 3 Nuclear Generating Plant (CR-3), for which the existing license, DPR-72, expires on December 3, 2016. The NRC's proposed Federal action is the decision whether to renew the license for an additional 20 years.

1.2 PURPOSE AND NEED FOR THE PROPOSED FEDERAL ACTION

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by other energy-planning decisionmakers. This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review required by the AEA or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, State regulatory agencies and FPC will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, December 3, 2016.

1.3 MAJOR ENVIRONMENTAL REVIEW MILESTONES

FPC submitted an environmental report (ER) (Progress Energy, 2008b) as part of its license renewal application (Progress Energy, 2008a) in December 2008. After reviewing the application and the ER for sufficiency, the NRC published a Notice of Acceptance and Opportunity for Hearing in the *Federal Register* (NRC, 2009a) on March 9, 2009. The NRC published another notice in the *Federal Register* on April 6, 2009 (NRC, 2009b), announcing its intent to prepare an EIS and conduct scoping, thus beginning the scoping period.

The NRC held two public scoping meetings on April 16, 2009, in Crystal River, Florida. The NRC report entitled, “Environmental Impact Statement Scoping Process Summary Report for Crystal River Unit 3 Nuclear Generating Plant,” dated March 2011, presents the comments received during the scoping process (NRC, 2011). Appendix A to this draft supplemental environmental impact statement (SEIS) presents the comments considered to be within the scope of the environmental license renewal review and the associated NRC responses.

In order to verify information given in the ER, NRC staff visited the CR-3 site in July 2009. During the site visit, NRC staff met with plant personnel; reviewed specific documentation; toured the facility; and met with interested Federal, State, and local agencies.

Figure 1.3-1 shows the major milestones in the public review of the SEIS. Upon completion of the scoping period and site visit, the NRC prepared and issued this draft SEIS. This document is made available for public comment for 45 days. During this time, the NRC will host public meetings and collect public comments. Based on the information gathered, the NRC will amend the draft SEIS findings as necessary and then publish the final SEIS.

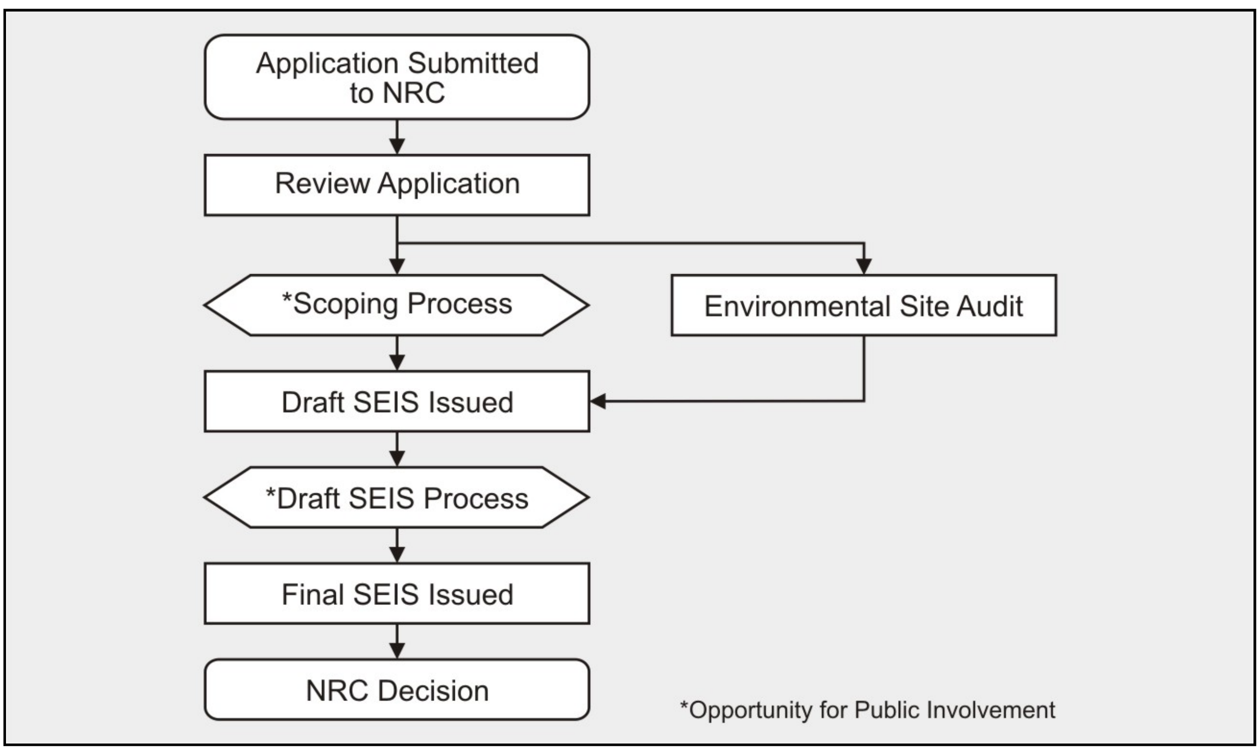

Figure 1.3-1. Environmental Review Process. *The process gives opportunities for public involvement.*

The NRC has established a license renewal process that can be completed in a reasonable period of time with clear requirements to assure safe plant operation for up to an additional 20 years of plant life. The safety review is done simultaneously with the environmental review. The findings of the safety review are documented in a safety evaluation report (SER). The NRC considers the findings in both the SEIS and the SER in its decision to either grant or deny the issuance of a renewed license.

1.4 GENERIC ENVIRONMENTAL IMPACT STATEMENT

To help in the preparation of individual operating license renewal EISs, the NRC prepared the *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS), NUREG-1437. In preparing the GEIS, the Commission determined that certain environmental impacts associated with the renewal of a nuclear power plant operating license were the same or similar for all plants and, as such, could be treated on a generic basis. In this way, repetitive reviews of these environmental impacts could be avoided. The generic assessment of the environmental impacts associated with license renewal was used to improve the efficiency of the license renewal process. The GEIS documents the findings of a systematic inquiry into the environmental impacts of continued operations and refurbishment activities associated with license renewal.

During the preparation of the GEIS, the NRC identified 92 environmental issues associated with license renewal. Of the 92 environmental issues analyzed, 69 issues were resolved generically (i.e., Category 1); 21 would require plant-specific analysis assessments by license renewal applicants and review by the NRC (i.e., Category 2); and 2 issues, chronic effects of electromagnetic fields and environmental justice, were not categorized. The NRC performs a plant-specific environmental justice impact analysis for each license renewal. Appendix B of this SEIS lists all 92 issues.

For each potential environmental issue, the GEIS provides the following information:

- describes the activity that affects the environment
- notes the population or resource that is affected
- assesses the nature and magnitude of the impact on the affected population or resource
- characterizes the significance of the effect for both beneficial and adverse effects
- determines if the results of the analysis apply to all plants
- considers if additional mitigation measures would be warranted for impacts that would have the same significance level for all plants

The NRC's standard of significance for impacts was established using the Council on Environmental Quality (CEQ) terminology for "significantly" as used in the NEPA, which requires consideration of both context and intensity (see 40 CFR 1508.27). The NRC established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE—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, important attributes of the resource.
- **LARGE**—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

> ***Significance*** shows the importance of likely environmental impacts and is determined by considering two variables: **context** and **intensity**.
>
> ***Context*** is the geographic, biophysical, and social context in which the effects will occur.
>
> ***Intensity*** refers to the severity of the impact, in whatever context it occurs.

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 (Figure 1.4-1). Issues are assigned a Category 1 or a Category 2 designation. As presented in the GEIS, Category 1 issues are those that meet the following criteria:

- 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.
- 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).
- 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.

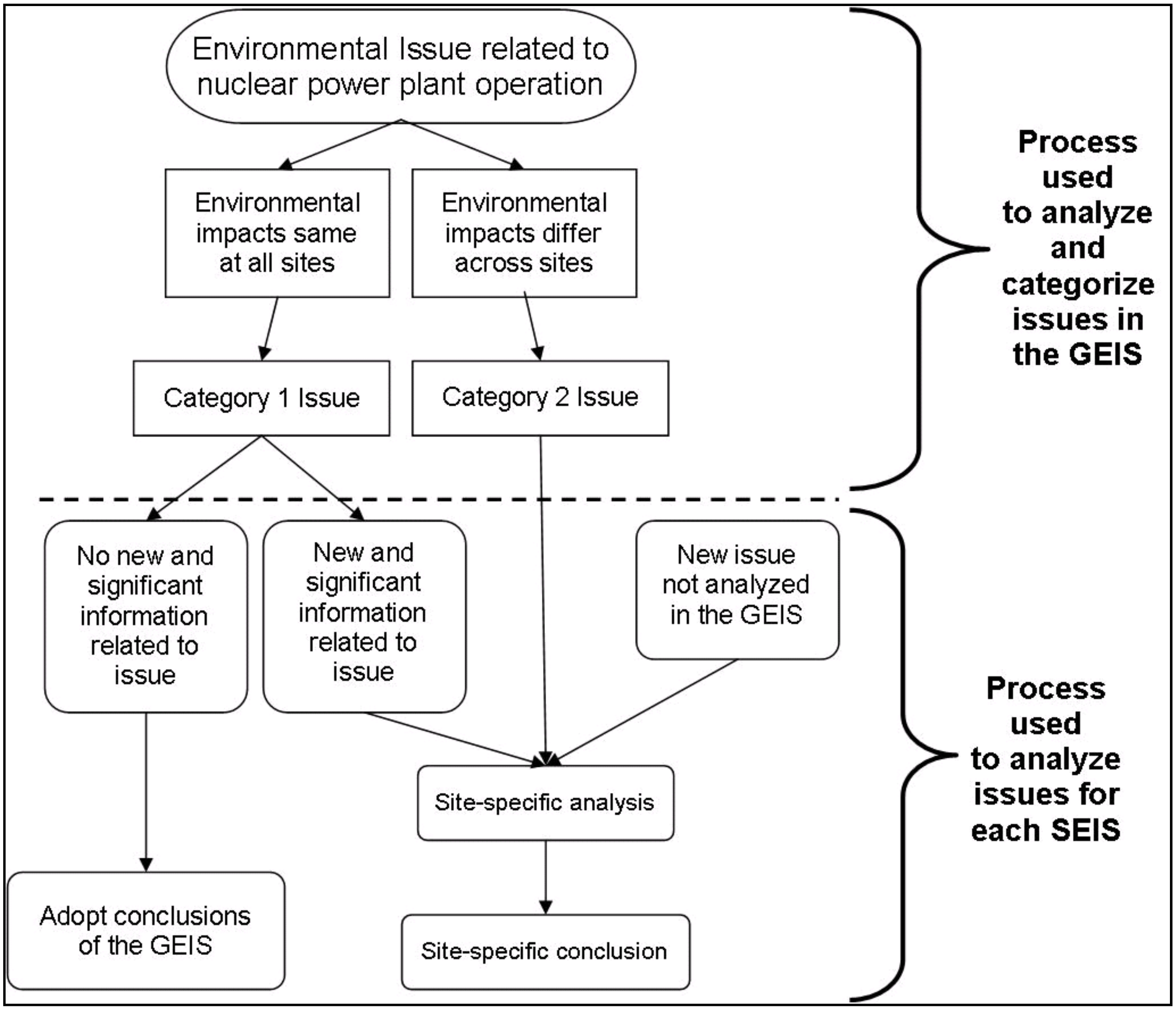

Figure 1.4-1. Environmental Issues Evaluated During License Renewal. *As previously discussed, the GEIS evaluated 92 issues. Of those 92 issues, 23 require a site-specific analysis.*

For generic issues (Category 1), a site-specific analysis is not required in this SEIS unless new and significant information is found. Chapter 4 of this SEIS presents the process for finding new and significant information. Site-specific issues (Category 2) are those that do not meet one or more of the criteria of Category 1 issues, and, therefore, a site-specific review for these issues is required. The SEIS presents the results of the site-specific review.

1.5 SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

The SEIS presents an analysis that considers the environmental effects of the continued operation of CR-3, alternatives to license renewal, and mitigation measures for minimizing adverse environmental impacts. Chapter 8 contains an analysis and comparison of the potential environmental impacts from alternatives, and Chapter 9 presents the preliminary recommendation to the Commission as to whether or not the environmental impacts of license renewal are so great that preserving the option of license renewal would be unreasonable. The recommendation will be made after consideration of comments received during the public scoping period and on the draft SEIS.

In the preparation of this SEIS for CR-3, the NRC carried out the following activities:

- reviewed the information given in the FPC ER
- consulted with other Federal, State, and local agencies
- carried out an independent review of the issues during the site visit
- considered the public comments received during the scoping process

New and significant information either notes a significant environmental issue that was not covered in the GEIS or was not considered in the analysis in the GEIS and leads to an impact finding that is different from the finding presented in the GEIS.

New information can be found from many sources, including the applicant, the NRC, other agencies, or public comments. If a new issue is revealed, then it is first analyzed to determine if it is within the scope of the license renewal evaluation. If it is not addressed in the GEIS, the NRC determines its significance and documents its analysis in the SEIS.

1.6 COOPERATING AGENCIES

During the scoping process, no Federal, State, or local agencies were identified as cooperating agencies in the preparation of this SEIS.

1.7 CONSULTATIONS

The Endangered Species Act of 1973, as amended; the Magnuson Stevens Fisheries Conservation and Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 require that Federal agencies consult with applicable State and Federal agencies and groups before taking action that may affect endangered species, fisheries, or historic and archaeological resources, respectively. Below are the agencies and groups with whom the NRC consulted; Appendix D includes copies of consultation documents.

- Advisory Council on Historic Preservation
- Crystal River Refuge Manager
- Florida Department of Environmental Protection
- Florida Fish and Wildlife Conservation Commission
- Florida Natural Areas Inventory
- Florida State Historic Preservation Office
- Miccosukee Tribe of Florida

- National Marine Fisheries Service, Southeast Region
- Seminole Indian Tribe
- Seminole Nation of Oklahoma
- U.S. Environmental Protection Agency, Region 4
- U.S. Fish and Wildlife Service, Southeast Regional Office

1.8 CORRESPONDENCE

During the course of the environmental review, the NRC contacted the Federal, State, regional, local, and Tribal agencies listed in Section 1.7.

Appendix E contains a chronological list of all the documents sent and received during the environmental review.

A list of persons who received a copy of this draft SEIS is provided in Chapter 11.

1.9 STATUTES AND REGULATORY REQUIREMENTS

FPC is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. Appendix H to the GEIS describes some of the major Federal statutes. Appendix C to this SEIS includes a list of the permits and licenses issued by Federal, State, and local authorities for activities at CR-3.

1.10 REFERENCES

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

Atomic Energy Act of 1954. § 42 U.S.C. § 2011, et seq.

Endangered Species Act of 1973. § 16 U.S.C. § 1531, et seq.

Magnuson Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996. § 16 U.S.C. § 1855, et seq.

National Environmental Policy Act of 1969. § 42 U.S.C. § 4321, et seq.

National Historic Preservation Act. § 16 U.S.C. § 470, et seq.

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volumes 1 and 2, Washington, D.C., May 1996, Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML040690705 and ML040690738.

NRC (U.S. Nuclear Regulatory Commission). 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, D.C., August 1999, ADAMS Accession No. ML040690720.

NRC (U.S. Nuclear Regulatory Commission). 2009a. "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. DPR-72 for an Additional 20-Year Period; Florida Power Corporation; Crystal River Unit 3 Nuclear Generating Plant," *Federal Register*, Vol. 74, No. 44, March 9, 2009, pp. 10099–10101.

NRC (U.S. Nuclear Regulatory Commission). 2009b. "Crystal River Unit 3 Nuclear Generating Plant; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process," *Federal Register*, Vol. 74, No. 64, April 6, 2009, pp. 15523–15525.

NRC (U.S. Nuclear Regulatory Commission). 2011. "Environmental Impact Statement Scoping Process Summary Report for Crystal River Unit 3 Nuclear Generating Plant," ADAMS Accession No. ML110490462.

Progress Energy (Progress Energy Florida, Inc.). 2008a. "Crystal River Unit 3 – License Renewal Application," November 2008, ADAMS Accession No. ML090080053.

Progress Energy (Progress Energy Florida, Inc.). 2008b. "Crystal River Unit 3 – License Renewal Application, Applicant's Environmental Report, Operating License Renewal Stage," November 2008, ADAMS Accession No. ML090080731.

2.0 AFFECTED ENVIRONMENT

Crystal River Unit 3 Nuclear Generating Plant (CR-3) is located in Citrus County, Florida, on Crystal Bay, an embayment of the Gulf of Mexico. The plant lies approximately 80 miles (mi) (129 kilometers [km]) north of Tampa, Florida. Figure 2.1-1 and Figure 2.1-2 present the 50-mi (80-km) and 6-mi (10-km) vicinity maps, respectively.

The plant is part of the larger Crystal River Energy Complex (CREC), which includes the single nuclear unit and four fossil-fueled units, Crystal River Units 1, 2, 4, and 5 (CR-1, CR-2, CR-4, and CR-5).

The CR-3 facility operating license lists 10 licensees: Florida Power Corporation (FPC), City of Alachua, City of Bushnell, City of Gainesville, City of Kissimmee, City of Leesburg, City of New Smyrna Beach Utilities Commission and City of New Smyrna Beach, City of Ocala, Orlando Utilities Commission and City of Orlando, and Seminole Electric Cooperative. FPC, now doing business as Progress Energy Florida, Inc., submitted the CR-3 license renewal application to the U.S. Nuclear Regulatory Commission (NRC). Progress Energy Florida, Inc. is a wholly owned subsidiary of Progress Energy, a diversified energy services company headquartered in Raleigh, North Carolina. In this supplemental environmental impact statement (SEIS), the applicant is referred to as FPC. In the environmental report and correspondence, the applicant refers to itself as Progress Energy Florida, Inc. (Progress Energy).

For purposes of the evaluation in this SEIS, the “affected environment” is the environment that currently exists at and around CR-3. Because existing conditions are at least partially the result of past construction and operation at the plant, the impacts of these past and ongoing actions and how they have shaped the environment are presented here. The facility and its operation are described in Section 2.1, and the affected environment is presented in Section 2.2.

2.1 FACILITY DESCRIPTION

CR-3 is single unit nuclear power plant that began commercial operation in March 1977. The CREC site boundary encloses approximately 4,738 acres (ac) (1,917 hectares [ha]). The most conspicuous structures on the CREC include four fossil-fueled units, two large cooling towers, coal delivery and storage areas, ash storage basins, office buildings, warehouses, stacks, roads, barge handling docks, and a railroad. Figure 2.1-3 provides an overview of the CREC site boundary and Figure 2.1-4 provides the general layout of the CREC.

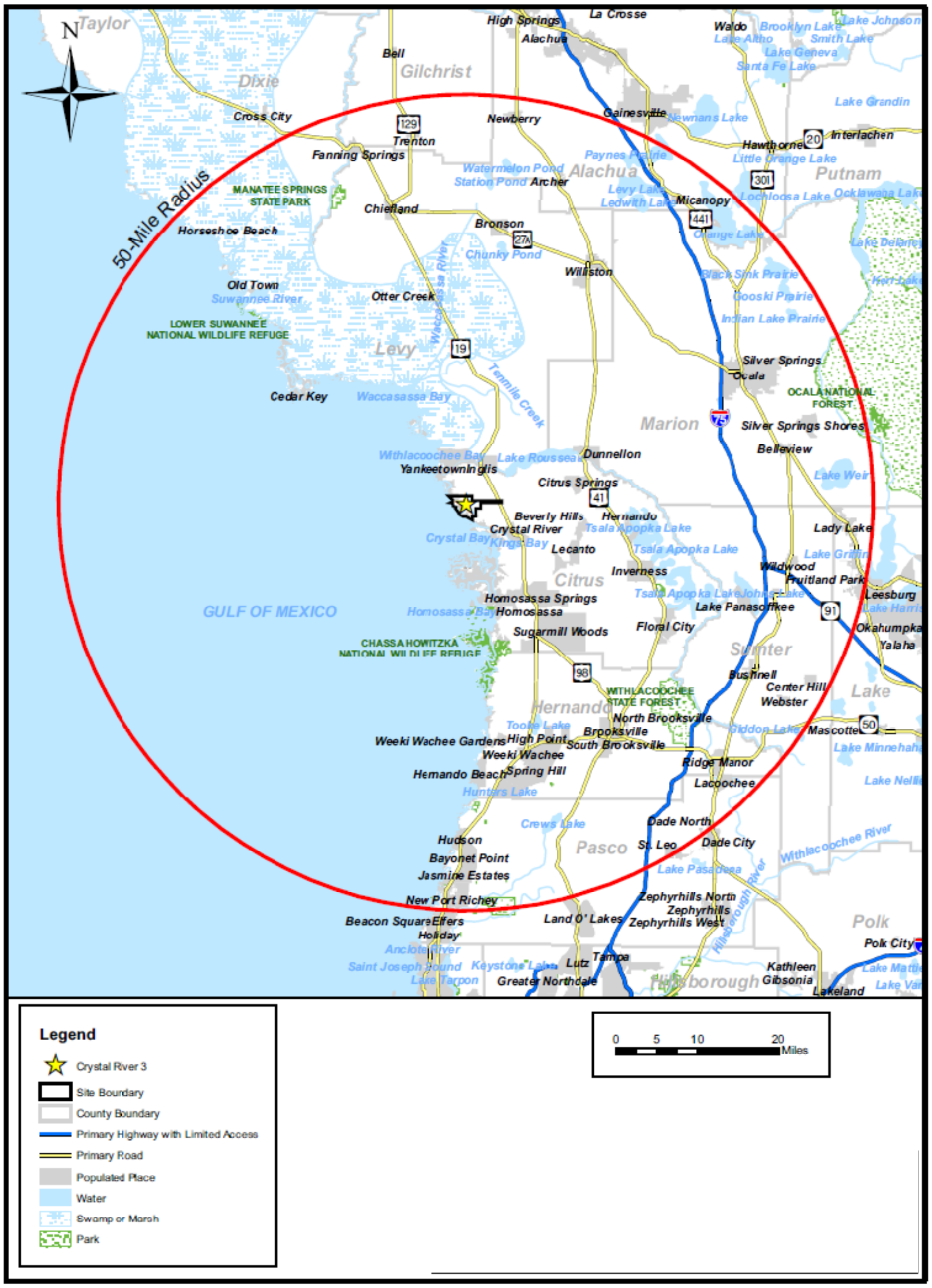

Figure 2.1-1. Location of Crystal River Unit 3 Nuclear Generating Plant, 50-Mile (80-Kilometer) Region (Source: Progress Energy, 2008a)

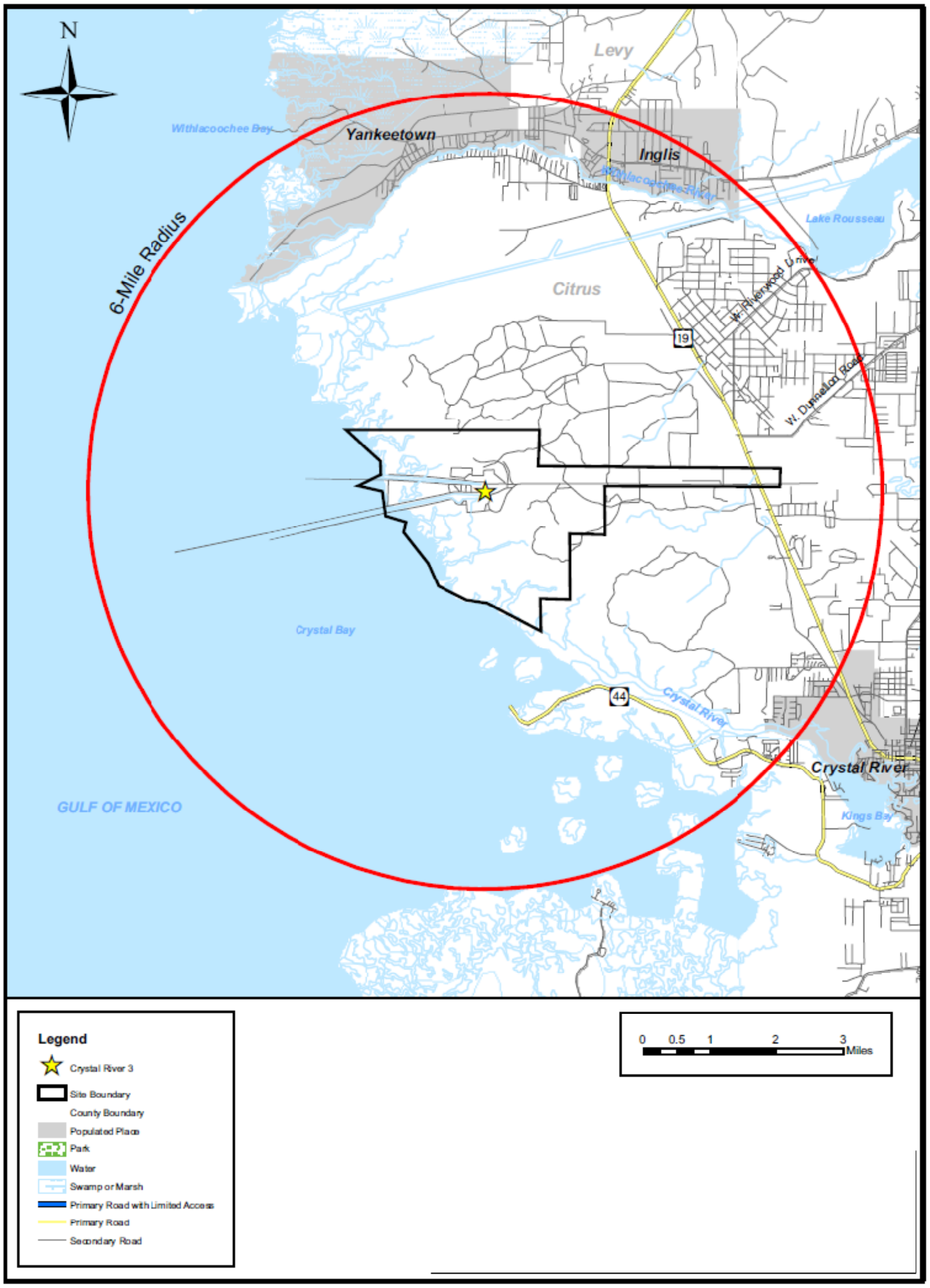

Figure 2.1-2. Location of Crystal River Unit 3 Nuclear Generating Plant, 6-Mile (10-Kilometer) Region (Source: Progress Energy, 2008a)

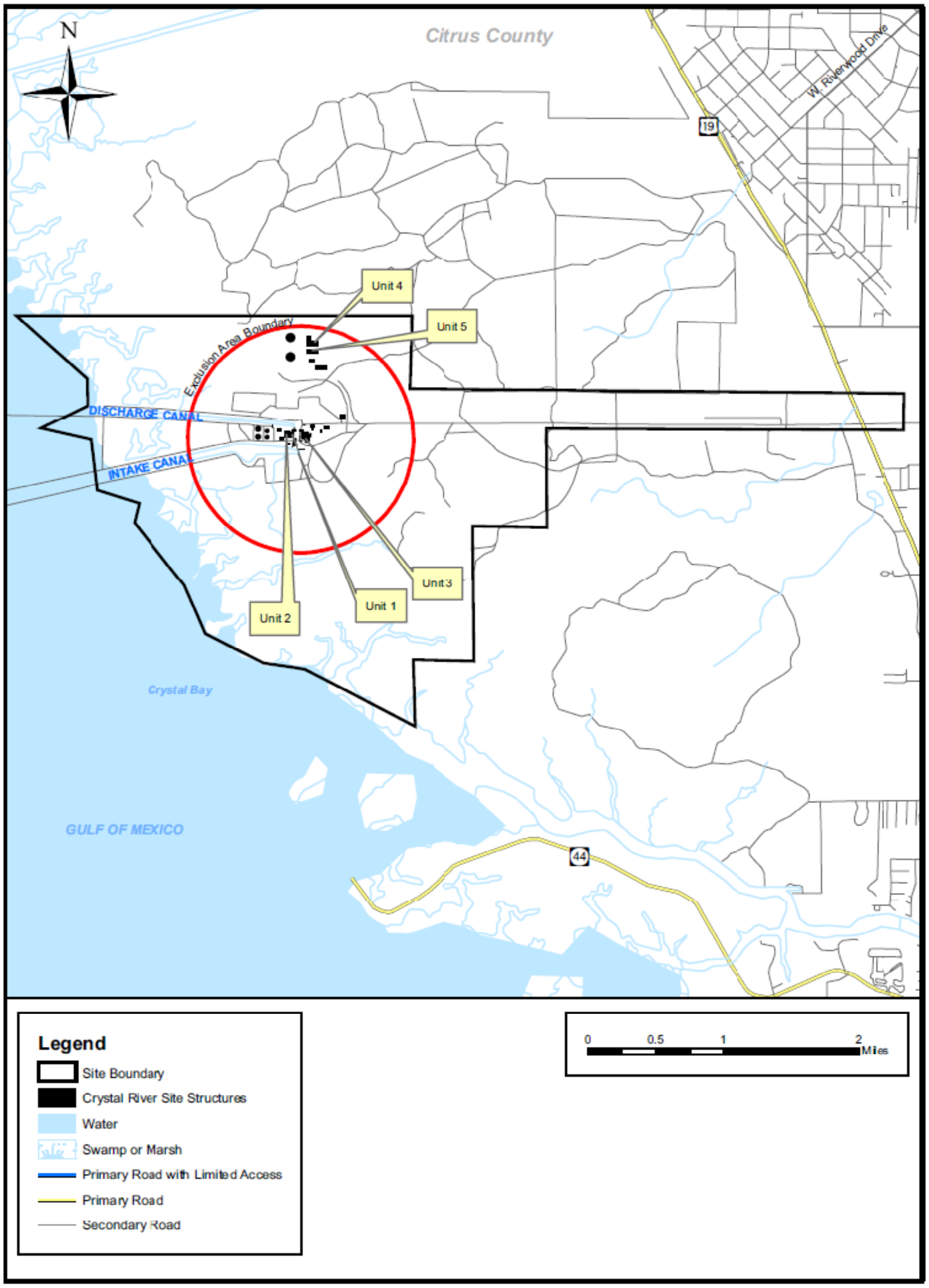

Figure 2.1-3. Crystal River Site (Source: Progress Energy, 2008a)

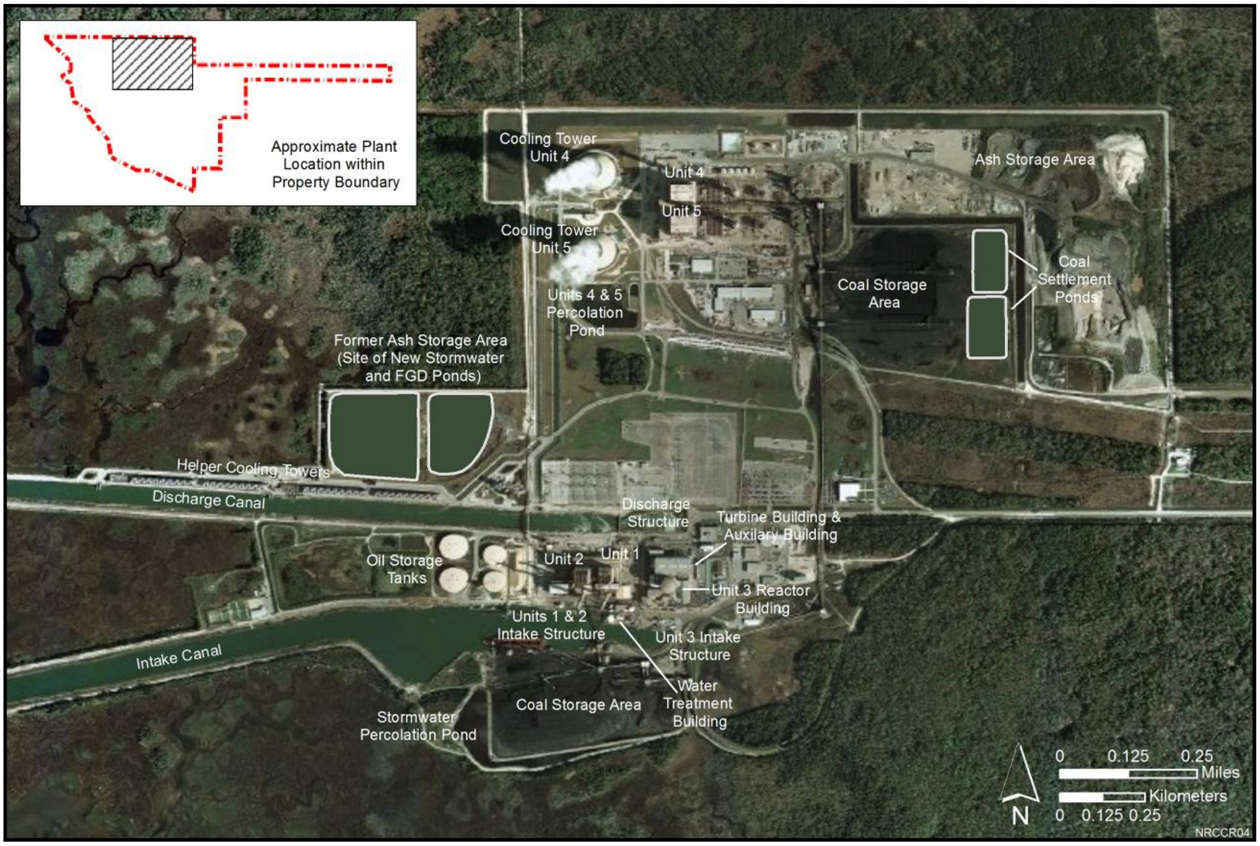

Figure 2.1-4. Layout of the Crystal River Energy Complex

2.1.1 Reactor and Containment Systems

CR-3 is a single-unit plant with a conventional domed concrete containment building. The plant includes a pressurized light-water reactor (PWR) nuclear steam supply system (NSSS) supplied by Babcock & Wilcox and a turbine generator designed and manufactured by Westinghouse Electric Company.

The reactor containment structure is a steel-lined, reinforced-concrete structure in the shape of a cylinder and capped with a hemispheric dome. The walls of the containment structure are approximately 3.5 feet (ft) (1.1 meters [m]) thick. With its engineered safety features, the containment structure (reactor building) is designed to withstand severe weather (e.g., tornadoes and hurricanes) and provide radiation protection during normal operations and design-basis accidents (DBAs).

The NSSS at CR-3 is typical of PWRs. The reactor core produces heated water that flows through a steam generator. The heated water in the steam generator creates steam which is routed to the turbines. The steam yields its energy to the turbines, which are connected to the electrical generator (Progress Energy, 2008a).

CR-3 fuel is low-enriched uranium dioxide cylindrical pellets. The pellets are clad in zirconium alloy tubing and sealed by zirconium alloy end caps, welded at each end. The maximum fuel rod burn-up is 62,000 megawatt days per metric ton uranium (MWd/MTU). CR-3 was initially licensed to operate at a maximum of 2,452 megawatts-thermal (MWt). In 1981, the NRC approved operation of CR-3 at up to 2,544 MWt. On June 5, 2002, FPC submitted a license amendment request, seeking NRC approval to operate at a power level of 2,568 MWt. On December 6, 2002, the NRC approved the request, noting that it would increase the generating capacity of the plant by 0.9 percent, from 895 megawatts-electric (MWe) to 903 MWe. On December 26, 2007, the NRC approved an FPC request to increase the licensed core power level of CR-3 by 1.6 percent, to 2,609 MWt. FPC has notified the NRC that it intends to submit a license amendment request for an extended power uprate (EPU) which would increase the power level from 2,609 MWt to 3,014 MWt (Progress Energy, 2008a).

2.1.2 Radioactive Waste

The radioactive waste systems collect, treat, and dispose of radioactive and potential radioactive wastes that are byproducts of plant operations. The byproducts are activation products resulting from the irradiation of reactor water and impurities (principally metallic corrosion products), and fission products resulting from defective fuel cladding or uranium contamination within the reactor coolant system. Operating procedures for the radioactive waste system ensure that radioactive wastes are safely processed and discharged from the plant. The systems are designed and operated to assure that the quantities of radioactive materials released from the plant are as low as is reasonably achievable (ALARA) and within the dose standards set forth in Title 10 of the *Code of Federal Regulations*, Part 20 (10 CFR Part 20), "Standards for Protection Against Radiation," and Appendix I to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." The CR-3 offsite dose calculation manual (ODCM) contains the methodology and parameters used to calculate offsite doses resulting from radioactive effluents. The methodology is used to ensure that radioactive material discharged from the plant meets regulatory dose standards.

Radioactive wastes resulting from plant operations are classified as liquid, gaseous, and solid. Radioactive liquid wastes are generated from liquids received directly from portions of the reactor coolant system or were contaminated by contact with liquids from the reactor coolant system. Radioactive gaseous wastes are generated from gases or airborne particulates vented from reactor and turbine equipment containing radioactive material. Radioactive solid wastes are solids filtered out of the reactor coolant system, material or equipment that came into contact with reactor coolant system liquids or gases, or solids used in the reactor coolant system or the power conversion system (Progress Energy, 2008a).

Reactor fuel that has exhausted a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages (RFOs), typically every 24 months. Spent fuel assemblies are stored in the spent fuel pool. In addition to the spent fuel pool, FPC began construction activities for an onsite independent spent fuel storage installation (ISFSI) in 2009 to store spent nuclear fuel in dry casks (Progress Energy, 2009f), (NRC, 2010).

2.1.2.1 *Radioactive Liquid Waste*

The radioactive liquid waste disposal system (RLWDS) is used to collect, store, and process radioactive liquid wastes for disposal or reuse. The RLWDS provides a means to process radioactive liquid waste prior to release and ensures that waste releases are performed in a controlled manner. The system is designed to minimize the total radioactivity and volume of radioactive liquid waste released to the environment. The components of the RLWDS are tanks, pumps, demineralizers, coolers, floor and equipment drains, sumps, valves, and piping. The system provides for the recovery of concentrated boric acid and purified water resulting from the cleanup of primary reactor coolant and refueling water. Recycle capability is provided to minimize the total radioactivity released to the environment. The collection and processing of liquid wastes is divided into two separate processing streams, dependent upon the quality of the waste. The primary processing stream is used to process the high purity waste, such as reactor coolant and refueling water. The second or miscellaneous processing stream is used to process the miscellaneous wastes from radioactive laboratory drains, building and equipment drains and sumps, regeneration solution for deborating demineralizers, and demineralizer backwash. The processed radioactive liquid waste is released into the discharge canal which flows into the Gulf of Mexico (Progress Energy, 2008a).

2.1.2.2 *Radioactive Gaseous Waste*

The radioactive gas waste disposal system (RGWDS) safely collects, stores, monitors, and releases gases released from reactor coolant and the RLWDS. The mixture of gases collected (nitrogen, hydrogen, and radioactive gaseous isotopes) is compressed and stored to allow for decay of its radioactive components prior to recycling or disposal through the plant vent stack to the atmosphere.

The RGWDS consists of gas compressors, waste gas decay tanks, a waste gas decay tank sequencer, a waste sampling system, and the interconnecting piping, control valves, and instrumentation.

The functions of the RGWDS include:

(1) a means for compressing gases contained above the liquids in the radioactive liquid waste and reactor coolant system

(2) capability for recycling and reuse of collected gases from the waste gas decay tanks

(3) storage for the decay of radioactive gases

(4) a means for controlling and monitoring the release of radioactive gases to the environment

Prior to their release into the atmosphere, the radioactive gases are sampled and analyzed in accordance with the surveillance requirements of the ODCM. The gases are filtered through charcoal and high-efficiency particulate air (HEPA) filters to further reduce the amount of any radioactive iodine and particulates that may be present in the waste stream (Progress Energy, 2008a).

2.1.2.3 *Radioactive Solid Waste*

The radioactive solid waste management process is designed to safely package, store, and transport radioactive waste, while minimizing radiation exposure to personnel. Wastes are packaged for storage, shipment to offsite waste processors, or shipment to burial facilities. Waste can also be returned to CR-3 from offsite waste processors for long-term storage. Solid waste packaging and transportation is performed in accordance with Department of Transportation and NRC regulations.

The types of radioactive waste generated at CR-3 include:

(1) dry active waste (DAW)

(2) spent resins

(3) tank and sump sludge

(4) spent filters

(5) contaminated oil

DAW consists of contaminated paper, plastic, cloth, rubber, glass, and metals. DAW can be placed into a strong, tight container for shipment to an offsite processor or compacted into 55-gallon drums.

Spent resins are generated primarily from the reactor coolant water makeup and purification, liquid waste processing, and condensate systems. The used resins are stored in the spent resin storage tank for radioactive decay. After a period of time, the resins are transferred into high-integrity containers (HICs), located within a shielded cask in the truck loading area of the auxiliary building. Resins are de-watered prior to shipment for offsite processing or direct disposal.

Tank and sump sludge is generated during the cleaning of various tanks and sumps located in the auxiliary and reactor buildings. The sludge is transferred into suitable containers and de-watered. Sludge can be processed into a form (i.e., solidified waste) suitable for disposal either onsite or by offsite waste processors using the process control program and procedures.

Spent filters are removed from service and stored to allow for radioactive decay. Filters are loaded for shipment into appropriate containers (e.g., HICs or 55-gallon drums) for disposal.

Contaminated oil is routinely generated during pump oil changes and sump cleaning. This oil is collected and sent to an offsite processor for disposal.

Low-level radioactive waste is stored on the CR-3 site in outside storage areas and the radioactive material storage warehouse.

The State of South Carolina's licensed low-level radioactive waste disposal facility, located in Barnwell, has limited the access from radioactive waste generators located in States that are not part of the Atlantic Low-Level Waste Compact. Florida is not a member of the Atlantic Low-Level Waste Compact. This has not affected CR-3's ability to safely handle its radioactive solid low-level waste. CR-3 has storage capacity for its radioactive waste during the license renewal term (Progress Energy, 2008a).

2.1.3 Nonradiological Wastes

CR-3 is part of the CREC which also includes four coal-fired steam plants. In addition to radioactive waste and mixed waste produced from CR-3 operations, the CREC also generates wastes categorized as regulated waste, universal waste, and hazardous waste as part of routine plant maintenance, cleaning activities, and plant operations. The Resource Conservation and Recovery Act (RCRA) governs the disposal of solid and hazardous waste. RCRA regulations are contained in 40 CFR, *Protection of Environment*, Parts 239 through 299 (40 CFR Part 239, et seq.). Parts 239 through 259 of these regulations cover solid (nonhazardous) waste, and Parts 260 through 279 regulate hazardous waste. RCRA Subtitle C establishes a system for controlling hazardous waste from "cradle to grave," and RCRA Subtitle D encourages States to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills.

The CREC has a sitewide coal combustion products (CCP)/solid waste materials management plan for all five units. To the extent possible, wastes are recycled or minimized by chemical control management. The applicant approves the vendors used for handling, recycling, or disposing of wastes. The appropriate waste characterization, waste profile, and disposal methods are determined by the appropriate CR-3 personnel in accordance with plant procedures. All recycling and disposal methods are done in compliance with State and Federal regulations (Progress Energy, 2010a).

In Florida, universal waste includes most rechargeable batteries; recalled pesticides or those collected due to a pesticide waste collection program; mercury-containing thermostats, manometers, switches, and fluorescent lamps; and hazardous waste pharmaceuticals (FDEP, 2010c).

2.1.4 Plant Operation and Maintenance

Various types of maintenance activities are performed at CR-3, including inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. CR-3 has a quality assurance program in place to ensure facility equipment is maintained, inspected, tested, and monitored on a routine basis. These maintenance activities include inspection requirements for reactor vessel materials, boiler and pressure vessel in-service inspection and testing, a maintenance structures monitoring program, and maintenance of water chemistry.

Other programs include those implemented in response to NRC generic communications; those implemented to meet technical specification surveillance requirements; and various periodic maintenance, testing, and inspection procedures. Certain program activities are performed during the operation of CR-3 while others are performed during scheduled refueling outages.

Nuclear power plants must periodically shutdown to remove spent fuel from the reactor and to load new fuel. During periods of plant shutdown, periodic in-service inspections are conducted and routine maintenance activities in those areas not accessible during power operation are performed.

2.1.5 Power Transmission System

Transmission lines considered within the scope of license renewal are those constructed specifically to connect the facility to the transmission system. The final environmental statement (FES) (AEC, 1973) discussed two 500-kilovolt (kV) transmission lines that were built to connect CR-3 to the regional transmission grid: (1) the Central Florida line terminating at the Central Florida Substation in Sumter County and (2) the Lake Tarpon line terminating at the Lake Tarpon Substation in Pinellas County. Combined, the two transmission corridors are approximately 125 mi (201 km) long and occupy 2,271 ac (919 ha). Both lines are owned and operated by the applicant. The applicant plans to maintain these transmission lines indefinitely, and the lines will remain a part of the transmission system after CR-3 is decommissioned (Progress Energy, 2008a). The Central Florida and Lake Tarpon corridors run parallel to each other but are separated by an undeveloped strip of land for the first 5.3 mi (8.5 km) and then diverge as the Central Florida line continues generally eastward and the Lake Tarpon line heads generally southward toward Tarpon Springs. These lines are shown in Figure 2.1-5 and described in the following paragraphs and Table 2.1.5-1.

The Central Florida line was placed into service in 1973. The line extends from the 500-kV switchyard at the CREC site and runs generally eastward and then southeast, for a total of about 53 mi (85 km) to the Central Florida Substation, located on the Sumter-Lake County line about 4 mi (6 km) west of Leesburg, Florida. The corridor is approximately 150 ft (46 m) wide and is within an easement already established for lines from an existing 230-kV switchyard that is not connected to CR-3. The Central Florida line crosses Citrus, Marion, and Sumter Counties.

The Lake Tarpon line, placed into service in 1973, runs generally south for 34.4 mi (55.4 km) to the Brookridge Substation approximately 1.7 mi (2.7 km) northwest of Brookridge, Florida, and then another 37.6 mi (60.5 km) to the Lake Tarpon Substation, approximately 8.5 mi (13.7 km) southeast of Tarpon Springs, Florida. The total line length is about 72 mi (116 km), and the corridor width is approximately 150 ft (46 m). Like the Central Florida line, the Lake Tarpon line follows an existing corridor for lines from the 230-kV switchyard that is not connected to CR-3. The Lake Tarpon line crosses Citrus, Hernando, Pasco, and Pinellas Counties.

The corridors pass through low population areas that are primarily forest and agricultural land (Progress Energy, 2008a), but also include commercial and rural residential areas (AEC, 1973). The lines cross several State and U.S. highways and the Withlacoochee, Pithlachascotee, and Anclote rivers. Where the transmission line corridors cross agricultural land, most of the land below the lines continues to be used for agriculture.

The NRC staff (Staff) reviewed National Wetland Inventory maps produced by the U.S. Fish and Wildlife Service (FWS) and determined that both lines also cross several areas of wetlands. The initial 5.3-mi (8-km) segment of both lines crosses several small emergent and open water wetlands. Forested wetlands occur in the undeveloped strip between the two corridors and to the north and south of the corridors. A 1.5-mi (2.4-km) portion of the southern edge of the common corridor is adjacent to the northern boundary of the Crystal River Preserve State Park. The Lake Tarpon line crosses several extensive wetland areas associated with the Starkey Wilderness Preserve (about 13 mi [21 km] of corridor) and the Brooker Creek Preserve (about 9 mi [14 km] of corridor). Wetland types that are crossed in these two segments include forested, scrub-shrub, emergent, and open water wetlands. The Central Florida line traverses fewer wetland areas. About 1.5 mi (2.4 km) of the line crosses emergent and open water wetlands in the Withlacoochee State Forest; about 1.2 mi (1.9 km) of the line crosses mostly forested wetlands associated with the Withlacoochee River floodplain in the Hálpata Tastanaki Preserve; and the line crosses another 0.7 mi (1.1 km) of emergent wetlands in the Ross Prairie State Forest. The portion of the Central Florida line that heads to the southeast crosses about 3.8 mi (6.1 km) of forested and emergent wetlands adjacent to the Lake Panasoffkee Wildlife Management Area. The final 3 mi (5 km) of the line crosses several emergent wetlands.

In 1973, FPC designed and constructed the CR-3 transmission lines in accordance with the National Electrical Safety Code and industry guidance that was current at the time (Progress Energy, 2008a). Right-of-way (ROW) surveillance and maintenance of these transmission facilities ensure continued conformance to these design standards.

FPC uses an Integrated Vegetation Management approach that includes both mechanical and chemical methods to maintain acceptable clearance between energized wires and tree branches (Progress Energy, 2004), (Progress Energy, 2006). Routine inspection and maintenance of the ROWs are a component of this approach. FPC chooses vegetation control methods based on terrain, soils, land use, and vegetation type. Mechanical methods of vegetation control include pruning, felling, mowing, and hand clearing. Herbicides registered with the U.S. Environmental Protection Agency (EPA) are used to control woody vegetation that re-seeds or re-sprouts after mowing. Herbicide applications are to be performed according to the EPA and State of Florida Department of Agriculture and Consumer Services requirements (Progress Energy, 2004), (Progress Energy, 2006). Herbicide treatments include low volume foliar applications, stump applications, and foliage herbicide treatments (Progress Energy, 2004), (Progress Energy, 2006). Certain conditions can restrict herbicide use including proximity to desirable vegetation (e.g., trees, crops, landscape plantings), rainy or windy conditions, and high temperatures. FPC requires low ground pressure equipment when working in designated wetland areas to avoid damaging plant roots (Progress Energy, 2004). Over time, the use of herbicides results in the growth of low-growing, nonwoody plants, such as grasses and other native plants, that do not interfere with power lines and provide habitat for species dependent on such conditions (Progress Energy, 2009e). Low-growing shrubs or small tree species such as yaupon holly (*Ilex vomitoria*), native viburnums (*Viburnum* spp.), and crape myrtles (*Lagerstroemia indica*) are not removed (Progress Energy, 2004), (Progress Energy, 2006). This vegetation management approach reduces the need for mowing and herbicide applications.

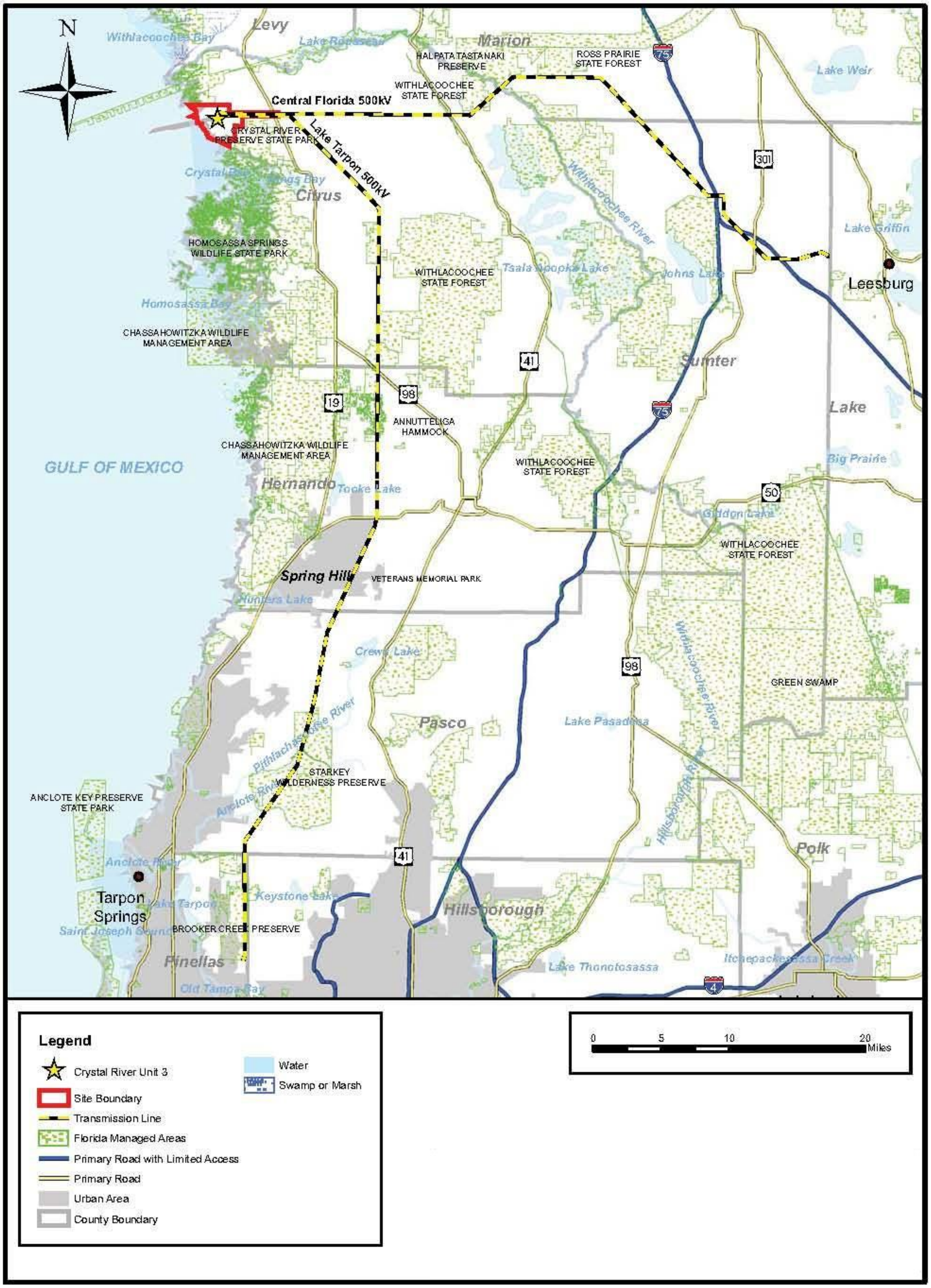

Figure 2.1-5. Crystal River Unit 3 Nuclear Generating Plant Transmission Lines (Source: Progress Energy, 2008a)

Table 2.1.5-1. Crystal River Unit 3 Nuclear Generating Plant Transmission Lines

Transmission Line Name	Line Segment	Approximate Distance	ROW Area
Central Florida	CR-3 to Central Florida Substation	52.9 mi (85.1 km)	962 ac (389 ha)
Lake Tarpon	CR-3 to Brookridge Substation	34.4 mi (55.4 km)	625 ac (253 ha)
Lake Tarpon	Brookridge Substation to Lake Tarpon Substation	37.6 mi (60.5 km)	684 ac (277 ha)
Total	**–**	**125 mi (201 km)**	**2,271 ac (919 ha)**

Source: Progress Energy, 2008a

(a) All lines are 500 kV and are located in a 150-ft (46-m) wide ROW

2.1.6 Cooling and Auxiliary Water Systems

CR-3 has a once-through heat dissipation system that withdraws water from, and discharges it to, Crystal Bay in the Gulf of Mexico. Cooling water circulates through CR-3 in one of two modes of operation: open cycle (once-through cooling, with no cooling towers in operation) and helper cycle (once-through cooling, with mechanical draft cooling towers in operation). The applicant selects the mode of operation so that thermal discharges at the point of discharge (POD) to Crystal Bay are in compliance with the thermal limits of the National Pollutant Discharge Elimination System (NPDES) Permit No. FL0000159 (FDEP, 2005a). Unless otherwise cited, the applicant's ER (Progress Energy, 2008a) is the source of the following information on the CR-3 cooling and auxiliary water systems.

The CR-3 cooling water system consists of the intake canal, intake structure and pumps, circulating water intake piping, condensers, circulating water discharge piping, outfall structure, discharge canal, and cooling towers. The intake canal, discharge canal, and cooling towers are shared systems with CR-1 and CR-2. CR-4 and CR-5 withdraw makeup water from, and discharge cooling tower blowdown to, the discharge canal. The cooling towers, described later in this section, were not a component of the cooling water system as described in the original FES for CR-3 (AEC, 1973).

The intake canal, which extends into the Gulf of Mexico, is 14 mi (22.5 km) long. It has a minimum depth of 20 ft (6 m) to accommodate barge traffic used to deliver coal for the fossil fuel units. A southern and northern dike parallel the intake canal for about 3.4 mi (5.4 km) offshore. The southern dike terminates at this point, while the northern dike extends an additional 5.3 mi (8.5 km) into the Gulf of Mexico. Starting at Fisherman's Pass, irregularly-spaced openings occur in the northern dike to allow boat traffic to pass in a north-south direction without having to completely circumnavigate the dike. The dikes are about 50 to 100-ft (15 to 30-m) wide on top and are elevated about 10 ft (3 m) above the water surface at mean low tide (FPC, 2002). The dikes are comprised of intake canal construction spoils (SWEC, 1985). Starting at the east end, the intake canal is 150 ft (45.6 m) wide for 2.8 mi (4.5 km); 225 ft (69.5 m) wide for the next 6.3 mi (10 km); and 300 ft (91 m) wide for the last 4.9 mi (7.8 km) (FPC, 2002). Current velocities at the mouth of the intake canal range from 0.6 to 2.6 feet per second (ft/s) (0.2 to 0.8 meters per second [m/s]) (SWEC, 1985). Dredging occurs in the intake canal every 5 to 7 years.

The cooling water intake structure for CR-3 is located near the eastern end of the intake canal and about 400 ft (122 m) east of the intake structures for CR-1 and CR-2. The intake structures for all three units are located on the north side of the intake canal. A security boom, to intercept floating and partially submerged debris and restrict access to CR-3, extends across the intake canal downstream of the intake structures for CR-1 and CR-2 and about 200 ft (61 m) from the face of the CR-3 intake structure. The CR-3 intake structure is 118 ft (36 m) wide. It is fitted with eight external trash racks with 0.38- by 4-inch (1- by 10-centimeter [cm]) steel bars on 4-inch (10-cm) centers, resulting in a 3.63-inch (9.2-cm) distance between adjacent bars. The bars extend from above the water line to the concrete slab on the bottom of the intake structure. The bar racks are aligned 10° from vertical with the bottoms of the bar racks extending about 5 ft (1.5 m) into the intake canal (FPC, 2002). Seven of the bar racks are in front of the traveling screens for the circulating water condenser system. They are each 33-ft (10-m) high and 15.6-ft (4.75-m) wide. The eighth bar rack is in front of the traveling screen that serves the nuclear services and decay heat water system. It is 33-ft (10-m) high and 9.3-ft (2.8-m) wide (FPC, 2002). A catwalk extends across the front of the bar racks in order to allow the racks to be inspected for debris. An overhead rail-mounted trash rake removes collected debris. About four times per year, bar racks are removed and pressure washed to remove barnacles or other marine growth and then coated with a biofouling material (FPC, 2002). Under normal water elevation and full-flow conditions, the velocity approaching the bar racks is 0.9 ft/s (0.27 m/s) and increases to 1 ft/s (0.30 m/s) at the traveling screens.

The CR-3 intake structure has four pump bays and eight traveling screens. The seven traveling screens for the circulating water system are 10 ft (3 m) wide by 35 ft (11 m) high with 0.38-inch (1-cm) mesh. The eighth traveling screen, used for the nuclear services and decay heat cooling water system, is of similar design but is only 6 ft (2 m) wide (Golder Associates, 2007a). Rotation and washing of the intake screens occurs every 8 hours or when there is a greater than or equal to 6-inch (15-cm) pressure differential across the screens. Debris washed from the screens goes into a common trough and then into a sump adjacent to the intake structure. Solid material (including impinged organisms) in the screen wash is collected in a screened basket. The solid material collected from the bar racks and intake screens is placed into the trash for ultimate disposal in the Citrus County landfill. The screen wash water, which is seawater pumped from the intake canal, is discharged back into the intake canal (Golder Associates, 2007b). Refurbishment of the traveling screens occurs every 7 years.

CR-3 has two circulating water pumps rated at 167,000 gallons per minute (gpm) (372 cubic feet per second [cfs] or 10.5 cubic meters per second [m^3/s]) and two rated at 179,000 gpm (399 cfs or 11.3 m^3/s). The design intake volume for CR-3 is 680,000 gpm (1,515 cfs or 42.9 m^3/s). The combined condenser flow limit for the three units is 1,897.9 million gallons per day (gpd) (2,936 cfs or 83.2 m^3/s) from May 1 through October 31 and 1,120,000 gpd (2,495 cfs or 70.7 m^3/s) from November 1 through April 30 (FDEP, 2005a). Throttling back on CR-1 and CR-2 accomplishes the flow reduction from November 1 through April 30 (Progress Energy, 2010a).

The four circulating water pumps send water through four 90-inch (229-cm) internal diameter reinforced concrete pipes to four 6.5- by 7.5-ft (2.0- by 2.3-m) rectangular reinforced concrete flumes that are connected to the four condenser tube banks. A separate flow path exists for the nuclear services and decay heat cooling water heat exchangers. Each condenser tube bank discharges separately into a 6.5- by 7.5-ft (2.0- by 2.3-m) reinforced concrete flume connected to a 90-inch (229-cm) diameter reinforced concrete pipe. The four concrete pipes terminate in a common outfall structure provided with a weir. Water flows over the weir and into the discharge canal (Wahanik, 1969). At operating design capacity, the discharge temperature rise from condenser passage from CR-1 through CR-3 are 14.9 °F (8.3 °C), 16.9 °F (9.4 °C), and 17.5 °F (9.7 °C), respectively (Mattson et al., 1998). The corresponding condenser cooling system heat rejection rate for each unit are approximately 2.28, 2.74, and 5.88 billion British thermal units per hour (Btu/hr), respectively. For all three units, the total heat rejection rate is 10.91 billion Btu/hr (Golder Associates, 2007a).

The nuclear services and decay heat cooling water system for CR-3 withdraws 10,000 gpm (22.3 cfs or 0.6 m^3/s) under normal conditions and up to 20,000 gpm (44.6 cfs or 1.3 m^3/s) under emergency conditions in order to provide sufficient capacity to remove heat generated by system operations. The nuclear services water system uses most of this flow. The decay heat cooling water system only operates for short time periods during unit shutdown, which occurs predominately during refueling outages once every 2 years (Progress Energy, 2010a).

Periodic addition of chlorine prevents the growth of biofouling organisms. The maximum total residual oxidant (as chlorine) concentration at the unit outfall cannot exceed 0.01 milligrams per liter (mg/L) (FDEP, 2005a). Cleaning balls, recirculated through the condensers, provides mechanical cleaning of the CR-3 condenser tubes (Golder Associates, 2007a). The applicant periodically injects the biocide Spectrus CT1300 into the nuclear services and decay heat cooling water system (Golder Associates, 2007a). The NPDES permit limits the rate of CT1300 application to no more than 4.5 mg/L for a period not to exceed 18 hours and at an interval of at least 21 days between applications (written approval is required to extend the length of applications or decrease the interval between applications) (FDEP, 2005a).

CR-3 cooling water discharges into a 125-ft (38-m) wide discharge canal just north of the unit. Cooling water from CR-1 and CR-2 also discharge into the canal. The discharge canal extends west about 1.6 mi (2.6 km) to the POD to Crystal Bay. The discharge canal, and an associated south dike, extends an additional 1.2 mi (1.9 km) from the POD. The dike is comprised of discharge canal construction spoils (SWEC, 1985). The discharge canal is the source of cooling system makeup for CR-4 and CR-5. The intake pumps for those units are located on the north side of the discharge canal and over 900 ft (274 m) west of the discharge for CR-1. The combined blowdown canal for CR-4 and CR-5 is also on the north side of the discharge canal and is located over 1,400 ft (427 m) east of the two units' intake pumps. The blowdown canal is located about 1,700 ft (518 m) upstream of the bank of cooling towers used for CR-1, CR-2, and CR-3. The bank of cooling towers consists of 4 permanent cooling towers (36 cells) and 67 modular cooling towers. When units CR-1, CR-2, and CR-3 are operating at maximum pumping capacity, the velocity in the discharge canal is about 2.4 ft/s (0.7 m/s) at low tide (Golder Associates, 2007a). Dredging maintains the discharge canal at a depth of about 10 ft (3 m).

Through NPDES Permit No. FL0000159, the Florida Department of Environmental Protection (FDEP) (2005) regulates the thermal limits of the combined discharge of CR-1 through CR-3 at the POD to Crystal Bay. The discharge temperature at the POD cannot exceed 96.5 °F (35.8 °C) as a 3-hour rolling average. Four permanent mechanical draft cooling towers (36 cells), installed in 1993, usually allow CR-1, CR-2, and CR-3 to meet this requirement without the need to reduce power generation for CR-1 and CR-2. The combined flow rate of the four permanent cooling towers is 684,600 gpm (1,525 cfs or 43.2 m^3/s) with a design heat dissipation rate of 4.569 billion Btu/hr. Each cell has a water flow rate of 19,017 gpm (42.4 cfs or 1.2 m^3/s) and a heat dissipation rate of 0.127 billion Btu/hr (Golder Associates, 2007a). Evaporative losses for the existing helper cooling towers total 9,957 gpm (22.2 cfs or 0.63 m^3/s) (Golder Associates, 2007a). An additional 67 modular cooling towers, installed in 2006, generally allow CR-1 and CR-2 to operate most of the time during the hottest times of summer without having to reduce their power in order to meet thermal discharge permit requirements. The combined flow rate of the modular cooling towers is 180,000 gpm (401 cfs or 11.4 m^3/s) with a design heat dissipation rate of 1.317 billion Btu/hr (Golder Associates, 2007a). The modular cooling towers are normally used after all of the permanent cooling towers have been placed in service and when the POD temperature limits may otherwise be exceeded without load reduction on the CREC generating units. The modular cooling towers are also the first turned off. Generally, the permanent and modular cooling towers operate between May 1 through October 31 (Progress Energy, 2007).

As mentioned in Section 2.1.1, FPC plans to add 180 megawatts (MW) of electrical generation to CR-3 (Golder Associates, 2007a). Two phases are required for the extended power uprate (EPU). Phase I, which is completed, added 40 MW of power and included a retrofit of the low pressure turbines and electrical generator, replacement of the main steam reheaters, and replacement of the steam generator (FDEP, 2008a). Phase II, which will add the remaining 140 MW, will occur before the current CR-3 operating license expires (December 3, 2016). This phase will retrofit the high-pressure turbine and turbine/generator coolers and replace the circulating water pumps, condensate and feedwater booster pumps, and motors (FDEP, 2008a). This will include alterations that will elevate temperatures within the reactor and the use of enriched uranium fuel. The four new circulating water pumps will each deliver as much as 207,778 gpm (463 cfs or 13.1 m^3/s) each. As a result, through-screen velocity will increase from 1.45 ft/s (0.44 m/s) (maximum at mean low water level) to as high as 2.02 ft/s (0.62 m/s) (maximum at mean low water level) (Golder Associates, 2007a).

The net increase in heat rejection for the CR-3 EPU would be 0.768 billion Btu/hr which is about a 13.1 percent increase over CR-3's current heat rejection (Golder Associates, 2007a). Unless mitigated in some manner, the increased heat rejection will result in an elevated thermal discharge temperature at the POD. Thus, plans for Phase II of the EPU called for the installation of a new south cooling tower. The south cooling tower would assist in offsetting the increased circulating water rejected heat, avoid potential increase in flow into the intake canal from Crystal Bay, and allow removal of the existing 67 modular cooling towers. One option for the operation of the south cooling tower is to recirculate some of the flow from the cooling tower discharge back into the intake canal, thus avoiding any increase in flow into the intake canal from Crystal Bay (FDEP, 2008a). Under this option, flow through the south cooling tower would be as high as 534,000 gpm (1,190 cfs or 33.7 m^3/s) which would include a maximum discharge of 320,000 gpm (713 cfs or 20.2 m^3/s) to the discharge canal and 214,000 gpm (477 cfs or 13.5 m^3/s) to the intake canal (Progress Energy, 2010a). This option will most likely occur if the intake for CR-3 increases from the current 680,000 gpm (1,515 cfs or 42.9 m^3/s) to 830,000 gpm (1,849 cfs or 52.4 m^3/s) (Golder Associates, 2007a), (Golder Associates, 2007b).

The more likely option is no change in the existing CR-3 flow of 680,000 gpm (1,515 cfs or 42.9 m^3/s) as a result of the EPU, but rather an increase in thermal load (increased temperature) to the discharge canal (Progress Energy, 2009a). Under this option, the south cooling tower will only discharge a maximum of 320,000 gpm (713 cfs or 20.2 m^3/s) to the discharge canal. The total heat rejection to Crystal Bay due to the EPU for either option will not exceed the currently permitted maximum rate of 10.91 billion Btu/hr (FDEP, 2008a).

The applicant planned to complete Phase II of the EPU in 2011. Due to the containment issues at CR-3, Phase II of the EPU is delayed and so will not be part of the renewed NPDES permit (i.e., aspects of the NPDES application related to the south cooling tower will be withdrawn). A renewed NPDES permit, expected in July 2011, will essentially involve the renewal of existing operating permit limits. Should Phase II of the EPU occur before the end of the next NPDES permit period, the applicant will be required to conduct a Clean Water Act (CWA) Section 316(a) Demonstration study, likely involving a 2-year study period initiated after completion of the Phase II EPU. The need for the study is to demonstrate compliance with CWA Section 316(a) in order to renew any applicable Section 316(a) variance (i.e., a variance from applicable thermal limitations to surface waters is allowed if the permittee demonstrates that the balanced indigenous community of aquatic organisms is protected and maintained).

Expediting Phase II of the EPU will occur by issuing an FDEP Administrative Order with the new NPDES permit. The Administrative Order would require the applicant to demonstrate reasonable assurance that it could meet the current POD thermal limit by derating the fossil units in place of building the south cooling tower. Tentatively, issuance of both the new NPDES permit and the Administrative Order will occur by midsummer of 2011 (NRC, 2011). Should the applicant decide to add the south cooling tower at a later date, an NPDES permit modification pertaining to the cooling tower will be required.

2.1.7 Facility Water Use and Quality

The CREC does not use public water supplies for plant operations, but instead relies on surface water from the Gulf of Mexico and groundwater from onsite production wells located east of the main complex. The following sections describe groundwater and surface water use and quality in both the south plant area (where CR-3 is located) and the north plant area of the CREC. The north plant area is included here because activities that impact water resources in the north plant area may also affect water resources in the south plant area.

2.1.7.1 *Groundwater Use*

Groundwater from the Upper Floridan aquifer is used by all the units at the CREC, including CR-3, for their operation. Specifically, groundwater is used for boilers and steam generators, ash processes, fire protection, and drinking water. Groundwater is withdrawn from production wells located to the east (upgradient) of the CREC and pumped to two water treatment plants: the north water treatment plant and the south water treatment plant. The plant maintains 14 production wells (Table 2.1.7-1). These wells are completed in the Upper Floridan aquifer and are permitted and regulated by the State of Florida. Water from wells PW-1, PW-2, PW-3, and PW-4 is treated in the north water treatment plant which serves CR-4 and CR-5. Water from wells SPW-3, SPW-4, and SPW-5 is treated in the south water treatment plant which serves CR-1, CR-2, and CR-3. Well water is filtered, softened, and chlorinated at the treatment plants to produce potable and demineralized water for use in boilers and steam generators. Well PW-1A/B produces brackish water that is used (untreated) for ash processes (Progress Energy, 2008a). Standby wells PW-5, PW-6, and PW-7 and new wells PW-8, PW-9a, and PW-10a provide water to the flue gas desulfurization (FGD) scrubber which began operating in December 2009 (Progress Energy, 2010a). Water for fire protection is kept in two dedicated 600,000-gallon storage tanks near CR-1 and CR-2; water is pumped from the storage tanks through a main line to the CR-3 fire service water system (Progress Energy, 2008a).

For the period 2001 through 2005, CR-3 used groundwater supplied to the south water treatment plant at a rate of 227 gpm or 49 percent of the south water treatment plant's production of 461 gpm during the same period (Johnson, 2006). From 2001 through 2009, the average annual groundwater usage for wells supplying both the north and south water treatment plants was 601 million gallons; the average production rate for wells during this period was 1,144 gpm or 1.65 million gpd (Progress Energy, 2010a). Annual groundwater usage at the plant has increased by about 22 percent since 2001; however, production rates remain well below the 2 million gpd authorized by the Southwest Florida Water Management District (SFWMD) water use permit (SFWMD, 2007) and the FDEP Conditions of Certification (FDEP, 2010b). On January 15, 2010, the FDEP increased the CREC's groundwater usage for wells

PW-1 through PW-8, PW-9a, and PW-10a to a combined annual average of 4.309 million gpd (FDEP, 2010a).

Table 2.1.7-1. Crystal River Energy Complex Production Wells

Well[(a)(b)]	Status	Areas Served	Well Casing/ Total Depth (ft)	Well Rating/ Capacity (gpd)[(d)]
PW-1	Active	North water treatment plant	35/200	250,000
PW-2	Active	North water treatment plant	47/200	250,000
PW-3	Active	North water treatment plant	60/200	250,000
PW-4	Active	North water treatment plant	41/200	250,000
PW-5	Standby	FGD scrubber	35/200	521,520
PW-6	Standby	FGD scrubber	50/200	521,520
PW-7	Standby	FGD scrubber	50/200	521,520
PW-8	Active	FGD scrubber	50/200	521,520
PW-9a	Active	FGD scrubber	50/200	521,520
PW-10a	Active	FGD scrubber	50/200	521,520
SPW-3	Active	South water treatment plant	36/90	380,000
SPW-4	Active	South water treatment plant	37/125	285,000
SPW-5	Active	South water treatment plant	U[(c)]/72	285,000
PW-1A/B	Active	Ash processes (brackish)	42/42	25,000

(a) Water use from wells PW-1 through PW-7 is authorized, pursuant to the conditions of certification approved by the FDEP. The combined pumping limit for these wells is 1 million gpd on an annual average basis and 3 million gpd on a peak daily basis. Water use from new wells PW-8, PW-9a, and PW-10, which will serve the FGD scrubber, will increase the approved combined usage (on an annual average basis) to 4.309 million gpd (FDEP, 2010b).

(b) Wells SPW-3 through SPW-5 and PW-1A/B are operated under SFWMD Water Use Permit 2004695.004 for the operation of Units 1, 2, and 3. Their combined pumping limit is 1 million gpd on an annual average basis and 1.5 million gpd on a peak monthly basis (SFWMD, 2007).

(c) A “U” indicates that the casing depth in well SPW-5 is unknown (FDEP, 2010b).

(d) Well capacity based on an annual average.

2.1.7.2 *Surface Water Use*

Surface water is withdrawn from and discharged back to the Gulf of Mexico for use in the once-through cooling system employed by CR-1, CR-2, and CR-3. CR-4 and CR-5 are closed-cycle units with natural draft cooling towers; cooling tower makeup water for these units is withdrawn from the discharge canal for CR-1, CR-2, and CR-3. The intake canal is located to the south of CR-1, CR-2, and CR-3 (Figure 2.1-4).

It is defined by two parallel dikes that extend westward into the Gulf of Mexico for about 3.4 mi (5.5 km). The southern dike terminates at this point; the northern dike extends another 5.3 mi (8.5 km) further into the Gulf of Mexico. The intake canal is dredged to a depth of about 20 ft (6.1 m) to accommodate coal barges, which dock on the south side of the canal (near the coal storage area) just west of the intakes for CR-1 and CR-2. There are openings in both dikes at irregular intervals to allow north-south boat traffic in the plant area. Measurements taken in 1983–1984 indicated velocities at the mouth of the canal ranged from 0.6 to 2.6 ft/s (0.2 to 0.8 m/s). Movement of water into the canal is influenced by tidal conditions (Golder Associates, 2006).

The intake structure for the CR-3 main condenser uses four circulating water pumps, which provide a total flow capacity of 680,000 gpm. Two of the pumps are rated at 167,000 gpm and two are rated at 179,000 gpm. Service pumps withdraw an additional 10,000 to 20,000 gpm, depending on the system demand. The combined condenser flow for CR-1, CR-2, and CR-3 is limited by the NPDES permit to 1,898 million gpd during the summer period (May 1 to October 31) and 1,613 million gpd during the winter period (November 1 and April 30) (FDEP, 2005a).

Cooling water for all CREC units is discharged back to the Gulf of Mexico through a common discharge canal[1], located to the north of CR-1, CR-2, and CR-3 (Figure 2.1-4). The site discharge canal extends westward into the Gulf of Mexico, about 1.6 mi (2.6 km) to the POD into Crystal Bay. The canal is bordered to the south by a spoil bank, which extends another 1.2 mi (1.9 km) beyond the POD into the bay. It is dredged to maintain a depth of about 10 ft (3 m). NPDES outfall locations and their monitoring requirements are discussed in Section 2.1.7.4. Helper cooling towers withdraw water from the combined discharge of CR-1, CR-2, and CR-3 to help the plant meet the NPDES daily maximum discharge limit of 96.5 °F (35.8 °C) (FDEP, 2005a).

2.1.7.3 *Groundwater Quality*

Groundwater at the CREC is a Class G-II water. Class G-II waters occur in aquifers with a total dissolved solids content of less than 10,000 mg/L and are considered suitable for potable use. As such, these waters are subject to the Primary and Secondary Drinking Water Standards for public water systems established pursuant to the Florida Safe Drinking Water Act, excluding permitted zones of discharge (see Florida Administrative Code [FAC], Rules 62-550.310, 62-550.320, 62-520.410, 62-520.620, and 62-520.465 [FDS, 2011a], [FDS, 2011b]). These standards are the basis of the compliance limits set in the Industrial Wastewater Permit that specifies groundwater monitoring requirements.

<u>South Plant Area</u>

In the south plant area where CR-1, CR-2, and CR-3 are located, the FDEP authorizes the operation of the domestic wastewater treatment plant, the percolation pond system, and the coal storage area (Figure 2.7.1-1). Permitted facilities at the CREC and their monitoring requirements are listed in Table 2.1.7-2. Only Industrial Wastewater Permit FLA016960 (FDEP, 2007a), (FDEP, 2008b), which regulates the percolation pond system, specifies groundwater monitoring requirements[2]. The coal storage area, which discharges to the site discharge canal via the CR-4 and CR-5 canal, is regulated under Industrial Wastewater (NPDES) Facility Permit FL0000159 and discussed in Section 2.1.7.4.

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[1] The common discharge canal is referred to as the site discharge canal in this section to distinguish it from the Units 4 and 5 discharge canal which receives cooling tower blowdown and runoff collection system discharges from Units 4 and 5 and empties into the site discharge canal just east of the helper cooling towers.

[2] Although groundwater monitoring is detailed in the plant's Industrial Wastewater Facility Permit FLA016960 (for the percolation pond system), the objectives of the plant's Groundwater Monitoring Plan (Golder Associates, 2007c) include monitoring the ash storage area (north plant), detecting potential releases to groundwater, and ensuring compliance with the plant's Conditions of Certification (FDEP, 2010b) and applicable groundwater quality regulations (Progress Energy, 2009b). In 2009, a new monitoring well (MWC-31) was installed to monitor the FGD blowdown ponds which began operating in December 2009 (FDEP, 2010b).

Domestic Wastewater Facility (Units 1, 2, and 3). The sewage treatment plant serving CR-1, CR-2, and CR-3 is authorized by Domestic Wastewater Facility Permit FLA118753 (FDEP, 2009a). The treatment plant, located to the south of CR-1 and CR-2 (Figure 2.1-4), has a 30,000 gpd 3-month average daily flow capacity and provides secondary treatment with basic disinfection (using sodium hypochlorite). It consists of three 5,000-gallon flow equalization basins, seven 5,000-gallon aeration basins, two 5,200-gallon clarifiers (with a total surface area of 156 square feet (ft^2) [14 square meters (m^2)]), one chlorine contact chamber (1,250 gallons), and two digesters (7,240 gallons). The treatment plant discharges its wastewater effluents to the percolation pond system (FDEP, 2009a).

Table 2.1.7-2. Crystal River Energy Complex Facilities Regulated under State of Florida Permits

Facility	Monitoring Requirements
South Plant Area	
Domestic Wastewater Treatment Facility[a]	• Flow monitoring (daily; 5 days/week) • Reclaimed water monitoring (daily, monthly)
Percolation Pond System[b]	• Flow monitoring (daily) • Discharge monitoring (quarterly) • Groundwater monitoring (quarterly)
Coal Storage Area[c]	• Flow monitoring (daily when discharging) • Discharge monitoring (daily when discharging)
North Plant Area	
Ash Storage Area[d]	• Flow monitoring (per discharge) • Discharge monitoring (prior to discharge) • Groundwater monitoring (quarterly)
Coal Storage Area[d]	• Flow monitoring (per discharge) • Discharge monitoring (prior to discharge)
Runoff Collection System[d]	• Flow monitoring (per discharge) • Discharge monitoring (per discharge)
FGD Settling Ponds[c]	• Flow monitoring (per discharge) • Discharge monitoring (per discharge) • Groundwater monitoring (quarterly)
Stormwater Pond[c]	• Flow monitoring (per discharge) • Discharge monitoring (per discharge)

(a) This wastewater treatment facility is regulated under Domestic Wastewater Facility Permit FLA118753 for Units 1, 2, and 3 (FDEP, 2009a).

(b) The percolation pond system and FGD settling ponds are regulated under Industrial Wastewater Facility Permit FLA016960 (FDEP, 2007a), (FDEP, 2008b).

(c) The south plant coal storage area for Units 1 and 2 is regulated under Industrial Wastewater Facility (NPDES) Permit FL0000159 (FDEP, 2005a). A former ash pond located just north of the site discharge canal was also regulated under NPDES Permit FL0000159; it was clean closed on December 15, 2009 (FDEP, 2009b) and is currently the location of the plant's new stormwater and FGD settling ponds.

(d) The north plant ash storage and coal storage area and runoff collection system are regulated under Industrial Wastewater Facility (NPDES) Permit FL0036366 (FDEP, 2005b).

Percolation Pond System. The percolation pond system is located between the site discharge and intake canals immediately to the west of the oil storage tank warehouses[3]. It is referred to as Land Application System G-001 in the Industrial Wastewater Permit FLA016960, issued by the FDEP on January 9, 2007 (Figure 2.1-4), (FDEP, 2007a), (FDEP, 2008b). The pond system consists of three ponds: Ponds 1, 2, and 3. Ponds 1 and 2 are settling basins with a total bottom surface area of about 87,120 ft^2 (8,094 m^2); industrial effluents are directed to one or the other pond (alternately). Settled effluents from either of these ponds is then routed to Pond 3. Pond 3 overflows into an 11-ac area called the "South Pond Expansion" for percolation. The pond system is authorized to receive (on average) 0.91 million gpd of process and non-process wastewater; discharges from power plant equipment drains, laboratory drains, and floor drains; neutralized regeneration wastes from demineralizer resin beds; reclaimed water from the water treatment process; boiler blowdown and drains (chemical cleanings); air pre-heater wash drains; sewage treatment plant effluents; stormwater drainage from the transformer area; blowdown from the FGD scrubber; precipitator washes; boiler washes; cooling water blowdown; and reverse osmosis/microfiltration concentrate. The south pond expansion area is designed to contain a 25-year, 24-hour rainfall event with no overflow to surface waters. Overflow from the expansion area rarely occurs but discharges to the Gulf of Mexico (Crystal Bay) via NPDES Outfall D-0C2 on the site discharge canal (FDEP, 2008b), (FDEP, 2009a).

Effluents from the percolation pond system are sampled quarterly at two monitoring locations within the ponds (at the discharge pipe to Pond 1 or 2, whichever is active, and within the percolation pond). Groundwater in the Upper Floridan aquifer is sampled quarterly from a well monitoring network to characterize ambient (background) conditions and ensure compliance with the limits specified in the wastewater permit (Table 2.1.7-3). Water levels relative to the National Geodetic Vertical Datum (NGVD) are also measured. Monitoring wells range in depth from 14 ft to 33 ft, although most are about 20 ft deep (FDEP, 2007a), (FDEP, 2008b). Figure 2.1.7-2 shows the monitoring well locations at the CREC.

Two wells are used to monitor groundwater in the vicinity of the percolation pond system: MWC-27 and MWC-1F2. From 2005 through 2009, sodium measured in these wells was consistently detected at concentrations exceeding the compliance limit (160 mg/L), with concentrations as high as 750 mg/L in the third quarter of 2007. Given their proximity to the intake and discharge canals, elevated sodium levels in these wells may reflect natural background levels associated with sea water influences from the Gulf of Mexico. The applicant is currently conducting a sodium background study to develop a conceptual model of the site's hydrogeologic conditions and to evaluate background surface water and groundwater quality, plant operational processes, and potential sodium sources in the area (Progress Energy, 2010b). Measurable levels of tritium ranging from 86 to 611 picocuries per liter (pCi/L) were also detected in these wells in 2009, down significantly from levels ranging from 244 to 1,199 pCi/L detected in 2007 (Progress Energy, 2008b), (Progress Energy, 2010b).

Well MWC-29 is located to the southwest (downgradient) of the south plant coal storage area. From 2005 through 2009, this well had few exceedences; however, gross alpha (measured in 2007, 2008, and 2009) was consistently at or just above the FDEP's Primary Drinking Water Standards (PDWS) and compliance limit of 15 pCi/L during most quarters.

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[3] The oil storage tanks were clean-closed and are currently being used as warehouse facilities (Progress Energy, 2010b).

1 **Table 2.1.7-3. Groundwater Monitoring Requirements[a][b]**

Parameter	Compliance Limit (units)
Total dissolved solids	Report (mg/L)
pH	Report (SU)
Temperature	Report (°F; in situ)
Specific conductance	Report (mmhos/cm; in situ)
Turbidity	Report (NTU; in situ)
Dissolved oxygen	Report (mg/L; in situ)
Nitrogen, Nitrate total (as N)	10.0 mg/L
Radium-226, -228	5.0 pCi/L
Gross alpha	15.0 pCi/L
Copper	Report (mg/L)
Chloride (as Cl)	Report (mg/L)
Sodium	160 mg/L
Iron	Report (mg/L)
Antimony	6.0 µg/L
Arsenic	10.0 µg/L
Boron	Report (mg/L)
Barium	2.0 mg/L
Beryllium	4.0 µg/L
Cadmium	5.0 µg/L
Mercury	2.0 µg/L
Selenium	50.0 µg/L
Chromium	100.0 µg/L
Lead	15.0 µg/L
Nickel	100.0 µg/L
Thallium	2.0 µg/L
Zinc	Report (mg/L)
Fluoride (as F)	Report (mg/L)
Cyanide	0.2 mg/L

(a) Groundwater monitoring requirements are specified in Industrial Wastewater Facility Permit FLA016960 (FDEP, 2007a).

(b) All groundwater samples are grab samples unless indicated otherwise; parameters are analyzed on a quarterly basis (FDEP, 2007a).

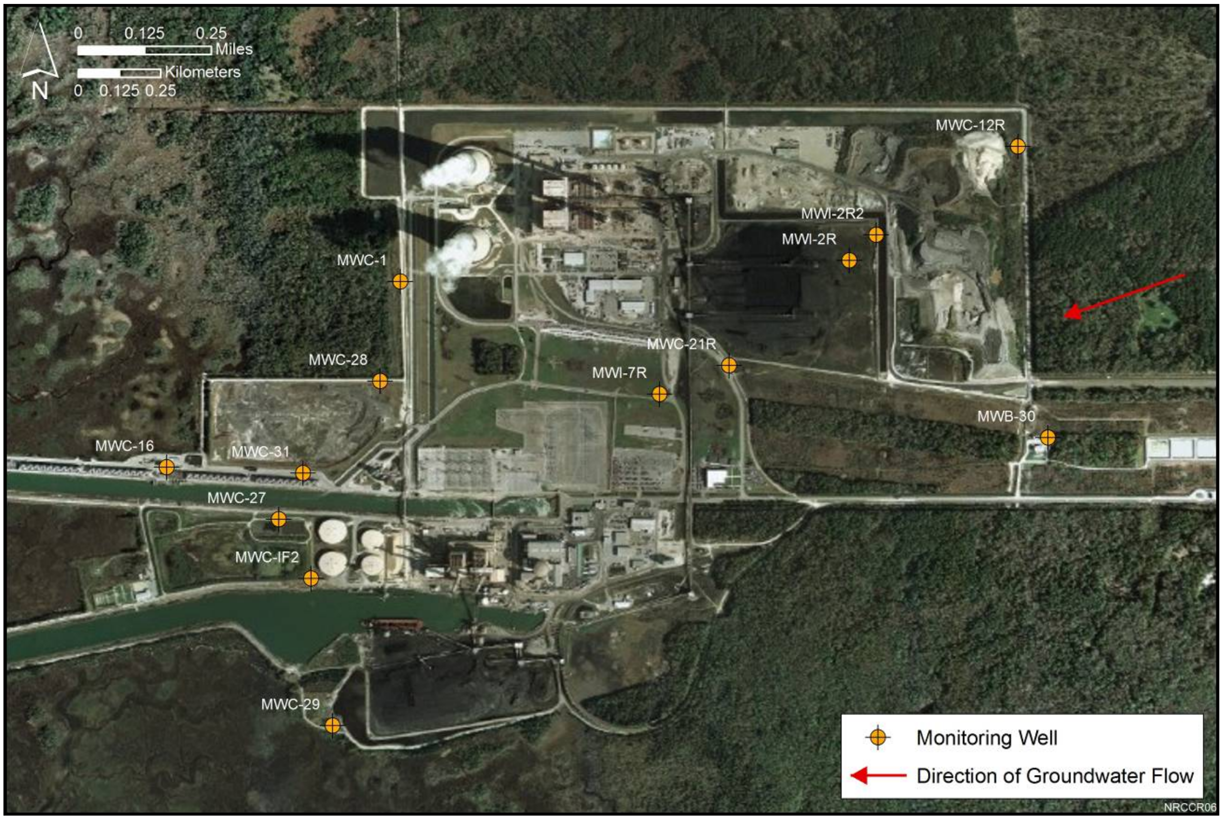

Figure 2.1.7-2. Monitoring Well Locations at the Crystal River Energy Complex (Monitoring well locations based on: Golder Associates, 2007c and FDEP, 2010b)

<u>North Plant Area</u>

In the north plant area where CR-4 and CR-5 are located, the FDEP authorizes the operation of the ash storage area, the coal storage area, the runoff collection system, the FGD settling ponds, and a stormwater pond (Table 2.1.7-2). Groundwater monitoring for these facilities is done in accordance with Industrial Wastewater Permit FLA016960 (FDEP, 2007a), (FDEP, 2008b). Analytical reports are submitted to the FDEP on a quarterly basis.

Because the coal storage area and runoff collection system are lined impoundments that discharge only to the CR-4 and CR-5 discharge canal (which discharges to the Gulf of Mexico via the site discharge canal), there are no groundwater monitoring requirements for these facilities. These facilities are regulated under Industrial Wastewater (NPDES) Facility Permit FL0036366 and discussed in Section 2.1.7.4.

<u>Ash Storage Area</u>. The ash storage area, located to the east of CR-4 and CR-5 (Figure 2.1-4), is a 95-ac (38-ha), unlined impoundment used to manage piles of dry fly ash and bottom ash from CR-1, CR-2, CR-4, and CR-5; commingled materials; and high chloride ash (Progress Energy, 2009c). Because it is unlined, leachate from the ash storage area has the potential to contaminate soil and groundwater. In 2007, the applicant sampled and analyzed ash storage area materials by synthetic precipitation leaching procedure and compared the results to PDWS (FAC Chapter 62-550), Secondary Drinking Water Standards (SDWS) (FAC Chapter 62-550), and Florida's Groundwater Guidance Concentrations (GGC) (FAC Chapter 62-777). Several constituents were found to exceed one or more of these standards: aluminum (SDWS),

antimony (PDWS), arsenic (PDWS), boron (GGC), molybdenum (GGC), selenium (PDWS), sulfate (SDWS), vanadium (GGC), and total dissolved solids (SDWS). To minimize the potential for leaching and infiltration, active areas of ash storage are sloped and compacted (Progress Energy, 2009c).

Four wells are used to monitor groundwater in the vicinity of the ash storage area: MWI-2R (downgradient), MWC-12R (upgradient), MWC-21R (downgradient), and MWB-30 (background) (Figure 2.1.7-2). Groundwater is collected on a quarterly basis and analyzed for the parameters listed in Table 2.1.7-3. Between 2005 and 2009, arsenic and gross alpha were detected at concentrations exceeding the PDWS and compliance limits (10 micrograms per liter [μg/L] and 15 pCi/L, respectively) in well MWC-2R, immediately downgradient of the ash storage area. In January 2009, gross alpha was also found to exceed the PDWS in well MWC-21R further downgradient (Progress Energy, 2009d).

<u>FGD Settling and Stormwater Ponds</u>. The FGD settling and stormwater ponds are located on the 29-ac site of the former north ash pond, just north of the helper cooling towers (Figure 2.1-4). The former ash pond was inspected by the FDEP and officially closed on December 15, 2009 (FDEP, 2009b). In 2007, the applicant sampled and analyzed ash materials by synthetic precipitation leaching procedure and compared the results to PDWS, SDWS, and Florida's GGC. Several constituents were found to exceed one or more of these standards: aluminum (SDWS), arsenic (PDWS), iron (SDWS), selenium (PDWS), and vanadium (GGC). Since then, residual ash has been removed and transferred to the high chloride ash pile within the north plant ash storage area. The FGD settling and stormwater ponds currently occupy the area (Progress Energy, 2009c).

Three wells are used to monitor groundwater in the vicinity of the former north ash pond/FGD settling ponds area: MWC-28 (upgradient; and downgradient of CR-4 and CR-5), MWC-16 (downgradient), and new well MWC-31 (downgradient) (Figure 2.1.7-2). New well MWC-31 has not been sampled yet and is not discussed here. Between 2005 and 2009, gross alpha and total radium-226 and -228 were consistently detected at concentrations exceeding the PDWS and compliance limits (15 pCi/L and 5 pCi/L, respectively) in both wells MWC-28 and MWC-16, with the highest concentrations occurring in well MWC-16. Sodium was also found to exceed its compliance limit of 160 mg/L (e.g., 7,400 mg/L in the fourth quarter of 2009). FPC is currently working with the FDEP to obtain a site-specific exemption for these constituents because it believes they are naturally occurring and not a result of contamination caused by the plant's operations (Progress Energy, 2009c), (Progress Energy, 2010a).

2.1.7.4 *Surface Water Quality*

Surface water quality is regulated through the EPA's NPDES permit program. Section 402 of the CWA specifies that, "NPDES prohibits [discharges] of pollutants from any point source into the nation's waters except as allowed under an NPDES permit." Its purpose is to regulate the discharge of wastewater to maintain water quality of receiving water bodies. The State of Florida has been delegated responsibility by the EPA for administration of the NPDES program in Florida. NPDES permits are issued by the FDEP on a 5-year cycle.

CR-1, CR-2, and CR-3 are currently operating under Industrial Wastewater Facility NPDES Permit FL0000159 issued on May 9, 2005 (FDEP, 2005a). CR-4 and CR-5 operate under Industrial Wastewater Facility NPDES Permit FL0036366 issued on August 15, 2005 (FDEP, 2005b). These permits specify the discharge standards and monitoring requirements for effluents at the CREC's outfalls on the Gulf of Mexico (Crystal Bay). The locations of the

NPDES outfalls are shown on Figure 2.1.7-3, and their monitoring requirements are summarized in Tables 2.1.7-5 and 2.1.7-6.

The Gulf of Mexico is a Class III marine water. Class III waters are managed to achieve and maintain a level of quality that supports recreation and the propagation and maintenance of a healthy, well-balanced population of fish and wildlife (FAC Chapter 62-302 [FDS, 2011c]).

In addition to the water quality parameters listed in Tables 2.1.7-5 and 2.1.7-6, the CREC is also required to monitor and report:

- discharge rates at all outfalls either by recordation or calculation
- discharge temperature at sampling point EFF-3D, the point of discharge from the site discharge canal to the Gulf of Mexico (“POD” on Figure 2.1.7-3), as a 3-hour rolling average (not to exceed 96.5 °F [35.8 °C])
- discharge temperature at sampling point EFF-3A, the monitoring point for the combined discharge of CR-4 and CR-5 cooling tower blowdown within the CR-4 and CR-5 discharge canal (report only)
- intake temperature at sampling point INT-1
- chlorination duration (in minutes) for once-through cooling water discharge, at sampling points EFF-1A, EFF-1B, and EFF-1C

Figure 2.1.7-3. National Pollutant Discharge Elimination System Outfall Locations at the Crystal River Energy Complex (Outfall locations based on: FDEP, 2005a and FDEP, 2005b)

Table 2.1.7-4. National Pollutant Discharge Elimination System Outfall Locations at the Crystal River Energy Complex

Outfall	Permitted Daily Flow Rate (mgpd)	Description
	Units 1, 2, and 3[(a)]	
D-011	1,897.9 (combined discharge; May 1 to October 31) 1,613.2 (combined discharge; November 1 to April 30)	Filtration and/or other biocide treatment of once-through non-contact condenser cooling water (OTCW) for Unit 1. Discharged to the Gulf of Mexico via the site discharge canal.
D-012	(b)	Filtration and/or other biocide treatment of OTCW for Unit 2. Discharged to the Gulf of Mexico via the site discharge canal.
D-013	(b)	Filtration and/or other biocide treatment of OTCW for Unit 3. Discharged to the Gulf of Mexico via the site discharge canal.
D-091	(c)	Unit 1 intake screen wash water discharged to the Gulf of Mexico via the intake canal.
D-092	(c)	Unit 2 intake screen wash water discharged to the Gulf of Mexico via the intake canal.
D-093	(c)	Unit 3 intake screen wash water discharged to the Gulf of Mexico via the intake canal.
D-0C1	(d)	Ash pond water (Units 1 and 2) discharged to the Gulf of Mexico via the discharge canal.
D-0C2	(d)	Percolation pond system wastewater (Units 1 and 2) discharged to the Gulf of Mexico via the discharge canal.
D-00F	(e)	Nuclear services and decay heat seawater system effluent discharged to the Gulf of Mexico via the discharge canal. Also receives effluents from internal discharges I-FG (regeneration waste neutralization tank) and I-FE (laundry and shower sump tank).
D-00H	(f)	Coal pile runoff (Units 1 and 2) discharged to an adjacent salt marsh.
D-071	(g)	OTCW from the helper cooling tower system (cells 1 and 2) to the Gulf of Mexico via the discharge canal.
D-072	(g)	OTCW from the helper cooling tower system (cells 3 and 4) to the Gulf of Mexico via the discharge canal.
D-094	(c)	Helper cooling tower intake screen wash water discharged to the Gulf of Mexico via the discharge canal.
D-100, D-200, D-300, D-400, D-500, D-600	(h)	Stormwater from plant areas discharged to the Gulf of Mexico via the intake (D-600) and discharge (D-100, D-200, D-300, D-400, and D-500) canals.

Table 2.1.7-4. National Pollutant Discharge Elimination System Outfall Locations at the Crystal River Energy Complex (continued)

Outfall	Permitted Daily Flow Rate (mgpd)	Description
	Units 4 and 5[(i)]	
D-074, D-075	44 (combined discharge)	Cooling tower blowdown for Units 4 and 5. Discharges to the Gulf of Mexico via the site discharge canal which receives discharge from the Units 4 and 5 discharge canal.
D-0CO	(j)	Runoff collection system overflow from Units 4 and 5 and from internal outfalls I-CHO (coal storage area runoff) and I-C40 (ash landfill area runoff). Also collects stormwater discharge. Discharges to the Gulf of Mexico via the site discharge canal which receives discharge from the Units 4 and 5 discharge canal.

mgpd = million gallons per day

(a) Discharges for Units 1, 2, and 3 are regulated by Industrial Wastewater Facility (NPDES) Permit FL0000159 (FDEP, 2005a).

(b) Same as for Outfall D-011.

(c) Effluent volume limits and monitoring are not required for intake screen wash water discharges.

(d) Effluent volume limits not required for ash pond or percolation pond system wastewater discharges; however, discharge volumes must be reported.

(e) Effluent volume limits not required for process wastewater; however, discharge volumes must be reported.

(f) Effluent volume limits not required for coal pile runoff.

(g) Effluent volume limits not required for OTCW; however, discharge volumes must be reported.

(h) Effluent volume limits and monitoring are not required for stormwater discharges which drain water from building areas, drainage ditches, parking lots, and roofs (Progress Energy, 2009b).

(i) Discharges for Units 4 and 5 are regulated by Industrial Wastewater Facility (NPDES) Permit FL0036366 (FDEP, 2005b).

(j) Effluent volume limits not required for runoff collection system overflow; however, discharge volumes from weir (EFF-4) must be reported when discharge occurs.

Sources: FDEP, 2005a; FDEP, 2005b; Progress Energy, 2009b

Table 2.1.7-5. Monitoring Requirements for Water Quality Parameters at National Pollutant Discharge Elimination System Outfalls for Crystal River Energy Complex Units 1, 2, and 3[(a)]

Outfall	Parameter (Daily Maximum Limit)	Monitoring Requirements
D-011, D-012, and D-013	Total residual oxidants (0.01 mg/L)	Twice per week (when OTCW is being chlorinated); multiple grab samples
D-00F	Oil and grease (20 mg/L)	Weekly (when discharging)
	Total suspended solids (100 mg/L)	Weekly (when discharging)
	pH (6.5–8.5)	Daily (when discharging)
	Copper (3.7 mg/L)	Daily (when discharging)
	Iron (8.345 mg/L)	Daily (when discharging)
	Hydrazine (0.341 mg/L)	Daily (when discharging)
	Total ammonia (0.047 mg/L)	Daily (when discharging)
	Morpholine (1.78 mg/L)	Daily (when discharging)
	Spectrus CT1300 (report only)	Once per application
	Toxicity (LC50 < 30%)	Once every 2 months until 6 valid bimonthly tests are completed
I-OFG (internal - to D-00F)	Oil and grease (20 mg/L)	One grab sample per monthly batch
	Total suspended solids (100 mg/L)	One grab sample per monthly batch
	pH (6.0–9.0)	One grab sample per monthly batch
	Copper (8.345 µg/L)	One grab sample per monthly batch
	Iron (8.345 µg/L)	One grab sample per monthly batch
D-0C1 and D-0C2	Oil and grease (5.0 mg/L)	Weekly (when discharging)
	Total suspended solids (100 mg/L)	Three times per week (when discharging); grab sample
	pH (6.5–8.5)	Monthly (when discharging)
	Arsenic (50.0 µg/L)	Monthly (when discharging)
	Cadmium (9.3 µg/L)	Monthly (when discharging)
	Chromium (50 µg/L)	Monthly (when discharging)
	Copper (3.7 µg/L)	Monthly (when discharging)
	Lead (8.5 µg/L)	Monthly (when discharging)
	Iron (0.3 mg/L)	Monthly (when discharging)
	Mercury (0.025 g/L)	Monthly (when discharging)
	Nickel (8.3 g/L)	Monthly (when discharging)
	Selenium (71 µg/L)	Monthly (when discharging)
	Zinc (8.5 µg/L)	Monthly (when discharging)
D-00H	Total suspended solids (50 mg/L)	Daily (when discharging)
	pH (6.5–8.5)	Daily (when discharging)
	Arsenic (50 mg/L)	Daily (when discharging)
	Cadmium (9.3 mg/L)	Daily (when discharging)
	Chromium (50 mg/L)	Daily (when discharging)
	Copper (3.7 µg/L)	Daily (when discharging)
	Lead (8.5 µg/L)	Daily (when discharging)
	Iron (0.3 mg/L)	Daily (when discharging)
	Mercury (0.025 g/L)	Daily (when discharging)
	Nickel (8.3 g/L)	Daily (when discharging)
	Selenium (71 µg/L)	Daily (when discharging)
	Zinc (86 µg/L)	Daily (when discharging)
	Vanadium (report)	Daily (when discharging)
D-071 and D-072	Total residual oxidants (0.01 mg/L)	Continuous
	Total residual oxidant discharge time (60 min/day)	Continuous
	pH (6.5–8.5)	Quarterly

(a) Discharges for Units 1, 2, and 3 are regulated by Industrial Wastewater Facility (NPDES) Permit FL0000159 (FDEP, 2005a).

(b) Permit FL0000159 authorizes intake screen wash water to be discharged from Outfalls D-091, D-092, D-093, and D-094 and stormwater to be discharged from Outfalls D-100, D-200, D-300, D-400, and D-500 to the discharge canal; and stormwater to be discharged from Outfall D-600 to intake canal, without limits or monitoring requirements.

Source: FDEP, 2005a

Table 2.1.7-6. Monitoring Requirements for Water Quality Parameters at National Pollutant Discharge Elimination System Outfalls for Crystal River Energy Complex Units 4 and 5[(a)]

Outfall	Parameter (Daily Maximum Limit)	Monitoring Requirements
D-074, D-075	Total residual oxidants (0.05 mg/L)	Continuous
	Total dissolved solids (report)	Weekly
	Biocides (report)	Once per application
	Toxicity (LC50 < 30%)	Quarterly until six valid quarterly tests are completed
I-CHO (internal - coal area runoff to D-0CO)	Total suspended solids (50 mg/L)	Prior to discharge
	Arsenic (report)	Prior to discharge
	Cadmium (report)	Prior to discharge
	Chromium (report)	Prior to discharge
	Copper (report)	Prior to discharge
	Iron (report)	Prior to discharge
	Lead (report)	Prior to discharge
	Mercury (report)	Prior to discharge
	Nickel (report)	Prior to discharge
	Vanadium (report)	Prior to discharge
	Zinc (report)	Prior to discharge
	Selenium (report)	Prior to discharge
I-C40 (internal - ash area runoff to D-0CO)	Total suspended solids (50 mg/L)	Prior to discharge
	Arsenic (report)	Prior to discharge
	Cadmium (report)	Prior to discharge
	Chromium (report)	Prior to discharge
	Copper (report)	Prior to discharge
	Iron (report)	Prior to discharge
	Lead (report)	Prior to discharge
	Mercury (report)	Prior to discharge
	Nickel (report)	Prior to discharge
	Vanadium (report)	Prior to discharge
	Zinc (report)	Prior to discharge
	Selenium (report)	Prior to discharge
D-0CO	Total suspended solids (50 mg/L)	Per discharge
	pH (6.5–8.5)	Per discharge
	Arsenic (50 µg/L)	Per discharge
	Cadmium (9.3 µg/L)	Per discharge
	Chromium (50 µg/L)	Per discharge
	Copper (3.7 µg/L)	Per discharge
	Iron (0.3 mg/L)	Per discharge
	Lead (8.5 µg/L)	Per discharge
	Mercury (0.25 µg/L)	Per discharge
	Nickel (8.3 µg/L)	Per discharge
	Vanadium (report; µg/L)	Per discharge
	Zinc (86 µg/L)	Per discharge
	Selenium (71 µg/L)	Per discharge

(a) Discharges for Units 4 and 5 are regulated by Industrial Wastewater Facility (NPDES) Permit FL0036366 (FDEP, 2005b).

Source: FDEP, 2005b

<u>South Plant Area</u>

Surface water discharges in the south plant area are regulated by Industrial Wastewater Facility (NPDES) Permit FL0000159, issued by the FDEP on May 9, 2005, for CR-1, CR-2, and CR-3 (FDEP, 2005a). The permit authorizes discharges to State waters via 12 outfall locations along the site discharge canal (Figure 2.1.7-3), two internal discharge locations, and six stormwater discharge locations (Table 2.1.7-4). The site discharge canal receives the following types of discharge: once-through condenser cooling water, treated nuclear auxiliary cooling water, treated coal pile rainfall runoff, intake screen wash water, and treated radioactive and nonradioactive waste. Surface impoundments in the south plant area include the percolation pond system and the coal storage area. The percolation pond system is regulated by Industrial Wastewater Permit FLA016960 (FDEP, 2007a), (FDEP, 2008b) and is discussed in Section 2.1.7-3. FPC submitted its application for a modification (extended power uprate of CR-3[4]) to NPDES Permit FL0000159 to the FDEP on September 11, 2009. Its permit renewal application was submitted on October 30, 2009.

The coal storage area is a lined impoundment located to the south of the intake canal that contains piles of coal, rock, and pyrite (Figure 2.1-4). It is designed to retain the runoff from a 10-year, 24-hour rainfall event with no overflow. Runoff from the coal storage area discharges to an adjacent salt marsh (southwest of the coal pile), a Class III marine water, via NPDES Outfall D-00H (FDEP, 2005a). Monitoring requirements for this outfall are listed in Table 2.1.7-5.

Between 2005 and 2009, one exceedence occurred on June 21, 2009, when the water temperature at the POD exceeded the 3-hour rolling average temperature limit of 96.5 °F (35.8 °C) for a period of about 2 hours (with a maximum 3-hour rolling average temperature of 96.7 °F [35.9 °C]). The exceedence was attributed to extreme heat, high humidity (which lowers the efficiency of cooling towers), and high tide. The facility performed load reductions at CR-1 and CR-2 throughout the 2-hour exceedence period and continued until the 3-hour rolling average temperature was maintained below 96.5 °F (35.8 °C) (Holt, 2009).

<u>North Plant Area</u>

Surface water discharges in the north plant area are regulated by Industrial Wastewater Facility (NPDES) Permit FL0036366, issued by the FDEP on August 15, 2005, for CR-4 and CR-5 (FDEP, 2005b). The permit authorizes discharges to the Gulf of Mexico (Crystal Bay) via two outfalls (D-074 and D-075) and one stormwater discharge location (D-0CO, which also captures internal overflow drainage from the sedimentation ponds at the ash and coal storage areas) along the CR-4 and CR-5 discharge canal, which in turn discharges to the site discharge canal via a concrete flume located just east of the helper cooling towers (Figure 2.1.7-3 and Table 2.1.7-4). FPC submitted its NPDES permit renewal application for Permit FL0036366 to the FDEP on January 25, 2010.

Surface impoundments in the north plant area include the ash storage area and stormwater retention system, the coal storage area, the runoff collection system, the FGD settling ponds, and a stormwater pond (discussed below). The FGD settlement and stormwater ponds are located on the site of the former north ash pond and are discussed under that heading.

<u>Ash Storage Area and Stormwater Retention System</u>. The north plant ash storage area, located to the east of CR-4 and CR-5 (Figure 2.1-4), is a 95-ac (38-ha), unlined impoundment used to manage piles of dry fly ash and bottom ash from CR-1, CR-2, CR-4, and CR-5; commingled materials; and high chloride ash (Progress Energy, 2009c). The storage area is permitted by

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[4] The extended power uprate of CR-3 would increase the thermal load to the site discharge canal. For this reason, Progress Energy would construct and operate a new cooling tower (called the helper cooling tower south) to comply with the existing permitted thermal limit at the point of discharge. The intake and discharge for the new cooling tower would be located on the site discharge canal. The permit modification would authorize two new outfalls to the site discharge canal and the relocation of an outfall to the intake canal (Shrader, 2009).

the plant's Conditions of Certification (PA77-09N) issued by the FDEP and most recently revised on January 15, 2010 (FDEP, 2010a).

Runoff from the ash storage area is diverted to the stormwater retention system to be disposed of by evaporation and percolation. The stormwater retention system consists of unlined retention ponds located on the south side of the ash storage area and a drainage ditch that runs along its west side. A retention canal is located on the east and north sides of the ash storage area. It is designed to retain the runoff from a 10-year, 24-hour rainfall event (8.34-inches); if this rainfall total is exceeded, water from the canal would discharge to the CR-4 and CR-5 retention ditch system via an overflow structure. Ash storage area runoff is initially held in a temporary settlement pond to allow for the settling of suspended solids before it is discharged to the stormwater system. All overflow runoff from the ash storage area ultimately discharges to the runoff collection system at NPDES Internal Outfall I-C40 (Figure 2.1.7-3) (FDEP, 2005b). Surface water is monitored on a per discharge basis at the I-C40 overflow weir before it is discharged to the runoff collection system; the parameters to be reported per discharge are listed in Table 2.1.7-6.

Coal Storage Area. The north plant coal storage area is a lined impoundment located to the east of CR-4 and CR-5 (Figure 2.1-4). The storage area is permitted by the plant's Conditions of Certification (PA77-09N) issued by the FDEP and most recently revised on January 15, 2010 (FDEP, 2010a). It is designed to retain the runoff from a 10-year, 24-hour rainfall event. Overflow runoff from the coal storage area discharges to the runoff collection system at NPDES Internal Outfall I-CHO (Figure 2.1.7-3) (FDEP, 2005b). Runoff is initially held in temporary settlement ponds to allow for the settling of suspended solids and buffering before it is discharged to the stormwater system. Surface water is monitored on a per discharge basis at the I-C40 overflow weir before it is discharged to the runoff collection system; the parameters to be reported per discharge are listed in Table 2.1.7-6.

Runoff Collection System. The runoff collection system is a lined impoundment designed to contain a 10-year, 24-hour rainfall event with no overflow. It receives infrequent overflow discharge from the north plant area ash storage area via internal Outfall I-C40 and the coal storage area via internal Outfall I-CHO and stormwater via Outfall D-0CO. Wastewaters from these areas are treated by settlement in the collection system. Overflow from the runoff collection system discharges to the Gulf of Mexico (Crystal Bay) via the site discharge canal which receives discharge from the CR-4 and CR-5 discharge canal (FDEP, 2005b). Monitoring requirements for this outfall are listed in Table 2.1.7-6.

Between 2007 and 2009, only one overflow event occurred at D-0CO due to excessive rainfall during a tropical storm (on August 22, 2008). Overflow was sampled but no permit limits were exceeded (Progress Energy, 2008b).

Former North Ash Pond/FGD Settling Ponds. Runoff from the former north ash storage pond is discharged to the Gulf of Mexico (Crystal Bay) via NPDES Outfall D-0C1 on the site discharge canal (FDEP, 2005a). Monitoring requirements for this outfall are listed in Table 2.1.7-5. Currently, the area is occupied by the FGD settlement and stormwater ponds. The FGD settling ponds are lined impoundments that receive FGD scrubber blowdown; each pond has a total bottom surface area of about 186,000 ft^2 (17,280 m^2) and a peak storage capacity of 26 ac-ft. NPDES Outfall D-0C1 will continue to provide an outlet for emergency overflow from these ponds to the site discharge canal (Progress Energy, 2010a).

2.2 AFFECTED ENVIRONMENT

This section provides general descriptions of the environment near CR-3 as background information and to support the analysis of potential environmental impacts in Chapter 4.

2.2.1 Land Use

CR-3 uses approximately 27 ac (11 ha) of previously disturbed land within the 1,062-ac (430-ha) developed portion of the 4,738-ac (1,917-ha) CREC. The remainder of the CREC site has been left undeveloped, providing a buffer zone containing 3,676 ac (1,488 ha) of primarily hardwood hammock forest and pineland, salt marches, small tidal creeks, and freshwater swamps, protected against encroachment from any other coastal development (Golder Associates, 2007a), (AEC, 1973), (Progress Energy, 2008a). The *Citrus County Comprehensive Plan* and the Citrus County Future Land Use Map designate the site on which the CREC and CR-3 are built for transportation, communication, and utilities (Golder Associates, 2007a).

The CREC includes the CR-3 and ancillary facilities, four fossil-fueled units, two large cooling towers, coal delivery and storage areas, ash storage basins, office buildings, warehouses, stacks, roads, barge handling docks, and a railroad. An ISFSI for storage of spent fuel will be located in a low-lying, 7-ac (3-ha) grassy area east of the CR-3 containment building currently used as a staging and storage area during RFOs (Progress Energy, 2008a). Cooling water is withdrawn through a 14-mi (22-km) long intake canal dredged to accommodate coal barges, while the 1.6-mi (2.7-km) discharge canal extends west to the bay (Progress Energy, 2008a).

U.S. Highway (US) 19 is located 1 mi (2 km) to the east of the CREC, its closest point, and State Routes (SRs) 44 and 490, and County Road (CR) 495 are located to the east of US 19 (see Figure 2.1-1). Public access to the plant site is restricted with no unauthorized public access or activity allowed on FPC property. The site boundary is posted and fenced to prevent public access. No public roads, railways, or waterways traverse the CREC.

2.2.2 Air Quality and Meteorology

CR-3 is located in the CREC in Citrus County, Florida, near the town of Crystal River. The closest National Weather Service (NWS) weather station is located in nearby Inverness, Florida [Inverness 3 SE, Florida (084289)]. Climate in the vicinity of the CREC is humid, subtropical, characterized by dry winters and rainy summers, but nevertheless with a high degree of sunshine days. The majority of weather systems impacting the area originate in the Gulf of Mexico. Because of Crystal River’s proximity to the western Gulf of Mexico coast, temperatures are moderated relative to locations further inland and typically range between 90 °F and 32 °F. Rainfall averages greater than 50 inches per year, but snowfall is virtually non-existent. Fog occurs regularly during winter months. Prevailing winds are from the east; however, Crystal River’s coastal location results in frequent erratic wind direction changes. The majority of weather systems impacting the area originate in the Gulf of Mexico. Because of Crystal River’s proximity to the western Gulf coast, temperatures are moderated

Data compiled at the NWS Station 084289, Inverness 3 SE, for the period of February 1, 1899, to December 31, 2008, are displayed in Table 2.2.2-1.

Table 2.2.2-1. Monthly Climate Summary for Inverness 3 SE, Florida (National Weather Service Station 084289)

Value	Range	Annual Average
Average maximum temperature (°F)	70.3 (Jan) – 91.0 (Jul)	81.9
Average minimum temperature (°F)	45.5 (Jan) – 71.8 (Aug)	59.2
Average total precipitation (inches)[(a)]	1.85 (Nov) – 8.22 (Jul)	52.77 (annual total)

Percentages of possible observations for period of record range from 97% to 97.2%

(a) Total precipitation occurred as rain only

Source: National Climate Data Center, Southeast Regional Climate Center (SERCC) Complete data available electronically at: http://www.sercc.com/cgi-bin/sercc/cliRECtM.pl?fl4289 (accessed May 15, 2009)

The area is also subject to severe storms. Tropical storms, including hurricanes originating in the warm Caribbean waters and approaching from the Gulf of Mexico, or, less frequently, across the Florida peninsula having made landfall on Florida's Atlantic Ocean coast, have impacted Citrus County. All landfalling hurricanes over that period are shown in Figure 2.2.2-1.

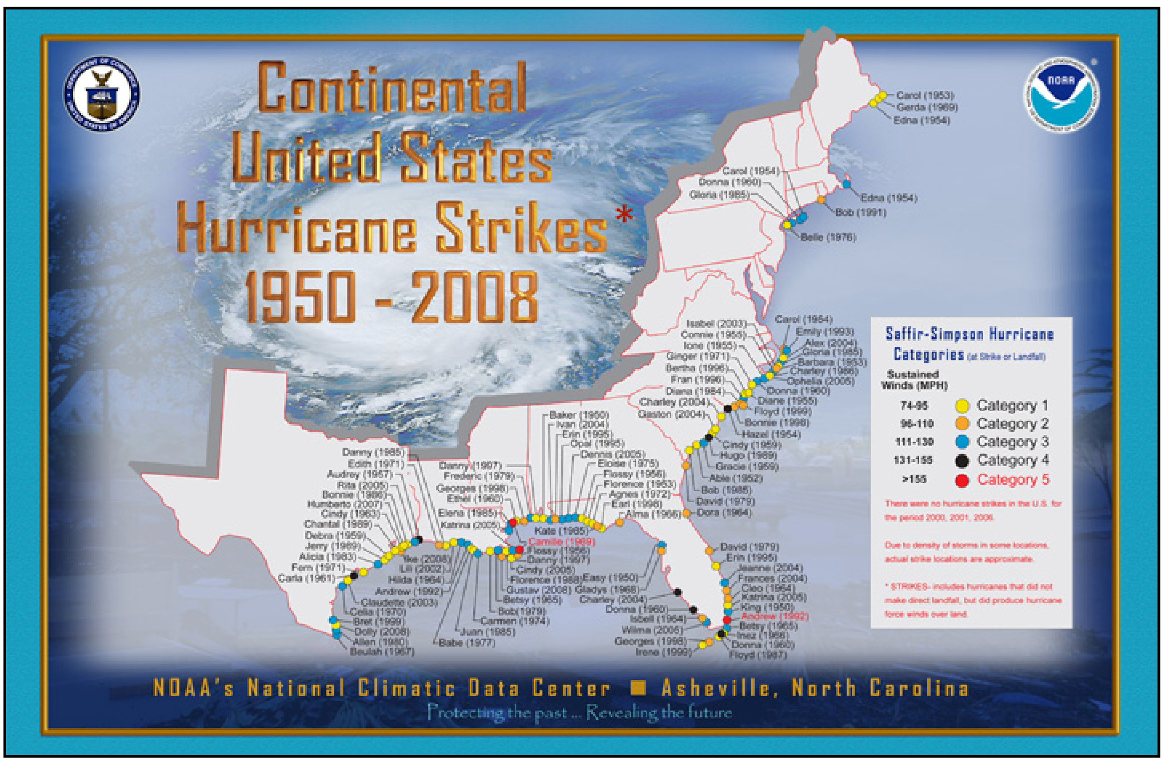

Figure 2.2.2-1. Landfalling Hurricanes in the Continental United States over the Period 1950 through 2008 (Source: NCDC, 2009)

Queries of the National Climatic Data Center (NCDC) Storm Events database (http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms) (NOAA, 2010) for Citrus County, Florida, over the period January 1, 1950, through December 31, 2009, identified 471 individual extreme weather events, among which were included: 133 thunderstorm and high wind events, 67 hail events, 60 fog events, 46 tornadoes (38 of which resulted in minor to moderate property damage), 45 occasions of temperature extremes (below freezing, with or without wind chill) (7 of which resulted in significant crop damage), 29 flood events (all but 6 of which resulted in minor to moderate property damage), 20 lightning events, 15 hurricane and tropical storm events (6 hurricanes landfalling on the west coast of Florida's peninsula – see Figure 2.2.2-1), 3 funnel clouds, 8 heavy precipitation events, 4 ocean storm surge events (2 of which resulted in moderate property damage), and 2 wild/forest fires (1 of which occurred in Crystal River in 2000). There were no drought, dust storm, or snow and ice events over the reporting period.

2.2.2.1 *Regional Air Quality Impacts*

Citrus County is within the West Florida Intrastate Air Quality Control Region (AQCR) (see 40 CFR Part 81). All of Florida, including the West Florida IAQCR, is currently in attainment for all Primary National Ambient Air Quality Standards (NAASQ[5]) (see 40 CFR 81.310[6]). Orange County, Duval County, the Tampa Bay area including Hillsborough and Pinellas Counties, and Southeast Florida including Dade, Broward, and Palm Beach Counties continue to be classified by the FDEP as attainment/maintenance areas for ozone and Tampa is a maintenance area for lead. The entire State remains unclassifiable for particulate matter, 10 microns or less in diameter (PM_{10}); although sufficient monitoring data exist, the EPA has not considered this pollutant for attainment determinations yet.

The current Primary NAAQS are shown in Table 2.2.2.1-1. In 2006, there were 216 ambient air monitors operating Statewide in 34 counties to monitor ambient air quality against Federal or State standards. Citrus County has one monitoring station monitoring continuously for particulate matter,

National Ambient Air Quality Standards (NAAQS)

The Clean Air Act (CAA) of 1970 established NAAQS for six pollutants, known as "criteria" pollutants—sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), and lead (Pb) (40 CFR Part 50). Collectively, the criteria pollutants are indicative of the quality of the ambient air. The primary standards are referred to as "health effects standards." These standards are set at levels to protect the health of the most susceptible individuals in the population: the very young, the very old, and those with respiratory problems. The EPA has designated secondary standards to protect public welfare. These are referred to as "quality of life standards." All of the standards are expressed as concentration in air and duration of exposure. Many standards address both short- and long-term exposures. Any individual State may adopt a more stringent set of standards. For example, the State of Florida has ambient standards for SO_2 that are somewhat more stringent than the NAAQS.

When the pollutant levels in an area have caused repeated violations of a particular standard, the area is classified as in "nonattainment" for that pollutant. The EPA has established classification designations based on regional monitored levels of ambient air quality in accordance with the CAA Amendments of 1990. Nonattainment designations require States to develop and implement a plan for attaining compliance. Such State Implementation Plans are approved by the EPA and invariably include increasingly stringent controls on major sources of criteria pollutants.

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[5] In October 2006, the EPA revised the 24-hour $PM_{2.5}$ standard and revoked the annual PM_{10} standard (see *Federal Register*, Volume 71, No. 200, 61144-61233, October 17, 2006). The final ozone rule was issued in March 2008. Implementation rules for the revised standard are currently under development. See the EPA Office of Air and Radiation website for additional details on all NAAQS: http://www.epa.gov/oar.

[6] The EPA designated Florida in attainment in 2006, based on ambient air monitoring data collected over the previous 3 years. Data collected since that EPA designation still demonstrate conformance with all criteria pollutants in all AQCRs in the State.

2.5 microns or less in diameter ($PM_{2.5}$) only. In 2006, for the 121 days for which valid monitoring data were available, the Air Quality Index [7]for Citrus County was in the "good" category 110 days and in the "moderate" category for 11 days (FDEP, 2007b). Statewide monitoring results included:

- CO (1-hour): all 22 monitors below 25 percent of the standard
- CO (8-hour): all 22 monitors below 35 percent of the standard
- NO_2: all 14 monitors were below 25 percent of the standard
- O_3 (1-hour): no exceedances at 53 monitors
- O_3 (8-hour): there were 30 exceedances (daily concentration greater than 0.08 parts per million [ppm]); however, none have contributed to a violation (3-year average of the fourth highest concentration greater than or equal to 0.08 ppm)
- PM_{10} (annual): all 45 monitors were less than 75 percent of the standard
- PM_{10} (24-hour): 44 of 45 monitors were below 65 percent of the standard; highest concentration of 130 $\mu g/m^3$ occurred in Hillsborough County
- $PM_{2.5}$ (annual): All monitors using the Federal Reference Method were less than 85 percent of the standard
- $PM_{2.5}$ (24-hour): two exceedances among 32 monitors; highest concentration occurred in Brevard County at 36 $\mu g/ m^3$
- Sulfur Oxides (annual Florida): all 26 monitors were below 25 percent of the standard
- Sulfur Oxides (24-hour Florida): all 26 monitors were below 65 percent of the standard
- Sulfur Oxides (3-hour Florida): all 26 monitors were below 35 percent of the standard
- Pb: No violations at any of the three monitors: highest value was 0.83 $\mu g/m^3$ in Hillsborough County

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[7] The Air Quality Index (AQI) is a simplified way of notifying the public on a daily basis of possible adverse health effects of pollutant levels in the ambient air. Measured values of five criteria pollutants are combined to create a single number corresponding generally to the descriptors of air quality: good, moderate, unhealthy for sensitive groups, unhealthy, and very unhealthy. For $PM_{2.5}$, an AQI of "good" corresponds to an ambient air concentration from 0.0 to 15.4 mg/m^3 while a "moderate" AQI corresponds to a concentration range of 15.4 to 40.4 mg/m^3.

Section 169A of the Clean Air Act, as amended (42 U.S.C., § 7491, Title I, Air Pollution Prevention and Control, Part C, Prevention of Significant Deterioration of Air Quality, Subpart 2, Visibility Protection for Federal Class I Areas) authorized the Secretary of the Interior, in consultation with other Federal land managers to "…review all mandatory class I Federal areas and identify those where visibility is an important value of the area." Altogether, 156 mandatory class I Federal areas were thus identified in 40 CFR Part 81 where deterioration of visibility could not be tolerated. There are three mandatory Class I Federal areas in the State of Florida: Chassahowitzka Wilderness Area, Everglades National Park, and St. Marks Wilderness Area, all under the stewardship of the FWS or within 62 mi (100 km) of the CREC. The closest Class I Federal area is the Okefenokee Wilderness Area in Georgia (also under the control of the FWS), approximately 110 mi (177 km) north-northeast of the CREC. Given the distances involved and the nature of the stationary air pollutant sources at the CREC associated with the nuclear reactor that have the potential to impact visibility, no adverse impacts on Class I Federal area visibilities can be reasonably anticipated from CREC operation.

Two other major regulatory programs recently promulgated under the CAA authority are the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR)[8]. Although the CAIR has since been struck down, Progress Energy is nevertheless going forward with modifications to its CR-4 and CR-5 coal units by installing pollution control devices that would have been required under the CAIR. The CAMR regulation does not apply to the nuclear reactor (CR-3) at the CREC, but it does apply to the other four coal-burning units at the CREC.

The CREC qualifies as a major source[9] under the Title V permit program by virtue of the operation of the coal-fired units on contiguous parcels all under the control of Progress Energy and, therefore, is required to obtain a Title V permit. Although none of the permit stipulations pertain directly to the operation of CR-3, the existence of that permit nevertheless has an indirect impact on the operation, monitoring, and recordkeeping requirements for stationary sources of criteria pollutants affiliated with CR-3. Specifically, drift from an auxiliary cooling tower shared between CR-3 and two coal-fired units is addressed in the permit and three diesel-fueled emergency power generators affiliated exclusively with the nuclear reactor are identified in the permit as unregulated stationary sources (FDEP, 2008c). The Florida Siting Board approved a 180-MW extended power uprate for CR-3 in August 2008 (Florida Siting Board, 2008). The FDEP issued Conditions of Certification for CR-3 and for CR-4 and CR-5, which are two coal-fired units, on August 28, 2008 (FDEP, 2008c).

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[8] In July 2008, the U.S. Court of Appeals for the Washington DC District struck down EPA's CAIR rulemaking after determining that EPA overstepped its authority. In December, 2008, that same Court reinstated CAIR. CAIR is designed to limit the amounts of SO_2 and NO_x released from fossil fuel power plants that threaten the ambient air quality in 28 eastern states and the District of Columbia. EPA is currently developing implementing regulations. CAMR was published on March 15, 2005 and is designed to cap mercury emissions from coal-burning power plants. More details on these regulations are available at the EPA Web site: http://www.epa.gov/oar/.

[9] Under the title V operating Permit program, EPA defines a Major Source as a stationary source with the potential to emit (PTE) any criteria pollutant at a rate > 100 tons/year, or any single HAP at a rate of > 10 tons/year or a combination of HAPs at a rate > 25 tons/year.

Table 2.2.4.2-1. National and Florida Ambient Air Quality Standards (NAAQS)[a]

Pollutant[b]	Averaging Time	National Standards		Standard Type[c]	Florida Standards
SO_2	3-hour	0.5 ppm	(1,300 $\mu g/m^3$)	S	0.5 ppm (1,300 $\mu g/m^3$)
	24-hour	0.14 ppm	(365 $\mu g/m^3$)	P	0.10 ppm (260 $\mu g/m^3$)
	Annual	0.030 ppm	(80 $\mu g/m^3$)	P	0.02 ppm (60 $\mu g/m^3$)
NO_2	Annual	0.053 ppm	(100 $\mu g/m^3$)	P, S	0.05 ppm (100 $\mu g/m^3$)
CO	1-hour	35 ppm	(40 mg/m^3)	P	35 ppm
	8-hour	9 ppm	(10 mg/m^3)	P	9 ppm
O_3	1-hour	0.12 ppm[d]	(235 $\mu g/m^3$)	P,S	0.12 ppm
	8-hour	0.075 ppm	(157 $\mu g/m^3$)	P, S	–
PM_{10}	24-hour	150 $\mu g/m^3$		P, S	150 $\mu g/m^3$
	Annual	–[g]		P, S	50 $\mu g/m^3$
$PM_{2.5}$	24-hour	35 $\mu g/m^3$[e]		P, S	–[g]
	Annual	15 $\mu g/m^3$		P, S	–[g]
Pb	Calendar quarter[f]	1.5 $\mu g/m^3$		P, S	1.5 $\mu g/m^3$

(a) Refer to 40 CFR Part 50 for detailed information on attainment determination and reference method for monitoring (refer to http://www.gpoaccess.gov/cfr/index.html and http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-8477.pdf).

(b) CO = carbon monoxide; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; $PM_{2.5}$ = particulate matter ≤ 2.5 µm; PM_{10} = particulate matter ≤ 10 µm; and SO_2 = sulfur dioxide.

(c) P = primary standards, which set limits to protect public health; S = secondary standards, which set limits to protect welfare and quality of life.

(d) On June 15, 2005, the 1-hour O_3 standard was revoked for all areas except the 8-hour O_3 nonattainment Early Action Compact (EAC) areas (those do not yet have an effective date for their 8-hour designations). The 1-hour standard will be revoked for these areas 1 year after the effective date of their designation as attainment or nonattainment for the 8-hour O_3 standard.

(e) Effective December 17, 2006, the EPA revoked the annual PM_{10} standard of the current 50 $\mu g/m^3$ and revised the 24-hour $PM_{2.5}$ standard from 65 $\mu g/m^3$ to 35 $\mu g/m^3$ (refer to http://a257.g.akamaitech.net/7/257/2422/01jan20061800/edocket.access.gpo.gov/2006/pdf/06-8477.pdf).

(f) On October 15, 2008, the EPA revised the lead standard from a calendar-quarter average of 1.5 $\mu g/m^3$ to a rolling 3-month average of 0.15 $\mu g/m^3$.

(g) No standard.

(h) As noted in (d) above, the Federal 1-hour ozone standard was vacated in February 1998 in Florida. It was reinstated in July 2000. Finally it was vacated again on June 15, 2005, but remains a Florida standard.

Sources: 40 CFR Part 50; 40 CFR 52.21

2.2.3 Groundwater Resources

CR-3 is located in the central portion of the CREC within the Gulf coastal lowlands of west-central Florida's coastal plain province. The CREC site occupies a filled area that was once marshland. Surface fill at the site ranges in thickness from 3 to 5 ft (0.9 to 1.5 m). The fill is underlain by a natural soil consisting of deposits of thinly laminated organic sandy silts and clays (typical of tidal marshes) inter-layered with marine sediments of the Pamlico Terrace formation (Pleistocene age). The Pamlico Terrace is an ancient shoreline that trends parallel to the present shoreline (Progress Energy, 2008a), (Knochenmus and Yobbi, 2001), (USDA, 1988).

Groundwater at the CREC is drawn from the Floridan aquifer system, which is a thick, vertically continuous sequence of Tertiary-age carbonate rocks (limestone and dolomite) with high relative permeability and regional extent. The system consists of the Upper Floridan aquifer, the middle confining unit, the Lower Floridan aquifer, and the sub-Floridan confining unit. The Upper Floridan aquifer is the principal source of potable water in west-central Florida; the Lower Floridan contains saltwater and is not used as a water supply source. The geologic units comprising the freshwater part of the Upper Floridan aquifer are (from oldest to youngest) the Avon Park formation and Ocala limestone (Eocene age), and the Suwannee limestone (Oligocene age). The Inglis formation (part of the Ocala limestone) is the uppermost unit below the CREC; the Suwannee limestone is absent. Because the surficial and intermediate aquifer systems that act as confining units to the Upper Floridan aquifer in other parts of Florida are absent in the west-central coastal area, the Upper Floridan aquifer is unconfined (Yobbi, 1992), (Knochenmus and Yobbi, 2001), (Marella and Berndt, 2005), (Sacks, 1996).

EnHydro (2007) describes two primary zones within the shallow portion (i.e., Inglis formation) of the Upper Floridan aquifer at the CREC: (1) an upper zone, consisting of a highly permeable network of interconnected solution cavities and channels, that extends from ground surface to a depth of about 30 ft; and (2) a deeper, less permeable zone, consisting of smaller voids and solution channels, that extends from a depth of about 40 to 60 ft (to the underlying Avon Park formation). The two zones are separated by a 10-ft thick unit of unfractured limestone.

Annual recharge to the aquifer is high (ranging from 10 to 30 inches [25 to 76 cm]) and occurs mainly in upland areas as infiltration through the ground surface and drainage into sinkholes. Flow within the aquifer at the site is mainly through solution cavities and along fractures. The hydraulic gradient in the vicinity of the CREC is about 2 ft/mi (0.379 m/km or 3.8×10^{-4}) to the west toward the coast (Ortiz, 2006). Natural discharge from the Upper Floridan aquifer occurs through numerous springs that feed coastal rivers, salt marshes, and swamps along the coast. Several springs also discharge offshore into the Gulf of Mexico. Groundwater in the vicinity of CR-3 flows to the west-southwest and discharges near the head of the intake and discharge canals. Shallow gradients fluctuate as much as 1 ft with tidal conditions, resulting in a steep gradient at low tide and a more flat gradient at high tide (EnHydro, 2007), (Florida Power, 2005), (Trommer, 1993), (Yobbi, 1992), (Marella and Berndt, 2005).

Water in the Upper Floridan aquifer is predominantly a calcium bicarbonate type formed by the dissolution of the aquifer by groundwater (Trommer, 1993). The CREC lies within the transition zone where water composition reflects a mixture of freshwater and saltwater. The landward extent of the transition zone is defined by Trommer (1993) as the location where all groundwater in a vertical section of an aquifer contains chloride concentrations of 25 mg/L or less. Causseaux and Fretwell (1982) use the value of 250 mg/L or less to define the freshwater-saltwater interface because it is the drinking water standard (Secondary Maximum

Contaminant Level) defined by the EPA for chloride, as a nonthreatening contaminant (EPA, 2009a). In the Upper Floridan aquifer, the 250-mg/L line of equal chloride concentration extends about 3 mi (5 km) inland, as measured in wells between 1987 and 1990 (Trommer, 1993). The landward extent of the transition zone (using the 25-mg/L line of equal chloride concentration) is about 9 mi (14 km). Chloride concentrations in CREC production wells are greater than 250 mg/L (Florida Power, 2005).

2.2.4 Surface Water Resources

The CREC is located on Crystal Bay, a shallow embayment of the Gulf of Mexico, midway between the mouths of two rivers[10]: the Withlacoochee River, about 4.5 mi (7.2 km) to the north, and the Crystal River, about 2.5 mi (4 km) to the south (Figure 2.2.4-1). The Withlacoochee River flows from the Green Swamp in northern Polk County along the Citrus-Levy County line to the Gulf of Mexico, and drains an area of about 2,020 square miles (m^2) (5,232 square kilometers [km^2]). It has an average annual flow of 1,027 cfs (29 m^3/s) at the Bypass Channel near Inglis, about 1.4 mi (2.3 km) upstream of its mouth (USGS, 2009a). The Withlacoochee River is in hydrologic contact with the Upper Floridan aquifer along much of its course. In its lower reaches, about half of its base flow is from the aquifer. The Crystal River originates from several fresh- and brackish-water springs at King's Bay, about 6 mi (10 km) inland. It has an annual average flow of about 846 cfs (24 m^3/s) at Bagley Cove, located about 3.6 mi (5.8 km) upstream of its mouth (USGS, 2009b). It is one of several shallow streams south of the CREC that alternately floods and drains the estuarine marshes during tidal fluctuations. Most of the water in these rivers derives from groundwater (from the Upper Floridan aquifer) and there is little surface drainage in the area. Diurnal tidal ranges are about 4.1 ft (1.2 m) at the mouth of the Withlacoochee River and 2.6 ft (0.79 m) near the mouth of the Crystal River (AEC, 1973), (Yobbi and Knochenmus, 1989), (Champion and Starks, 2001).

While forested wetlands and salt marshes are found in the undeveloped (northeastern and southeastern) portions of the CREC and to the south of the site, there are no natural surface water bodies on or immediately adjacent to CR-3.

The west-central coast of Florida is an area of low relief, ranging in elevation from mean sea level to about 5 ft (1.5 m). It is a low-wave energy coast dominated by salt marshes and swamps that are dissected by dendritic tidal channels. These features occur in a 1-mi (1.6-km) wide band along the coast near the CREC, separating the uplands to the east from the Gulf of Mexico. Nearshore areas off the coast are shallow (with an average depth of less than 20 ft [6.1 m]), broad, and gently sloping. Thin, discontinuous sands cover a carbonate (karst) platform with limestone outcrops, sinks, and submarine springs. Many sinks and springs have been filled with sand carried by a northward-flowing longshore current. Karst features decrease away from the shore (USGS, 1997), (Morton et al., 2004), (Yobbi and Knochenmus, 1989).

Salinities in spring-fed streams and marshes are seasonally variable and depend mainly on the effects of streamflow and tidal conditions. Streamflows and tides are typically higher in summer and fall than in the winter and spring. Salinities rise during periods of lower freshwater flow and

[10] As Class III water bodies, the Withlacoochee River and Crystal River are designated for recreational use and for the propagation and maintenance of a healthy, well-balanced population of fish and wildlife (see FAC, Rule 62-302.400). They are also designated for special protection under the Outstanding Florida Waters listing (see FAC, Rule 62-302.700).

higher tides, and fall during periods of higher freshwater flow and lower tides. Salinity in springs along the coast tends to be high (brackish) but generally decreases with distance inland from the coast, since water level elevations in the Upper Floridan aquifer are higher away from the coast and saltwater in the aquifer occurs only at depth (Section 2.2.3). Spring discharges tend to be freshest during times of high water levels in the aquifer. When water levels in the aquifer are low, saltwater mixes with freshwater as it flows toward the spring opening, increasing salinity in the spring discharge (Yobbi and Knochenmus, 1989).

Because of high rainfall and large volumes of freshwater that discharge from rivers and springs along the coast, nearshore waters in the Gulf of Mexico are generally low in salinity. Wind direction and the direction of currents in the Gulf of Mexico are also important factors in distributing freshwater along the coast and out to sea (Yobbi and Knochenmus, 1989).

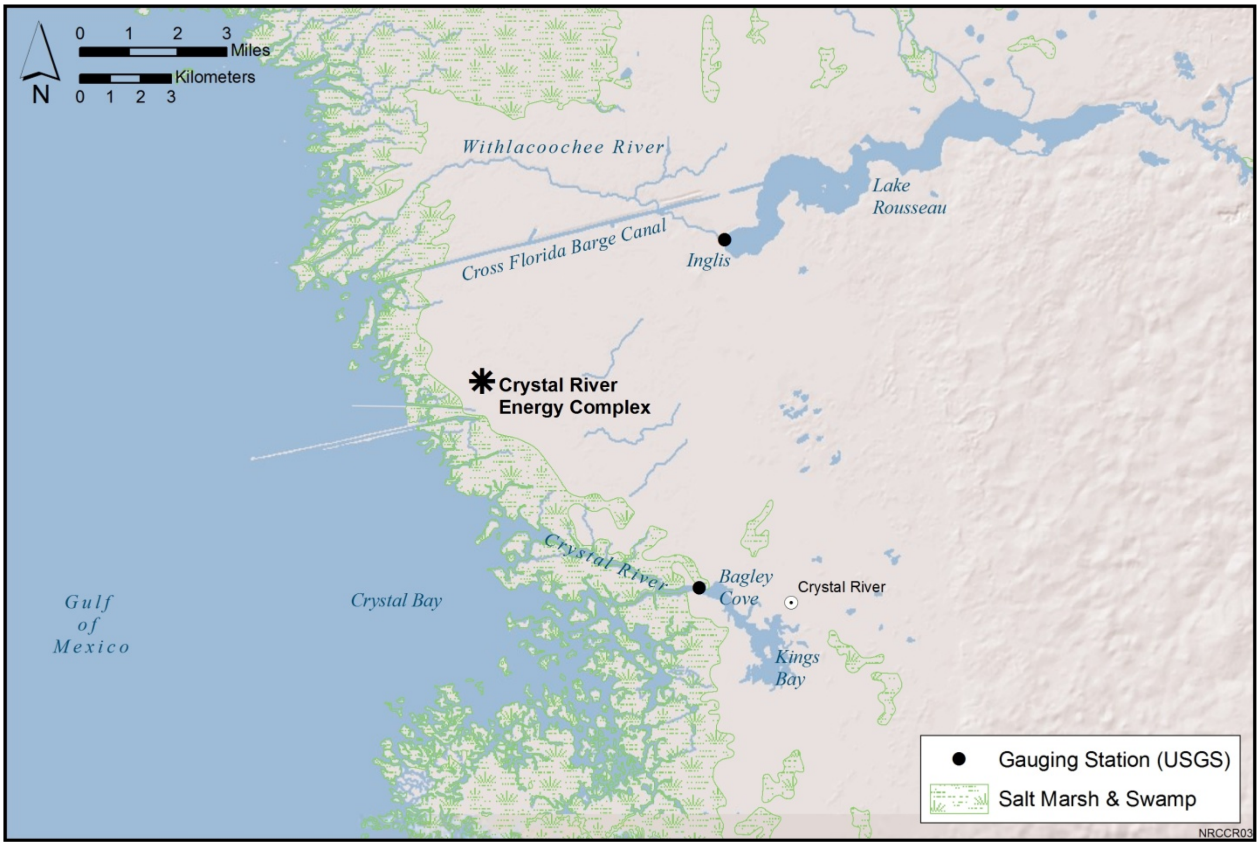

Figure 2.2.4-1. Surface Water in the Vicinity of the Crystal River Energy Complex

2.2.5 Aquatic Resources

CR-3 has a once-through condenser and auxiliary cooling system that withdraws water from, and discharges it to Crystal Bay (Section 2.1.6). Crystal Bay is a shallow estuarine embayment of the Gulf of Mexico largely located between the Cross Florida Barge Canal (Marjorie Harris Carr Cross Florida Greenway) and Crystal River, and extending offshore for about 10 mi (16 km) (SWEC, 1985). It is located within Florida's Big Bend which includes the coastlines between Franklin County and Pinellas County (i.e., the coastlines of Wakulla, Jefferson, Taylor, Dixie, Levy, Citrus, Hernando, and Pasco Counties). The estuary areas of Big Bend total over

250,000 ac (101,000 ha) (Kilgen and Dugas, 1989). Section 2.2.4 provides an overview of the hydrology of Crystal Bay.

2.2.5.1 *General Characteristics of Aquatic Systems near Crystal River Unit 3 Nuclear Generating Plant*

Very gentle slopes characterize the Big Bend bathymetry, increasing about 3 ft (1 m) in depth per 3 mi (5 km) distance from shore (Hale et al., 2004). Crystal Bay is shallow with depths less than 10 ft (3 m) out to 3 mi (5 km) from shore. Oyster reefs parallel the shore. It has relatively low wave energy with many rocky reef areas, oyster bars, and seagrass beds. Salt marshes are extensive in undeveloped areas of the coast (SWEC, 1985). Most oyster reefs are underwater at high tide with portions exposed at low tide (SWEC, 1985). Small numerous basins created by the oyster reefs run in a north-south orientation in the area of the CREC intake and discharge canals (Progress Energy, 2008a). During the tidal cycle, water levels fluctuate from 2 to 4 ft (0.6 to 1.2 m) (ReMetrix, 2007). Salinities tend to be higher offshore and near the POD, while areas near the rivers and the Cross Florida Barge Canal have reduced salinities (SWEC, 1985). Nearshore waters of Crystal Bay have a salinity of 22 to 29 parts per thousand (ppt) (AEC, 1973); while salinities about 8 to 10 mi (13 to 16 km) offshore are about 35 ppt, a value typical of open ocean waters (National Ocean Service, 2008). Shallow estuaries are less able to store heat compared to deeper waters, and water temperatures fluctuate from 39 °F to 90 °F (4 °C to 32 °C) annually (EPA, 1999). Annual water temperatures near the CREC intake average 71.2 °F (21.8 °C), ranging from 43 °F (6.1 °C) to 94.6 °F (34.8 °C) (Golder Associates, 2007a).

Overall, the shallow waters of Florida's Big Bend have exceptional water quality and clarity (Handley et al., 2007). Land use practices such as agriculture, urbanization, and industrial development affect water quality; resulting in hydrologic alterations to watersheds that flow into Big Bend and result in nutrient enrichment of the estuarine and coastal waters (GMP, 2004), (Mattson et al., 2007). Water quality within the estuarine areas of Citrus County are affected by increased urban stormwater runoff, seepage from onsite sanitary sewage disposal, sewage treatment plant effluent, residential use of pesticides, herbicide and fertilizers, and activities associated with commercial and leisure boating (CCBCC, 2009).

2.2.5.2 *Major Aquatic Habitats near Crystal River Unit 3 Nuclear Generating Plant*

A variety of habitats, discussed below, support an abundance of aquatic resources in Crystal Bay. Open water habitats include saltwater, tidally-influenced water of variable salinities, and tidal freshwater areas. The bottom of Crystal Bay provides a number of different benthic habitats, with their characteristics dictated by salinity, tides, and substrate type. Unless cited otherwise, the habitat descriptions are from the Florida Fish and Wildlife Conservation Commission (FWC, 2005).

<u>Artificial Structures</u>

Artificial structures include artificial reefs and hardened shorelines. The construction of artificial reefs can enhance recreational fishing and diving opportunities; while hardened shorelines (e.g., rip-rap, other types of coastal armoring, breakwaters, piers, and docks) enhance coastal development. While hardened shorelines provide some habitat for bivalves, shellfish, and some finfish, they alter natural marine and estuarine shoreline processes and alter or replace naturally-occurring coastal habitats. The dikes that parallel the CREC intake and discharge canals are artificial structures. Other artificial structures in the area are the spoils islands located along the South Florida Barge Canal. These structures and the oyster reefs (discussed later in this section) affect tidal flux and current patterns in the area of the CREC (Steidinger and Van Breedveld, 1971).

Coastal Tidal Rivers and Streams

Coastal tidal rivers and streams are the segments of rivers and streams that experience a tidal influence that affects water levels, flow rates, and salinity concentrations. Water flow in tidal rivers and streams is bidirectional, and salinity can range from freshwater to brackish. Many tidal rivers and streams occur within the Big Bend region of Florida. Tidal rivers and streams near the CREC include the Withlacoochee River, Cross Florida Barge Canal, Crystal River, Cutoff Creek, and Salt Creek.

Oyster Reefs

Dense concentrations of Eastern oysters (*Crassostrea virginica*) attach to hard substrates and to each other to create oyster reefs. The Eastern oyster occurs within estuarine areas with salinities of 15 to 30 ppt. Oyster reefs generally consist of an upper layer of live oysters over a core of buried shell and mud. The reefs can range from small mounds or patches to long ridges extending several miles. Large reefs have a significant role in the energy flow dynamics of estuaries by dividing bays, changing circulation patterns (GMFMC, 2004), and causing flow restrictions during portions of the tidal cycle (Galya and McDougall, 1985). Oyster reefs also absorb wave energy, which helps to minimize shore erosion, and help to maintain water quality through live oyster filtering capacities (GMFMC, 2004). Oyster reef habitats provide nursery grounds, refugia, and foraging areas for over 300 species of macroinvertebrates and fishes (Stanley and Sellers, 1986). Peterson et al. (2003) determined that 108 ft^2 (10 m^2) of restored oyster reef can yield an additional 2.5 kilograms per year (kg/yr) (5.5 pounds per year [lb/yr]) of production of fish and large mobile crustaceans. Under 13,600 ac (5,500 ha) of oyster reefs are currently mapped for Florida, but spatial data are lacking for most oyster and other bivalve reefs (FWC, 2005). A number of oyster reefs parallel the shoreline near the CREC (Progress Energy, 2008a).

Oyster spawning occurs between March and November at temperatures consistently above 68 °F (20 °C) with mass spawning occurring at temperatures above 77 °F (25 °C) (Stanley and Sellers, 1986). Generally, spawning only occurs at salinities above 10 ppt (GMFMC, 2004). The Eastern oyster is a broadcast spawner. A female produces 15 to 115 million eggs per spawning event and may spawn several times in a season (Stanley and Sellers, 1986). Eggs hatch into free-swimming trochophore larvae, followed by the veliger larval stage (GMFMC, 2004). The daily mortality rate for larvae is about 10 percent (Stanley and Sellers, 1986). After 3 weeks, a larva develops a “foot” and settles to the bottom where it seeks a hard substrate, preferably an adult oyster. The newly settled larvae (spat) cement themselves to the substrate and start their metamorphosis to an adult (GMFMC, 2004). The Eastern oyster can reach maturity in as little as 4 weeks after settling (FWC, 2009a). In the Gulf, Eastern oysters obtain lengths of 3 inches (7.6 cm) within 2 years and nearly 6 inches (15 cm) by 5 or 6 years. They can live up to 30 years and attain a size of almost 12 inches (30.5 cm) (FWC, 2009a). Annual mortality of spat is typically 60 percent but can be as high as 99 percent, and the annual mortality of adults can range from 5 to 80 percent (Stanley and Sellers, 1986).

The Eastern oyster tolerates widely fluctuating temperatures, salinities, and suspended solids concentrations (Stanley and Sellers, 1986). Optimal temperatures for growth, reproduction, and survival are 68 °F to 86 °F (20 °C to 30 °C) (Stanley and Sellers, 1986); while optimal salinities are 12 to 25 ppt (GMFMC, 2004). Exposure of Eastern oysters to 95 °F (35 °C) rarely caused death, but did inhibit effective reproduction by causing premature spawning, spawning out of season, and deterioration of oyster condition (Quick, 1971). Mortality can occur from extended exposure to salinities less than 2 ppt (GMFMC, 2004).

Larval oysters feed on phytoplankton; while adults consume phytoplankton, bacteria, detritus, and other organisms less than 10 microns in size (GMFMC, 2004). Protozoans, ctenophores, jellyfish, hydroids, worms, bivalves, barnacles, crabs, and fish consume eggs, embryos, and early oyster larvae. Stone crabs, mud crabs, blue crabs, southern oyster drill, crown conch, lightning whelk, starfish, boring sponge, sea anemone, flatworms, and some fishes such as black drum and rays consume oyster spat and adults (GMFMC, 2004).

Most commercial landings of Eastern oyster in Florida occur along the panhandle and Big Bend area. The FWC (2011a) reported 2010 annual commercial landings of oysters to be 1,694,664 lb (768,687 kg) for the west coast of Florida with no commercial landings reported for Citrus County. In Citrus County, the Florida Department of Agriculture and Consumer Services (2011) allows oyster harvesting south of the Crystal River intake (normally opened to harvesting, but may be temporarily closed during periods of red tide, hurricanes, and sewage spills) during spring and fall months; and conditionally approved (periodically closed to shellfish harvesting during predictable pollution events) during winter months.

Salt Marshes

Salt marshes occur where wave energies are low and mangroves are absent. About 442,600 ac (179,100 ha) of salt marshes occur in Florida. Tidal rivers and streams often dissect larger stretches of salt marsh. The herbaceous plants of salt marshes include grasses, sedges, and rushes. Salt marshes provide nursery areas for many larval and juvenile invertebrates and fishes; provide a major source of organic matter to sustain estuarine detrital food webs; and reduce erosion, buffer inland areas from storm damage, recycle inorganic nutrients, and remove contaminants (GMFMC, 2004). The salinity of salt marsh waters ranges from 0.5 to 34 ppt (Ward, 1999). Soil salinity and tidal frequency affect primary production in salt marshes. When the density, growth, and survival of juvenile fishes and decapod crustaceans are considered, the relative nursery value of salt marsh habitats for nekton appear higher than open water habitats but lower than seagrass habitats (Minello et al., 2003).

A 0.5 to 1 mi (0.8 to 1.6 km) band of salt marshes drained by numerous small creeks occurs in the CREC area (SWEC, 1985). The salt marshes near the CREC are typical of northwest Gulf shoreline areas. Sediments in the salt marsh area are primarily mud with small areas of exposed limestone and oyster shell banks. Rushes and cordgrass (e.g., *Juncus roemerianus* and *Spartina patens*, respectively) and other salt-tolerant plants border shallow creeks and bayous. Smaller areas of mangroves and glasswort (*Salicornia* spp.) are scattered throughout the salt marshes. *Spartina*-dominated areas also occur along the intake and discharge spoil banks for the CREC.

Submerged Aquatic Vegetation

Submerged aquatic vegetation habitats include any combination of seagrasses, attached macroalgae, and drift algae that cover 10 to 100 percent of the substrate (GMP, 2004). Seagrasses are marine flowering plants adapted for underwater growth and reproduction. Seagrass beds occur in areas of low wave energy and often occur next to tidal-flat, salt-marsh, and mangrove communities. Salt marshes and adjacent seagrass beds share a diverse fauna (Dawes et al., 2004). Seagrasses help maintain water clarity, stabilize substrates, provide habitat for fish and shellfish, provide food for some marine animals, and provide nursery areas for recreationally and commercially important fish and shellfish (Sargent et al., 1995), (FDEP, 2008d), (Handley et al., 2007). Nearly all of the commercially and recreationally valuable estuarine and marine animals depend on seagrass beds as refuge or habitat for parts or all of their lifecycles (Dawes et al., 2004).

Over 2.4 million ac (1 million ha) of seagrass beds occur in Florida (FWC, 2005). The Big Bend area of Florida has the highest acreage of seagrass along the northern Gulf of Mexico. Potential seagrass habitat in Big Bend out to a depth of 60 ft (18 m), which includes deepwater *Halophila* beds, is 3,496,534 ac (1,415,028 ha) (Handley et al., 2007).

Handley et al. (2007) reported the following areal coverage of seagrasses in Big Bend:

- In 1984 – 197,880 ac (80,891 ha) of continuous seagrass and 619,648 ac (250,768 ha) of patchy seagrass
- In 1992 – 67,110 ac (27,159 ha) of continuous seagrass and 200,529 ac (81,153 ha) of patchy seagrass
- In 2003 – 70,443 ac (28,508 ha) of continuous seagrass and 541,372 ac (219,090 ha) of patchy seagrass

Seagrass habitats occur within the shallows of Crystal Bay and extend westward about 7 to 12 mi (11 to 19 km) into the Gulf (CCBCC, 2009).

Seven seagrass species occur in Florida (FDEP, 2008d). The four most widespread species are shoal grass (*Halodule beaudettei*, formerly known as *Halodule wrightii*), ditch grass or widgeon grass (*Ruppia maritima*), turtle grass (*Thalassia testudinum*), and manatee grass (*Syringodium filiforme*). The other three species are star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and Johnson's seagrass (*Halophila johnsonii*) (FDEP, 2008d). Turtle grass, manatee grass, and shoal grass are the major species of seagrass present in the Big Bend area (GMP, 2004). Shoal grass, widgeon grass, star grass, and attached macroalgae are pioneer species that rapidly colonize bare areas. Manatee grass then occurs, usually intermixed with shoal grass in early stages of seagrass bed development and turtle grass in later stages. Turtle grass is the climax species in seagrass succession (GMFMC, 2004).

Shoal grass, ditch grass, turtle grass, manatee grass, and star grass occur near the CREC (AEC, 1973), (SWEC, 1985), (Progress Energy, 2008a). However, during the 316 Demonstration study (SWEC, 1985) to determine potential water intake and discharge impacts from CREC operations on Crystal Bay, only shoal grass occurred at sampling stations most affected by the CREC's heated discharge; whereas the biomass of shoal grass, ditch grass, and turtle grass were lower in areas less affected by thermal discharges compared to areas unaffected by thermal discharges. Section 4.5.4 provides further information on the effect of CREC thermal discharges on seagrasses.

Submerged aquatic vegetation habitats, including those dominated by seagrasses, can also contain rooted green algae, particularly *Caulerpa* and *Sargassum* spp., and epiphytic algae. Algae can contribute over 50 percent of primary production in seagrass habitats (GMFMC, 2004). Epiphytic algae growth may affect seagrass photosynthesis by intercepting incident light (Hale et al., 2004). Some macroalgae found in submerged aquatic vegetation habitats include attached macroalgae that has broken loose from other locations. These drift algae can comprise an important component of submerged aquatic vegetation habitat (Dawes et al., 2004), (GMFMC, 2004). Crabs, isopods, and sea urchins are direct grazers on seagrasses; while other invertebrates may feed on the epiphytes that occur on the seagrasses (Dawes et al., 2004). Total fish density in Tampa Bay was similar at sites dominated by either drift algae or seagrasses but was significantly reduced at sites with little cover by either vegetation type. Thus, both drift algae and seagrasses are essential habitats for juvenile and small adult fishes (Rydene and Matheson, 2003). Drift algae functions as both a dispersal mechanism and an alternative habitat for seagrass-associated fish and macroinvertebrates (Rydene and Matheson, 2003).

Both natural perturbations (e.g., storms, floods, droughts, hurricanes, and overgrazing by manatees and sea turtles) and anthropogenic perturbations (e.g., nutrient loading) can affect submerged aquatic vegetation (Dawes et al., 2004), (GMP, 2004), (Handley et al., 2007). Since the 1950s, over 2 million ac (800,000 ha) of seagrasses were eliminated in Florida due to nutrient loading, salinity changes caused by water control projects, boat propeller and trawl net damage, dredging, and other human-related causes (Sargent et al., 1995). Eutrophication from nutrient loading is the major cause of seagrass habitat degradation (GMP, 2004), (Hale et al., 2004). Increased nutrient loading in the Big Bend region has increased phytoplankton abundance and possibly periphyton abundance on seagrass blades. This has altered the light regime available to seagrasses, reducing the maximum depth of occurrence since the late 1970s (Hale et al., 2004). Similar effects on seagrasses can occur when nutrients increase macroalgae growth (Dawes et al., 2004).

Subtidal Unconsolidated Marine/Estuary Sediments

Subtidal unconsolidated marine/estuary sediment habitats consist of open areas of mineral substrates within tidal zones (i.e., less than 10 percent of the habitat is comprised of submerged aquatic vegetation or corals). Substrates consisting of unconsolidated sediments (e.g., mud, mud/sand, sand, or shell) occur throughout the coastal areas of Florida. These habitats can support large populations of infaunal organisms such as tube worms, sand dollars, mollusks, isopods, amphipods, burrowing shrimp, and crabs and are important feeding grounds for bottom-feeding fish and invertebrate species. Microscopic photosynthetic eukaryotic algae and cyanobacteria, anaerobic photosynthetic bacteria, and chemosynthetic bacteria occur in unconsolidated sediments (MacIntyre et al., 1996).

2.2.5.3 *Aquatic Biota near Crystal River Unit 3 Nuclear Generating Plant*

The following provides an overview of the plankton, macrophytes and marine algae, macroinvertebrates, and fishes that occur near the CREC. Section 2.2.5.2 also addresses macrophytes, marine algae, and oysters, as these organisms are the foundation of submerged aquatic vegetation and oyster reef habitats.

Plankton

Plankton includes primary producers (phytoplankton) and consumers (zooplankton) whose movements are controlled more by tides and currents than by their own movements. Phytoplankton includes microscopic, single-celled algae that are responsible for most of the primary production in the water column. Components of the estuarine phytoplankton include green algae (Chlorophyta), blue-green algae (Cyanobacteria), golden-brown algae (Chrysophyta), brown algae (Phaeophyta), and red algae (Rhodophyta). Periphyton (algae attached to solid submerged objects) includes species of diatoms (Bacillariophyta) and other algae that grow on natural or artificial substrates. These species can become planktonic as a result of scouring or other actions that separate individuals from their substrate.

Zooplankton is defined as the heterotrophic plankton that prey on phytoplankton, detritus, and other zooplankton. In turn, zooplankton is a food source for filter feeders, fish larvae, invertebrates, and larger zooplankton. Components of the zooplankton include:

- Holoplankton (organisms planktonic for their entire life such as amphipods and copepods)
- Meroplankton (organisms that are planktonic for a portion of their life [usually during the larval stage] such as sea urchins, sea stars, crustaceans, marine worms, some marine gastropods, and many fish)
- Ichthyoplankton (eggs and larvae of many fish species)

The AEC (1973) reported few protozoa species in the intake and discharge canals at the CREC. Bacterial populations were also low. Most nanoplankton consisted of algal cells dominated by diatoms (AEC, 1973). Calanoid copepods dominated the zooplankton population in the intake and discharge canals (AEC, 1973).

In 2008, CH2M Hill (2009) collected zooplankton on four occasions in the portion of Crystal Bay affected by CREC discharge. Zooplankton abundance ranged from 570 to 2,541 individuals/100 ft^3 (20,132 to 89,743 individuals/100 m^3). Holoplankton, dominated by copepods and chaetognath (arrow) worms, accounted for about 32 percent of the zooplankton; meroplankton, dominated by larvae of mud crabs, brachyuran crabs, mud shrimps, caridean shrimps, and gastropods, accounted for 32 percent of the zooplankton; and ichthyoplankton, dominated by anchovy eggs and larvae and goby larvae, accounted for about 1 percent of the zooplankton. Overall, mud crab larvae and copepods accounted for 57 to 66 percent of the mean zooplankton numbers, respectively (CH2M Hill, 2009).

The mean abundance of fish eggs ranged from 0.4 to 34.6 individuals/100 ft^3 (15 to 1,224 individuals/100 m^3) and included eggs of Carangidae, Clupeidae (sardines and menhaden), Engraulidae (anchovies), Haemulidae, Merluccidae, Paralichthyidae, Sciaenidae (croakers and drums), and Serranidae (CH2M Hill, 2009). The mean abundance of fish larvae ranged from 2.2 to 11.7 individuals/ft^3 (76 to 414 individuals/100 m^3). Larvae of Gobiidae (gobies) and Engraulidae were collected year-round indicating they have year-round resident populations with continuous reproduction (CH2M Hill, 2009). Larvae of pelagic fishes collected included Sciaenidae, Clupeidae, Atherinopsidae (silversides), and Gerridae (mojarras); while larvae of the demersal fishes from the families Blenniidae (blennies) and Achiridae were also collected (CH2M Hill, 2009). Zooplankton samples also included post-yolk-sac larvae of the commercially or recreationally important silver perch, red drum, spotted seatrout, and southern kingfish (*Menticirrhus americanus*) (CH2M Hill, 2009).

<u>Macrophytes and Marine Algae</u>

Submerged aquatic vegetation (including both macrophytes and macroalgae) performs a variety of roles in aquatic ecosystems, including serving as food, habitat, and/or shelter for a variety of waterfowl, fish, shellfish, and invertebrates; and contributing to important aquatic chemical processes, such as absorbing nutrients and oxygenating the water column. Dense vegetative beds can also attenuate wave energy and slow water currents, thereby allowing suspended sediment to settle out of the water column, reducing resuspension of sediments, and reducing erosion of shoreline areas (Hall et al., 1978), (EPRI, 2003). Factors that affect the distribution and condition of submerged aquatic vascular plants include weather and hydrology, sedimentation, suspended solids and water quality, and consumption and disturbance by fish and wildlife (Handley et al., 2007).

Phillips (1960) collected marine plants from Crystal Bay (south of CREC) in 1958 and 1959. He collected five species of seagrasses: shoal grass, widgeon grass, turtle grass, manatee grass, and star grass. These species of seagrass currently occur in the CREC area (Progress Energy, 2008a). Phillips (1960) also collected 46 taxa of algae of which 25 were epiphytic forms. These included 5 blue-green algae taxa, 7 green algae taxa, 8 brown algae taxa, and 26 red algae taxa. The marine algae occurred on both muddy sand substrates between oyster bars and on oyster bars. The brown alga *Sargassum pteropleuron*, occurring on oyster bars, was particularly abundant (Phillips, 1960).

Steidinger and Van Breedveld (1971) identified 106 taxa of marine algae in Gulf waters adjacent to the CREC. These included 19 taxa of green algae, 24 taxa of brown algae, and 63 taxa of red algae. Lowest algal species diversity occurred in winter (Steidinger and Van Breedveld, 1971). Steidinger and Van Breedveld (1971) also identified the same five species of seagrasses collected by Phillips (1960). Epiphytes and invertebrates attached to benthic algae included bryozoans, hydroids, and chain-forming diatoms. Steidinger and Van Breedveld (1971) noted that these organisms can stress benthic algae by causing physical stress, competing for nutrients, reducing available light, and possibly by producing inhibitory metabolites.

During the 316 Demonstration study, 5 species of seagrasses, 10 species of benthic green algae, 33 species of drift algae (mostly red algae), 2 species of attached brown algae, and 42 species of epiphytic algae were identified (Mattson et al., 1988). Red algae, particularly *Gracilaria* spp., were the dominant component of drift algae in the study area. Percent cover, the only parameter of drift algae quantitatively measured, showed no clear trends in distribution in the area of the CREC (Mattson et al., 1988).

While all species of seagrasses in Florida flower within a temperature range of 68 °F to 79 °F (20 °C to 26 °C), vegetative growth from rhizomes is the principal way that seagrasses expand in the Gulf coast (Dawes et al., 2004). Most seagrass species decline in areal density and blade length below 68 °F (20 °C) (ReMetrix, 2007). The following provides some environmental characteristics for the five seagrass species that occur in Crystal Bay:

- Shoal grass occurs from the intertidal zone to relatively deep water. It probably grows in pure stands closer to shore than other species of seagrass. Optimum temperature for shoal grass is between 68 °F to 86 °F (20 °C to 30 °C) (Dineen, 2001a). Shoal grass is most abundant at salinity ranges of 12 to 38.5 ppt. It grows on silty mud to coarse sands with varying amounts of mud (Dineen, 2001a).

- Widgeon grass can survive a temperature range of 44.6 °F to 102.9 °F (7 °C to 39.4 °C) (Dineen, 2001b). It generally occurs at salinities of 25 ppt or less. Widgeon grass predominantly grows on a mixture of mud and silt with fine textured sand. It occurs in intertidal areas to depths of 7 ft (2.1 m), with densest growth at mean high tide depths of 2 to 4 ft (0.6 to1.2 m) (Dineen, 2001b).

- Turtle grass is the dominant seagrass species along the Florida Gulf coast. Turtle grass occurs at depths up to 46 ft (14 m), but is most abundant at depths less than 16 ft (5 m). In murky conditions, turtle grass only occurs at depths up to 6 ft (1.8 m) (Dineen, 2001c). Temperatures of 68 °F to 86 °F (20 °C to 30 °C) are the optimal range for turtle grass growth, while temperatures of 95 °F (35 °C) or more will kill turtle grass leaves (Dineen, 2001c). Optimal salinity range is 25 to 38.5 ppt, although turtle grass occurs at salinities as low as 10 ppt in Crystal Bay (Dineen, 2001c).

- The densest growth of manatee grass occurs at depths of 2 to 4.5 ft (0.6 to1.4 m) mean low tide. Manatee grass is eurythermal, although leaf kill occurs when temperatures drop to about 68 °F (20 °C) (Dineen, 2001d). Manatee grass forms dense beds at salinities of 22 to 35 ppt. It can withstand periods of salinity as low as 10 ppt (Dineen, 2001d).

- Star grass occurs at depths up to 47 ft (14.4 m). Temperatures of 71.6 °F to 81.5 °F (22 °C to 27.5 °C) and a photoperiod over 12 hours are required for sexual reproduction to occur (Dineen, 2001e).

Aquatic weeds, particularly hydrilla (*Hydrilla verticillata*), have become a problem in many of the freshwaters of Citrus County as it can displace native aquatic plant species, alter water chemistry, alter aquatic fauna, and choke waterways an public water supplies (Masterson, 2007). Control of hydrilla includes mechanical, biological, and chemical procedures. These procedures do not occur in winter, as overwintering Florida manatees (*Trichechus manatus latirostris*) eat hydrilla (CCBCC, 2009).

<u>Macroinvertebrates</u>

Macroinvertebrates are animals without backbones that are generally large enough to see with the naked eye. This group of organisms performs many ecological functions. Some benthic macroinvertebrates form habitat by building reefs (e.g., oysters, corals, and some polychaetes) or by stabilizing or destabilizing soft substrates (e.g., some bivalves, amphipods, and polychaetes). Some macroinvertebrates are filter feeders that clean the overlying water (such as oysters, other bivalves, and some polychaetes), and others consume detritus. Macroinvertebrates also provide a trophic base for fish and shellfish valued as commercial and recreational species by humans.

Species composition and abundance of benthic macroinvertebrates can indicate ecosystem health. Generally, the greater the diversity of species and the more abundant those species are, the healthier the ecosystem is considered. Lyons et al. (1971) identified 286 taxa of macroinvertebrates in trawl samples from the estuary area near the CREC in 1969 (only CR-1 was operational in January through October; CR-2 came online in November 1969). Most invertebrate species were wide-ranging estuarine forms capable of withstanding a wide variation of environmental conditions and included 128 species of mollusks and 83 species of arthropods (Lyons et al., 1971). Selected limitations of trawl collections limited the number of species collected and some groups such as sponges, amphipods, and ascidians (sea squirts) were not included in the totals due to taxonomic difficulties. Macroinvertebrates collected by Lyons et al. (1971) included cnidarians (hydroids, jellyfish, anemones, and corals), gastropods (snails), pelecypods (bivalves), cephalopods (squids and octopi), polychaetes (bristleworms), isopods, decapods (e.g., shrimp and crabs), bryozoans, and echinoderms (sea stars, sea urchins, and sea cucumbers). The most abundant cnidarian was the sea whip (*Leptogorgia virgulata*). Abundant mollusks included the variable bittium (*Bittium varium*), semiplicate dove shell (*Anachis semiplicata*), lunar dove shell (*Mitrella lunata*), common eastern nassa (*Nassarius vibex*), scorched mussel (*Brachidontes exustus*), lateral musculus (*Musculus lateralis*), and

Eastern oyster. The most abundant cephalopod was the brief squid (*Lolliguncula brevis*). The most numerous shellfish in the Crystal Bay area were the Eastern oyster, blue crab (*Callinectes sapidus*), Florida stone crab (*Menippe mercenaria*), and pink shrimp (*Farfantepenaeus duorarum*) (AEC, 1973).

Benthic collections made between June 1983 and August 1984 for the combined 316a and 316b Demonstration contained over 900 macroinvertebrate taxa (SWEC, 1985). Polychaetes, mollusks, and crustaceans dominated the study area, as is typical of marine benthic communities. Generally, the number of species increased offshore. Among nearshore stations, the lowest number of species occurred in the thermal area and near the intake canal (SWEC, 1985). The lowest densities of benthic infauna occurred during July through September and the highest densities in April (SWEC, 1985). Many species of polychaetes were common to abundant. Nine species of polychaetes, plus a shrimp-like crustacean in the Order Tanaidacea, comprised over 50 percent of the benthic fauna (SWEC, 1985). SWEC (1985) recognized two benthic communities: (1) the polychaete genera *Aricides*, *Streblospio*, *Tharyx*, and *Fabricia* numerically dominated the inshore community (which included areas potentially affected by the thermal discharge); and (2) the polychaete genera *Mediomastus*, *Myriochele*, and *Goniadides* numerically dominated the offshore community (SWEC, 1985). As summarized by Hutchings (1998) and Marzialetti et al. (2009), polychaetes are often the dominant component in most benthic marine and estuarine sediments (both in numbers of individuals and number of species) and play a major role in the functional structure of macroinvertebrate communities by recycling and reworking of sediments, burying of organic matter, and enhancing various sedimentary processes by their feeding and burrowing activities.

CH2M Hill (2009) collected benthic macroinvertebrates in July and November 2008 in the portion of Crystal Bay affected by CREC discharge. Densities ranged from 739 to 1,333 individuals/ft^2 (7,980 to 14,395 individuals/m^2); and were comprised of polychaetes, oligochaetes, bivalves, crustaceans, gastropods, and cnidarians (jellyfish, box jellies, hydrozoans, sea anemones, and corals). Polychaetes dominated the infaunal community and accounted for 77 to 91 percent of the sampling station means; while oligochaetes and bivalves accounted for 3.3 and 3.2 percent of the mean abundance, respectively (CH2M Hill, 2009). Dominant species included *Mediomastus* spp., *Fabricinuda trilobata*, *Monticellina dorsobranchialis*, and *Lumbrineris verrilli*.

CH2M Hill (2009) also collected motile macroinvertebrates in trawls and crab traps in April, June, August, and November 2008. Trawling collected 21 macroinvertebrate species. The most abundant species were the yellowline arrow crab (*Stenorhynchus seticornis*), pink shrimp, and mud crabs which represented 19, 15, and 10 percent of the total catch, respectively. The crab traps collected 66 Florida stone crabs, 16 blue crabs, and 1 crown conch (*Melongena corona*) (CH2M Hill, 2009).

<u>Fishes</u>

In a 2.5-year study of fishes near the CREC conducted from 1969 through the first half of 1971, 96 species plus 9 taxa either grouped together or identified only to genus were collected (Mountain, 1972). The frequency of occurrence of the four most abundant species (pigfish [*Orthopristis chrysoptera*], silver perch [*Bairdiella chrysoura*], spot [*Leiostomus xanthurus*], and pinfish [*Lagodon rhomboides*]) collected throughout 1970 were not significantly different between areas affected by thermal discharges from CR-1 and CR-2 and areas that were not affected by thermal discharges (Grimes and Mountain, 1971). A trend of generally increasing species diversity from the Cross Florida Barge Canal to south of the CREC intake canal was noted and may be potentially related to similar increases in salinity from north to south. Habitat destruction associated with dredging of the Cross Florida Barge Canal, Withlacoochee River channel, and CREC canals may have also accounted for the decreased diversity of fishes north of the CREC discharge and intake canals (Grimes and Mountain, 1971).

The striped mullet (*Mugil cephalus*) is among the important forage species that occurs near the CREC; while species sought by anglers include spot, Atlantic croaker (*Micropogonias undulatus*), red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), sheepshead (*Archosargus probatocephalus*), black drum (*Pogonias cromis*), and crevalle jack (*Caranx hippos*) (AEC, 1973). Due to security and safety concerns, fishing is no longer allowed within the inshore portion of the discharge canal or shoreward from where the south intake canal dike ends. The shallow waters and oyster bars hinder commercial fishing in the area of the CREC.

For the combined 316a and 316b Demonstration (SWEC, 1985), adult and juvenile fish were collected monthly from June 1983 through May 1984 using trawls and seines from inshore and offshore marine habitats and from tidal creek habitats. Trawls collected 98 species from marine habitats and 43 species in creeks, while seines collected 49 species from marine habitats. The composition of fish species collected during the 316 Demonstration was similar to that collected during the CR-3 preoperational surveys (SWEC, 1985).

As part of the fish impingement study conducted from December 2006 to November 2007, Ager et al. (2008) conducted monthly nearfield trawling at three locations near the CREC intake canal. Ager et al. (2008) collected 50 fish species in the limited area sampled by trawls. Most of the species collected were the same as those collected in more intensive collections reported by Mountain (1972) and SWEC (1985).

On four sampling events in 2008, CH2M Hill (2009) collected 1,290 fish from 63 species of adult and juvenile fishes using beach seines, otter trawls, gill nets, cast nets, and minnow traps at two stations in the area of the CREC discharge. In beach seines, 664 individuals from 13 fish species were collected. The dominant species collected were typical inhabitants of salt marshes and included killifishes, mojarras, needlefish, tidewater silverside (*Menidia peninsulae*), and sheepshead minnow (*Cyprinodon variegatus*) (CH2M Hill, 2009). Trawls, used to collect demersal fish, collected 391 individuals from 20 fish species (CH2M Hill, 2009). On all four sampling dates, collections included silver perch, pinfish, and pigfish. Gill nets collected 107 individuals from 24 fish species. The numerically dominant species were yellowfin menhaden (*Brevoortia smithi*, 18 percent of the total catch), black drum (12 percent), Atlantic thread herring (*Opisthonema oglinum*, 10 percent), pinfish (9 percent), and spinner shark (*Carcharhinus brevipinna*, 9 percent) (CH2M Hill, 2009). Cast netting collected 87 individuals from 18 fish species. Striped mullet accounted for 35 percent of the total catch and white mullet (*Mugil curema*) accounted for 24 percent of the total catch (CH2M Hill, 2009). Minnow traps collected 27 individuals among 8 fish species. Pinfish and pigfish were the most abundant fish caught representing 39 and 23 percent of the total catch, respectively (CH2M Hill, 2009).

Overall, fish species composition based on fish collections from Crystal Bay near the CREC, coupled with information from impingement collections made at the CREC (see Section 4.5.3), indicate that a diverse, stabile fish community has occurred near the CREC since the late 1960s.

2.2.5.4 *Selected Important Species near Crystal River Unit 3 Nuclear Generating Plant*

Important species include: (1) species sensitive to adverse harm from plant operations (e.g., thermally sensitive species), (2) species that use the local area for spawning or nursery grounds (including those species that migrate past the plant to spawn), (3) species of commercial or recreational value, (4) species that are habitat formers and critical to the functioning of the local environment, and (5) species that are important links in the local food web (McLean et al., 2002). The following is an overview of the life history and environmental characteristics for 13 selected important fish and shellfish species in the area of the CREC. The selected important species, as originally chosen by SWEC (1985) for the 316 Demonstration study, include the bay anchovy (*Anchoa mitchilli*), polka-dot batfish (*Ogcocephalus radiatus*), pigfish, pinfish, silver perch, spotted seatrout, spot, red drum, striped mullet, brief squid, blue crab, Florida stone crab, and pink shrimp.

Bay Anchovy (*Anchoa mitchilli*)

The bay anchovy, a member of the anchovy family (Engraulidae), occurs from the Gulf of Maine and Cape Cod, Massachusetts, south to Yucatan, Mexico, and throughout the Gulf of Mexico (Masterson, 2008a). The bay anchovy is one of the most common coastal fish species (Robinette, 1983). It grows to about 4 inches (10 cm) in length (Masterson, 2008a). The bay anchovy is often numerically dominant, at least seasonally, where it occurs. It is a pelagic species that is encountered over seagrass beds and unvegetated benthic areas (Masterson, 2008a). Spawning occurs both within estuaries and in offshore waters to depths of 100 ft (30 m) (SCDNR, 2006) and takes place from February to October, peaking in July (Benson, 1982). Nine gravid bay anchovy females collected during the 316 Demonstration averaged 2,240 eggs per female (SWEC, 1985). Eggs hatch in about 24 hours (Benson, 1982).

The bay anchovy exhibits a broad temperature range and is euryhaline. It has been collected at temperatures ranging from 40.1 °F to 103.6 °F (4.5 °C to 39.8 °C) (Robinette, 1983), but the largest numbers occurred at water temperatures of 50 °F to 58.8 °F (10 °C to 14.9 °C) (Benson, 1982). It has a general offshore movement from shallow, cooler waters to deeper, warmer waters in winter (Benson, 1982). The bay anchovy occurs in salinities ranging from freshwater to 45 ppt (Robinette, 1983). The bay anchovy is intolerant of low oxygen levels (Masterson, 2008a).

Larvae and juvenile bay anchovies prey mostly on calanoid copepods. At least 50 percent of the adult diet is also copepods, but mysid shrimp become important in its diet (Benson, 1982). Most piscivorous fish species and many seabirds prey upon the bay anchovy (Benson, 1982). The FWC (2011a) did not report 2010 annual commercial landings for the bay anchovy.

Pigfish (*Orthopristis chrysoptera*)

The pigfish, a member of the grunt family (Congiopodidae), occurs from Massachusetts to the tip of Florida, throughout the Gulf of Mexico, and the coastal waters of Bermuda (Sutter and McIlwain, 1987). Most pigfish live past 4 years of age. Pigfish are sexually mature by their second year (Sutter and McIlwain, 1987). It spawns around March near the Crystal River area of the Gulf (Grimes and Mountain, 1971). Eggs are buoyant (Sutter and McIlwain, 1987). Larvae occur at depths less than 164 ft (50 m); while juveniles inhabit shallow bays over shallow flats with abundant plant growth during spring and early summer. In late summer and fall, pigfish juveniles move to deep flats and edges of channels (Sutter and McIlwain, 1987). Adults occur in deeper flats and channels with sparse vegetation and in offshore and open-shelf areas of the Gulf (Sutter and McIlwain, 1987). Pigfish attain a standard length of 18 inches (46 cm) and a weight of 2 lb (0.9 kg) (Sutter and McIlwain, 1987).

The pigfish is most abundant at a temperature of about 77 °F (25 °C) and a salinity of 25.1 ppt; and occurs at a temperature range of about 57 °F to 97 °F (14 °C to 36 °C) and a salinity range of 0 to 38 ppt (Sutter and McIlwain, 1987). However, pigfish generally avoid temperatures below 57 °F (14 °C) by migrating to deeper waters. It also tends to avoid salinities less than 15 ppt (Sutter and McIlwain, 1987).

Young pigfish primarily consume copepods, while adults consume amphipods, shrimp, and other benthic organisms (Sutter and McIlwain, 1987). Other predatory fishes prey upon pigfish. It has limited commercial value, but recreational fishermen often catch pigfish (Sutter and McIlwain, 1987). The FWC (2011a) did not report 2010 annual landings for the pigfish.

Pinfish (*Lagodon rhomboids*)

The pinfish, a member of the porgy family (Sparidae), occurs in coastal waters from New England south to Florida, Bermuda, the northern Gulf of Mexico, northern coast of Cuba, and the Yucatan (Masterson, 2008b). Pinfish occur in estuarine and nearshore waters along all Florida counties (Masterson, 2008b). It has been collected at depths from less than 1 to 121 ft (0.3 to 73 m) deep (Benson, 1982). The pinfish is a demersal estuarine species found in seagrass beds, rocky reefs, jetties, and mangrove swamps (Muncy, 1984), (Masterson, 2008b). It can live to be 7 years old, but few live that long. Pinfish mature after 1 or, usually, 2 years (Masterson, 2008b). Mature pinfish migrate offshore in the late fall to spawn from late fall through early spring. Fecundity averages 21,600 eggs. Fertile eggs are semibuoyant (Masterson, 2008b). Larval pinfish begin moving into estuarine waters through spring and early summer (Masterson, 2008b). Late larvae and juvenile pinfish are numerically dominant in seagrass beds during spring and summer (Benson, 1982). During summer, adults and older juveniles occur in deeper open areas of estuaries and channel edges (Benson, 1982).

Pinfish can tolerate temperatures between 50 °F and 95 °F (10 °C and 35 °C); however, most will move into cooler deep waters when shallow estuaries exceed 89.6 °F (32 °C). It stops feeding at 95 °F to 96.8 °F (35 °C to 36 °C) and succumbs after a 24-hour exposure to 96.8 °F (36 °C) (Masterson, 2008b). Pinfish are euryhaline, occurring at a salinity range of 1 to 75 ppt (Muncy, 1984).

Larval pinfish primarily feed on copepods; while juvenile and subadult pinfish feed primarily on small crustaceans. Adult pinfish feed on plant material in addition to animal prey, particularly bivalves (Benson, 1982). A number of larger fish species and the bottlenose dolphin prey upon pinfish (Masterson, 2008b). The FWC (2011a) reported 2010 annual landings of pinfish to be 171,351 lb (77,724 kg) for the west coast of Florida and 360 lb (163 kg) for Citrus County.

Polka-dot Batfish (*Ogcocephalus radiatus*)

The polka-dot batfish, a member of the batfish family (Ogcocephalidae), ranges from North Carolina to Mexico at depths from shoreline to 230 ft (70 m). It may attain a length of 15 inches (38 cm). It is a benthic species, inhabiting seagrass beds and open substrates of coral rubble, mud, or sand. The polka-dot batfish preys on small crabs, shrimp, mollusks, polychaetes, and small fish (Patton, 2010). The FWC (2011a) did not report 2010 annual landings for the polka-dot batfish.

Red Drum (*Sciaenops ocellatus*)

The red drum, a member of the drum family (Sciaenidae), occurs from the Gulf of Maine to Tuxpan, Mexico (Reagan, 1985). In the Gulf of Mexico, red drum can live up to 40 years; males mature when 1 to 3 years old and females when 3 to 6 years old (FWC, 2009a). Spawning occurs in inlets, estuaries, or nearshore shelf waters during late summer and early fall (FWC, 2009a). Most spawning in the Gulf of Mexico occurs from mid-August to December, with spawning along the west coast of Florida beginning in September and peaking in October (Reagan, 1985). A female red drum can produce 20,000 to 2 million eggs per spawn (Reagan, 1985). Newly hatched larvae spend about 20 days in the water column before becoming demersal (FWC, 2009a). While in the water column, the larvae passively move into estuaries (GMFMC, 2004). Within estuaries, small juveniles inhabit rivers, bays, canals, tidal creeks, boat basins, and passes. Subadults also occur in these habitats. Additionally, large aggregations of subadults occur on seagrass beds, oyster reefs, mud flats, and sand bottoms. Adults mostly occur in nearshore shelf waters (FWC, 2009a). Schools of red drum are common at depths less than 230 ft (70 m) (GMFMC, 2004).

The red drum tolerates a temperature range of 35.6 °F to 99.5 °F (2 °C to 37.5 °C) and a salinity range of less than 1 to over 50 ppt (Reagan, 1985). Adults are most abundant at salinities of 30 to 55 ppt (Buckley, 1984). The red drum spawns at temperatures from 71.5 °F to 86 °F (22 °C to 30 °C) with optimal temperatures at 71.5 °F to 77 °F (22 °C to 25 °C) (Buckley, 1984).

The red drum is a major estuarine predator (Reagan, 1985). Juveniles feed on copepods, mysids, and amphipods (FWC, 2009a). Larger juveniles and adults feed on fish and shellfish (Buckley, 1984), (GMFMC, 2004). Spot and Atlantic croaker feed on juvenile red drum; while sharks, amberjacks, and other large fish feed on adults (GMFMC, 2004). No commercial landings of red drum occur in Florida as there is a prohibition on the sale of red drum in Florida. No permitted commercial harvesting of red drum occurs in Florida (FWC, 2011b).

Silver Perch (*Bairdiella chrysoura*)

The silver perch, a member of the drum family (Sciaenidae), occurs from New York to northern Mexico (Murdy et al., 1997). It seldom exceeds 9 inches (23 cm) in length (FWC, 2011c). The silver perch occurs in deeper offshore waters in winter and moves to bays and coastal lagoons in spring where it inhabits seagrass beds, salt marshes, and tidal creeks and rivers (FWC, 2011c), (CH2M Hill, 2009). It matures by the second or third year and may live up to 6 years (FWC, 2011c). Spawning occurs between May and September within shallow, saline areas of bays and other inshore areas (FWC, 2011c). Females collected near the CREC averaged 48,140 eggs per female (SWEC, 1985). Eggs are pelagic and hatch in 40 to 50 hours at 64.4 °F to 70 °F (18 °C to 21 °C) and within 18 hours at higher temperatures (Welsh and Breder, 1923), (Kuntz, 1913). The silver perch preys upon small crustaceans, polychaetes, and fish (Murdy et al., 1997) and is prey for many economically important fish species (Waggy et al., 2007). As it is very abundant, it is an important link in the estuarine food web (Waggy et al., 2007). The silver perch is not an important commercial or recreational fish (Murdy et al., 1997). The FWC (2011a) did not report 2011 annual landings for the silver perch.

Spot (*Leiostomus xanthurus*)

The spot, a member of the drum family (Sciaenidae), occurs along the Atlantic coast from Massachusetts Bay to the Gulf of Mexico and south to the Bay of Campeche, Mexico (Benson, 1982). Highest abundance occurs from Chesapeake Bay through the Carolinas (Murdy et al., 1997). The spot inhabits waters to a depth of at least 670 ft (204 m) (FWC, 2009a), but typically occurs on sandy or muddy bottoms at depths up to 197 ft (60 m) (Hill, 2005a). It grows to about 11 inches (28 cm) in total length. The lifespan is up to 5 years (Hill, 2005a), but spot usually do not live longer than 2 years (Stickney and Cuenco, 1982). Most spot spawn in deep waters (e.g., 15 mi [24 km] offshore at depths of 90 ft [27 m]) (Benson, 1982), although some spawn in nearshore waters and estuaries. In the Gulf of Mexico, spawning begins in December and peaks in January and February. Spot may spawn repeatedly over several weeks (Hill, 2005a). Fecundity for spot is about 77,000 to 84,000 eggs per season. The buoyant eggs hatch within 48 hours (Hales and Van Den Avyle, 1989). Larvae, which are initially found in surface waters and become more demersal as they grow, are passively transported into estuary and bay nursery habitats; reaching these areas when about 40 to 47 days old (Hill, 2005a). Post-larvae and smaller juveniles congregate in shallow water areas of tidal creeks for 3 to 6 months, after which they migrate to other estuarine habitats and often to deeper waters (Hill, 2005a).

The lower and upper thermal tolerance of the spot are about 41 °F and 95 °F (5 °C and 35 °C), respectively (Benson, 1982), (Hill, 2005a). Spot are euryhaline, occurring at salinities of 0 to 60 ppt (Benson, 1982). Adult spot mostly occur at salinities above 5 ppt (Murdy et al., 1997).

Larvae are selective zooplankton feeders, while juveniles and adults are benthic feeders preying on infaunal and epifaunal invertebrates. Due to its abundance, the spot is an important prey item for piscivorous fishes (Hales and Van Den Avyle, 1989). The spot has limited commercial and recreational importance. The FWC (2011a) reported 2010 annual commercial landings of spot to be 1,703 lb (772 kg) for the west coast of Florida, with no commercial landings for Citrus County.

<u>Spotted Seatrout (*Cynoscion nebulosus*)</u>

The spotted seatrout, a member of the drum family (Sciaenidae), ranges from Massachusetts through Florida and into the Gulf of Mexico to Texas and Mexico (Hill, 2005b). It can reach a total length of 3.3 ft (1 m) and a weight of 17.4 lb (7.9 kg) (Hill, 2005b). The spotted seatrout generally occurs in shallow, vegetated, brackish, and marine waters to a depth of 33 ft (10 m) (Hill, 2005b). The spotted seatrout depends on estuaries for feeding, spawning, and nursery grounds (Lassuy, 1983). There tends to be little movement of spotted seatrout from one estuary to another (Kostecki, 1984). Lifespan in Florida is 9 years for males and 8 years for females (FWC, 2009a). Juvenile spotted seatrout tend to occur in or adjacent to seagrass habitats (Kostecki, 1984). The spotted seatrout matures at 1 to 4 years of age (Hill, 2005b). Spawning occurs from March to September, peaking in April to July (Benson, 1982). Spawning occurs in nearshore and estuarine waters including tidal rivers above the area of tidal influence (Kostecki, 1984), (Hill, 2005b). A female may spawn 9 to 60 times during the spawning season and release 3 to 20 million eggs annually. Eggs hatch about 18 hours after fertilization (Hill, 2005b). Eggs are pelagic or demersal depending on salinity (e.g., they sink at 25 ppt but are buoyant at 30 ppt) (Kostecki, 1984). The larvae are most common in seagrass beds. After about 20 days, larvae metamorphose into juveniles. After about 6 to 8 weeks, juveniles form schools of similar-sized individuals. Schooling behavior persists until about age 6 or 7 when they become semi-solitary. Adults occur in seagrass beds, oyster reefs, and over sand bottoms (Hill, 2005b).

Spawning occurs at temperatures of 68 °F to 86 °F (20 °C to 30 °C) and salinities of 30 to 35 ppt (Benson, 1982), (Hill, 2005b). Spawning tends to cease at temperatures over 82.4 °F (28 °C) (Hill, 2005b). Optimal temperatures for adult spotted seatrout are 15 °F to 80.6 °F (15 °C to 27 °C) and 73.4 °F to 91.4 °F (23 °C to 33 °C) for larvae. Spotted seatrout will migrate to deeper waters when temperatures fall below 45 °F (7 °C) or in response to high water temperatures during hot summer months (Benson, 1982), (Hill, 2005b). The spotted seatrout is euryhaline: larvae occur at 0 to 36 ppt, juveniles at 10 to 25 ppt, and adults at 2 to 75 ppt (Benson, 1982), (Bester, 2010a).

The spotted seatrout is among the top estuarine predators (Lassuy, 1983). It feeds in the water column and near the bottom over all types of substrates (Benson, 1982). Seatrout that are 0.8 to 2 inches in size (2 to 5 cm) feed on zooplankton. As they grow, their diet shifts to mysids, then to penaeid shrimp and small fish, and then to primarily fish when adults. Adults feed on anchovies, pinfish, silversides, mullet, croakers, menhaden, snappers, gobies, mojarras, and silver trout. It is a major commercial and game fish species throughout its range (Lassuy, 1983). The FWC (2011a) reported the 2010 annual commercial landings of spotted seatrout to be 13,289 lb (6,028 kg) for the west coast of Florida and 24 lb (11 kg) for Citrus County.

Striped Mullet (*Mugil cephalus*)

The striped mullet, a member of the mullet family (Mugilidae), occurs worldwide in subtropical and tropical climates (Benson, 1982). In the western Atlantic Ocean, the striped mullet occurs from Cape Cod to Brazil, including the Gulf of Mexico, Caribbean, and the West Indies (Hill, 2004a). The striped mullet can attain a length of 47.2 inches (120 cm) and a weight of 17.6 lb (8 kg), and lives between 4 to 16 years (Bester, 2010b). The striped mullet occurs at depths from 3 to 394 ft (1 to 120 m) (GMFMC, 2004), occurring in estuarine intertidal, freshwater, and coastal marine habitats (Hill, 2004a). The striped mullet is catadromous, spending most of its life in freshwater, but spawns in saltwater as much as 50 mi (80 km) offshore at depths over 3,200 ft (1,000 m) (Bester, 2010b). Females mature in their fourth year and males in their third (Hill, 2004a). In early fall, large schools of mullet gather in lower reaches of estuaries and river mouths prior to migration to offshore spawning grounds (Hill, 2004a). Although the striped mullet has been reported to spawn inshore, most spawning in the Gulf of Mexico occurs 37 to 50 mi (60 to 80 km) offshore in water 3,280 to 5,905 ft (1,000 to 1,800 m) deep (Collins, 1985). Spawning occurs from October through May, and some females may spawn more than once per season (Benson, 1982). Fecundity ranges from 270,000 to 1.6 million eggs per individual per season. Over her lifetime, a female may produce 2.9 to 16 million eggs (Hill, 2004a). Eggs are pelagic and hatch within 48 hours (Collins, 1985). The pelagic larvae become abundant between November and December in water temperatures between 73.4 °F to 77 °F (23 °C to 25 °C). The larvae migrate into estuaries. Juveniles inhabit salt marshes, impoundments, and high intertidal areas over mud and sand (Hill, 2004a). Following spawning, adults return to their home estuary (GMFMC, 2004). Within estuaries, adults inhabit mud flats, oyster reefs, salt marshes, seagrass beds, and tidal freshwater and riverine habitats (SCDNR, 2006).

The striped mullet occurs at a temperature range of 40.1 °F to 98.6 °F (4.5 °C to 37 °C) (Benson, 1982). Juveniles (up to 3.1 inches or 8 cm long) mostly occur at a temperature range of 77 °F to 86 °F (25 °C to 30 °C) and salinities of 0 to 10 ppt. Those up to 4 inches (10 cm) long are abundant at temperatures of 45 °F to 86 °F (7 °C to 30 °C) and salinities of 0 to 20 ppt (Benson, 1982). Adults are euryhaline and can survive a range of salinities from 0 to 75 ppt (Collins, 1985).

Larval striped mullet eat phytoplankton and zooplankton; while juveniles and adults consume detritus and algae. Other fish, dolphins, seabirds, and American alligators (*Alligator mississippiensis*) prey upon juvenile and adult striped mullet (GMFMC, 2004). The striped mullet is highly susceptible to red tide organisms (Hill, 2004a). The striped mullet is an important component in both the commercial and recreational fishery. The FWC (2011a) reported 2010 annual commercial landings of striped mullet to be 4,256,791 lb (1,930,848 kg) for the west coast of Florida and 221,153 lb (100,313 kg) for Citrus County.

Blue Crab (*Callinectes sapidus*)

The blue crab, a member of the swimming crab family (Portunidae), ranges from Nova Scotia though Argentina (FWC, 2009a). It occurs throughout the Gulf of Mexico in estuaries, rivers, nearshore, and offshore habitats at depths of 3 to 295 ft (1 to 90 m) and salinities of 0 to 60 ppt. Blue crabs reach maturity during their second year at a carapace length of 4.7 to 6.7 inches

(12 to 17 cm), and may grow as large as 9.8 inches (25 cm) carapace length. Female blue crabs only mate once in their lifetime. Following mating, males tend to stay in the estuary, while females migrate to high salinity nearshore areas near barrier islands, bays, and passes to spawn. In the Gulf of Mexico, two spawning periods are common: February through March and August through September (Hill, 2004b). Some females overwinter in mud burrows before spawning. The female extrudes her fertilized eggs (an average of 2 million) into a cohesive mass (sponge) that remains attached to her abdomen until the larvae emerge (Zinski, 2006). Eggs hatch in about 2 weeks. Optimal salinities for hatching are between 23 and 30 ppt at a temperature range of 66 °F to 84 °F (19 °C to 29 °C). The upper temperature range for hatching is about 90 °F (32 °C) (Benson, 1982).

Blue crabs undergo a series of developmental stages. After hatching, the larvae pass through zoeal and megalopal stages. The first zoeae are about 0.01 inches (0.25 mm) in width. Zoeae live a planktonic existence. There are usually seven zoeal molts. The zoeal stage lasts 31 to 49 days (Zinski, 2006). Zoeae occur at temperatures ranging from 66 °F to 90 °F (19 °C to 32 °C) and salinities of 21 to 32 ppt (Benson, 1982). The final zoeae are about 0.04 inches (1 mm) in width. Its molt results in the metamorphosis to the megalopal stage (Zinski, 2006). Megalopae migrate into estuaries where they settle to the bottom in seagrass beds or shoreline habitats (GMFMC, 2004). They have been collected at temperatures ranging from 55 °F to 90 °F (13 °C to 32 °C) and salinities of 5 to 37 ppt (Benson, 1982). The megalopal stage lasts 6 to 20 days after which it molts into the juvenile whose appearance is similar to that of the adults (i.e., first crab stage). Initial juveniles are about 0.1 inches (2.5 mm) wide (Zinski, 2006).

Juvenile blue crabs live in estuarine nursery grounds throughout the year, inhabiting seagrass beds, salt marsh edge habitats, rivers, mud, sand, benthic algae, and drift algae (GMFMC, 2004). The juveniles live in waters that range from 39 °F to 95 °F (4 °C to 37 °C) and salinities of 0 to 32 ppt. Optimal conditions are temperatures between 68 °F to 79 °F (20 °C to 26 °C) and salinities of 5 to 15 ppt (Benson, 1982). Juveniles molt about nine times by winter. Molting stops during winter and resumes when waters warm in the spring. Juveniles reach maturity during spring or summer after a total of about 18 to 20 post-larval molts (Zinski, 2006).

Adults range in size from 3.9 to 9.4 inches (9.9 to 23.9 cm) carapace width (FWC, 2009a). Adults live an average of less than 1 year after reaching maturity (Zinski, 2006). Adults inhabit seagrass beds, benthic and drift algae, mud, sand, and salt marshes (GMFMC, 2004). Growth occurs at temperatures of 59 °F to 86 °F (15 °C to 30 °C) and ceases at temperatures below 50 °F (10 °C). Torpor occurs at temperatures below 41 °F (5 °C) (Hill, 2004b). Females tend to occur in higher salinity areas than males (GMFMC, 2004).

Larvae are planktivorous; post-larvae consume fish larvae, small shellfish, and aquatic plants; juveniles eat macroinvertebrates, fish, carrion, and vegetation; and adults consume oysters, clams, fish, carrion, vegetation, detritus, crustaceans, gastropods, oligochaetes, and insect larvae. Juveniles and adults are also cannibalistic (GMFMC, 2004). Many fishes and birds prey upon blue crabs. Some sea turtles and raccoons (*Procyon lotor*) also eat blue crabs (GMFMC, 2004). The blue crab is an important commercial and recreational resource. Commercial landings of blue crabs in Florida were about 10.4 million lb (4.7 million kg) during 2007, with 59 percent caught in the Gulf. Between 25 to 33 percent of blue crab landings in Florida are from the Big Bend area (GMP, 2004). The FWC (2011a) reported 2010 annual commercial landings of blue crab to be 4,589,614 lb (2,081,814 kg) for the west coast of Florida and 570,991 lb (258,997 kg) for Citrus County.

Brief Squid (*Lolliguncula brevis*)

The brief squid, a member of the squid family (Loliginidae), ranges from Maryland to Rio de la Plata, Argentina, including the Caribbean Sea and the Gulf of Mexico (Laughlin and Livingston, 1982). The brief squid is the most abundant squid in estuaries and nearshore marine waters along the Gulf of Mexico (Benson, 1982) and is considered an important indicator species for the health of these communities (SCDNR, 2006). In Tampa Bay, the brief squid occurs over substrates of mud, clay, or silt and were absent over substrates of coarse sand and seagrasses (Dragovich and Kelly, 1967). In the Gulf of Mexico, the brief squid lives about 100 to 200 days. It obtains a maximum dorsal mantle length (body length excluding the head and arms) of 3.9 inches (10 cm) for females and 3.3 inches (8.3 cm) for males (Jackson et al., 1997). Spawning occurs year-round, peaking in April to July and September to November (Bartol et al., 2002). Fecundity ranges from 1,400 to 3,900 eggs (Benson, 1982). Squid typically attach egg strings to oyster shells, clam shells, or other bare, solid objects (SCDNR, 2006). Alteration of intertidal and subtidal mud flats, especially if it causes siltation that covers shell and other hard structures, could reduce optimal substrate for brief squid egg string attachment (SCDNR, 2006). From spring through fall, they occur in estuaries but move to warmer, deeper waters during winter (December through March). Maximum abundance in estuaries occurs in summer and early fall (Benson, 1982).

Unlike most squids, the brief squid tolerates a wide range of environmental conditions including low salinities (Bartol et al., 2002). The brief squid occurs at a temperature range of 41 °F to 95 °F (5 °C to 35 °C) and at salinities ranging from 5 to 35.5 ppt (Benson, 1982). Most catches of brief squid have occurred at temperatures of 55 °F to 61 °F (12.8 °C to 16.1 °C) and salinities above 15 ppt (Benson, 1982). In the Gulf of Mexico, the brief squid occurs at temperatures of 51.8 °F to 88.9 °F (11 °C to 31.6 °C) (Bartol et al., 2002). Slight increases in temperature during the early stages of development of the brief squid can shorten its life span (Jackson et al., 1997).

Smaller brief squid feed on benthic crustaceans and small fish; larger squid feed on small fish such as schooling anchovies and silversides (SCDNR, 2006). A strong predator-prey association seems to exist between the brief squid and bay anchovy (Masterson, 2008a). The brief squid is an important prey item for commercial and recreational fish species (Benson, 1982). The FWC (2011a) reported 2010 annual commercial landings of squid to be 30,825 lb (13,982 kg) for the west coast of Florida; no commercial landings were reported for Citrus County.

Florida Stone Crab (*Menippe mercenaria*)

Stone crabs, members of the mud crab family (Xanthidae), range from North Carolina to the Yucatan Peninsula and Belize and throughout the Bahamas and Greater Antilles (FWC, 2009a). Two species of stone crabs occur along the Gulf coast of Florida: the Florida stone crab and the Gulf stone crab (*Menippe adina*). The Gulf stone crab generally replaces the Florida stone crab in the northern and western portions of the Gulf of Mexico. Some hybridization between the species occurs between Cedar Key, Levy County, Florida, and Cape San Blas, Gulf County, Florida (GMFMC ,2004). Most stone crabs in the Crystal Bay area would be the Florida stone crab.

Generally, the Florida stone crab occurs in subtidal areas but does occur to depths of 197 ft (60 m) (Puglisi, 2008). Juvenile stone crabs are benthic dwellers that inhabit any refugia closely located to their food source. Such habitats include shell bottoms, sponges, sargassum mats, and deep seagrass flats. Adult stone crabs inhabit burrows under rock ledges, coral heads, dead shells, and seagrass patches; they also occur on oyster bars, rock jetties, and artificial reefs that have adequate refugia (GMFMC, 2004). Females generally spawn when they reach 2 years of age (Puglisi, 2008). Spawning occurs year-round, but most often from April through September (GMFMC, 2004); an individual female may produce 4 to 6 egg masses during a single mating season, with each egg mass containing 160,000 to 1 million eggs (Lindberg and Marshall, 1984). The female carries the fertilized eggs under her abdomen until they hatch (Puglisi, 2008). The Florida stone crab has five zoeal stages and one megalopal stage. The first crab stage occurs about 27 to 30 days after egg hatch (Puglisi, 2008).

The most rapid growth of the planktonic stone crab larvae occurs in warm water 86 °F (30 °C) and salinities of 30 to 35 ppt; with larval survival and growth declining rapidly below temperatures of 77 °F (25 °C) and a salinity of 25 ppt (GMFMC, 2004). At temperatures of 68 °F (20 °C) or less, larval crabs do not survive past the megalopal stage; while temperatures of 41 °F to 59 °F (5 °C to 15 °C) inhibit molting of post-settlement juveniles (Puglisi, 2008). The upper temperature limit for survival is between 95 °F and 104 °F (35 °C and 40 °C) (Brown and Bert, 1993). Adult stone crabs occur at temperatures ranging from 46.4 °F to 89.6 °F (8 °C to 32 °C) (Lindberg and Marshall, 1984).

Larvae consume zooplankton and phytoplankton; juveniles consume small mollusks, polychaetes, and crustaceans; and adults prey on mollusks, carrion, and vegetation such as seagrasses (GMFMC, 2004). Fish, conchs, octopus, and sea turtles prey on stone crabs. Stone crabs are also cannibalistic (GMFMC, 2004). The commercial fishery only involves the larger claw; the crab is released after the claw is removed (Gerhart and Bert, 2008). The FWC (2011a) reported 2010 annual commercial landings of stone crab claws to be 1,806,341 lb (819,342 kg) for the west coast of Florida and 188,443 lb (85,476 kg) for Citrus County.

Pink Shrimp (*Farfantepenaeus duorarum*)

The pink shrimp, a member of the penaeid shrimp family (Panaeidae), occurs from the lower Chesapeake Bay to south Florida, into the Gulf of Mexico, and to Isla Mujeres, Mexico (Bielsa et al., 1983). It inhabits coastal waters and estuaries (Hill, 2002). Pink shrimp occur to depths of 361 ft (110 m), although most occur in waters less than 164 ft (50 m) deep (GMFMC, 2004). Most adult pink shrimp occur at depths between 29 and 144 ft (9 and 44 m) (Bielsa et al., 1983). Primary habitats are sand, sand-shell, or coral-mud substrates (Hill, 2002). As pink shrimp near maturity, they move to deeper areas of the estuary before final emigration to offshore habitats (GMFMC, 2004). Pink shrimp may live a year or more (Hill, 2002). Large males reach a total length of 6.7 inches (170 mm) and obtain sexual maturity at 2.9 inches (74 mm); while large females are 8.3 inches (210 mm) long and reach sexual maturity at 3.3 inches (85 mm) (Bielsa et al., 1983).

The pink shrimp spawns offshore at depths between 13 and 499 ft (4 and 52 m) (Benson, 1982). It can spawn multiple times, with peak spawning occurring from April through July. Spawning occurs at temperatures between 66 °F and 86 °F (19 °C and 30 °C) (Hill, 2002). Fecundity ranges from 44,000 to 534,000 eggs (Hill, 2002). Mating occurs between hard-shelled males and soft-shelled females. Fertilization occurs as eggs and spermatozoa are simultaneously released from the female (NMFS, 2010a). Hatching takes only 2 to 3 minutes. There are five naupliar, three protozoeal, three mysid, and several post-larval stages (Hill, 2002). Post-larvae migrate into estuaries and become benthic once reaching their nursery grounds. Pink shrimp then metamorphose to the juvenile stage (GMFMC, 2004). Post-larval and juvenile pink shrimp commonly occur in seagrass habitats. Subadults and adults burrow into the substrate during the day and feed at night (Hill, 2002). Preferred substrates are calcareous-type sediments and sand/shell/mud mixtures (GMFMC, 2004).

Pink shrimp larvae occur at temperatures as high as 99 °F (37 °C). Juveniles have been collected at temperatures from 39 °F to 93 °F (4 °C to 34 °C) and adults at a temperature range of 50 °F to 97 °F (10 °C to 36 °C) (Benson, 1982). Pink shrimp are euryhaline, and juveniles and adults have been collected at salinities ranging from 0 to 70 ppt (Benson, 1982).

The pelagic larvae prey on planktonic algae and zooplankton. Juvenile and adult pink shrimp are opportunistic feeders on detritus, small invertebrates and fishes, and plants. In turn, fish, blue crabs, and seabirds prey upon them. The FWC (2011a) reported 2010 annual commercial landings of pink shrimp to be 6,839,868 lb (3,102,512 kg) for the west coast of Florida and 1,180 lb (535 kg) for Citrus County.

2.2.6 Terrestrial Resources

2.2.6.1 *Terrestrial Resources at the Crystal River Energy Complex Site*

The CREC is located in Citrus County in west-central Florida between the mouths of the Withlacoochee and Crystal rivers and adjacent to the Gulf of Mexico. The site and associated transmission lines are within the Southern Coastal Plain Ecoregion, which consists of mostly flat plains, but also barrier islands, coastal lagoons, marshes, and swampy lowlands along the Gulf and Atlantic coasts (EPA, 2002). The region was once covered by a variety of forest communities that included longleaf pine (*Pinus palustris*), slash pine (*P. elliottii*), pond pine (*P. serotina*), American beech (*Fagus grandifolia*), sweetgum (*Liquidambar styraciflua*), large-flower magnolia (*Magnolia grandiflora*), white oak (*Quercus alba*), and laurel-leaf oak (*Q. laurifolia*), but is now predominantly slash and loblolly pine (*P. taeda*) (with oak-gum-cypress forest in some low lying areas), citrus groves, cattle pasture, and urban development. Much of the area adjacent to the CREC is undeveloped wetland habitat, especially near the coast, but extensive areas of pine plantations and about 900 ac (360 ha) of quarry lakes also occur in the vicinity. Terrain in the northwestern portion of Citrus County, in which the CREC is located, rises gradually from mangrove swamp and coastal marshes along the coast to gently rolling hills about 16 mi (26 km) inland. The CREC site and surrounding areas are about 2 to 5 ft (0.6 to 1.5 m) above mean sea level (AEC, 1973).

The CREC site occupies about 4,738 ac (1,917 ha). The developed portions of the site occupy about 1,062 ac (430 ha) and contain a single nuclear unit (CR-3), four fossil-fueled units (CR-1, CR-2, CR-4, and CR-5), associated buildings, maintenance facilities, parking lots, roads, railroads, and transmission facilities. The remaining 3,676 ac (1,488 ha) are largely undeveloped and support four habitat types: salt marsh, hardwood hammock forest, pineland, and freshwater swamp (AEC, 1973).

Salt or tidal marshes (FNAI, 1990) occur on the westernmost portion of the site along the Gulf coast in a band about 0.75 mi (1.2 km) wide and are crossed by the intake and discharge canals associated with CR-3 (Progress Energy, 2008a). Salt marshes are wetland habitats that are tidally-influenced and dissected by many naturally occurring tidal creeks or channels. Salt marshes of the site are dominated by smooth cordgrass (*Spartina alterniflora*) and Roemer's rush (*Juncus roemerianus*) (AEC, 1973). Salt marshes are used by many animal species, especially wading bird such as egrets and herons (Ardeidae) (Progress Energy, 2008a). The FES (AEC, 1973) listed the following vertebrate animals as occurring in onsite salt marshes: great blue heron (*Ardea herodias*), white ibis (*Eudocimus albus*), mallard (*Anas platyrhynchos*), red-winged blackbird (*Agelaius phoeniceus*), marsh rice rat (*Oryzomys palustris*), round-tailed muskrat (*Neofiber alleni*), and American mink (*Neovison vison*). According to the Florida Natural Areas Inventory (FNAI, 1990), typical animals of this community type include salt marsh snails (Littorinidae, Ellobiidae), periwinkle (Littorinidae), mud snails (Nassariidae), spiders, fiddler crabs (*Uca* spp.), marsh crab (*Decapoda* spp.), isopods, amphipods, diamondback terrapin (*Malaclemys terrapin*), saltmarsh snake (*Nerodia clarkii*), wading birds, waterfowl, osprey (*Pandion haliaetus*), rails (*Rallus* spp.), marsh wren (*Cistothorus palustris*), seaside sparrow (*Ammodramus maritimus*), round-tailed muskrat, and raccoon (*Procyon lotor*).

Hardwood hammock forests (hydric hammock in FNAI, 1990) lie immediately inland of the salt marshes and is the habitat type on which most CREC facilities were developed (AEC, 1973). Numerous hardwood hammocks are scattered throughout the undeveloped portion of the site, especially to the south and southeast of most facilities. Hardwood hammocks support a diverse flora and are slightly elevated and drier than the surrounding areas and often have an island-like appearance. Common plant species of hardwood hammocks at the CREC include large-flowered magnolia, laurel-leaf oak, and American hornbeam (*Carpinus caroliniana*) (AEC, 1973). Hardwood hammocks provide habitat for many different birds, mammals, reptiles, and amphibians (Progress Energy, 2008a). The FES (AEC, 1973) listed the following vertebrate animals as present in onsite hardwood hammocks: turkey vulture (*Cathartes aura*), northern cardinal (*Cardinalis cardinalis*), marsh rabbit (*Sylvilagus palustris*), eastern gray squirrel (*Sciurus carolinensis*), and bobcat (*Lynx rufus*). According to the FNAI (1990), typical animals of this community type include the green anole (*Anolis carolinensis*), flycatchers (Tyrannidae), warblers (Parulidae), and the eastern gray squirrel (FNAI, 1990).

Pine flatwoods (mesic flatwoods in FNAI, 1990) are found inland of hardwood hammocks on the CREC site. Onsite pine flatwoods are dominated by slash pine and loblolly pine, often with a dense understory of saw palmetto (*Serenoa repens*) (Progress Energy, 2008a). In general, the number of species of plants and animals in pine flatwoods is considerably lower than in hardwood hammocks (AEC, 1973). The FES (AEC, 1973) listed the following vertebrate animals as present in onsite pine flatwoods: northern bobwhite (*Colinus virginianus*), prairie warbler (*Dendroica discolor*), Virginia opossum (*Didelphis virginiana*), Florida deermouse (*Podomys floridanus*), and striped skunk (*Mephitis mephitis*). According to the FNAI (1990), typical animals of this community type include the oak toad (*Bufo quercicus*), little grass frog (*Pseudacris ocularis*), eastern narrowmouth toad (*Gastrophryne carolinensis*), southern black racer (*Coluber constrictor priapus*), red cornsnake (*Pantherophis guttatus*), southeastern American kestrel (*Falco sparverius paulus*), brown-headed nuthatch (*Sitta pusilla*), pine warbler (*Dendroica pinus*), Bachman's sparrow (*Aimophila aestivalis*), hispid cotton rat (*Sigmodon hispidus*), Florida deermouse, American black bear (*Ursus americanus*), raccoon, gray fox (*Urocyon cinereoargenteus*), bobcat, and white-tailed deer (*Odocoileus virginianus*).

Freshwater swamps (basin swamp in FNAI, 1990) occur in occasionally flooded wet depressions within pine flatwoods on the CREC site (Progress Energy, 2008a). The extent of surface water present in these habitats depends on recent rainfall and, in some areas, saltwater intrusion (AEC, 1973). Typical tree species in these swamps are pond cypress (*Taxodium ascendens*), swamp blackgum (*Nyssa biflora*), and Carolina ash (*Fraxinus caroliniana*) (AEC, 1973). According to the FNAI (1990), typical animals of this community type include the southern dusky salamander (*Desmognathus auriculatus*), southern cricket frog (*Acris gryllus*), little grass frog, chicken turtle (*Deirochelys reticularia*), striped mud turtle (*Kinosternon baurii*), ring-necked snake (*Diadophis punctatus*), scarlet kingsnake (*Lampropeltis triangulum elapsoides*), crayfish snake (*Regina* spp.), cottonmouth (*Agkistrodon piscivorus*), wood duck (*Aix sponsa*), hawks, wild turkey (*Meleagris gallopavo*), great horned owl (*Bubo virginianus*), barred owl (*Strix varia*), pileated woodpecker (*Dryocopus pileatus*), songbirds (Order

Passeriformes), eastern gray squirrel, American black bear, raccoon, American mink, North American river otter (*Lontra canadensis*), bobcat, and white-tailed deer.

Old-field and other early successional or human-altered plant communities exist on the CREC site wherever construction disturbance has somewhat stabilized, such as roadway borrow pits and drainage ditches, or where the vegetation is managed (e.g., beneath transmission lines and adjacent to facilities) (AEC, 1973). Plant species found in these communities vary and depend in part on the original habitat type, the degree of disturbance, and the current maintenance practices. A variety of shrubs and small trees occur along the length of the intake and discharge canals. In general, these developed portions of the CREC site provide habitat for animal species commonly encountered in urban landscapes in Florida, including the southern toad (*Bufo terrestris*), green anole, eastern ratsnake (*Pantherophis alleghaniensis*), house sparrow (*Passer domesticus*), northern mockingbird (*Mimus polyglottos*), blue jay (*Cyanocitta cristata*), hispid cotton rat, and gray squirrel (Progress Energy, 2008a).

The FWS National Wetland Inventory (FWS, 2010b) has mapped most of the undeveloped portions of the CREC site, where CR-3 and associated facilities are located, as wetland. Salt marsh habitat described above is classified by the FWS as estuarine intertidal emergent and shrub/scrub wetland (Cowardin et al., 1979). Hardwood hammocks are classified as palustrine forested evergreen and deciduous wetlands. Palustrine emergent wetlands exist as patches within these habitats and within pine flatwoods. Freshwater swamps within pine flatwoods (described above) are classified as palustrine forested evergreen and deciduous wetland by the FWS (2010b).

The FWC (2009c) identified a number of potentially affected terrestrial resources near the CREC site including the following: (1) American black bear range (Chassahowitzka subpopulation); (2) priority wetlands for the American alligator (*Alligator mississippiensis*), American oystercatcher, Homosassa shrew (*Sorex longirostris eionis*), and other wildlife species of concern; (3) strategic habitat conservation areas for the bald eagle (*Haliaeetus leucocephalus*) and Scott's seaside sparrow (*Ammodramus maritimus peninsulae*); (4) FNAI conservation lands (Waccasassa Bay Preserve State Park, Crystal River Archeological State Park, Crystal River Preserve State Park, Felburn Park, Yankeetown Conservation Area, and Marjorie Harris Carr Conservation Area); and (5) underrepresented natural communities (pine flatwoods and sandhill). These areas are all within 5 mi (8 km) of the CREC site, but none are within the CREC site boundary (FWC, 2009c).

In 2003, the applicant granted permission for the FWC to post signs for the protection of shorebird and sea bird nesting sites on the CREC site, especially those of least terns (*Sternula antillarum*), black skimmers (*Rynchops niger*), and American oystercatchers (*Haematopus palliatus*) (Progress Energy, 2008a). Posted areas are on sandbars and spoil islands owned or managed by the applicant and on spoil islands along the barge canal leading to the intake canal.

From 1981 through 1994, FPC conducted a monitoring study of the potential effects of salt drift from the CREC power plant cooling towers (CR-1 through CR-5). The study compared vegetation conditions (including damage to plants) and salt deposition rates (sodium and chloride) in control areas and in different onsite and offsite habitat types exposed to cooling tower drift (KBN Engineering and Applied Sciences, Inc., 1995). Monitoring demonstrated that annual salt deposition levels were higher in areas exposed to cooling tower drift relative to control areas, but salt drift injury was limited to only a few individual plants. The highest deposition levels appeared to have been caused by coastal storms. On the basis of these results, FPC requested permission of the FDEP to discontinue salt drift monitoring (FPC, 1995). This request was approved in 1996 (FDEP, 1996).

2.2.6.2 *Terrestrial Resources Along the Transmission Line Rights-of-Way*

Section 2.1.5 describes the routes of the transmission lines that were built to connect CR-3 to the transmission system and that are within the scope of this SEIS. These transmission corridors are maintained to keep vegetation heights low enough to prevent interference with the transmission lines. The principal land use types traversed by the transmission corridors are agriculture and forest (Progress Energy, 2008a).

The Central Florida and Lake Tarpon transmission lines use a common corridor for the first 5.3 mi (8.5 km) east of CR-3. A 1.5-mi (2.4-km) portion of the southern edge of the common corridor is adjacent to the northern boundary of the Crystal River Preserve State Park.

Three segments of the Lake Tarpon corridor cross State forest and natural areas. The Lake Tarpon corridor crosses 4 mi (6 km) of the Citrus Tract within the Withlacoochee State Forest, and an additional 2-mi (3-km) segment is adjacent to the Citrus Tract (FDACS, 2004), (Progress Energy, 2008a). Typical tree species of this forest habitat include slash pine, longleaf pine, pond cypress, bald cypress (*Taxodium distichum*), large-flowered magnolia, and various hardwood trees (FDACS, 2004). Animal species inhabiting the forest include fox squirrel (*Sciurus niger*), white-tailed deer, wild turkey, eastern cottontail, gray squirrel, bald eagle, and gopher tortoise. An 8-mi (13-km) segment of the Lake Tarpon corridor crosses the Starkey Wilderness Preserve in Pasco County, one of the largest undeveloped tracts in Pasco County. The preserve supports a variety of natural habitats including pine flatwoods, cypress domes, freshwater marshes, stream and lake swamps, sandhill, and scrub communities (SFWMD, 2010). About 6,000 ac (2,400 ha) of wetland occur in the Starkey Wilderness Preserve (SFWMD, 2010).

In northeastern Pinellas County, the Lake Tarpon transmission corridor crosses a 4.5-mi segment of the 8,500-ac (3,500-ha) Brooker Creek Preserve. Natural plant communities consist mainly of pine flatwoods and freshwater swamps (Progress Energy, 2008a). The preserve supports populations of white-tailed deer, wild turkey, North American otter, gopher tortoise, bobcat, and coyote (*Canis latrans*) (Friends of Brooker Creek Preserve, 2009). Also, the preserve contains a variety of orchids, Bachman's sparrow, and the tiger swallowtail butterfly (*Papilio glaucus*).

The FWC (2009c) identified potentially affected terrestrial resources near the Lake Tarpon transmission line corridor including: (1) American black bear range (Chassahowitzka subpopulation); (2) priority wetlands for the American alligator, limpkin (*Aramus guarauna*), Homosassa shrew, and other wildlife species of concern; (3) strategic habitat conservation areas for wading birds and scrub communities; (4) FNAI conservation lands (Starkey Wilderness Park, Brooker Creek Preserve, Withlacoochee State Forest, Annutteliga Hammock, Chassahowitzka Wildlife Management Area, and Lake Dan Preserve); and (5) underrepresented natural communities (pine flatwoods, sandhill, and scrub).

The Central Florida transmission corridor crosses an area identified by the FNAI as oak scrub habitat (Progress Energy, 2008a). Scrub habitat is considered by the FNAI to be imperiled in Florida (FNAI, 2009a). Scrub communities have variable characteristics but are often characterized as a closed to open canopy forest of sand pines with dense clumps or vast thickets of scrub oaks and other shrubs dominating the understory (FNAI, 1990). Typical tree species in scrub habitat include sand pine (*P. clausa*), sand live oak (*Quercus geminata*), myrtle oak (*Q. myrtifolia*), Chapman's oak (*Q. chapmanii*), and scrub oak (*Q. inopina*). Because of the openness of the canopy, scrub habitat typically supports several shrub species. Typical animals include the six-lined racerunner (*Aspidoscelis sexlineata*), sand skink (*Neoseps reynoldsi*), blue-tailed mole skink (*Plestiodon egregius lividus*), Florida scrub lizard (*Sceloporus woodi*), oak toad, coachwhip (*Masticophis flagellum*), common ground-dove (*Columbina passerina*), Florida scrub jay (*Aphelocoma coerulescens*), loggerhead shrike (*Lanius ludovicianus*), yellow-rumped warbler (*Dendroica coronata*), eastern towhee (*Pipilo erythrophthalmus*), Florida deermouse, and eastern spotted skunk (*Spilogale putorius*) (FNAI, 1990).

In Marion County, portions of the Central Florida transmission corridor run along the edge of the 16,000-ac (6,500-ha) Ross Prairie Conservation Area, which includes the Hálpata Tastanaki Preserve and the Ross Prairie State Forest. The conservation area contains a mosaic of habitat types, including bottomland hardwood swamps, hardwood hammocks, pine flatwoods, oak scrub, wet prairies, and longleaf pine-wiregrass sandhills (Smith, 2006), (SFWMD, 2009). Animal species in the Ross Prairie Conservation Area include many rare and listed species including the eastern indigo snake (*Drymarchon couperi*), gopher tortoise, Florida scrub jay, Florida deermouse, and Florida gopher frog (*Rana capito aesopus*).

The FWC (2009c) identified potentially affected terrestrial resources near the Central Florida transmission line corridor including: (1) American black bear range (Chassahowitzka and Ocala subpopulations); (2) priority wetlands for the American alligator, limpkin, Homosassa shrew, and other wildlife species of concern; (3) strategic habitat conservation areas for the bald eagle, limpkin, sandhill communities, and rare plant species; (4) FNAI conservation lands (Ventura Ranch, Gum Slough Springs, Ross Prairie State Forest, Hálpata Tastanaki Preserve, Withlacoochee State Forest, Potts Preserve, Lake Panasoffkee, and Crystal River Preserve State Park); and (5) underrepresented natural communities (pine flatwoods, sandhill, and upland hardwood forest).

2.2.7 Threatened and Endangered Species

The National Marine Fisheries Service (NMFS) and the FWS are responsible for listing aquatic and terrestrial species as threatened and endangered at the Federal level, as delegated by the Endangered Species Act (ESA). The State of Florida lists additional species that are regionally threatened or endangered. This section describes the Federally- and State-listed species that occur or potentially occur in the counties in which CR-3 (Citrus County) and the associated transmission line corridors lie (Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties). Aquatic species and terrestrial species are discussed in Sections 2.2.7.1 and 2.2.7.2, respectively.

The applicant (Holt, 2008a), (Holt, 2008b) and the NRC (2009a; 2009b) contacted both the FWS and NMFS to determine the Federally-listed species and their habitats that could be affected by continued operations of CR-3 under the license renewal term. Responses from both agencies were received (FWS, 2008a), (NMFS, 2009a), (NMFS, 2009b). The Staff also contacted the FWC (NRC, 2009c) and the FNAI (NRC, 2009d) to request information that could assist the NRC in its assessment of the environmental impacts associated with license renewal. The FWC responded to the NRC request by letter dated July 20, 2009, and provided information on State-listed natural resources and their habitats potentially affected by the relicensing action at the CREC site and potentially affected by maintenance activities along the ROWs (FWC 2009c). The NRC did not receive a response from the FNAI.

2.2.7.1 *Aquatic Species*

Table 2.2.7-1 lists the Federally- and State-listed aquatic species that occur in the Gulf of Mexico in the area of CR-3 and from other aquatic habitats within the counties where CR-3 and associated transmission lines are located. The text that follows addresses the Federally-listed species.

Table 2.2.7-1. Federally- and State-Listed Aquatic Species that Could Occur in the Vicinity of Crystal River Unit 3 Nuclear Generating Plant and Associated Transmission Lines

Species		Status[a]		Habitat[b]	Occurrence in Project Area[c]
Scientific Name	Common Name	Federal Status	State Status		
Fishes					
Acipenser oxyrinchus desotoi	Gulf sturgeon	T	SC	Primarily marine and estuarine waters in winter; migrates to upper rivers in spring for spawning and returns to sea/estuary in fall. Spends first 2 years in riverine habitats.	Citrus, Hernando, Pasco, Pinellas[d]
Cyprinodon variegates hubbsi	Lake Eustis minnow	--	SC	Lake Eustis and other headwater lakes of the Oklawaha River.	Marion
Etheostoma olmstedi maculaticeps	Southern tessellated darter	--	SC	Sandy and muddy pools of headwaters, creeks, and small to medium rivers; shores of lakes.	Marion
Pristis pectinata	Smalltooth sawfish	E	--	Shallow coastal, estuarine, and fresh waters; often in brackish water near river mouths and large embayments. Mature individuals regularly at depths over 164 ft (50 m).	Citrus, Hernando, Pasco, Pinellas[d]
Pteronotropis welaka	Bluenose shiner	--	SC	Backwaters and quiet vegetated pools of creeks and small to medium rivers, over mud and sand. Schools in water 3 to 6 ft (1 to 2 m) deep.	Marion
Sea Turtles					
Caretta caretta	Loggerhead	T	T	Open seas, mostly over continental shelf; also bays, estuaries, lagoons, creeks, and mouths of rivers.	Citrus, Hernando, Pasco, Pinellas
Chelonia mydas	Green turtle	E	E	Fairly shallow waters (except when migrating) inside reefs, bays, and inlets.	Citrus, Hernando, Pasco, Pinellas
Dermochelys coriacea	Leatherback	E	E	Open oceans, often near edge of continental shelf; also seas, gulfs, bays, and estuaries	Citrus, Hernando, Pasco, Pinellas

Species		Status[a]		Habitat[b]	Occurrence in Project Area[c]
Scientific Name	Common Name	Federal Status	State Status		
Eretmochelys imbricata	Hawksbill	E	E	Shallow coastal waters with rocky bottoms, coral reefs, and mangrove-bordered bays and estuaries.	Citrus, Hernando, Pasco, Pinellas
Lepidochelys kempii	Kemp's ridley	E	E	Open ocean and gulf waters.	Citrus, Hernando, Pasco, Pinellas
Crocodilians					
Alligator mississippiensis	American alligator	SAT	SC	Fresh and brackish marshes, ponds, lakes, rivers, swamps, bayous, and large spring runs. Basks on land by water.	Citrus, Hernando, Marion, Pasco, Pinellas, Sumter
Marine Mammals					
Trichechus manatus latirostris	Florida manatee	E	E	Shallow coastal waters, estuaries, bays, rivers, and lakes; prefers rivers and estuaries over marine habitats.	Citrus, Hernando, Marion, Pasco, Pinellas

(a) E = endangered; T = threatened; SAT = threatened due to similarity of appearance; SC = special concern; -- = not listed (FWC, 2009b), (FWS, 2009b).

(b) Source of habitat information: FNAI, 2001a; NatureServe, 2009a; Page and Burr, 1991; FWS, 2009a.

(c) Source of distribution occurrence: FNAI, 2009a.

(d) Not reported from these counties by FNAI, 2009a; however, its probable occurrence is assumed based on known distribution within the Gulf of Mexico.

Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*), a subspecies of the Atlantic sturgeon (*Acipenser oxyrinchus*), is a Federally-threatened species (NMFS, 1991) and a State species of special concern (FWC, 2009b). The FWS and NMFS (2003) designated 14 geographic areas as critical habitat for the Gulf sturgeon. These areas include over 1,727 mi (2,780 km) of rivers and 1.5 million ac (600,000 ha) of estuarine and marine habitat. None of the geographic areas of critical habitat occur near the CREC. Reproducing populations range from the Suwannee River, Florida, to the Pearl River, Louisiana (USGS, 2008), (FNAI, 2001a). The Suwannee, Choctawhatchee, and Yellow rivers are the only high-quality spawning areas for the species (FNAI, 2001a). Non-breeding individuals occur as far south as Florida Bay (FNAI, 2001a). The Gulf sturgeon reaches a length of 8 ft (2.4 m) and a weight of 200 lb (91 kg) (USGS, 2008). Sexual maturity occurs at 8 to 17 years for females and 7 to 12 years for males. They can live at least 25 to 30 years (Bester, 2009). Spawning occurs in the headwaters of rivers in areas of limestone outcrops (FNAI, 2001a). Adults spend the summer in the mid- to lower-reaches of the river (USGS, 2008). When in marine waters, it inhabits shallow seagrass beds and muddy and sandy substrates of the continental shelf (Bester, 2009). They feed on benthic invertebrates while in the Gulf, but do not feed while inhabiting rivers (USGS, 2008). Threats to the Gulf sturgeon include blockage of spawning migration by dams, pollution, dredging, incidental bycatch, poaching, watercraft collisions, and habitat loss and degradation (USGS, 2008), (FWS and NMFS, 2009). Natural events such as red tide outbreaks also threaten the species (FWS and NMFS, 2009).

Critical Habitat

Specific geographic areas, whether occupied by listed species or not, that are determined to be essential for the conservation and management of listed species, and that have been formally described in the Federal Register.
(FWS, 2010a)

Smalltooth Sawfish

The smalltooth sawfish (*Pristis pectinata*) within the United States is a distinct population segment that is Federally-listed as endangered (NMFS, 2003), (FWS, 2005a); it is not State-listed (FWC, 2009b). The smalltooth sawfish is a circumtropical species. In the western Atlantic, they range from the southern Chesapeake Bay to Brazil (Hill, 2006). The core range of the smalltooth sawfish is located between Charlotte Harbor and Florida Bay in southwestern Florida (Simpfendorfer and Wiley, 2006). Critical habitat for the smalltooth sawfish includes two units located within this core area (NMFS, 2009c). Regular encounters of the smalltooth sawfish occur only in south Florida between the Caloosahatchee River and the Florida Keys (NMFS, 2009c). Juveniles occur year-round throughout Florida; while reports for adults occur south of Charlotte Harbor (Simpfendorfer and Wiley, 2006). The abundance of the smalltooth sawfish is unknown (NMFS, 2009d).

Smalltooth sawfish mature at about 10 years of age and may live up to 30 years (Hill, 2006). Young are born in late winter and spring (Hill, 2006). Females produce litters every other year with brood size averaging about seven individuals (NMFS, 2009d). Smalltooth sawfish are about 31 inches (79 cm) long at birth and may grow to a maximum length of 25 ft (7.6 m) (Hill, 2006), (NMFS, 2009d). They most commonly occur within 1 mi (1.6 km) of land at depths less than 33 ft (10 m) (NMFS, 2009d). Juveniles inhabit shallow coastal bays, banks, estuaries, and river mouths; over substrates of mud, sand, seagrass, limestone hard bottom, rock, coral reef, and sponge bottom (Poulakis and Seitz, 2004). Adults also occur in these habitats, as well as offshore to depths greater than or equal to 394 ft (120 m) (NMFS, 2009d). Lower thermal limits for the smalltooth sawfish is about 60.8 °F to 64.4 °F (16 °C to 18 °C). The smalltooth sawfish is euryhaline and will enter freshwater areas for extended periods of time (NMFS, 2009d). They prey upon small schooling fish and also feed on crustaceans and other benthic invertebrates (NMFS, 2009d). Threats to the species include bycatch, habitat loss and degradation, entanglement in debris, pollution, harassment, and injury by saw removal (Seitz and Poulakis, 2006), (NMFS, 2009d).

American Alligator

The American alligator (*Alligator mississippiensis*) is Federally-listed as similarity of appearance (threatened) due to its similarity in appearance to the American crocodile (*Crocodylus acutus*), which is a Federally-threatened species that occurs in Dade County, Florida (FWS, 2009b). It is a State species of special concern (FWC, 2009b). The American alligator ranges from North Carolina to Texas; it occurs Statewide in Florida although it is rare in the Keys. It inhabits most permanent freshwaters and occasionally will enter brackish and salt waters (FNAI, 2001a). One observation has been made of an American alligator in the Gulf of Mexico 39 mi (63 km) from the nearest point of mainland in Louisiana (Elsey, 2005). Maximum total length is about 19 ft (5.8 m), but most are usually less than or equal to 13 ft (4 m) (NatureServe, 2009a). American alligators become sexually mature at about 6 or 7 years of age. Nesting occurs between May and July. Twenty-five to 30 percent of adult females nest each year. Mounded nests are comprised of leaves, mud, rotting vegetation, rocks, and other debris. They are located in marshes or lake or river margins. A female lays about 20 to 60 eggs. Hatchlings may stay in the vicinity of the nest and mother for up to 3 years (NatureServe, 2009a). The American alligator is an opportunistic feeder. Juveniles primarily consume small invertebrates, fish, and frogs. Large adults will eat nearly all aquatic and terrestrial prey; mostly fish, turtles and other reptiles, birds, and small mammals. They tend to stop eating at temperatures below 73 °F (23 °C) (Britton, 2009). During winter, the American alligator hibernates in its den although it may occasionally emerge during brief spells of warmer weather (Britton, 2009). It basks on land adjacent to water and digs dens in river or lake margins or in marshes (NatureServe, 2009a). The American alligator occurs within larger wetlands on the CREC site and along the two transmission corridors (FWC, 2009c). Current threats to the species include habitat destruction and pollution (FNAI, 2001a).

Green Turtle

The green turtle (*Chelonia mydas*) is Federally-listed as endangered for Florida and Mexico's coastal breeding colonies and as threatened for all other areas (NMFS, 2010b). Critical habitat includes the coastal waters surrounding Culebra Island, Puerto Rico (NMFS, 1998). The State of Florida lists the green turtle as endangered (FWC, 2009b). Green turtles occur in temperate and tropical estuarine and marine coastal and oceanic waters throughout the world. In the southeastern United States, it occurs in the U.S. Virgin Islands, Puerto Rico, and along the shorelines of the Gulf and Atlantic coasts from Texas to Massachusetts (NMFS, 2010b). Carapace lengths of adults generally range from 35 to 48 inches (88 to 122 cm) and weigh between 220 to 450 lb (104 to 204 kg) (FNAI, 2001a). Green turtles spend most of their time in coastal foraging grounds (i.e., open coastlines and protected lagoons and bays) (NMFS and FWS, 2007a). They most commonly feed in shallow, low-energy waters with abundant seagrass beds (NatureServe, 2009a). The diet of this species changes as it grows; younger green turtles eat polychaete worms, small crustaceans, aquatic insects, seagrasses, and algae; adults are primarily herbivorous, eating seagrasses and algae (NMFS and FWS, 2007a), (FWS, 2009c).

Age to maturity ranges from less than 20 years to 40 years or more (NMFS and FWS, 2007a). Females return to their natal beaches for nesting. A female nests every 2 to 4 years, but averages over three clutches during a nesting season. Each clutch averages about 136 eggs (FWS, 2009a). About 5,600 green turtle nests occur each year in Florida (NMFS and FWS, 2007a). These nests mostly occur along the Atlantic coast of Florida and in the Gulf coasts along southwestern Florida, and the western panhandle of Florida (FNAI, 2001a). Nesting does not occur in the Big Bend area of Florida, which includes Citrus County (NMFS and FWS, 2007a). The Gulf coast along Citrus and Levy Counties, the Indian River Lagoon, shallow hard substrates along the southeastern coast of Florida, and Florida Bay are important areas for young green turtles (FNAI, 2001a). The primary threats to this species are the commercial harvest of eggs for food, incidental catch in commercial fishing nets, habitat loss and degradation, watercraft strikes, and artificial lighting at nesting sites. Natural causes such as red tide outbreaks can also lead to mortality of adults and juveniles (FNAI, 2001a), (NMFS and FWS, 2007a).

Hawksbill

The hawksbill (*Eretmochelys imbricata*) is Federally- and State-endangered (NMFS, 2009a), (FWC, 2009b). Critical habitat includes the coastal waters surrounding Mona and Monito Islands, Puerto Rico (NMFS, 1998). The hawksbill is primarily tropical, but occurs along the Atlantic seaboard as far north as Maine. It occurs yearlong in southern Florida (FNAI, 2001a). Adults generally have a carapace length of 25 to 37 inches (63 to 94 cm) and weigh between 95 to 165 lb (43 to 75 kg) (FNAI, 2001a). Hawksbills inhabit rocky areas, coral reefs, shallow coastal areas, lagoons or oceanic islands, and narrow creeks and passes; seldom occurring in areas with water depths over 65 ft (20 m). Hatchlings often occur on masses of floating sea plants (FWS, 2009d). Hawksbills feed primarily in coral reef systems on sponges, anemones, squid, and shrimp.

Age at sexual maturity is unknown, but is probably over 30 years of age (FWS, 2009d). About 15,000 females nest each year throughout the world (FWS, 2009d). Females nest at intervals of 2 to 3 years. However, they may nest more than four times per season. Each clutch averages about 140 eggs (FWS, 2009d). Nesting occurs on sand beaches, often in vegetation. No primary nesting rookeries are located in the United States (NMFS and FWS, 2007b). Nesting does not occur in Citrus County (FNAI, 2001a). The primary threats to this species include harvest for its shell to create “tortoise shell” ornaments, removal of eggs from nesting sites, incidental take by commercial fishing operations, destruction or disruption of nesting beaches, pollution, watercraft strikes, and the disorientation of adults and juveniles from artificial lighting of shorelines (NMFS and FWS, 2007b), (FWS, 2009d).

Kemp’s Ridley

The Kemp’s ridley (*Lepidochelys kempii*) is Federally- and State-listed as endangered (NOAA, 2009), (FWC, 2009b). It is the most seriously endangered sea turtle species; however, critical habitat for the species is not designated (FWS, 2009e). Kemp’s ridley sea turtles occur in the Gulf of Mexico, but juveniles can range north along the Atlantic Ocean. Adults generally have a carapace length of 23 to 28 inches (58 to 71 cm) and weigh 70 to 100 lb (32 to 45 kg) (FNAI, 2001a). Preferred habitat is shallow areas with sandy or muddy bottoms where crabs, their primary diet, are numerous (NatureServe, 2009a). They also eat mussels, shrimp, sea urchins, squids, jellyfish, and fish (Texas Parks and Wildlife Department, 2008). Kemp’s ridleys occur year-round in Florida. Gulf waters are important for young (FNAI, 2001a). It nests primarily in northern Mexico and southernmost Texas. Although rare, nesting has occurred in Florida since 1989. Nesting does not occur in Citrus County (FNAI, 2001a). Like all sea turtles, the Kemp's ridley nests multiple times in a nesting season (NMFS and FWS, 2007c). The major threats to the species include destruction of nests, habitat destruction, pollution, collection of eggs, entanglement in commercial fishing nets, watercraft strikes, impingement at power plants, and ingestion of debris (NMFS and FWS, 2007c). Habitat destruction and degradation, including pollution of estuaries and marine waters, also threatens immature turtles using Florida waters (FNAI, 2001a).

Leatherback

The leatherback (*Dermochelys coriacea*) is Federally- and State-listed as endangered (NMFS, 2009a), (FWC, 2009b). Critical habitat for the leatherback is the waters adjacent to Sandy Point Beach, St. Croix, U.S. Virgin Islands (NMFS, 1979). The NMFS (2010c) has proposed to revise the critical habitat to include crucial feeding areas off the west coast of the United States. It has the widest distribution of sea turtles, nesting on beaches of tropical and subtropical waters and foraging into sub-polar waters. They are present year-round in Florida. Juveniles occur in waters warmer than 79 °F (26 °C) (NMFS and FWS, 2007d). Adults generally have a carapace length of 53 to 70 inches (135 to 178 cm) and weigh between 650 to 1,300 lb (295 and 590 kg) (FNAI, 2001a). Leatherbacks primarily feed on jellyfish, although they will also consume other invertebrates, fish, and aquatic plants (NatureServe, 2009a). Leatherbacks reach sexual maturity at 6 to 10 years of age (FWS, 2009f). Females nest at 2- to 3-year intervals. Nesting occurs from early spring through early summer with hatchlings emerging in late spring and summer. A female will nest an average of five to seven times during the nesting season (FWS, 2009f). Clutches are typically 70 to 90 eggs (NatureServe, 2009a). Worldwide, 26,000 to 43,000 females nest annually (FWS, 2009f). About 800 and 900 nests per year occur in Florida (NMFS and FWS, 2007d). Nesting does not occur in Citrus County (FNAI, 2001a). The primary threats to the leatherback include bycatch in commercial fishing nets, loss and degradation of nesting habitat, artificial lighting, pollution, harvest of females and eggs, watercraft strikes, and the ingestion of marine debris such as plastic bags (NMFS and FWS, 2007d).

Loggerhead

The loggerhead (*Caretta caretta*) is Federally- and State-listed as a threatened species (NMFS, 2009a), (FWC, 2009b). Critical habitat for the loggerhead is not designated (FWS, 2009g). Loggerheads are found in temperate and tropical waters throughout the world and feed in coastal bays and estuaries and in the shallow waters along the continental shelves of the Atlantic, Pacific, and Indian Oceans, where they spend most of their lives. The loggerhead is the most common sea turtle in the coastal waters of the United States. They are present year-round in Florida (FNAI, 2001a). Carapace lengths of adults range from 28 to 49 inches (70 to 125 cm) and adults can weigh up to 350 lb (159 kg) (FNAI, 2001a). Their diet consists of shellfish, including horseshoe crabs (*Limulus polyphemus*), clams, and mussels. A female will nest about four times per season with a clutch size of up to 126 eggs (FWS, 2009g). A female will generally nest every 2 to 3 years (FWS, 2009f). Nesting occurs late April to early September, with hatchlings emerging from July through November. The number of nesting females along the U.S. Atlantic and Gulf coasts is between 32,000 and 56,000 (NMFS and FWS, 2007e). Nesting does not occur in Citrus County (FNAI, 2001a). The greatest threats to survival include the destruction or alteration of nesting and feeding habitats, incidental capture by commercial and recreational fishermen, entanglement in shallow-water debris, legal and illegal harvesting, pollution, artificial lighting, and watercraft strikes (NMFS and FWS, 2007e).

<u>Florida Manatee</u>

The Florida manatee (*Trichechus manatus latirostris*), a subspecies of the West Indian manatee (*Trichechus manatus*), is Federally- and State-listed as endangered (FWS, 2009a), (FWC, 2009b). The Florida manatee has designated critical habitat (FWS, 1976). Critical habitat within Citrus County occurs in the Crystal River and its headwaters (Kings Bay) (exclusive of areas that have man-made structures or settlements) (FWS, 1976). This area of critical habitat is adjacent to the southern boundary of the CREC. The Florida manatee inhabits marine, estuarine, and freshwater habitats (coastal tidal rivers and streams, mangrove swamps, salt marshes, freshwater springs, and vegetated bottoms). It makes use of specific areas for foraging (especially shallow grass beds with ready access to deep water), drinking (springs and freshwater runoff sites), resting (secluded canals, creeks, embayments, and lagoons), and for travel corridors (open waterways and channels) (FWS, 2007). While Florida manatees can occur at depths greater than 12 ft (4 m), most occur in relatively shallow water (Haubold et al., 2006).

Most adults are about 10 ft long and weigh 800 to 1,200 lb (363 to 544 kg) (FWS, 2008b). They can live up to 60 years of age (Haubold et al., 2006). The Florida manatee reaches breeding maturity when 3 to 10 years old. Females give birth every 2 to 5 years, usually to a single calf (FWS, 2008b). The Florida manatee feeds on submerged, floating, and emergent vegetation and requires freshwater for drinking (FWS, 2009h). In some cases (e.g., at docks), they actively consume invertebrates (Courbis and Worthy, 2003). The Florida manatee is intolerant of cold waters. They seek warm-water sites when temperatures drop below 68 °F (20 °C) and are unable to tolerate prolonged exposures to temperatures colder than 61 °F (16 °C) (Haubold et al., 2006). To avoid cold water, the Florida manatee seeks refuge in natural, warm-water sites (e.g., springs, deep water areas, and areas thermally-influenced by the Gulf Stream) and industrial plant thermal discharges (Laist and Reynolds, 2005). Nearly two-thirds of Florida manatees winter in industrial plant discharges, most of which are power plants (FWS, 2007). In the spring, they leave warm-water sites and often travel large distances along the Gulf and Atlantic coastlines. During warmer months, they range from Texas to Massachusetts but remain most common in Florida and coastal Georgia (FWS, 2007), (FWS, 2009h).

There are about 3,800 Florida manatees with 3,300 of them occurring in Florida during winter (FWS, 2007). The FWS (2007) has identified four relatively distinct management units of Florida manatees. However, preliminary genetic analyses indicate that the four management units are not genetically isolated enough to be subpopulations (FWS, 2007). Exchange of individuals among the management units is limited during winter. The Northwest Management Unit, home to at least 377 Florida manatees, extends from the Florida panhandle to the Paso County line. It encompasses the area which includes the CREC. Among the warm-water refuges for the Northwest Management Unit, the CREC is a secondary warm-water refuge site for the Florida manatee. The nearby Crystal River Springs is a primary warm-water refuge site (FWS, 2007).

Threats to the Florida manatee include watercraft-related strikes, habitat loss, entrapment and/or crushing in water control structures, entanglement in fishing and crabbing gear, and harassment (e.g., from swimmers, snorkelers, and divers); natural threats include cold stress syndrome and brevitoxicosis (caused by neurotoxins known as brevetoxins that are produced by the red tide dinoflagellate *Karenia brevis*) (Ackerman et al., 1995), (FWS, 2007).

The *Citrus County Manatee Protection Plan*, coupled with coastal speed zones and manatee sanctuaries, has significantly reduced man-related fatalities in the county (CCBCC, 2009).

Seven manatee sanctuaries (areas that prohibit human activities so that manatees can breed, nurse, and rest free from human harassment) occur in Citrus County, all of which are in Kings Bay. Manatee refuges also occur in the county. These are areas that allow interaction, but where certain waterborne activities are restricted. Florida manatees use the CREC discharge area during spring and fall as a layover area. The FPC discharge canal (like most warm industrial discharge areas) usually lack vegetation necessary to maintain manatees over the winter months. As boat access to the discharge canal is restricted, manatees in the canal receive protection from boat collisions (CCBCC, 2009). Most of the shoreline areas in the area of the Florida Power Energy Complex are 25 mile per hour (mi/hr) (40 kilometer per hour [km/hr]) speed zones. The area within the discharge canal and area just north of the discharge dike is a slow speed zone (speed that makes little or no wake) from November 15 through April 30 and a 25 mi/hr (40 km/hr) speed zone the remainder of the year (FWC, 2002).

2.2.7.2 *Terrestrial Species*

Table 2-6 includes all Federally- and State-listed terrestrial species that occur or potentially occur in the counties in which CR-3 and the associated transmission line corridors lie. The preferred habitat of each of these species is also provided in this table.

<u>Federally-Protected Species</u>

Eight Federally-listed plant species and eleven Federally-listed animal species have been reported in the counties in which the CREC site is located or that are traversed by CR-3 transmission line corridors. The endangered wood stork (*Mycteria americana*) is the only Federally-listed species that has been observed at the CREC site (Progress Energy, 2008a). The gopher tortoise (*Gopherus polyphemus*) is currently under review for listing under the ESA (FWS, 2009i). Each of the Federally-listed species known from counties of the project area is discussed below. In addition, the peregrine falcon (*Falco peregrinus*) and the bald eagle (*Haliaeetus leucocephalus*) have either been observed at the CREC site or within the counties traversed by the transmission line corridors (FNAI, 2009b), (FNAI, 2009c), (Progress Energy, 2008a), (NatureServe, 2009a). The peregrine falcon was once a Federally-listed species, but was delisted in 1999. The bald eagle was likewise a listed species, but was delisted in 2007. Both the peregrine falcon and the bald eagle are protected under the Migratory Bird Treaty Act (MBTA), and the bald eagle is also protected under the Bald and Golden Eagle Protection Act.

<u>Plant Species</u>

<u>*Florida Bonamia*</u>. The Florida bonamia (*Bonamia grandiflora*), a perennial trailing vine with stout stems and blue flowers, is Federally-listed as threatened and State-listed as endangered. Florida bonamia is endemic to the Florida peninsula, where most of its known populations exist in the Ocala National Forest in Marion County (FWS, 2005b), about 14 mi (23 km) northeast of the Central Florida transmission corridor (Progress Energy, 2008a). The species occurs in vegetated sandy areas with openings or disturbed areas in white sand scrub on central Florida ridges, with scrub oaks, sand pine, and lichens (FNAI, 2000a). In the Ocala National Forest, Florida bonamia is restricted to bare sunny sand areas, including the margins of sand pine stands on road ROWs, fire lanes, and other places that are kept clear of trees and shrubs (FWS, 2005b). Florida bonamia habitat has been drastically reduced and fragmented by citrus groves, housing developments, and fire suppression (FNAI, 2000a).

Brooksville Bellflower. The Brooksville bellflower (*Campanula robinsiae*), an annual herb (6 inches [15 cm] tall) with solitary blue to purple flowers, is Federally- and State-listed as endangered. The species is found only on the Brooksville Ridge in north-central Hernando County in wet prairie and along the edges of ponds near pastureland (FNAI, 2000b), (FWS, 2005c). There are only two known populations of this species (FWS, 2005c). Known locations occupied by the species are approximately 8 mi (13 km) east of the Lake Tarpon transmission line corridor. Primary threats to the Brooksville bellflower are alterations of hydrology from changes in runoff and residential development (FWS, 2005c).

Florida Golden Aster. The Florida golden aster (*Chrysopsis floridana*), a perennial herb (10 to16 inches [25 to 40 cm] tall) with yellow flowers in flat-topped clusters, is Federally- and State-listed as endangered. The species grows in open, sunny areas in sand pine-evergreen oak scrub vegetation on fine sand (FNAI, 2000d), (FWS, 2005d), and along railroad and highway ROWs (FNAI, 2000d). The Florida golden aster is known to occur in several central Florida counties including Pinellas County, which is crossed by the Lake Tarpon transmission line corridor (Progress Energy, 2008a). No information is available on its possible distribution in Pinellas County. The major threat to continued existence of this species is habitat loss from residential and commercial development; the plant does not tolerate mowing (FWS, 2005d).

Longspurred Mint. The longspurred mint (*Dicerandra cornutissima*), a perennial herb (up to 1.6 ft [0.5 m] tall) with pink axillary flowers, is Federally- and State-listed as endangered. The species occurs in open areas in sand pine scrub or oak scrub, and in the ecotones between these and turkey oak communities, and along the edges of road ROWs (FWS, 2005e). The 15 known populations are in Marion and Sumter Counties (FWS, 2005e), which are crossed by the Central Florida transmission line corridor (Progress Energy, 2008a). The FNAI database indicates the occurrence of this species (recorded in 1988) in the vicinity of the Central Florida transmission line corridor approximately 0.5 mi (0.8 km) south of the Marion-Sumter County line (Progress Energy, 2008a). The primary threat to the longspurred mint is development; mild disturbances appear to have little effect and may stimulate the species by reducing competition (FWS, 2005e).

Scrub Buckwheat. Scrub buckwheat (*Eriogonum longifolium* var. *gnaphalifolium*), a perennial herb (up to 3 ft [1 m] tall) with small, white, silky haired flowers, is Federally-listed as threatened and State-listed as endangered. The species occurs in sandhill, oak-hickory scrub on yellow sands, high pineland between scrub and sandhill, and turkey oak barrens in seven counties of central Florida (FNAI, 2000e); two of which (Marion and Sumter) are crossed by the Central Florida transmission line corridor. No information is available on its distribution along the Central Florida transmission line corridor in Marion and Sumter Counties. It is threatened by habitat loss from land use conversions to agriculture and residential development (FWS, 2005f).

Cooley's Water Willow. Cooley's water willow (*Justicia cooleyi*), a perennial herb (16 inches [40 cm] tall) with dark pink flowers, is Federally- and State-listed as endangered. It is native to the Brooksville Ridge in north central Hernando County approximately 8 mi (13 km) east of the Lake Tarpon transmission line corridor (FWS, 2005c). The species is found in hardwood forests on uplands or hills, but some occur on low rises in wet hammocks or swamps (FWS, 2005c). Seventeen populations of this species are known, but the species' habitat has been greatly diminished by limerock mining, clearcutting, and agricultural and residential development (FNAI, 2000c).

Britton's Beargrass. Britton's beargrass (*Nolina brittoniana*), a perennial herb (3 to 6 ft [1 to 2 m] tall) with long, stiff leaves in a grass-like clump with showy white flowers, is Federally- and State-listed as endangered. This species occurs in scrub, sandhill, scrubby flatwoods, and xeric hammocks (FNAI, 2000f), (FWS, 2005g). Britton's beargrass has been recorded in Marion County, which is crossed by the Central Florida transmission line corridor, and in Hernando and Pasco Counties (FNAI, 2009b), (FNAI, 2009c) which are crossed by the Lake Tarpon transmission line corridor. No information is available on distribution of this species along or in the vicinity of the transmission lines. The FNAI indicates that greater than 90 percent of historic habitat has been lost to agriculture and development (FNAI, 2000f).

Lewton's Polygala. Lewton's polygala (*Polygala lewtonii*), also known as Lewton's milkwort, is a perennial herb (up to 8 inches [20 cm] tall) with small dark pink flowers. The species is Federally- and State-listed as endangered. Lewton's polygala is endemic to the central Florida ridges in oak scrub, sandhills, and transition zones between high pine and turkey oaks (FNAI, 2000g). About 100 populations are known, mostly from the Ocala National Forest and nine conservation areas. The Central Florida transmission line corridor traverses a portion of Marion County west of the central ridges, making it unlikely that the species would be found within or near the transmission line corridor.

Animal Species

Frosted Flatwoods Salamander. The frosted flatwoods salamander (*Ambystoma cingulatum*), a small (up to 4.5-inch [11-cm] long) salamander with a silvery net-like pattern on a black background, is Federally-listed as threatened. The frosted flatwoods salamander occurs in pine flatwoods (longleaf pine [*Pinus palustris*] or slash pine [*P. elliottii*]) communities with wiregrass (*Aristida stricta*) ground cover and scattered wetlands often dominated by cypress (*Taxodium* spp.) or gum (*Nyssa* spp.). The species' diet consists of earthworms and other invertebrates. Frosted flatwoods salamanders breed in wetland ponds with emergent vegetation that lack predatory fish. Within the project area it is known from Marion County, but only historically (FNAI, 2001b). Flatwoods salamanders are not likely to occur in the project area since the geographic range of the species is mostly in northern Florida and southern Georgia (FWS, 2009j); the FWS North Florida Ecological Species Office does not list any Federally-listed amphibian species in any of the project counties (FWS, 2009b). The major threat to the frosted flatwoods salamander is loss of both its longleaf pine-slash pine flatwoods terrestrial habitat and its ponded breeding habitat (FWS, 2009j).

Eastern Indigo Snake. The eastern indigo snake (*Drymarchon corais couperi*), a large (up to 8-ft [2.4-m] long), stout-bodied, shiny black snake, is Federally- and State-listed as threatened. This species is found throughout Florida and uses a variety of habitat types including sandhills, flatwoods, hammocks, coastal scrub, dry glades, palmetto flats, prairie; riparian habitats; and wet fields (NatureServe, 2009b), (FNAI, 2001c). It is often found near wetlands and in association with gopher tortoise (*Gopherus polyphemus*) burrows (NatureServe, 2009b). It forages for small mammals, birds, frogs, snakes, and lizards, especially along the edges of wetlands (NatureServe, 2009b). The eastern indigo snake could occur in suitable habitats on the CREC or any of the CR-3 transmission line corridors. In the 1970s and 1980s, it was recorded in the Withlacoochee State Forest in the general vicinity of the Lake Tarpon transmission line corridor (Progress Energy, 2008a). Major threats are habitat loss, degradation, and fragmentation; highway mortality; and illegal collection (FNAI, 2001c).

Sand Skink. The sand skink (*Neoseps reynoldsi*), a small (4- to 5-inch [10- to 13-cm] long), light brown, nearly legless lizard, is Federally- and State-listed as threatened and is endemic to Florida (FNAI, 2001d). The species occurs only on Florida's Central Ridge region (NatureServe, 2009c). It requires large patches of relatively unvegetated loose sand for burrowing (FNAI, 2001d). Its preferred habitat is rosemary scrub, but it also occurs in sand pine and oak scrub, scrubby flatwoods, turkey oak ridges within scrub, and along edges of citrus groves that have been created in scrub habitat (FNAI, 2001d). Sand skinks feed on invertebrates including adult beetles, beetle larvae, caterpillars, spiders, and termites (NatureServe, 2009c). Of the counties in the project area, the species is known only from Marion County, but it is unlikely to occur along the CR-3 transmission line corridors because its range in the county is limited to areas of the Central Ridge further east and southeast of the lines. Loss of scrub habitat to citrus groves and commercial and residential development along the Central Ridge is a major threat to this species (FNAI, 2001d), (NatureServe, 2009c).

Gopher Tortoise. The gopher tortoise (*Gopherus polyphemus*) is a medium size terrestrial turtle with a domed, unmarked, brown carapace. The species is currently listed under the ESA as threatened in the western portion of its range (Alabama, Mississippi, and Louisiana). The eastern population is under review for listing as threatened (FWS, 2009i). The gopher tortoise is endemic to the southeastern Coastal Plain of the United States; the largest portion of the species' total range occurs in the State of Florida (FWS, 2009i). Gopher tortoises excavate and use deep burrows for refuge from predators, weather, and fire. Consequently, it occurs in habitats with relatively well-drained, sandy soils, and in association with a variety of plant community types including longleaf pine-xeric oak sandhills, scrub, xeric hammock, pine flatwoods, dry prairie, coastal grasslands and dunes, mixed hardwood-pine communities, and disturbed habitats (FWS, 2009i), (FNAI, 2001e). Although the species has not been observed along the CR-3-associated transmission line corridors, it could occur in suitable habitat along either line. Threats to the species include loss of preferred habitats to agriculture, citrus groves, forestry, mining, and urban and residential development, and the recent outbreak of a bacterial respiratory disease (FWS, 2009i), (FNAI, 2001e).

Florida Scrub-Jay. The Florida scrub-jay (*Aphelocoma coerulescens*), a medium size, pale blue and gray, crestless bird, is Federally- and State-listed as threatened. It is restricted in distribution to peninsular Florida and occurs in fire-dominated open canopied oak-scrub habitat on well-drained soils (FNAI, 2001f), (NatureServe, 2009d). Florida scrub-jays are opportunistic omnivores and consume mostly lizards and arthropods in spring and summer, and acorns in fall and winter (NatureServe, 2009d). The scrub jay could occur in suitable habitat along the CR-3 transmission line corridors. The Central Florida transmission line corridor crosses oak scrub habitat in Marion County very close to the Citrus County line. The applicant reported that the FWS observed several scrub-jays along the transmission line corridors from 1992–1996 (Progress Energy, 2008a). The greatest threats to Florida scrub-jays are fire suppression and habitat loss (NatureServe, 2009d).

Piping Plover. The piping plover (*Charadrius melodus*), a small, pale brown, shorebird with a black bill and yellow legs, is Federally- and State-listed as threatened in Florida. Piping plovers are rare or uncommon winter residents on the Gulf and Atlantic coasts of Florida where they are found on open, sandy beaches and on tidal mud flats and sand flats (FNAI, 2001g). Winter diet consists of invertebrates found on the sandy beaches or on mudflats (NatureServe, 2009e). The piping plover has not been observed along the CR-3-associated transmission line corridors or at the CREC site (Progress Energy, 2008a), although mud flats are present along the western shoreline of the CREC site. Primary threats are destruction and degradation of summer and winter habitat, shoreline erosion, disturbance of nesting and foraging birds, and predation (NatureServe, 2009e).

Wood Stork. The wood stork, a tall, mostly white, long-legged bird, is Federally- and State-listed as endangered. It occurs throughout peninsular Florida in freshwater marshes, swamps, lagoons, ponds, flooded fields, and brackish wetlands (FNAI, 2001i), (NatureServe, 2009f). It nests in rookeries in the upper portions of cypress, mangrove, or dead hardwood trees over water or on islands, and forages mainly in shallow water for small fishes (NatureServe, 2009f). It has been observed using the percolation ponds and other wetlands of the CREC site (Progress Energy, 2008a) and could occur in wetlands crossed by and in the vicinity of both CR-3 transmission line corridors. The Staff observed several wood storks flying over the CREC site during the site visit in July 2009. The applicant indicated that there are no rookeries at the CREC site, but surveys for rookeries have not been conducted (Progress Energy, 2008a). The main threats to the wood stork include alteration of normal water regimes in wetlands that reduce fish supplies, nest predation by raccoons, prolonged drought, and loss of nesting trees (NatureServe, 2009f).

Red-Cockaded Woodpecker. The red-cockaded woodpecker (*Picoides borealis*), a medium size, black and white woodpecker, is Federally-listed as endangered and is designated a species of special concern by the State of Florida. It inhabits open, mature pine woodlands that have a diversity of grasses, forbs, and shrubs in longleaf pine flatwoods in north and central Florida, mixed longleaf pine and slash pine in south-central Florida, and slash pine in south Florida (FNAI, 2001j). Preferred habitats are often open and park-like with little mid-story vegetation that are maintained by regular, low-intensity fires (NatureServe, 2009g). Its distribution is tied to the remaining areas of old-growth pine forests in the State (FNAI, 2001j). Red-cockaded woodpeckers nest and roost in cavities that are almost exclusively in old but living pine trees, usually with a diameter of at least 14 inches (35 cm) and often infected with red heart disease, which attacks the heartwood and causes the wood to become soft and pithy. Food consists primarily of invertebrates (NatureServe, 2009g). The red-cockaded woodpecker has been recorded in all of the counties of the project area (FNAI, 2009b), (FNAI, 2009c) but suitable habitat does not appear to occur on the CREC site or along the CR3 transmission line corridors (Progress Energy, 2008a). Major threats include loss of habitat, forest fragmentation, competition with other cavity-nesting species, catastrophic events, and genetic isolation (NatureServe, 2009g).

Everglade Snail Kite. The Everglade snail kite (*Rostrhamus sociabilis plumbeus*), a medium size, dark brown hawk, is Federally- and State-listed as endangered. Critical habitat for the Everglade snail kite was designated in Broward, Dade, Glades, and Palm Beach Counties in extreme southeastern Florida (FWS, 1977). It formerly occurred throughout peninsular Florida, but now occurs primarily in southern Florida in the St. Johns River headwaters; southwestern Lake Okeechobee; small areas in Broward, Dade, and Palm Beach Counties; parts of Everglades National Park; Loxahatchee National Wildlife Refuge; and Big Cypress National Preserve (FNAI, 2001k), (NatureServe, 2009h). Preferred habitat for the Everglade snail kite is large, open, and shallow freshwater marshes and lakes with a low density of emergent vegetation where it feeds exclusively on applesnails (*Pomacea paludosa*) caught at the water's surface (FNAI, 2001k). Nests are usually located over the water in low trees or shrubs (FNAI, 2001k). Within the project area, the Everglade snail kite has been recorded in Marion County (FNAI, 2001k), (NatureServe, 2009h). It is likely that these are records of transients since the geographic range is mainly in southern Florida (Progress Energy, 2008a). Threats to the species include wetland drainage, development, introduction of nonnative plants, and pollution from agricultural runoff that causes eutrophication and snail die-off (FNAI, 2001k).

Florida Panther. The Florida panther (*Puma concolor coryi*), a large, light brown cat, is Federally- and State-listed as endangered. Although the species ranged historically throughout most of the southeastern United States, it is apparently extirpated in all States but Florida, and is now limited in range to the southern portions of Florida (NatureServe, 2009i). The Florida panther requires extensive blocks of mostly forested areas with large wetlands that are inaccessible to humans for refuge during the day; panthers also occur in developed areas interspersed in a landscape of natural communities (FNAI, 2001l). Florida panthers are carnivores that feed on a variety of vertebrates. Data from southwestern Florida panthers indicate that wild hog (*Sus scropha*), white-tailed deer, raccoons, and nine-banded armadillos (*Dasypus novemcinctus*) comprised the bulk of their diet (NatureServe, 2009i). The FNAI database shows records of the Florida panther from Citrus and Marion Counties traversed by the Central Florida transmission line corridor (FNAI, 2009b), (FNAI, 2009c) but NatureServe (2009i) reports no records of the species in any of the counties of the project area. Major threats to the Florida panther are habitat loss from logging, wetland drainage, oil field activity, housing development, citrus agriculture, and road construction. Other factors include the possibility of mercury contamination from their prey (in areas where panthers consume mostly raccoons), vehicle collisions, and loss of genetic variability (NatureServe, 2009i).

Whooping Crane. The whooping crane (*Grus americana*), a large, tall, mostly white, long-legged bird, is Federally-listed as endangered (considered a non-essential, experimental population in Florida) and is State-listed as a species of special concern (FNAI, 2009b), (FNAI, 2009c). The species is also protected under the MBTA. Habitat during migration and winter includes marshes, shallow lakes, lagoons, salt flats, grain and stubble fields, and barrier islands (NatureServe, 2009j). Whooping cranes are omnivores and consume grains, acorns, berries, insects, crustaceans, mollusks, fish, amphibians, and reptiles (NatureServe, 2009j).

Fifty nine captive-raised individuals were released in Florida to create a non-migratory population in central Florida; 64 individuals were introduced between 2001 and 2005 that migrate between Wisconsin and Florida in an eastern migratory population (NatureServe, 2009j). New classes of young cranes are brought each June to Necedah National Wildlife Refuge in central Wisconsin to begin a summer of conditioning behind ultralight aircraft to prepare them for their fall migration to Florida (FWS, 2009k). In 2009, 14 juvenile whooping cranes from Necedah National Wildlife Refuge were led by ultralight aircraft to St. Marks National Wildlife Refuge along the Gulf coast south of Tallahassee, Florida (FWS, 2009k). About half of the migrants were expected to overwinter there and the remainder to migrate southward to the Chassahowitzka National Wildlife Refuge, located 10 mi (16 km) south of the CREC (FWS, 2009k). In 2010, 10 juvenile cranes were led to the Chassahowitzka National Wildlife Refuge from Wisconsin (FWS, 2010c). At least 17 juvenile whooping cranes died at the refuge during a storm on February 1 and 2, 2007 (International Crane Foundation, 2011).

Most recently, five juvenile whooping cranes led by ultralight aircraft arrived at the Chassahowitzka National Wildlife Refuge from Wisconsin on January 15, 2011. Additionally, four of the endangered whooping cranes from the essential, wild population were killed by gunshot in Georgia and Alabama in December 2010 and January 2011. A new experimental population of whooping cranes is being introduced into Louisiana in February 2011 (International Crane Foundation, 2011).

Whooping cranes could occur within the project area as migrants or winter residents. Whooping cranes cross the transmission line corridor several miles east of the CREC during migration from Wisconsin to wintering grounds at the Chassahowitzka National Wildlife Refuge. The whooping cranes also overwinter in the immediate vicinity of the eastern section of the shared transmission line corridor.

State Protected Species

A total of 59 plants and 17 animals that are listed by the State of Florida as endangered, threatened, or species of special concern are known to occur in the county in which the CREC is located (Citrus County) or in the counties that are crossed by the Central Florida or Lake Tarpon transmission line corridors (Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties). Most of the Federally-listed plant and animal species that were discussed in the preceding section are also State-listed; only the frosted flatwoods salamander and red-cockaded woodpecker are not State-listed species. The habitats and potential occurrences of each State-listed species in the project area are presented in Table 2-6.

The bald eagle and the wood stork (both State-listed as endangered) are the only two State-listed species that are known to occur on the CREC site. The wood stork was discussed in the preceding section, and the bald eagle is discussed below. Additional information on these species is also found in Section 4.7.2 of this SEIS.

The bald eagle, a large, dark brown raptor with a white head and tail, is State-listed as threatened and is no longer a Federally-listed species under the ESA. Bald eagles are typically found along coastal areas, bays, lakes, and rivers or other bodies of water that provide concentrations of their preferred foods, which include fish, waterfowl, and wading birds (FNAI, 2001h), (NatureServe, 2009k). Florida has the largest breeding population of bald eagles of any State outside of Alaska. The species usually nests in tall trees near water, with clear views of surrounding areas (FNAI, 2001h). Three bald eagle nests have been documented within the CREC site boundaries, but no eagle nests have been recorded along the CR-3 transmission line corridors (FWC, 2009d). Each of these three eagle nests was located to the south of the developed portions of the site. One of the nests was last active in 1991; one was active from 2005 through 2007; and the other was active from 2005 through 2008. Another bald eagle nest was recorded slightly north of the CREC and was active from 2005 through 2008 (FWC, 2009b). None of these nests were surveyed in 2009. Bald eagles are occasionally observed flying and foraging along Crystal Bay and perching in trees at the CREC (Progress Energy, 2008a).

State-listed species that are known to occur along the Central Florida transmission line corridor include the longspurred mint (endangered; Marion County) and the Florida scrub-jay (threatened; Citrus and Marion Counties).

State-listed species known to occur along the Lake Tarpon transmission line corridor include pondspice (*Litsea aestivalis*; endangered; Pasco County), scrub stylisma (*Stylisma abdita*; endangered; Citrus County), eastern indigo snake (threatened; Citrus County), Florida scrub-jay (threatened; Pasco and Pinellas Counties), southeastern American kestrel (*Falco sparverius paulus*; threatened; Citrus, Hernando, and Pasco Counties), and the bald eagle (threatened; known to nest along the corridor in Pasco County). It is likely that the whooping crane (discussed in the preceding section and State-listed as a species of special concern) flies over both transmission line corridors during its migrations.

Table 2-6. Federally- and State-Listed Threatened and Endangered Species that Could Occur in the Vicinity of Crystal River Unit 3 Nuclear Generating Plant and Associated Transmission Lines

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat[(b)]	Occurrence in Project Area
Plants					
Acrostichum aureum	golden leather fern	--	T	Brackish and freshwater marshes	Known to occur in Pinellas County
Adiantum tenerum	brittle maidenhair fern	--	E	Shaded limestone ledges and walls of sinkholes	Known to occur in Citrus, Hernando, and Marion Counties
Agrimonia incisa	incised groove-bur	--	E	Herbaceous layer of longleaf pine-oak forest	Known to occur in Citrus, Hernando, and Marion Counties
Asplenium erosum	auricled spleenwort	--	E	Epiphyte on trees and logs in swamps, hammocks	Known to occur in Hernando, Pasco, and Sumter Counties
Asplenium pumilum	dwarf spleenwort	--	E	Shaded limestone boulders in forests	Known to occur in Citrus, Hernando, and Marion Counties
Asplenium verecundum	modest spleenwort	--	E	Limestone outcrops on boulders and cliffs in shaded forests	Known to occur in Citrus and Sumter Counties
Bigelowia nuttallii	Nuttall's rayless-goldenrod	--	E	Sand pine scrub on sandstone outcrops; disturbed sand, and slash pine forest	Known to occur in Pinellas County
Blechnum occidentale	sinkhole fern	--	E	Shady hammocks in rocky areas	Known to occur in Citrus, Hernando, and Pasco Counties
Bonamia grandiflora	Florida bonamia	T	E	Sand pine (*Pinus clausa*) scrub vegetation with evergreen scrub oaks and sand pine	Known to occur in Marion County
Calamintha ahsei	Ashe's savory	--	T	Openings of sand pine scrub or along roadsides, fire lanes, abandoned fields	Known to occur in Marion County
Campanula robinsiae	Brooksville bellflower	E	E	Pond margins in wet prairies or in seepage areas of adjacent hardwood forests.	Known to occur in Hernando County
Carex chapmanii	Chapman's sedge	--	E	Well-drained hammock woodlands, sandy hammocks; in beech-magnolia-maple with some oak-pine; floodplains of black-water streams	Known to occur in Citrus, Hernando, and Marion Counties

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat[(b)]	Occurrence in Project Area
Centrosema arenicola	sand butterfly-pea	--	E	Open areas in slash pine-turkey oak sandhills	Known to occur in Marion, Pasco, and Sumter Counties
Chamaesyce cumulicola	sand-dune spurge	--	E	Coastal scrub and stabilized dunes	Known to occur in Pinellas County
Cheilanthes microphylla	southern lip fern	--	E	Crevices of limestone outcrops and on terrestrial shell mounds in partial to full sun	Known to occur in Citrus County
Coelorachis tuberculosa	Piedmont jointgrass	--	T	Margins or shallow of lakes and ponds or in wet savanna swales	Known to occur in Hernando and Marion Counties
Chrysopsis floridana	Florida golden aster	E	E	Sand pine scrub with exposed sunny openings or ecotonal edges of scrub	Known to occur in Pinellas County
Dicerandra cornutissima	longspurred mint	E	E	Openings in longleaf pine-turkey oak scrub/sandhill or low rises in slash pine-palmetto scrub	Known to occur in Marion and Sumter Counties; known to occur along the central Florida line in Marion County
Drosera intermedia	spoon-leaved sundew	--	T	Wet sandy marsh areas	Known to occur in Marion County
Eragrostis pectinacea tracyi	Sanibel Island lovegrass	--	E	Dry compact soils of disturbed beach dunes, maritime hammocks, coastal strands, coastal grasslands, old fields, and clearings	Known to occur in Pinellas County
Erigonum longifolum var. *gnaphalifo-lium*	scrub buckwheat	T	E	Dry pinelands, sandhills, and scrub; in transition habitats between scrub and high pine and in turkey oak barrens	Known to occur in Marion and Sumter Counties
Euphorbia communta	wood spurge	--	E	Rocky wooded areas along streams	Known to occur in Marion County
Forestiera godfreyi	Godfrey's privet	--	E	Upland hardwood forest on slopes, along lakes, and rivers	Known to occur in Marion County
Glandularia maritima	coastal vervain	—	E	Sandy clearings in coastal dune swales, scrub, pinelands, and open live oak-cabbage palm woods	Known to occur in Citrus County

Scientific Name	Common Name	Federal Status[a]	State Status[a]	Habitat[b]	Occurrence in Project Area
Glandularia tampensis	Tampa vervain	--	E	Sandy coastal hammocks and dunes, clearings, well-drained live oak-slash or longleaf pine-saw palmetto flats, and disturbed areas	Known to occur in Citrus, Pasco, and Pinellas Counties
Gossypium hirsutum	wild cotton	--	E	Disturbed sites along roads in well-drained areas	Known to occur in Pinellas County
Hartwrightia floridana	hartwrightia	--	T	Slash pine/longleaf pine flatwoods, pineland swamps, or bogs	Known to occur in Marion County
Illicium parviflorum	star anise	--	E	Sandy loams or sandy peat mucks in hydric hammock and floodplain swamps, along relatively large spring-fed streams and in bayheads	Known to occur in Marion County
Justica cooleyi	Cooley's water willow	E	E	Fine sandy loams or silty, clay loams of shady, moist, deciduous hammocks underlain by limestone, along small gullies or meandering streams, low rises in swamp woodlands, and hammocks	Known to occur in Hernando and Sumter Counties
Lechea cemua	nodding pinweed	--	T	Evergreen scrub oak on deep sand soils	Known to occur in Pinellas County
Lechea divaricata	pine pinweed	--	E	Deep sands of sand pine scrub, ancient dunes, scrub oak, and moist dune swales	Known to occur in Hernando and Pinellas Counties
Litsea aestivalis	pondspice	--	E	Wet, sandy, or peaty acidic soils on margins of swamps, ponds, bay heads, pitcher plant savannas, and in low wet woodlands	Known to occur in Marion and Pasco Counties; known to occur along the Lake Tarpon line in Pasco County
Matelea floridana	Florida spiny-pod	--	E	Moist woods to dry, open oak-hickory or oak-hickory-pine upland forests	Known to occur in Citrus, Marion, and Sumter Counties
Monotropa hypopthys	pinesap	--	E	Sand pines in dry sandy soil	Known to occur in Marion County

Scientific Name	Common Name	Federal Status[a]	State Status[a]	Habitat[b]	Occurrence in Project Area
Monotropsis reynolsiae	pygmy pipes	--	E	Upland mixed hardwood forest, mesic and xeric hammocks, sand pine, and oak scrub	Known to occur in Citrus, Marion, Hernando, and Pasco Counties
Najas filifolia	narrowleaf naiad	--	T	Freshwater lakes and river reaches that are dark water habitats	Known to occur in Marion County
Nemastylis floridana	celestial lily	--	E	Sunny areas in wet flatwoods, swamp, marsh borders; wet, grassy, clearings in slash pine-saw palmetto vegetation and cabbage palm hammocks	Known to occur in Pasco County
Nolina atoopocarpa	Florida beargrass	--	T	Wet pine flatwoods in black, sandy-peaty soil	Known to occur in Marion County
Nolina brittoniana	Britton's beargrass	E	E	Deep, fine-textured, well-drained sands in openings of sand pine-evergreen, oak scrub, or longleaf pine-turkey oak sandhill forest	Known to occur in Hernando, Marion, and Pasco Counties
Ophioglossum palmatus	hand fern	--	E	Epiphyte on persistent leaf bases of Sabal palmetto in moist hammocks	Known to occur in Pasco County
Parnassia grandifolia	large-leaved grass-of-parnassas	--	E	Ecotonal seepage slopes between mesic flatwoods and swamps; calcareous seeps, fens, and springs	Known to occur in Marion County
Pecluma dispersa	widespread polypody	--	E	Tree branches and limestone outcrops in dry hammocks	Known to occur in Hernando and Marion Counties
Pecluma plumula	plume polypody	--	E	Tree branches or limestone on hammocks; wet forests	Known to occur in Hernando, Marion, and Sumter Counties
Pecluma ptilodon	swamp plume polypody	--	E	Rocky hammocks; wet forests on fallen logs and bases of trees	Known to occur in Citrus, Marion, and Sumter Counties
Peperomia humilis	terrestrial peperomia	--	E	Shell mounds, limestone outcrops in mesic hammocks; coastal berms, cypress swamps	Known to occur in Citrus, Hernando, and Sumter Counties

Scientific Name	Common Name	Federal Status[a]	State Status[a]	Habitat[b]	Occurrence in Project Area
Polygala lewtonii	Lewton's polygala	E	E	Sandhills with longleaf pine and low scrub oaks; occasionally, inhabits power line clearings or new roadsides	Known to occur in Marion County
Pteroglossaspis ecristata	giant orchid	--	T	Scrub oak, pine rocklands, pine-palmetto flatwoods, and dry-mesic pine savanna	Known to occur in Citrus, Hernando, Marion, and Pinellas Counties
Pycnan-themum floridanum	Florida mountain-mint	--	T	No information found	Known to occur in Hernando and Marion Counties
Salix floridana	Florida willow	--	E	Very wet, calcareous soils, usually in dense floodplain woods, edges of cool, clear spring runs, and roadside ditches	Known to occur in Marion County
Schizachy-rium niveum	scrub bluestem	--	E	Dry, deep, white or yellow sandy areas in sandhill or scrub	Known to occur in Hernando County
Sideroxylon alachuense	silver buckthorn	--	E	Hammocks in upland hardwood forests on calcareous sandy soils and shell middens; often occurs around limesinks	Known to occur in Marion County
Sideroxylon lycoides	buckthorn	--	E	Floodplain forests, bordering streams, or cypress ponds	Known to occur in Marion County
Spigelia loganoides	pinkroot	--	E	Floodplain forests, upland and wet hardwood forests; hammocks	Known to occur in Marion and Sumter Counties
Spiranthes polyantha	green ladies'-tresses	--	E	In cracks and crevices of limestone in thin scrub oak forests	Known to occur in Citrus County
Stylisma abdita	scrub stylisma	--	E	Dry, sandy soil in oak or sand pine scrub or turkey oak barrens	Known to occur in Citrus and Marion Counties; known to occur along the Lake Tarpon line in Citrus County
Thelypteris reptans	creeping maiden fern	--	E	Rocky calcareous banks, ledges, cliffs and limestone sinks; hammocks and upland mixed forests	Known to occur in Citrus County

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat[(b)]	Occurrence in Project Area
Trichomanes punctatum ssp. floridanum	Florida filmy fern	--	E	Limestone sinks or on rocks in hammocks	Known to occur in Sumter County
Triphora craigheadii	Craighead's noddingcaps	--	E	Hammocks in mesic hardwood forests	Known to occur in Citrus, Hernando, and Sumter Counties
Vicia ocalensis	Ocala vetch	--	E	Sandy peat of open, wet thickets, open marshlands, and stream margins	Known to occur in Marion County
Amphibians					
Ambystoma cingulatum	frosted flatwoods salamander	T	--	Longleaf pine-wiregrass flatwoods and savannas	Historically occurred in Marion County
Reptiles					
Drymarchon couperi	eastern indigo snake	T	T	Sandhill regions dominated by mature longleaf pine, turkey oak, and wiregrass; flatwoods; hammocks; coastal scrub; dry glades; palmetto flats; prairie; brushy riparian corridors; and wet fields	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties; known to occur along the Lake Tarpon line in Citrus County
Neoseps reynoldsi	sand skink	T	T	In areas of loose sand, including sand pine and oak scrub, scrubby flatwoods, turkey oak ridges within scrub, and along edges of citrus groves in former scrub	Known to occur in Marion County
Stilosoma extenuatum	short-tailed snake	--	T	Dry, sandy uplands, especially longleaf pine-turkey oak and adjacent xeric oak hammocks and rosemary-sand pine scrub; also sphagnum bogs adjacent to typical habitat	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties
Gopherus polyphemus	gopher tortoise	UR	T	Dry upland habitats, including sandhills, scrub, xeric oak hammock, and dry pine flatwoods; also disturbed habitats such as pastures, oldfields, and road shoulders	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties

Scientific Name	Common Name	Federal Status[(a)]	State Status[(a)]	Habitat[(b)]	Occurrence in Project Area
Birds					
Aphelocoma coerulescens	Florida scrub-jay	T	T	Open, fire-maintained oak scrub without a dense canopy	Known to occur in Citrus, Hernando, Marion, Pasco, and Sumter Counties; known to occur along the central Florida line in Citrus and Marion Counties; also, along the Lake Tarpon line in Pasco and Pinellas Counties
Charadrius alexandrinus	snowy plover	--	T	Nest on dry, sandy beaches; forage in tidal flats along inlets and creeks	Known to occur in Pinellas County
Charadrius melodus	piping plover	T	T	Winter habitat in Florida is open, sandy beaches, tidal mudflats, and sandflats along both coasts	Known to occur in Citrus, Hernando, Pasco, and Pinellas Counties
Falco peregrinus	peregrine falcon	--	E	Farmlands, marshes, lakeshores, river mouths, tidal flats, dunes and beaches, broad river valleys, cities, and airports	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties
Falco sparverius paulus	southeastern American kestrel	--	T	Optimal habitat is sandhill, although occurs in a wide variety of other open habitats	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties; known to occur along the Lake Tarpon line in Citrus, Hernando, and Pasco Counties
Grus americana	whooping crane	E, XN	SC	Habitat during migration and winter includes marshes, shallow lakes, lagoons, salt flats, grain and stubble fields, and barrier islands	Experimental population overwinters in Florida, in the project area, or as a transient during migration
Grus canadensis pratensis	Florida sandhill crane	--	T	Wet prairies, marshy lake regions, low lying pastures, and shallow flooded open areas	Known to occur in Citrus, Hernando, Marion, Pasco, and Sumter Counties

Scientific Name	Common Name	Federal Status[a]	State Status[a]	Habitat[b]	Occurrence in Project Area
Haliaeetus leucocephalus	bald eagle	--	T	Coastal areas, bays, rivers, lakes, or other large bodies of water	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties; known to use the CREC site for nesting and foraging; known to nest along the Lake Tarpon line in Pasco County
Mycteria americana	wood stork	E	E	Freshwater wetlands, including marshes, swamps, lagoons, ponds, and flooded fields	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties; has been observed on the CREC site
Picoides borealis	red-cockaded woodpecker	E	--	Open, mature pine woodlands	Known to occur in Citrus, Hernando, Marion, Pasco, Pinellas, and Sumter Counties
Rostrhamus sociabilis plumbeus	Everglade snail kite	E	E	Large, open freshwater marshes and lakes with shallow open waters	Known to occur in Marion County
Sterna antillarum	least tern	--	T	Coastal areas throughout Florida, including beaches, lagoons, bays, and estuaries	Known to occur in Citrus, Hernando, Pasco, and Pinellas Counties
Mammals					
Puma concolor coryi	Florida panther	E	E	Forested areas in lowlands and swamps, but also upland forests in some parts of range; depends on large contiguous blocks of wooded habitat	Known to occur in Citrus and Marion Counties
Ursus americanus floridanus	Florida black bear	--	T	Large undeveloped wooded tracts	Known to occur in Citrus, Hernando, Marion, and Pasco Counties

(a) E = Endangered, T =Threatened, SC = Species of Special Concern; UR = under review for listing; XN = experimental, non-essential population

(b) NatureServe, 2009a

(c) FNAI, 2009b and FNAI, 2009c

(d) FWC, 2009a

2.2.8 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at CR-3. The nuclear plant and the communities that support it can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required to operate the nuclear power plant. Power plant operations, in turn, provide wages and benefits for people and dollar expenditures for goods and services. The measure of the communities' ability to support CR-3 operations depends on the ability of the community to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomics region of influence (ROI) is defined by the area where CR-3 employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The CR-3 ROI consists of Citrus County, where approximately 83 percent of plant employees reside, and includes the cities of Inverness (estimated 2008 population of 7,276) and Crystal River (3,553).

FPC employs approximately 450 permanent workers at CR-3 (Progress Energy, 2008a). Approximately 83 percent live in Citrus County, Florida (Table 2.2.8-1). The remaining 17 percent of the workforce is divided among 8 counties in Florida with numbers ranging from 1 to 32 employees per county. Given the residential locations of CR-3 employees, the most significant impacts of plant operations are likely to occur in Citrus County. The focus of the analysis in this SEIS is, therefore, on the impacts of CR-3 in this county.

Table 2.2.8-1. Crystal River Unit 3 Nuclear Generating Plant Permanent Employee Residence by County in 2006

County	Number of Employees	Percentage of Total
Citrus County	372	83
Marion County	32	7
Levy County	21	5
Hernando County	15	3
Others (5)	11	2
Total	**451**	**100**

Source: Progress Energy, 2009f

Refueling outages at CR-3 normally occur at 24-month intervals. During refueling outages, site employment increases by 1,540 workers for approximately 40 days (Progress Energy, 2008a). Most of these workers are assumed to be located in the same geographic areas as the permanent CR-3 employees. The following subsections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding the CR-3 site.

2.2.8.1 *Housing*

Table 2.2.8.1-1 lists the total number of occupied housing units, vacancy rates, and median value in the ROI. According to the 2000 census, there were over 62,000 housing units in the ROI, of which approximately 53,000 were occupied. The median value of owner-occupied units was $84,400. The vacancy rate was 15.3 percent, partly due to the large number of seasonal and recreational housing units in the county (8.3 percent; see Table 2.2.8.5-4).

By 2009, the total number of housing units in Citrus County grew by almost 24 percent (15,000 units) to an estimated total of approximately 77,000 units. The total number of occupied units grew by approximately 8,000 units to 60,522. As a result, the number of available vacant housing units increased by almost 7,000 units to 16,566, or 21.5 percent, of all housing units (USCB, 2011)

Table 2.2.8.1-1. Housing in Citrus County, Florida

	Citrus County
2000	
Total	**62,204**
Occupied housing units	52,634
Vacant units	9,570
Vacancy rate (percent)	15.4
Median value (dollars)	84,400
2009 estimate	
Total	**77,088**
Occupied housing units	60,522
Vacant units	16,566
Vacancy rate (percent)	21.5
Median value (dollars)	137,700

Source: USCB, 2009a; USCB, 2011

2.2.8.2 *Public Services*

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

Water Supply

CR-3 obtains potable water from three groundwater wells on the plant site and is not connected to the public water system.

Historically, the majority of Citrus County residents received potable water from private wells, drawing groundwater from the aquifer system. As the population in the county increased, several communities developed water service utilities, and in the 1980s, Citrus County established the Citrus County Utilities Division (CCUD). Prompted, in part, by increasing saltwater intrusion into coastal groundwater supplies, the CCUD also began a coordinated effort to develop a public water supply system by acquiring and developing private water systems and constructing distribution lines (Citrus County, 2006).

The CCUD currently operates two major interconnected water treatment and distribution facilities, as well as a number of small, isolated systems. The county is also served by six facilities operated by private and semi-public utilities. Table 2.2.8.2-1 details usage and capacity information for the major water-providing systems.

Although there are currently no water supply capacity restrictions in Citrus County, there are some water quality issues in coastal areas and other selected parts of the county, particularly with regard to saltwater intrusion and water supply contamination. Very few individual wells in this portion of the county meet Federal drinking water standards (Citrus County, 2006). In response, the county installed new wells further inland in productive aquifer areas, transporting water to coastal users, and has connected water users to other water suppliers from other parts of the county. Water supplies in certain areas west of the US 41 corridor have high mineral content, particularly iron and manganese, and additional treatment of the raw water in these locations is sometimes required (Citrus County, 2006).

Table 2.2.8.2-1. Major Public Water Supply Systems (million gallons per day)

Water Supplier[a]	Water Source[a]	Average Daily Production[b]	Maximum Daily Production[b]	Design Capacity[b]
Citrus County Utilities Department	GW	6.1	7.8	14.5
Beverly Hills Subdivision	GW	4.0	7.5	5.6
Citrus Springs	GW	4.1	7.2	5.2
Inverness Water Department	GW	1.5	1.9	3.5
City of Crystal River	GW	0.9	1.4	2.2
Floral City Water Association	GW	0.4	0.8	1.8
Homosassa Special Water District	GW	1.1	10.7	1.6

GW = groundwater
(a) EPA, 2009b
(b) FDEP, 2009c

Education

CR-3 is located in the Citrus School District, Citrus County. The school district has 24 schools and in 2007, had an enrollment of approximately 16,087 students and employed 1,034 teachers (NCES, 2009). There are no other public school districts in Citrus County.

Transportation

Road access to CR-3 is via US 19 (see Figure 2.1–5). The plant access road, West Power Line Street, intersects with US 19. North of this intersection, US 19 intersects with CR 488. Employees traveling from the north, northwest, northeast, east, and west of CR-3 would use these roads to reach the CR-3 site. South of the access road intersection, US 19 intersects with CR 495, SR 44, CR 494, CR 490, and CR 480. Employees traveling from the south, southeast, southwest, east, and west would use a combination of these roads to reach CR-3 (Progress Energy, 2008a).

With projected increases in recreational visitation and in retirement in Citrus County, traffic volumes are expected to increase over the next several decades. To meet current and projected capacity requirements, the county plans to upgrade the county road system. Additionally, the Florida Department of Transportation is currently conducting a project development and environment (PD&E) study supporting Suncoast Parkway 2, a new four-lane highway, which would extend from US 98 to US 19, alleviating congestion along US 19, around Crystal River and other towns along the west coast of Citrus County (Progress Energy, 2008a).

In determining the significance levels of transportation impacts for license renewal, the Staff used the Transportation Research Board's level of service (LOS) definitions (NRC, 1996). In its *Citrus County Comprehensive Plan*, *Draft Evaluation and Appraisal Report Based Amendments*, "Chapter 6: Traffic Circulation Element," the county calculated LOS ratings for most roads in Citrus County (Citrus County, 2007). Table 2.2.8.2-2 lists roadways in the vicinity of CR-3, the annual average daily traffic (AADT) volumes, and the LOS determinations, as assessed by Citrus County. LOS designations were developed by the Transportation Research Board (1985) and range from "A" to "F." "A" through "C" represent good traffic operating conditions with some minor delays experienced by motorists, with "F" representing jammed roadway conditions.

Although traffic volumes are slightly lower on those segments of US 19 nearer the plant access road compared to the segments in the northern and southern portions of Citrus County, the LOS is also lower on the segment of US 19 closer to the plant. Venable Street, CR 44, SR 44, and CR 495 are classified as minor arterial roads.

Table 2.2.8.2-2. Average Annual Daily Traffic Counts in the Vicinity of Crystal River Unit 3 Nuclear Generating Plant[(a)]

Roadway and Location	Annual Average Daily Traffic (2004)	Level of Service (AADT) (2007)
US 19		
From CR 494 to Venable Street	30,768	C
From Venable Street to CR 44	33,115	B
From CR 44 to SR 44	35,584	B
From SR 44 to CR 495	36,698	B

Sources: Citrus County, 2006; Citrus County, 2008

(a) All AADTs represent traffic volume during the average 24-hour day during 2004

2.2.8.3 *Offsite Land Use*

This section focuses on Citrus County because approximately 83 percent of the permanent CR-3 workforce lives in this county and because CR-3 pays property taxes in Citrus County.

Citrus County encompasses approximately 773 mi^2 (494,720 ac), including approximately 584 mi^2 (373,760 ac) of land and 104 mi^2 (66,233 ac) of inland water with the remaining area encompassing estuaries and coastal river systems (Citrus County, 2009). Although much of Citrus County is still rural in nature with a large percentage of land area undeveloped, the county has been experiencing rapid population growth with an influx of retirees and a growing tourism industry, and the consequent expansion of the construction, wholesale and retail trade, and service sectors (Citrus County, 2009). Residential and commercial developments, as well as other land uses, are sporadically located throughout the county (Citrus County, 2009). Citrus

County uses its comprehensive land use plan and land development regulations (Citrus County Land Development Code) to guide development. Although the county has no formal growth control measures, housing density limits are used to: (1) encourage growth in areas where public facilities, such as water and sewer systems, exist or are scheduled to be built in the future; and (2) promote the preservation of the communities' natural resources.

Land committed to residential use is currently the largest single use of developed land in the county, with 107 mi^2 (68,727 ac) of residentially committed land, representing 18 percent of the unincorporated land area as of 2004 (Citrus County, 2009). The greatest concentrations of residential land are located adjacent to the incorporated cities of Inverness and Crystal River, and the unincorporated areas of Homosassa Springs and Beverly Hills. Commercial development is located along US 19, SR 44, US 41, and on CR 491 near the urbanized areas of Crystal River, Inverness, Homosassa, Beverly Hills, and Hernando. Although, due to widespread urban development, agricultural land in the county is limited; this land use type still constitutes approximately 20 percent of the unincorporated land in the county. The majority of the county agricultural land is classified as improved pasture, and most of the farms are owned by individual or family organizations. There has been little change in agricultural acreage over the past decade (Citrus County, 2009).

Conservation lands in Citrus County, designated for such purposes as protecting and managing natural resources and including private, Federal, State, and county reserves stood at 195 mi^2 (124,498 ac) of land and inland water at the end of 2004 (Citrus County, 2009). Expansion of conservation acreage has come as a result of land purchases by the State and the SFWMD, and also serves flood control purposes. Conservation areas have been used for the Chassahowitzka National Wildlife Refuge, Crystal River State Buffer Preserve, Crystal River National Wildlife Refuge, Withlacoochee State Forest, Flying Eagle Ranch, Pott's Preserve, Chassahowitzka Riverine Swamp Sanctuary, Two-Mile Prairie, the McGregor-Smith Boy Scout Reservation, Annuteliga Hammock, and the Marjorie Harris Carr Cross Florida Greenway (Citrus County, 2011).

2.2.8.4 *Visual Aesthetics and Noise*

The CR-3 facility is situated within the 4,738-ac (1,917-ha) CREC and includes four principal structures. The reactor containment building is the tallest building at CR-3 at 157 ft (48 m), and the primary auxiliary building, control complex building, and the turbine building are lower in height. Also located on the CREC site are four fossil-fueled power units with two 600-ft (183-m) and two 500-ft (152-m) exhaust stacks, a 550-ft (168-m) scrubber flue, and two 450-ft (137-m) hyperbolic cooling towers (Progress Energy, 2009f). Other facilities supporting fossil-fuel power generation at the CREC site include coal delivery and storage areas, ash storage basins, office buildings, and warehouses. Compared to the fossil-fuel power generation facilities at the CREC, CR-3 is less noticeable. The size of the overall land parcel has a substantial buffer zone around the developed portion of the site (AEC, 1973).

There are no public access roads to land areas adjacent to the plant site except for the plant access road (Progress Energy, 2008a). An FWC program to protect shorebird and sea bird nesting sites along the CREC shoreline restricts access in the area to the public (Progress Energy, 2008a).

Noise from nuclear plant operations can be detected offsite. Sources of noise at CR-3 and CREC include the turbines, construction activities, large pump motors, and rail traffic moving on and off the site (Progress Energy, 2008a). Given the industrial nature of the station, noise emissions from the station are generally nothing more than an intermittent minor nuisance.

However, noise levels may sometimes exceed the 55 decibal (dBA) level that the EPA uses as a threshold level to protect against excess noise during outdoor activities (EPA, 1974). However, according to the EPA this threshold does “not constitute a standard, specification, or regulation,” but was intended to provide a basis for State and local governments establishing noise standards. To date, no noise complaints associated with operations at CR-3 have been reported from neighboring communities.

2.2.8.5 *Demography*

In 2000, approximately 89,491 persons lived within a 20-mi (32-km) radius of CR-3, which equates to a population density of 125 persons per mi^2 (Progress Energy, 2008a). This density translates to a Category 4 (greater than or equal to 120 persons per mi^2 within 20 mi) using the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) measure of sparseness (NRC, 1996), (NRC, 1999). At the same time, there were approximately 825,847 persons living within a 50-mi radius of the plant, for a density of 170 persons per mi^2 (Progress Energy, 2008a). Therefore, CR-3 falls into Category 2 (no city with 100,000 or more persons and between 50 and 190 persons per mi^2 within 50 mi) on the NRC sparseness and proximity matrix. A Category 2 value indicates that CR-3 is in a medium density population area.

Table 2.2.8.5-1 shows population projections and growth rates from 1970 to 2050 in Citrus County. The growth rate in Citrus County since 1970 has been substantial and the population has grown, and is projected to continue to grow, through 2050.

Table 2.2.8.5-1. Population and Percent Growth in Citrus County, Florida, from 1970 to 2000 and Projected for 2010 and 2050

	Citrus County	
Year	**Population**	**Percent Growth[(a)]**
1970	19,196	—
1980	54,703	184.9
1990	93,513	70.9
2000	118,085	26.3
2009	**142,609**	**20.8**
2010	142,800	20.9
2020	165,700	16.0
2030	189,700	14.5
2040	212,967	12.3
2050	236,417	11.0

— = No data available.

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

Sources: Population data for 1970 through 1990 (USCB, 2009c); 2000 (USCB, 2011); projected population data for 2009, 2010, 2020, and 2030 (BEBR, 2010); population projections for 2040 and 2050 (calculated)

The 2000 demographic profile of the ROI population is included in Table 2.2.8.5-2. Persons self-designated as minority individuals comprise 7 percent of the total population in 2000. The minority population is composed largely of Hispanic or Latino and Black or African American residents.

Table 2.2.8.5-2. Demographic Profile of the Population in the Crystal River Unit 3 Nuclear Generating Plant Region of Influence in 2000

	Citrus County	Percent
Total Population	**118,085**	**--**
Race (Not-Hispanic or Latino)		
White	109,828	93.0
Black or African American	2,712	2.3
American Indian and Alaska Native	389	0.3
Asian	886	0.8
Native Hawaiian and Other Pacific Islander	29	0.0
Some other race	45	0.0
Two or more races	1,055	0.9
Ethnicity		
Hispanic or Latino	3,141	2.7
Minority Population (including Hispanic or Latino ethnicity)		
Total minority population	**8,257**	**7.0**

Source: USCB, 2009d

According to American Community Survey 2009 estimates, minority populations in Citrus County increased by approximately 6,700 persons and comprised 10.6 percent of the total population (see Table 2.2.8.5-3). Most of this increase was due to an estimated increase of Hispanic or Latinos (over 2,800 persons); an increase in population of 89.8 percent from 2000. The next largest increase in minority population was Black or African American, an estimated additional 1,980 persons or an increase of 73.2 percent from 2000, followed by Asian, an estimated 1,200 persons or an increase of 135.4 percent from 2000 (USCB, 2011).

Table 2.2.8.5-3. Demographic Profile of the Population in the Crystal River Unit 3 Nuclear Generating Plant Region of Influence in 2009

	Citrus County	Percent
Total Population	**140,357**	--
Race (Not-Hispanic or Latino)		
White	125,442	89.4
Black or African American	4,696	3.3
American Indian and Alaska Native	353	0.3
Asian	2,086	1.5
Native Hawaiian and Other Pacific Islander	125	0.1
Some other race	594	0.4
Two or more races	1,099	0.8
Ethnicity		
Hispanic or Latino	5,962	4.2
Minority Population (including Hispanic or Latino ethnicity)		
Total minority population	**14,915**	**10.6**

Source: USCB, 2011

Transient Population

Within 50 mi (80 km) of CR-3, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services. In 2004, there were approximately 385 students attending colleges and universities within 50 mi (80 km) of CR-3 (NCES, 2009).

In 2000, 8.3 percent of all housing units in Citrus County were considered temporary housing for seasonal, recreational, or occasional use (USCB, 2009a). Table 2.2.8.5-4 provides information on seasonal housing within 50 mi (80 km) of CR-3.

Table 2.2.8.5-4. Seasonal Housing within 50 Miles (80 Kilometers) of Crystal River Unit 3 Nuclear Generating Plant, 2000

County[(a)]	Number of Housing Units	Vacant Housing Units for Seasonal, Recreational, or Occasional Use	Percent
Alachua	95,113	688	0.7
Citrus	62,204	5,192	8.3
Dixie	7,362	1,375	18.7
Gilchrist	5,906	384	6.5
Hernando	62,727	3,566	5.7
Lake	102,830	6,721	6.5
Levy	16,570	1,085	6.5
Marion	122,663	5,256	4.3
Pasco	173,717	14,915	8.6
Sumter	25,195	2,283	9.1
Total	**674,287**	**41,465**	**6.1**

(a) Counties within 50 mi (80 km) of CR-3 with at least one block group located within the 50-mi (80-km) radius

Source: USCB, 2009a

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 CR-3, 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 a significant amount of time in an area without being actual residents, migrant workers may not be included in the local census. If uncounted, these workers would be "underrepresented" in the U.S. Census Bureau (USCB) minority and low-income population counts.

The 2007 Census of Agriculture collected information on migrant farm and temporary labor. Table 2.2.8.5-5 provides information on migrant farm workers and temporary (less than 150 days) farm labor within 50 mi (80 km) of CR-3. According to 2007 Census of Agriculture estimates, Citrus County hosts relatively small numbers of migrant workers, with 594 temporary farm laborers employed on 82 farms in the county (USDA, 2009). The county with the most temporary farm workers within 50 mi (80 km) of CR-3 was Lake County with 2,251 workers on 223 farms.

Table 2.2.8.5-5. Migrant Farm Workers and Temporary Farm Labor within 50 Miles (80 Kilometers) of Crystal River Unit 3 Nuclear Generating Plant, 2007

County[(a)]	Number of Farm Workers Working for Less than 150 Days	Number of Farms Hiring Workers for Less than 150 Days	Number of Farms Reporting Migrant Farm Labor	Number of Farms with Hired Farm Labor
Alachua	2,158	186	20	234
Citrus	594	82	9	99
Dixie	67	21	4	27
Gilchrist	550	57	10	77
Hernando	270	100	13	133
Lake	2,251	223	39	321
Levy	374	123	12	174
Marion	1,543	483	34	732
Pasco	1,285	157	27	213
Sumter	563	126	12	154
Total	**9,655**	**1,558**	**180**	**2,164**

Source: USDA, 2009

(a) Counties within 50 mi (80 km) of CR-3, with at least one block group located within the 50-mi (80-km) 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 2008, the civilian labor force in Citrus County increased at an annual average rate of 3 percent to 52,822 (USDOL, 2009). In 2009, the educational services, health care, and social assistance industry employed the most people in Citrus County, followed by retail and arts, entertainment, recreation, accommodation, and food services industries (USCB, 2011). The largest employer in Citrus County in 2006 was the Citrus County School Board with 1,000 employees (Table 2.2.8.6-1). The majority of employment in Citrus County is located in the cities of Crystal River and Inverness.

Table 2.2.8.6-1. Major Employers in Citrus County in 2006

Firm	Number of Employees
Citrus County School Board	1,000
Florida Power Corporation	1,000
Citrus Memorial Hospital	1,000
Seven Rivers Community Hospital	500
Pro-Line Boats	250
Citrus County Sheriff's Department	250
Spring Lodge 378	100
Service Zone, Inc.	100
Citrus County Detention Facility	100
Cypress Creek Correctional Facility	100

Source: Enterprise Florida, 2009

Estimated income information for the CR-3 ROI is presented in Table 2.2.8.6-2. According to the American Community Survey 2009 estimates, median household and per capita income in Citrus County were both below the Florida average. In 2009, an estimated 15.8 percent of the population and 11 percent of families in Citrus County were living below the official poverty level, while the percentages for Florida as a whole were slightly lower at 14.9 and 10.7 percent, respectively (USCB, 2011).

Table 2.2.8.6-2. Income Information for Crystal River Unit 3 Nuclear Generating Plant, 2009

	Citrus County	Florida
Median household income (dollars)[a]	38,128	44,736
Per capita income (dollars)[a]	21,890	24,692
Percent of persons below the poverty level	15.8	14.9
Percent of families living below the poverty level	11.0	10.7

(a) In 2008 inflation-adjusted dollars

Source: USCB, 2011

Unemployment

According to the American Community Survey 2009 estimates, the annual unemployment average for Citrus County was 16.1 percent, which was higher than the annual unemployment average of 12.1 percent for Florida (USCB, 2011).

Taxes

The owners of CR-3 pay annual property taxes to Citrus County. From 2005 through 2008, Citrus County collected between $8.4 and $10.1 million annually in property tax revenues from CR-3 owners (See Table 2.2.8.6-3). Each year, Citrus County collects these taxes and disburses them to the Board of County Commissioners, the Citrus County School District, the

Southwest Florida Water Management District, the Citrus County Hospital Board, the Homosassa Special Water District, mosquito control, and the county's municipalities to fund their respective operating budgets (Progress Energy, 2009f). For the years 2005 through 2008, CR-3's property taxes have represented 4.6 to 5.3 percent of Citrus County's total property tax revenues.

Any changes in assessed valuation of plant property and equipment that may occur in the future could affect property tax payments to Citrus County and other jurisdictions in the county, including school districts. However, any changes to CR-3 property tax rates due to deregulation would be independent of license renewal.

Table 2.2.8.6-3. Citrus County Property Tax Revenues, 2005 to 2008, and Progress Energy Property Taxes, 2005 to 2008

Year	Citrus County Total Property Tax Revenues (in millions of dollars)	Property Taxes Paid by Progress Energy (in millions of dollars)	Progress Energy Property Tax as a Percentage of the Total County Tax Revenues
2005	160.9	8.4	5.2
2006	194.3	9.0	4.6
2007	198.8	10.1	5.1
2008	186.1	9.9	5.3

Sources: Progress Energy, 2009f; FDOR, 2010

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at the CR-3 site and in the surrounding area.

2.2.9.1 *Cultural Background*

The area in and around CR-3 has the potential for significant prehistoric and historic resources. Many sites (e.g., shell middens) have been recorded within the CREC (see Section 2.2.9.2) and surrounding vicinity. Human occupation in this region roughly follows a standard chronological sequence for prehistory in the southeastern United States, starting with the Paleoindian Period (12,000 years before present [B.P.] to 10,000 B.P.) and the Archaic Period (10,000 B.P. to 3,000 B.P.). The Archaic period is followed by periods of increased regional variation and cultural diversity, identified as the Middle and Late Prehistoric periods (3,000 to 1,000 B.P. and A.D. 1,000 to the time of European contact (circa 1600), respectively).

In general, the Paleoindian Period is characterized by highly mobile bands of hunters and gatherers, hunting both small game and now-extinct megafauna (e.g., mastodon, saber-tooth tiger, and camel), and gathering wild plants and shellfish. A typical Paleoindian site might consist of an isolated stone point or knife (of a style characteristic of the period) in an upland area near permanent fresh surface water. Less than 100 Paleoindian sites have been recorded in Florida (Milanich and Payne, 1993); many unrecorded sites undoubtedly exist but are: (1) submerged offshore on the continental shelf, (2) in wet areas, or (3) deeply buried. Sea level at that time was 197 to 328 ft (60 to 100 m) lower than today and current coastal areas would have been well inland from the coast and in upland areas (Milanich and Payne, 1993).

The Archaic Period represents a transition from a highly mobile existence to a more sedentary existence. It is a period of increased local resource exploitation (e.g., hunting deer, waterfowl, and small mammals; fishing and collecting shellfish and other aquatic resources; and gathering nuts and seeds), more advanced tool development, and increased complexity in social organization (including burials). The sea level was continuing to rise, so, similar to the Paleoindian sites, many Archaic sites are possibly submerged offshore. Approximately 1,500 Archaic sites have been recorded in Florida (Milanich and Payne, 1993).

The Middle and Late Prehistoric periods date in this area from roughly 2,500 B.P. to A.D. 1600. Approximately 300 sites from this period have been recorded in this region (Milanich and Payne, 1993). Many of the sites along the coast are linear shell middens, and almost all of them are actively eroding into the Gulf of Mexico due to the rising sea levels. These middens are an accumulation of shells and bone, including, but not limited to, oyster, clam, scallop, whelk, conch, crab shells and fish, turtle, and alligator bones, from either seasonal camps or village sites. Larger sites with circular middens on larger landforms, some of which are large mounds, are spaced with some regularity along the coast (every 3 to 6 mi [5 to 10 km]) and are thought to be associated with more permanent villages. Burial mounds are also associated with the larger sites, although isolated burials have also been found along the rivers and coastal areas (islands and mainland) (Milanich and Payne, 1993).

Much of what is known archaeologically for the region near the CREC is based on work that was completed in the early 1900s at the Crystal River Indian Mounds, located approximately 5 mi southwest of CR-3 at the mouth of the Crystal River. The site was occupied by Native Americans from approximately 500 B.P., until it was abandoned shortly before Spaniards arrived in the region in the 16th century. The mound complex is thought to be a ceremonial center or gathering place and is considered one of the most significant sites on the coast. Many of the other mound sites in the region have been destroyed by excavation and looting, including portions of this site, but the Crystal River Indian Mounds are receiving some protection. The site was purchased by the State of Florida in the mid-1960s. It was listed in the National Register of Historic Places (NRHP) in 1970 and was designated a National Historic Landmark in 1990. The site is managed and preserved as part of the 61-ac (25-ha) Crystal River Archaeological State Park (Florida State Parks, 2002).

The historic period begins with the arrival of Spanish conquistadors searching for precious metals. The first Spaniard recorded in the area is Panfilo de Narvaez, who, with an army of 300, proceeded north along the Gulf Coast looking for gold in 1528 (MacRae, 1993). He was followed by an expedition led by Hernando de Soto in 1539 that was looking for gold and silver. Neither expedition was successful. In 1559, Tristan de Luna y Arellano attempted to colonize the area and establish a settlement in Pensacola Bay; his attempt failed. Spain controlled the area from 1565 until 1763. England occupied the region between 1763 and 1784, but then lost control to the Spanish again until 1821. The United States reclaimed the area in 1821 (FDS, 2010a). U.S. settlement in the region began in places like Port Inglis and Red Level, and centered around phosphate mining, timber production, ranching, farming, and commerce (MacRae, 1993), (AEC, 1973).

Three Seminole wars took place in the region between 1817 and 1855. The first was initiated when President Andrew Jackson attacked the Seminoles in 1817, because the Seminoles enlisted with the British against the United States in a fight to control Florida, and would harbor escaped slaves from other southern States. The second war began in 1835 to enforce the Treaty of Payne’s Landing. This treaty required the Seminole Indians to give up their land and move west; however, many Seminoles refused to leave. Small battles between settlers and the

Seminoles are reported to have occurred within the vicinity of the CREC during this second war. The third war lasted from 1855 to 1858. This war occurred as a result of land disputes between the remaining Seminoles and settlers. By the end of the war, the Seminole population in Florida was reduced to approximately 200 (FDS, 2010b).

Despite few systematic surveys or formal excavations in the area, there are 195 recorded archaeological sites within a 6-mi (10-km) radius of the CREC site (New South Associates, 2006). Most of the sites (173) are associated with prehistoric cultures. Four of the sites are historic, including two homesteads, one shipwreck, and one fort. The affiliations of the remaining 18 sites are unspecified in the Florida Master Site File (New South Associates, 2006).

Eight properties are listed on the NRHP within Citrus County, but only two of them are within a 6-mi (10-km) radius of the CREC site. The two properties are the Crystal River Indian Mounds (as discussed above) and Mullet Key. Mullet Key is an historic island just south of the mouth of the Crystal River, where Fort De Soto County Park is located. Fort De Soto is a military post that was installed in 1898 to defend Tampa Bay during a U.S. conflict with Cuba. A mortar battery associated with the fort is the property listed on the NRHP. The battery housed eight 12-inch (30-cm) mortars (Pinellas County Parks and Recreation, 2010). In addition, three historic period cemeteries (dating from 1860 to 1925) are also recorded within the 6-mi (10-km) radius of the site (New South Associates, 2006).

2.2.9.2 *Historic and Archaeological Resources at the Crystal River Unit 3 Nuclear Generating Plant Site*

The CREC site encompasses approximately 4,738 ac (1,917 ha) of land. The undeveloped portions of the site (approximately 3,676 ac [1,488 ha]) consist primarily of salt marsh, hardwood hammock forest, pineland, and freshwater swamp. Approximately 1,062 ac (430 ha) of the site are developed or maintained. The developed or maintained areas include power production and support facilities, parking lots, roads, railroads, transmission corridors, and other related infrastructure. As discussed in Section 2.2.9.1, prehistoric shell middens and other site types, including mound sites, are known to have been situated within physiographic settings similar to portions of the CREC site.

In 1972, the U.S. Atomic Energy Commission (AEC) consulted with the Florida Division of Archives, History, and Records Management regarding the issuance of an operating license for CR-3. By letter dated March 30, 1972, the Florida Division of Archives, History, and Records Management stated that the coastal salt marshes were favorable to prehistoric occupation and the area had not been adequately surveyed. The letter recommended an intensive archaeological survey to facilitate the Division’s review of the project (Williams, 1972). The survey was conducted as recommended and resulted in the recordation of the 20 archaeological sites (Miller, 1973).

The survey focused on islands, coastal marshes, and streams north and south of the developed core of the CREC. Twenty archaeological sites were recorded (Miller, 1973). Of these 20 sites, 18 are prehistoric, 1 has prehistoric and historic components, and 1 is of unspecified affiliation; all are associated with shell middens. None of the sites were impacted during the construction of CR-3. A file search of the Florida Master Site File conducted through the Florida Division of Historical Resources in July 2009 indicated that these are the only recorded sites within the CREC.

There are no NRHP-listed properties on the CR-3 site. However, none of the 20 recorded archaeological sites on the CREC have been evaluated for listing on the NRHP. Therefore, all of these sites are considered potentially eligible for listing on the NRHP until a formal evaluation and determination of eligibility or non-eligibility has been made. In addition, one of the sites recorded in 1972, 8CI91, was considered at the time to be a rich shell midden that “should be preserved for future excavation,” and it was “recommended that the Division of Archives, History, and Records Management be notified if this site is to be disturbed in any manner” (Miller, 1973).

A search of the Florida Master Site File of recorded archaeological sites along the Lake Tarpon and Central Florida transmission lines found 63 recorded sites within the ROWs. The 72-mi (116-km) long Lake Tarpon line running generally south from the CREC has approximately 54 recorded sites within the ROW and 20 sites in close proximity. The 53-mi (85-km) long Central Florida line running generally eastward from the CREC has 9 recorded sites within the ROW and 12 additional sites in close proximity. Table 2.2.9.2-1 provides the site numbers of the sites recorded within the ROWs. Most of the sites located along the transmission line ROWs were determined to be not eligible for listing on the NRHP. However, nine sites have received no evaluation of eligibility according to the Florida Master Site File, and one site, 8CI00795 (the Etna Turpentine Camp Archaeological Site), was recently listed in the NRHP in December 2009. All recorded sites that have not been evaluated are considered potentially eligible for listing on the NRHP until a formal evaluation and determination of eligibility can be made.

Table 2.2.9.2-1. Historic and Archaeological Sites in the Crystal River Energy Complex Associated Transmission Lines

Site Name	NRHP Status	Site Name	NRHP Status
8PA00662	Not Eligible	8HE00347	Not Eligible
8PA00661	Not Eligible	8HE00244	Not Eligible
8PA00109	Not Eligible	8HE00349	Not Eligible
8PA00660	Not Eligible	8HE00346	Not Eligible
8PA00092	Not Eligible	8HE00345	Not Eligible
8PA00659	Not Eligible	8HE00344	Not Eligible
8PA00095	Not Eligible	8HE00343	Not Eligible
8PA00098	Not Eligible	8CI00799	Not Eligible
8PA00640	Not Eligible	8CI00798	Not Eligible
8PA00658	Not Eligible	8CI00797	Not Eligible
8PA00639	Not Eligible	8CI00796	Not Eligible
8PA00657	Not Eligible	8CI00795	Listed
8PA00638	Not Eligible	8CI00804	Not Eligible
8PA00418	Not Eligible	8CI00802	Not Eligible
8PA00417	Not Eligible	8CI00801	Not Eligible
8PA00433	Not Eligible	8CI00794	Not Eligible
8PA00033	Not Eligible	8CI00793	Not Eligible
8PA00436	Not Eligible	8CI01075	Not Eligible
8PA00435	Not Eligible	8CI00792	Not Eligible
8HE00364	Not Eligible	8CI00805	Not Eligible
8HE00356	Undetermined	8CI00800	Not Eligible
8HE00355	Not Eligible	8CI01039	Not Eligible
8HE00363	Not Eligible	8CI00977	Undetermined
8HE00362	Not Eligible	8MR01108	Undetermined
8HE00361	Not Eligible	8MR01910	Undetermined
8HE00358	Not Eligible	8MR01911	Undetermined
8HE00357	Not Eligible	8MR01912	Undetermined
8HE00351	Not Eligible	8SM00076	Undetermined
8HE00350	Not Eligible	8SM00130	Undetermined
8HE00404	Not Eligible	8SM00131	Undetermined
8HE00402	Not Eligible	8SM00093	Not Eligible
8HE00348	Not Eligible		

2.3 RELATED FEDERAL PROJECT ACTIVITIES AND CONSULTATIONS

The Staff reviewed the possibility that activities of other Federal agencies might impact the renewal of the operating license for CR-3. 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 CR-3 SEIS.

The Staff has determined that there are no Federal projects that would make it desirable for another Federal agency to become a cooperating agency in the preparation of the SEIS. Federal lands, facilities, national wildlife refuges, forests, and parks within 50 mi (80 km) of CR-3 are listed below.

<u>U.S. Fish and Wildlife Service Land</u>

- Cedar Keys National Wildlife Refuge
- Chassahowitzka National Wildlife Refuge
- Crystal River National Wildlife Refuge
- Lower Suwannee National Wildlife Refuge

<u>U.S. Forest Service Land</u>

- Ocala National Forest

The NRC is required under Section 102(2)(c) of the National Environmental Policy Act of 1969 (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 consultation correspondence and comments on the SEIS are presented in Appendix D.

2.3.1 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 National Oceanic and Atmospheric Administration's (NOAA's) 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. Federal consistency is the CZMA requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone must be consistent to the maximum extent practicable with the enforceable policies of a coastal State's Federally-approved coastal management program. The Federal consistency regulations implemented by the 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. The NOAA must approve each plan. One of the components of an approved plan is "enforceable policies," by which a State exerts control over coastal uses and resources (NOAA, 2011a), (NOAA, 2011b).

The NOAA approved the Florida Coastal Management Program in 1981. The program consists of 23 Florida statutes administered by eight State agencies and five water management districts. The FDEP is responsible for directing the implementation of the statewide coastal management program and maintains a Web site that describes the program (http://www.dep.state.fl.us/cmp/default.htm). Florida's coastal zone includes the entire State, but only coastal cities and counties which include or are contiguous to State water bodies are eligible to receive coastal management funds (NOAA, 2011c).

CR-3 is located in Citrus County and is subject to the rules and policies of Florida's Coastal Management Program, which administers the CZMA. License renewal requires a coastal zone consistency certification for States like Florida that are managed through the CZMA. For CR-3, CR-4, and CR-5, this certification is documented by the FDEP in Section XXV, "Coastal Zone Consistency," of Progress Energy Florida's Conditions of Certification (FDEP, 2010b).

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10 CFR Part 71. *Code of Federal Regulations*, Title 10, *Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

License renewal actions include refurbishment for the extended plant life. These actions may have an impact on the environment that requires evaluation, depending on the type of action and the plant-specific design. Environmental issues associated with refurbishment, which were determined to be Category 1 issues, are listed in Table 3-1.

The U.S. Nuclear Regulatory Commission (NRC) staff analyzed site-specific issues (Category 2) for Crystal River Unit 3 Nuclear Generating Plant (CR-3) and assigned them a significance level of SMALL, MODERATE, LARGE, or not applicable to CR-3 because of site characteristics or plant features. Section 1.4 in Chapter 1 explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE.

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B	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
Groundwater Use and Quality	
Impacts of refurbishment on groundwater 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

Environmental issues related to refurbishment considered in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC, 1996), (NRC, 1999) that are inconclusive for all plants, or for specific classes of plants, are Category 2 issues. Table 3-2 lists these issues.

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 archaeological resources	3.7.7	K
Environmental Justice		
Environmental justice[a]	Not addressed	Not addressed

(a) Guidance related to environmental justice was not in place at the time the NRC prepared the GEIS and the associated revision to 10 CFR Part 51. If an applicant plans to undertake refurbishment activities for license renewal, the applicant's environmental report and the NRC staff's environmental impact statement must address environmental justice.

The potential environmental effects of refurbishment actions are noted, and the analysis will be summarized within this section, if such actions are planned. The applicant stated in its environmental report (Progress Energy, 2008) that it has performed an evaluation of systems, structures, and components under Section 54.21 of Title 10 of the *Code of Federal Regulations* (10 CFR 54.21) to note the need to undertake any major refurbishment activities that are necessary to support continued operation of CR-3 during the requested 20-year period of extended operation. Table B.2 of the GEIS lists items that are subject to aging and might require refurbishment to support continued operation during the renewal period.

The results of the evaluation of systems, structures, and components for CR-3, as required by 10 CFR 54.21, noted steam generator replacement as a refurbishment activity. The environmental report contained an analysis of the potential impacts of this activity. However, after the submission of the environmental report but prior to the issuance of the new license, the steam generator replacement was completed as described in the environmental report. Since the applicant subsequently determined that this activity was necessary regardless of the outcome of the NRC's license renewal review, the NRC does not consider the steam generator replacement a refurbishment activity. In February 2009, the NRC issued a *Federal Register* notice which explained how National Environmental Policy Act (NEPA) obligations were fulfilled and that the steam generator replacement met the conditions for a categorical exclusion (NRC, 2009a). In May 2009, the NRC approved a license amendment which authorized the activity (NRC, 2009b). Subsequently, no further detailed analysis of the steam generator replacement is required in this supplemental environmental impact statement.

3.1 REFERENCES

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

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

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4.0 ENVIRONMENTAL IMPACTS OF OPERATION

This chapter addresses potential environmental impacts related to the period of extended operation of Crystal River Unit 3 Nuclear Generating Plant (CR-3). These impacts are grouped and presented according to resource. Generic issues (Category 1) rely on the analysis provided in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, prepared by the U.S. Nuclear Regulatory Commission (NRC) and are discussed briefly (NRC, 1996), (NRC, 1999). The NRC staff (Staff) analyzed site-specific issues (Category 2) for CR-3 and assigned them a significance level of SMALL, MODERATE, LARGE, or not applicable to CR-3 because of site characteristics or plant features. Section 1.4 in Chapter 1 explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE.

4.1 LAND USE

Onsite land use issues that could be affected by license renewal are listed in Table 4.1-1. As discussed in the GEIS, onsite land use and power line right-of-way (ROW) conditions are expected to remain unchanged during the license renewal term at all nuclear plants and thus impacts would be SMALL. These issues were, therefore, classified as Category 1 issues. Section 2.2.1 of this supplemental environmental impact statement (SEIS) describes the land use conditions at CR-3.

The NRC did not find any new and significant information that would change the conclusions presented in the GEIS during its review of the applicant's environmental report (ER) (Progress Energy, 2008a), the site visit, or the scoping process. Therefore, for these Category 1 issues, impacts during the renewal term are not expected to exceed those discussed in the GEIS.

Table 4.1-1. Land Use Issues. *Section 2.2.1 of this SEIS describes the land use around CR-3.*

Issues	GEIS Section	Category
Onsite land use	4.5.3	1
Power line right-of-way	4.5.3	1

4.2 AIR QUALITY

As discussed in Section 2.2.2.1, all of Florida, including Citrus County is currently in attainment for all National Ambient Air Quality Standards (NAAQS). CR-3 is located within the Crystal River Energy Complex (CREC) in Citrus County. In addition to the CR-3 nuclear reactor, the CREC includes four large coal-burning boilers, as well as facilities for the handling of coal, coal combustion residue (fly ash and bottom ash), and other waste materials related to the operation of pollution control devices. Because of those boilers, the CREC is considered to be a major source with respect to its potential to emit (PTE) greater than 100 tons/year of any criteria pollutant[1]. Consequently, all sources of criteria pollutant emissions at the CREC, including those associated exclusively with the operation of the nuclear reactor, are subject to a Title V operating permit, issued by the Florida Department of Environmental Protection (FDEP). The

[1] A major air pollution source is defined in Florida Administrative Code (FAC), Rule 62-212.400.

Title V permit (No. 0170004-024-AV) (FDEP, 2006a), issued on May 29, 2006, and renewed on December 28, 2009 (FDEP, 2009a), now addresses the operation of all stationary sources of criteria pollutants as well as portable sources such as portable emergency generators. While the majority of the sources addressed by the permit are associated with the coal-fired boilers at CREC, there are also 12 diesel-fueled reciprocating internal combustion engine (RICE) sources listed in the permit that are exclusive to CR-3 operation. All of these sources, either individually or collectively, have the potential for only minor impact on air quality either because of their small size or limited hours of operation. Table 4.2-1 provides critical parameters for the CR-3 RICE stationary sources.

Table 4.2-1. Internal Combustion Engine Stationary Sources of Criteria Pollutants Associated with the Operation of Crystal River Unit 3 Nuclear Generating Plant

Source	Design Heat Rating/Horsepower (hp)	Five-Year Maximum Annual Run Time (hour/year)
Diesel Emergency Generator EGDG 1A	3,500 kW/4,694 hp	38.1
Diesel Emergency Generator EGDG 1B	3,500 kW/4,694 hp	34.3
Diesel Emergency Generator EGDG 1C	3,500 kW/4,694 hp	49.5
Diesel Emergency Generator - Met-1	260 kW/349 hp	6
Diesel-Fired Pump	Data not provided	30
Diesel-Fired Pump	Data not provided	6
Diesel Emergency Generator - Security	30 kW/40 hp	70
Diesel Emergency Generator - SAB	125 kW/168 hp	47.5
Diesel-Driven Emergency Feed Pump EFP-3	1,670 hp	6.1
CR-3 Diesel Emergency Fire Pump FSP-2A	255 hp	7.2
CR-3 Diesel Emergency Fire Pump FSP-2B	255 hp	5.4
Diesel Driven Emergency Makeup Pump (B.5.b)	230 hp	20

kW = kilowatts

Source: CREC Operating Data Reciprocating Internal Combustion Engine Diesel Usage Summary Database, Progress Energy, 2009a

Each of the RICE sources listed in Table 4.2-1 is enrolled in a preventative maintenance program that calls for periodic inspection and operation, triggered by recurring work orders, to ensure operability. Records reviewed demonstrate that required preventative maintenance actions are completed in a timely way and problems are corrected promptly (Progress Energy, 2009b), (Progress Energy, 2009c), (Progress Energy, 2009d), (Progress Energy, 2009e), (Progress Energy, 2009f), (Progress Energy, 2009g), (Progress Energy, 2009h). Annual emission reports submitted by the applicant to the FDEP for the period 2004 through 2008 (Progress Energy, 2005a), (Progress Energy, 2006a), (Progress Energy, 2007a), (Progress Energy, 2008b), (Progress Energy, 2009i) report on the criteria pollutant emissions from each of the RICE sources. Table 4.2-2 shows the criteria pollutant emissions from two of the largest emergency generators.

Table 4.2-2. Criteria Pollutant Emissions from the Operation of 3,500-kW Emergency Generators Supporting Crystal River Unit 3 Nuclear Generating Plant Operation[a]

	Emissions in Tons/Year			
Year	**Carbon Monoxide**	**Particulate**	**Nitrogen Oxides**	**Sulfur Dioxide**
2004	1.004	0.118	3.781	0.597
2005	1.449	0.170	5.455	0.086
2006	0.933	0.110	3.512	0.055
2007	0.933	0.110	3.512	0.055
2008	0.987	0.116	3.714	0.059

(a) Depending on the year, totals represent the operation of two or three 3,500-kW generators.

Sources: Progress Energy, 2005a; Progress Energy, 2006a; Progress Energy, 2007a; Progress Energy, 2008b; Progress Energy, 2009i

In addition to RICE sources, the numerous cooling towers operating at the CREC are also sources of particulate emissions in the form of drift[2]. Heated seawater returned from heat exchangers of the steam cycles of all the CREC steam generators (fossil fuel CR-1, CR-2, CR-4, and CR-5 and nuclear reactor CR-3) is discharged to a common intake/discharge canal. Water is withdrawn from the canal and passed through as many as four mechanical draft helper cooling towers (collectively, emission Unit 13 in the Title V permit) and as many as four modular mechanical draft cooling towers (collectively, emission Unit 20 in the Title V permit) in sequence to the extent necessary to meet the thermal limits of the National Pollutant Discharge Elimination System (NPDES) permit applicable to seawater at its point of ultimate release from the intake/discharge canal[3]. Because of this configuration and extant operating protocols, air quality impacts from individual cooling tower operations cannot be exclusively attributed to the operation of CR-3. Annual reports of emissions submitted to FDEP for the years 2004 through 2008 (Progress Energy, 2005a), (Progress Energy, 2006a), (Progress Energy, 2007a), (Progress Energy, 2008b), (Progress Energy, 2009i) show that the hours of operation of the four helper cooling towers varied from a low of 2,331 hours in 2008 to a high of 3,265 hours in 2007, operating, on average, 30.5 percent of the time. Over the period 2006 through 2008, the modular cooling towers operated only 8.6 percent of the time[4]. In 2008, the helper cooling towers emitted 42.1 tons/year of particulate matter (PM), including 21 tons/year of particulate matter, 10 microns or less in diameter (PM_{10}), while the modular towers emitted 8.2 tons/year of PM, including 0.5 tons/year PM_{10} (Meyer, 2009). However, as noted above, cooling tower configuration prevents a precise determination of how much of those amounts were attributable exclusively to supporting the operation of CR-3 over those timeframes.

To accommodate increased heat rejection demands of CR-3 as a result of the 40-megawatt (MW) power uprate undertaken in the fall of 2009, the applicant is constructing an additional cooling tower on the south leg of the intake/discharge canal. Known as the south cooling tower

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2 The cooling towers act to cool heated seawater. Because the cooling towers are once-through systems, the seawater is not chemically treated for control of scale and biological organisms. Drift from the towers involves droplets of seawater which Florida rules define as particulate.

3 Two natural draft cooling towers are also operational on the CREC; however, they support coal-fired CR-4 and CR-5 exclusively and are not in any way associated with the other cooling towers discussed here or with the intake/discharge canal.

4 Modular cooling towers were installed in 2006. Operating hours will vary based on steam loads, as well as ambient temperature and humidity conditions. Modular towers are used only as needed to meet permit thermal limits.

(SCT), this new tower will have a cooling capacity greater than what is demanded by the CR-3 uprate. Because the SCT discharges into the canal at a point upstream of the existing towers, once it is operational (and all 18 cells are installed), the applicant anticipates being able to retire the helper towers and still meet the collective heat rejection demands of all the CREC steam cycles. The permit issued by the FDEP for the SCT (FDEP, 2009b) authorizes a maximum flow rate of 342,306 gallons per minute (gpm) and limits drift (with drift eliminators installed) to 0.0005 percent of the circulating water flow, representing a water consumption rate of 1.8×10^{11} gallons/year if the tower were to operate continuously. Based on a typical total dissolved solids (TDS) concentration of saltwater of 25,307 parts per million (ppm) and a saltwater density of 8.57 pounds/gallon (lb/gal) (64.2 pounds per cubic feet [lb/ft^3]), this equates to a maximum emission rate of 22.3 lb/hour or 97.9 tons/year of PM, of which 1.35 lb/hour or 5.9 tons/year is expected to be released as PM_{10}, based on all 18 cells installed and continuous operation (8,760 hours/year) (Golder Associates, Inc., 2007a). Although operating data are not yet available, it can be reasonably anticipated that the projected increase in particulate emissions of 97.9 tons/year will be offset by the reduction in emissions due to retirement of the helper towers (averaging 46.5 tons/year over the period 2004 through 2008) for a net projected annual particulate emission of 51.4 tons/year, notwithstanding additional minor contributions from the limited operation (expected to be no more than 10 percent of the time) of the modular towers.

Heating, ventilation, and air conditioning (HVAC) equipment as well as industrial chillers in service at CR-3 contain refrigerants, including R-11 (trichlorofluoromethane), R-22 (chlorodifluoromethane), and R-134a (1,1,1,2-tetraflouroethane). Depending on the refrigerant and the amount present, Federal regulations (40 CFR Part 82) applicable to ozone depleting compounds (ODC) apply to the operation and maintenance of this equipment. All refrigerant-containing equipment is enrolled in preventative maintenance programs to ensure their proper, uninterrupted operation and also to ensure that management of ODCs remains compliant with Federal regulations. Various written procedures outlining the preventative maintenance of this equipment (Progress Energy, 2009b), (Progress Energy, 2009c), (Progress Energy, 2009d) require regular inspections, guarantee proper management of refrigerants and compressor oils removed from the equipment, and require documentation adequate to demonstrate compliance with applicable regulations. Scheduled preventative maintenance events are directed by work order, as are service visits to correct reported malfunctions. Representative preventative maintenance logs reviewed by the Staff (Progress Energy, 2009e), (Progress Energy, 2009f) demonstrate that preventative maintenance procedures are being followed. All servicing is performed by properly certified Progress Energy employees.

Written procedures are also in place for preventative maintenance of meteorological instruments and for management of meteorological data (Progress Energy, 2009g), (Progress Energy, 2009h), (Progress Energy, 2009j). Procedures integrate instrument manufacturers' maintenance and calibration recommendations with relevant NRC regulations and FPC policies to ensure acceptable quality of meteorological data and adequate data capture frequencies. Procedures call for visual inspections of instruments, the tower and surrounding vicinity to identify and remove any potential interference to data quality, verification of proper instrument function, documentation of completion of required checks and calibrations, and resolution of identified problems. Procedures also prescribe notifications to key FPC personnel in the event of observed malfunctions so that alternative data capture procedures can be implemented until repairs are completed.

In late 2009, the applicant shut down CR-3 for a planned steam generator replacement refueling outage. The existing transportation infrastructure was sufficient to support delivery of the new steam generators. A temporary concrete batch plant was constructed on site to support the project. Air quality impacts included those related to operation of the concrete batch plant, those associated with operation of RICE in construction vehicles and equipment and in the privately owned vehicles of the commuting construction workforce, and potential emissions of wind-eroded particulate from disturbed land surfaces[5]. Air quality was also modestly impacted by a temporary increase in workforce traffic to support the steam generator replacement. Overall, steam generator replacement related impacts are minimal and will cease once the steam generator installation is complete. Subsequent operation of CR-3 will not result in new air impacts during the period covered by a license renewal.

CR-3 will also undergo a major extended power uprate (EPU). The EPU will be accomplished in two phases, the first began in the fall of 2009 and the second was planned to occur in 2011. The EPU will be completed within the term of the current license. Air impacts will result from the operation of RICEs in construction equipment and workforce vehicles, as well as from wind erosion on disturbed ground. The estimated impacts (Golder Associates, Inc., 2007b) are minimal and will occur over a very limited period of time, ceasing completely once the EPU action is completed. Subsequent operation of the uprated reactor will not result in increases to air impacts over those now occurring from reactor operation.

Finally, to ensure compliance with new Florida air pollution regulations such as the Clean Air Interstate rule (CAIR[6]), the applicant has undertaken major construction and modification projects for its two largest coal-fired boilers, CR-4 and CR-5. Under Florida regulations, such major modifications require the applicant to obtain permits to construct the new equipment and to apply for modifications to its Title V operating permit to accommodate operation of the newly installed equipment. Other actions such as the steam generator replacement involved the introduction of new air pollution sources which also required permit modifications. Although none of these actions directly impact the operation of CR-3, the minor stationary sources of criteria pollutants associated with CR-3 are listed in a common Title V permit that addresses the entirety of operations at the CREC. Therefore, the applicant's compliance with FDEP administrative requirements relating to permitting of new or modified air pollution sources is critical to retention of its Title V permit which is essential to the continued safe operation of CR-3. Consequently, the Staff reviewed the administrative record to determine whether the applicant has met its compliance obligations with respect to construction and modification projects at CREC. In addition to the Title V permit (FDEP, 2006a) and the construction permit for the SCT (FDEP, 2009a) referenced above, the applicant has applied for and received the following necessary permits for construction or modifications of conditions of certification: helper cooling towers for CR-1, CR-2, and CR-3 (ARMS Permit No. 0170004-010-AC) (FDEP, 2006b); installation of low-nitrogen oxide (NO_x) burners; selective catalytic reduction equipment; flue gas desulfurization equipment for coal-fired CR-4 and CR-5; construction of one 550-foot

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[5] In October 2009, FPC discovered delamination in the containment building wall. Following repairs, additional delaminated concrete was discovered in March 2011. As a result, further changes to the scope and timing of the repairs will be necessary.

[6] The U.S. Environmental Protection Agency (EPA) promulgated the final CAIR on March 10, 2005. The rule was vacated by the Circuit Court for the District of Columbia Court of Appeals on July 11, 2008, but reinstated by the Court for an indefinite period of time on December 23, 2008; however, the EPA is required to make major revisions to the rule to address what the Court identified as fatal flaws in its construction. The FDEP adopted the CAIR implementation regulations at FAC, Rule 62-296.470 and associated definitions at FAC, Rule 62-210.200. In addition, the FDEP issued an administrative order in July 2007 providing annual and ozone-season CAIR NO_x allowance allocations for each source in Florida subject to CAIR for control periods 2009 through 2012.

(ft) exhaust stack (Air Permit No. PSD-FL-383) (FDEP, 2007a); and air construction permits for modifications to CR-4 and CR-5 (Permit No. 0170004-014-AC and final Title V permit 0170004-015-AV modifications to conditions of certification) (FDEP, 2007b). In addition, the applicant has made timely notice to the FDEP for modifications to its Title V permit involving the introduction of an insignificant source (the concrete batch plant) needed to support its steam generator replacement (Progress Energy, 2009k[7]).

Table 4.2-3 lists the air quality issue applicable to CR-3. The Staff did not identify any Category 2 issues for air quality. The Staff also did not identify any new and significant information regarding Category 1 issues during the review of the applicant's ER (Progress, Energy, 2008a), the site visit, or during the scoping process or review of public comments. A review of the administrative record finds the applicant to be in good standing with respect to the Title V operating permit that authorizes the continued operation of the stationary sources of criteria pollutants on the CREC, including those minor sources that are critical to the safe operation of CR-3. This conclusion is consistent with the findings of the State's Power Plant Siting Authority which affirmed the applicant's compliance with local and State regulations at the time of the CREC certification in August 2008 (Florida Siting Board, 2008).[8] Therefore, for plant operation during the license renewal term, there are no air quality impacts beyond those discussed in the GEIS. For these issues, the NRC concludes in the GEIS that the impacts are SMALL.

Table 4.2-3. Other Air Quality Issues Associated with Continued Operation of Crystal River Unit 3 Nuclear Generating Plant

Issue	GEIS Section	Category
Air quality effects of transmission lines	4.5.2	1

4.3 GROUNDWATER

The Category 1 and Category 2 groundwater issues applicable to the CREC are listed in Table 4.3-1 and discussed below. An overview of groundwater use and quality at the CREC is provided in Section 2.1.7.

Table 4.3-1. Groundwater Use and Quality Issues

Issue	GEIS Sections	Category
Impacts of refurbishment on groundwater use and quality	3.4.2	1
Groundwater use conflicts (potable and service water, and dewatering plants that use >100 gpm)	4.8.1.1	2
Groundwater quality degradation (saltwater intrusion)	4.8.2	1

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[7] Under Florida regulations, Title V permit modifications are not required to accommodate the introduction of an insignificant source. Instead, a timely notice of the intent to install such a source must be made and the appendix to the Title V permit that provides an inventory of all insignificant sources will be modified at the next scheduled revision date for that inventory.

[8] The CREC was already in existence when the State's requirement that power plant sites be certified went into effect. However, the decision to uprate CR-3 was considered a major modification that triggered the applicability of the power plant certification requirement.

4.3.1 Generic Groundwater Issues

A brief description of the Staff's review and the GEIS conclusions, as codified in Title 10 of the *Code of Federal Regulations*, Part 51 (10 CFR Part 51), Table B-1, follows:

- Impacts of refurbishment on groundwater use and quality. Based on information in the GEIS, the Commission concluded that refurbishment would not affect groundwater use and quality because no liquid wastes would be discharged to groundwater and deep excavations and site dewatering (which could induce saltwater intrusion) would not be required.

- Groundwater quality degradation (saltwater intrusion). Based on information in the GEIS, the Commission concluded that groundwater quality degradation due to saltwater intrusion would not occur as a result of plant operations because groundwater withdrawals represent less than 10 percent of the regional total (in rural Citrus County).

The Staff did not identify any new and significant information regarding Category 1 issues during the review of the applicant's ER (Progress Energy, 2008a), the site visit, or during the scoping process or review of public comments. The Staff also evaluated and reviewed the plant's various industrial wastewater permits, the Conditions of Certification, solid waste management plan, and monitoring reports. Therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS. For these Category 1 issues, the NRC concludes in the GEIS that the impacts are SMALL.

Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, require additional plant-specific review. Category 2 issues related to groundwater use that are applicable to the CREC during the renewal term are discussed in the section that follows.

4.3.2 Groundwater Use Conflicts (plants using greater than 100 gallons per minute)

For power plants that pump more than 100 gpm (379 liters per minute [L/min]) of groundwater from onsite wells, groundwater use conflicts with nearby groundwater users are considered a Category 2 issue that requires a plant-specific assessment before license renewal.

Although the CREC currently maintains 14 onsite production wells completed in the Upper Floridan aquifer (Table 2.1.7-1), CR-3 draws its water only from the south treatment plant, which is supplied by three wells: SPW-3, SPW-4, and SPW-5. The average annual pump rate for these wells from 2001 through 2009 was 504 gpm (0.73 million gallons per day [mgpd]). This rate is well below the 1 mgpd authorized by the Southwest Florida Water Management District (SFWMD) water use permit (SFWMD, 2007)[9].

The SFWMD (2009) estimates that the rate of groundwater withdrawals by public supply, self-supply, recreational, agricultural, mining, and industrial/commercial users in Citrus County was 27.764 gpd in 2008. Assuming the highest average annual pump rate of 585 gpm

[9] As shown in Table 2.1.7-1, the 1 mgpd authorized by the SFWMD water use permit applies to the three wells (SPW-3, SPW-4, and SPW-5) that supply the south treatment plant and one well (PW-1A/B) that supplies water for ash processes (SFWMD, 2007).

(0.84 mgpd), reported for the south treatment plant in 2008, the south treatment plant uses as much as 3 percent of the total groundwater consumed in Citrus County. Because the wells supplying the south treatment plant pump groundwater at rates well below the authorized water right and CR-3 uses only a portion of the water from the south treatment plant (about 49 percent [Johnson, 2006]), the Staff concludes that impacts due to groundwater use conflicts would be SMALL and no additional mitigation is warranted.

4.4 SURFACE WATER

4.4.1 Generic Surface Water Issues

The Category 1 surface water quality issues applicable to the CREC are listed in Table 4.4-1 and discussed below. An overview of surface water use and quality at the CREC is provided in Section 2.1.7. None of the Category 2 issues set forth in the GEIS apply to the CREC.

Table 4.4-1. Surface Water Quality Issues

Issue	GEIS Sections	Category
Impacts of refurbishment on surface water quality	3.4.1	1
Impacts of refurbishment on surface water use	3.4.1	1
Altered current patterns at intake and discharge structures	4.2.1.2.1	1
Altered salinity gradients	4.2.1.2.2	1
Temperature effects on sediment transport capacity	4.2.1.2.3	1
Scouring caused by discharged cooling water	4.2.1.2.3	1
Eutrophication	4.2.1.2.3	1
Discharge of chlorine or other biocides	4.2.1.2.4	1
Discharge of other metals in waste water	4.2.1.2.4	1
Water use conflicts (plants with once-through cooling systems)	4.2.1.3	1

A brief description of the Staff's review and the GEIS conclusions, as codified in 10 CFR Part 51, Table B-1, follows:

- Impacts of refurbishment on surface water quality. Based on information in the GEIS, the Commission concluded that the potential impacts of refurbishment on surface water quality would be small for all plants and could, if needed, be further reduced by additional mitigation measures such as more stringent construction control practices.

- Impacts of refurbishment on surface water use. Based on information in the GEIS, the Commission concluded that increases in water consumption during refurbishment would be of small significance.

- Altered current patterns at intake and discharge structures. Based on information in the GEIS, the Commission concluded that altered current patterns at intake and discharge structures would be localized and of small significance.

- Altered salinity gradients. Based on information in the GEIS, the Commission concluded that alterations in salinity gradients would be localized and of small significance.

- Temperature effects on sediment transport capacity. Based on information in the GEIS, the Commission found no indication that increased temperature (and the resulting decreased viscosity of water) caused changes in sediment transport capacity to a significant extent. Altered sediment transport processes are likely the result of structures such as jetties and canals or current patterns near intakes and discharges and are readily mitigated.

- Scouring caused by discharged cooling water. Based on information in the GEIS, the Commission found that sediment scouring due to cooling water discharges has not been a problem at most power plants and that where it occurs, it is localized and of small significance.

- Eutrophication. Based on information in the GEIS, the Commission found that power plant-induced eutrophication has not been a problem at most power plants and that where it occurs, it is localized and of small significance.

- Discharge of chlorine or other biocides. Based on information in the GEIS, the Commission found that chlorine and other biocides are regulated by the NPDES permit of each power plant and that due to their toxic effects, many power plants have reduced or eliminated their usage. It concluded that the water quality effects of discharge of chlorine and other biocides are of small significance for all power plants as long as water quality criteria such as those set in NPDES permits are not violated.

- Discharge of other metals in waste water. Based on information in the GEIS, the Commission found that concentrations of discharged metals are regulated by the NPDES permit of each power plant and that due to their toxic effects, States may develop their own control strategies. It concluded that potential impacts of heavy metal discharges are of small significance for all power plants as long as water quality criteria such as those set in NPDES permits are not violated.

- Water use conflicts (plants with once-through cooling systems). Based on information in the GEIS, the Commission concluded that impacts of power plant water use are of small significance because net consumption is negligible compared with the size of the body of water used.

The Staff did not identify any new and significant information during its review of the applicant's ER (Progress Energy, 2008a), the site visit, or the scoping process. The Staff also evaluated and reviewed the plant's various industrial wastewater permits, the Conditions of Certification, solid waste management plan, and monitoring reports. Therefore, for plant operation during the license renewal term, there are no surface water impacts beyond those discussed in the GEIS. For these issues, the NRC concludes in the GEIS that the impacts are SMALL.

4.5 AQUATIC RESOURCES

Section 2.1.6 of this SEIS describes the CR-3 cooling water system; Section 2.2.5 describes the aquatic resources. The following discussion addresses the Category 1 and Category 2 issues related to aquatic resources applicable to CR-3 (Table 4.5-1).

Table 4.5-1. Aquatic Resources Issues

Issues	GEIS Sections	Category
For All Plants		
Accumulation of contaminants in sediments or biota	4.2.1.2.4	1
Entrainment of phytoplankton and zooplankton	4.2.2.1.1	1
Cold shock	4.2.2.1.5	1
Thermal plume barrier to migrating fish	4.2.2.1.6	1
Distribution of aquatic organisms	4.2.2.1.6	1
Premature emergence of aquatic insects	4.2.2.1.7	1
Gas supersaturation (gas bubble disease)	4.2.2.1.8	1
Low dissolved oxygen in the discharge	4.2.2.1.9	1
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10	1
Stimulation of nuisance organisms	4.2.2.1.11	1
For Plants with Cooling-Tower-Based Heat Dissipation Systems		
Entrainment of fish and shellfish in early life stages	4.3.3	1
Impingement of fish and shellfish	4.3.3	1
Heat shock	4.3.3	1
For Plants with Once-Through and Cooling Pond Heat Dissipation Systems		
Entrainment of fish and shellfish in early life stages	4.1.2	2
Impingement of fish and shellfish	4.1.3	2
Heat shock	4.1.4	2

4.5.1 Generic Aquatic Resources Issues

The NRC did not find any new and significant information during the environmental review regarding these Category 1 issues. Therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS for these Category 1 issues, and the NRC concludes in the GEIS that the impacts are SMALL.

4.5.2 Entrainment

For power plants with once-through cooling systems, such as CR-3, the entrainment of fish and shellfish in early life stages by nuclear power plant cooling systems is a site-specific, or Category 2, issue and requires a site-specific assessment for the license renewal review. Entrained organisms include ichthyoplankton (fish eggs and larvae), eggs and larval stages of shellfish and other macroinvertebrates, and all life stages of zooplankton and phytoplankton. During transport through the cooling system, entrained organisms experience thermal stress, mechanical and hydraulic forces, and exposure to chemical contaminants. While some entrainment survival may occur in once-through cooling systems, an estimate of 100 percent mortality of entrained organisms is normally assumed (EPA, 2004), (NRC, 1999b).

To perform the entrainment assessment for CR-3, the Staff reviewed the applicant's ER (Progress Energy, 2008a), related documents, entrainment studies conducted at CR-3 (SWEC, 1985), and visited the CREC site. The Staff also reviewed the applicant's NPDES permit; documents related to the planned EPU for CR-3; and scientific articles, documents, technical reports, and compilations associated with the Crystal Bay area and with entrainment impacts. The Staff notes that the applicant's NPDES permit (No. FL0000159) was issued on May 9, 2005, with an expiration date of May 8, 2010 (FDEP, 2005a). The applicant submitted an application for renewal of its NPDES permit on October 28, 2009 (Progress Energy, 2009l). Since the applicant applied for its permit on time, the existing NPDES permit remains in effect until issuance of a new NPDES permit.

Entrainment

Entrainment is the incorporation of all life stages of fish and shellfish with intake water flow entering and passing through a cooling-water intake structure and into a cooling water system (40 CFR § 125.83).

On July 9, 2004, the U.S. Environmental Protection Agency (EPA) published a final rule in the *Federal Register* (EPA, 2004) that addressed cooling water intake structures at existing plants, such as CR-3, where flow levels exceeded a minimum threshold value of 50 mgpd. The rule was Phase II in the EPA's development of Clean Water Act (CWA) 316(b) regulations that were to establish national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that exceeded the threshold value for water withdrawals. The national requirements, implemented through the NPDES permitting process, would minimize the adverse environmental impacts associated with the continued use of the intake systems. Section 316(b) of the CWA requires that the location, design, construction, and capacity of the cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts (Title 33, Section 1326, of the *United States Code* [33 U.S.C. § 1326]).

Under the Phase II rule, licensees would have been required to demonstrate compliance with the Phase II performance standards at the time of renewal of their NPDES permit. As part of the NPDES permit renewal, licensees may have been required to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigative measures to comply with this regulation. The new performance standards were designed to significantly reduce environmental losses due to water withdrawals associated with cooling water intake structures used for power production. Any additional site-specific mitigation required as a result of the 316(b) Phase II reviews would result in less impact from entrainment during the license renewal period. On March 20, 2007, the EPA issued a memorandum informing its Regional Administrators that they should consider the Phase II rule suspended (EPA, 2007a). Effective July 9, 2007, the EPA suspended the Phase II rule (EPA, 2007b). As a result, all NPDES permits for Phase II facilities should include conditions under Section 316(b) of the CWA developed on a best professional judgment basis, rather than the best technology available. Any site-specific mitigation required under the NPDES permitting process would result in a reduction in the impacts of continued plant operations.

Entrainment at the CREC is limited to those organisms that can pass through the 3/8-inch (1-centimeter [cm]) mesh intake screens and are a function of the volume of water withdrawn from the intake canal that is connected to Crystal Bay. Water intake for the CREC is 310,000 gpm (690 cubic feet per second [cfs] or 19.6 cubic meters per second [m^3/s]) for CR-1, 328,000 gpm (731 cfs or 20.7 m^3/s) for CR-2, and 680,000 gpm (1,515 cfs or 42.9 m^3/s) for CR-3 (NUS Corporation, 1978).

Adults and other stages of small planktonic invertebrates (e.g., copepods) and phytoplankton (e.g., diatoms) are generally not sampled in entrainment studies due to their small size and the assumption that their large population sizes and rapid growth and reproduction make ecologically important impacts (e.g., population loss or alteration of community structure) unlikely (York et al., 2005). Nevertheless, prior to CR-3 becoming operational, Fox and Moyer (1973) and Alden (1976) determined entrainment survival of phytoplankton and zooplankton at the CREC.

Fox and Moyer (1973) observed that phytoplankton were either killed or at least hindered in their ability to assimilate carbon due to passage through the CREC; whereas, bacteria survive the passage and even increased in numbers due to prolonged exposure to increased heat. Primary production decreased 13.8 to 48.1 percent from passage through the CREC when the intake temperature was 80.6 °F (27 °C) or higher. In summary, if the intake temperature is 80.6 °F (27 °C) or more, there is a loss of primary production by a temperature increase of 9 °F (5 °C). Fox and Moyer (1973) concluded that as long as the temperature remains above 89.6 °F (32 °C), primary production will continue to drop. However, Fox and Moyer (1973) noted that phytoplankton recovery was rapid; primary production values reached or exceeded those recorded at the intake water within 1 mile (mi) from the plant discharge (i.e., recovery would occur within the discharge canal).

Alden (1976) analyzed the growth, reproduction, and survival of copepods subject to entrainment at the CREC and the associated thermal stress on copepods of the Crystal River estuary. Mortality was generally low for temperatures below 86 °F (30 °C), moderate at 87.8 °F to 95 °F (31 °C to 35 °C), and increased exponentially between 95 °F and 98.6 °F (35 °C and 37 °C). He noted that entrained juvenile copepods and juveniles collected from the discharge canal showed depressed growth and reproduction rates compared to copepods collected from the intake canal. Alden (1976) concluded that mechanical damage from condenser passage accounted for only a small percentage of the mortality, but may be the major lethal factor during colder months. Alden (1976) observed that the long-term survival of copepods that did survive entrainment was not significantly different from control populations.

The only study conducted at CREC to determine potential entrainment effects on fish and shellfish is that done as part of the 316 Demonstration study (SWEC, 1985). Ichthyoplankton and other meroplankton collections occurred at 15 locations over a 15-month period from 1983 through 1984. The sample locations included sites within the intake and discharge canals, as well as sites located offshore in Crystal Bay. To determine entrainment at the CREC, SWEC (1985) first used the highest meroplankton densities determined from the intake or discharge canal sample locations to obtain a conservative estimate of the number of organisms per m^3 of water. SWEC (1985) then multiplied this value by how many m^3 of water the CREC withdrew to obtain the number of organisms entrained.

SWEC (1985) observed the highest densities of fish eggs in April and May and the highest invertebrate meroplankton densities in July and August. As determined by SWEC (1985), Table 4.5-2 presents the annual entrainment and equivalent adult loss for the selected representative species described in Section 2.2.5. Among these species, the most entrained finfish was the bay anchovy (*Anchoa mitchilli*). Annual entrainment totaled over 14.5 billion eggs, prolarvae, post-larvae, and juveniles. The equivalent adult loss was about 32.4 million bay anchovies. Invertebrate entrainment included about 3.35 billion Florida stone crab

(*Menippe mercenaria*) zoea and megalops (SWEC, 1985). The equivalent adult loss was about 3,642 Florida stone crabs.

Table 4.5-2. Estimated Annual Entrainment and Equivalent Adult Loss of Selected Representative Species at the Crystal River Energy Complex

Species	Life Stage	Total Entrainment	Equivalent Adult Loss[a]
Bay anchovy (*Anchoa mitchilli*)[b]	Eggs	11,674,000,000	10,400,000
	Prolarvae	960,400,000	940,000
	Post-larvae	1,774,600,000	17,300,000
	Juveniles	154,600,000	3,800,000
Pigfish (*Orthopristis chrysoptera*)[c]	Eggs	433,500,000	40,000
	Post-larvae	760,000	76,000
Pinfish (*Lagodon rhomboides*)	Post-larvae	16,690,000	37,000
	Juveniles	2,150,000	47,000
Polka-dot batfish (*Ogocephalus radiatus*)	Juveniles	190,000	19,000
Red drum (*Sciaenops ocellatus*)	Post-larvae	300,000	18
Silver perch (*Bairdiella chrysoura*)	Prolarvae	80,000	2
	Postlarvae	21,640,000	6,000
	Juveniles	220,000	600
Spot (*Leiostomus xanthurus*)[d]	Eggs	1,102,000,000	27,500
	Prolarvae	14,630,000	360
	Post-larvae	12,280,000	280,000
	Juveniles	1,730,000	410,000
Spotted seatrout (*Cynoscion nebulosus*)	Post-larvae	6,500,000	900
Striped mullet (*Mugil cephalus*)[e]	Post-larvae	57,000	95
	Juveniles	3,500,000	5,800
Blue crab (*Callinectes sapidus*)[f]	Megalops	35,190,000	202
Brief squid (*Lolliguncula brevis*)	All	910,000	3,600
Florida stone crab (*Menippe mercenaria*)	Zoeal stage 1	3,029,430,000	3,297
	Zoeal stage 2	254,630,000	6
	Zoeal stage 3	52,010,000	15
	Zoeal stage 4	14,840,000	6
	Zoeal stage 5	380,000	5
	Megalops	2,350,000	313
Pink shrimp (*Farfantepenaeus duorarum*)[g]	Mysis	220,000	22
	Post-larvae	18,830,000	18,830
	Juveniles	1,023,000	10,230

(a) A 10 percent survival between development stages was assumed where data on survivorship was not known.
(b) Includes some prolarvae and post-larvae identified only to genus.
(c) All entrained Haemulidae eggs were assumed to be pigfish.
(d) All Sciaenidae eggs and prolarvae were assumed to be spot.
(e) All entrained Mugillidae post-larvae and juveniles were assumed to be striped mullet.
(f) Includes some megalops identified only to genus.
(g) All entrained penaeid shrimp were assumed to be pink shrimp.
Source: SWEC, 1985

SWEC (1985) concluded that entrainment only had a localized effect on fish and invertebrates of Crystal Bay, with populations concentrated offshore and in the northwest section of the Crystal Bay study area less affected by entrainment. An EPA fact sheet on the CREC NPDES permit prepared in 1993 (as cited in Golder Associates, Inc., 2006) stated that the results of the 316 Demonstration study (SWEC, 1985) showed that entrainment at the CREC has an adverse impact to the aquatic resources of Crystal Bay. The applicant and the EPA determined that a combination of seasonal flow reduction and stock enhancement through rearing and stocking of commercially and recreationally important species would be the most prudent methods to mitigate entrainment losses (Progress Energy, 2008a). Flow reductions at the CREC began in 1992; the NPDES permit for the CREC (CR-1 through CR-3) stipulated that cooling water withdrawals would be limited to 1,318,000 gpm over the period May 1 through October 31 and 1,132,792 gpm from November 1 through April 30 (Progress Energy, 2008a). The 15 percent withdrawal reduction from November 1 through April 30 minimizes impacts to fall, winter, and early spring spawners including pinfish (*Lagodon rhomboides*), Atlantic croaker (*Micropogonias undulates*), Gulf flounder (*Paralichthys albigutta*), Gulf menhaden (*Brevoortia patronus*), striped mullet (*Mugil cephalus*), and spot (*Leiostomus xanthurus*) (Golder Associates, Inc., 2007b). The flow reductions at the CREC began in 1992. Golder Associates (2006) determined that the hydraulic zone of influence (that portion of Crystal Bay hydraulically influenced by the intake within which very weakly motile or planktonic organisms are possibly influenced by the induced flow and, therefore, most likely to be entrained) is up to 197 acres (ac) (79.7 hectares [ha]) when the maximum intake flow is 1,318,000 gpm (2,937 cfs or 83.2 m^3/s) (May 1 through October 31) and up to 142 ac (57.5 ha) when the maximum intake flow is 1,132,792 gpm (2,524 cfs or 71.5 m^3/s) (November 1 through April 30) (Golder Associates, Inc., 2006). The acreages assume an ambient mean velocity in the Bay of 0.1 ft/s (0.03 m/s); as ambient velocities increase, the hydraulic zone of influence would decrease (Golder Associates, Inc., 2006).

The logic behind fish stocking is that releasing a large number of larvae, juvenile, or adult fish or shellfish into a water body may directly compensate for the mortality associated with impingement and entrainment (EPRI, 2003). As part of the negotiated settlement with the EPA to mitigate impacts of the CREC once-through cooling system, Florida Power Corporation (FPC) opened the Crystal River Mariculture Center in 1991 (FWC, undated). Initial cultures included red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), striped mullet, and pink shrimp (*Farfantepenaeus duorarum*). Subsequent species cultured at the Mariculture Center included pigfish (*Orthopristis chrysoptera*), silver perch (*Bairdiella chrysoura*), blue crab, and Florida stone crab. To date, Mariculture Center releases of pigfish to Crystal Bay have not occurred. Total releases made from 1992 through 2009 for the other seven species are as follows (Progress Energy, 2010a):

Mariculture

Mariculture is the farming and husbandry of marine plants and animals to replenish natural populations of marine biota depleted by natural or man-made effects (FWC, undated).

- Red drum – 947,394 fingerlings and 1,375,500 larvae
- Silver perch – 39,942 first feeding larvae
- Spotted seatrout - 1,131,813 fingerlings and 715,000 larvae

- Striped mullet – 525,000 first feeding larvae
- Blue crab – 93,746,281 zoeal stage I
- Pink shrimp – 415,102
- Stone crab – 32,347,962 zoeal stage I

Releases of fish and shellfish produced at the Mariculture Center occur in areas of the Gulf for which they are best suited, based on time of year and water quality conditions (Progress Energy, 2008a).

As discussed in Section 2.1.6, Phase II of the planned CR-3 EPU should not alter the volume of water withdrawn at the entrance of the intake canal. Therefore, an increase in the number of organisms entrained at CR-3 due to the EPU is not expected. Annual entrainment losses will continue at CR-3 during the license renewal term; with numbers of fish and shellfish entrained expected to be in the billions of organisms with equivalent adult losses in the millions, as observed by SWEC (1985). Nevertheless, studies conducted near the CREC since the late 1960s (Mountain, 1972), (Grimes and Mountain, 1971), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009) indicate that Crystal Bay near the CREC has maintained a diverse assemblage of fish and shellfish species.

Based on the review of the information presented above, coupled with the paucity of entrainment studies at the CREC, the Staff has determined that the potential impacts of entrainment of fish and shellfish by CR-3 on the Crystal Bay aquatic community during the 20-year renewal period would be SMALL to MODERATE. Under the provisions of the CWA 316(b), the FDEP may impose further restrictions or require modifications to the cooling system to reduce the impact of entrainment under the NPDES permitting process. The Site Certification Application for the Levy Nuclear Plant (LNP) was approved by the Governor’s Siting Board on August 11, 2009, and includes a requirement that the applicant shut down CR-1 and CR-2 by the end of 2020 (or by the end of the year when LNP begins operation) (Progress Energy, 2009m). This will lessen entrainment impacts to Crystal Bay due to CREC operations.

4.5.3 Impingement

For power plants with once-through cooling systems, such as CR-3, the impingement of fish and shellfish in early life stages by nuclear power plant cooling systems is a Category 2 issue that requires a site-specific assessment for license renewal review. Impinged organisms at CR-3 include fish and shellfish. Impingement of sea turtles also occurs on the trash (bar) racks and, more rarely, intake screens at the CREC (see Section 4.7.1). Impingement can kill organisms due to starvation and exhaustion, suffocation, injury, or exposure to air (e.g., during the rotation of the intake screens for cleaning). The potential for injury or death relates to how long an organism is on the intake screen, its susceptibility to injury, and the physical characteristics of the screen washing and, if used, the fish return system at the facility.

Impingement

Impingement is the entrapment of all life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of water withdrawal (40 CFR § 125.83).

To perform the impingement assessment for CR-3, the Staff reviewed the applicant's ER (Progress Energy, 2008a), related documents, impingement studies conducted at CR-3 (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), and visited the CREC site. The Staff also reviewed the applicant's NPDES permit; documents related to the planned EPU for CR-3; and scientific articles, documents, technical reports, and compilations associated with the Crystal Bay area and with impingement impacts. The Staff notes that the applicant's NPDES permit (No. FL0000159) was issued on May 9, 2005, with an expiration date of May 8, 2010 (FDEP, 2005a). The applicant submitted an application for renewal of its NPDES permit on October 28, 2009 (Progress Energy, 2009l). Since the applicant applied for its permit on time, the existing NPDES permit remains in effect until issuance of a new NPDES permit.

On July 9, 2004, the EPA published a final rule in the *Federal Register* (EPA, 2004) that addressed cooling water intake structures at existing plants, such as CR-3, where flow levels exceeded a minimum threshold value of 50 mgpd. The rule was Phase II in the EPA's development of CWA 316(b) regulations that were to establish national requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that exceeded the threshold value for water withdrawals. The national requirements, implemented through the NPDES permitting process, would minimize the adverse environmental impacts associated with the continued use of the intake systems. Section 316(b) of the CWA requires that the location, design, construction, and capacity of the cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts (33 U.S.C. § 1326).

Under the Phase II rule, licensees would have been required to demonstrate compliance with the Phase II performance standards at the time of renewal of their NPDES permit. As part of the NPDES permit renewal, licensees may have been required to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigative measures to comply with this regulation. The new performance standards were designed to significantly reduce environmental losses due to water withdrawals associated with cooling water intake structures used for power production. Any additional site-specific mitigation required as a result of the 316(b) Phase II reviews would result in less impact from impingement during the license renewal period. On March 20, 2007, the EPA issued a memorandum informing its Regional Administrators that they should consider the Phase II rule suspended (EPA, 2007a). Effective July 9, 2007, the EPA suspended the Phase II rule (EPA, 2007b). As a result, all NPDES permits for Phase II facilities should include conditions under Section 316(b) of the CWA developed on a best professional judgment basis, rather than the best technology available. Any site-specific mitigation required under the NPDES permitting process would result in a reduction in the impacts of continued plant operations.

The intake design through-screen velocity can influence the rate of impingement. Generally, the higher the through-screen velocity, the greater the number of fish impinged. The EPA established a national standard for the maximum design through-screen velocity of no more than 0.5 ft/s (66 FR 65256). The EPA determined that species and life stages evaluated in various studies could endure a velocity of 1 ft/s, then applied a safety factor of 2 to derive the threshold of 0.5 ft/s. The mean intake velocities at the CREC's once-through units are: 0.64 ft/s (0.20 m/s) during high tide and 0.7 ft/s (0.21 m/s) during low tide for CR-1; 0.87 ft/s (0.27 m/s) during high tide and 0.94 ft/s (0.29 m/s) during low tide for CR-2; and 0.81 ft/s (0.25 m/s) during high tide and 0.97 ft/s (0.03 m/s) during low tide for CR-3 (NUS Corporation, 1978). Average velocities in the intake canal are currently about 1.05 ft/s (0.32 m/s) during high tide and 1.26 ft/s (0.38 m/s) during low tide from May through October and 0.89 ft/s (0.27 m/s) during high tide and 1.07 ft/s (0.33 m/s) during low tide from November through April (Golder Associates, Inc., 2007c).

There is no fish return system at the CREC so all organisms impinged on the intake screens are considered losses from the Crystal Bay ecosystem. Impingement on the CREC intake screens is limited to individuals that can first pass through the 3.6-inch (9.2-cm) openings of the trash racks located in front of the intake screens.

Mountain (1972) reported 59 taxa of fishes and 15 taxa of invertebrates from 24-hour screen wash samples collected monthly from CR-1 and CR-2 from January 1969 through February 1971. Most impinged individuals were juveniles or weak-swimming species. Grimes (1971) noted an inverse relationship between intake water temperature and impingement. Highest impingement occurred during the first cold temperatures of winter and when the lowest water temperatures of winter occurred (Grimes, 1971). Based on the impingement samples collected at CR-1 and CR-2, the U.S. Atomic Energy Commission (AEC) (1973) calculated that impingement at CR-1 and CR-2 totals about 200,000 finfish and 50,000 shellfish annually; and that this total would double once CR-3 began operation.

The following three major impingement studies occurred at the CREC since CR-3 became operational:

- impingement samples collected between March 13, 1977, and March 13, 1978, to meet NRC environmental technical specifications (NUS Corporation, 1978)
- impingement samples collected from June 1983 to June 1984 as part of a 316 Demonstration (SWEC, 1985)
- impingement samples collected from December 2006 to November 2007 to serve as a baseline assessment against which to compare impingement from the proposed EPU of CR-3 (Ager et al., 2008)

For the NUS Corporation (1978) study, estimated yearly impingement totaled 2,642,402 fishes and 271,672 invertebrates for CR-1 through CR-3. Estimated annual numbers impinged at each unit were as follows:

- CR-1 – 245,535 (9.3 percent of fish) and 46,952 invertebrates (17.4 percent of invertebrates)
- CR-2 – 323,471 fish (12.2 percent of fish) and 92,005 invertebrates (33.9 percent of invertebrates)
- CR-3 – 2,073,396 fish (78.5 percent of fish) and 132,715 invertebrates (48.9 percent of invertebrates)

Impingement was much higher than predicted by the AEC (1973). CR-2 was not online during November and December of 1977. Had CR-2 been operational, impingement numbers would have been even higher; especially since 64 percent of all impinged fishes and 56 percent of all impinged organisms occurred in December and January. High impingement in these 2 months was primarily due to large catches of scaled sardine (*Harengula jaguana*) and Atlantic thread herring (*Opisthonema oglinum*). Cold snaps may make these two species more susceptible to impingement (e.g., due to the fish being dead or moribund from exposure to cold water). Increased impingement was also associated with increased turbidity and large amounts of seagrass carried into plant intake caused by barge movements (NUS Corporation, 1978). Impingement numbers were lowest in May, June, and October (NUS Corporation, 1978).

Scaled sardine, bay anchovy, pinfish, sea catfish (*Arius felis*), and silver perch were the most abundant of the 106 finfish species impinged. Fish species impinged every month included shrimp eel (*Ophichthus gomesi*), bay anchovy, gulf toadfish (*Opsanus beta*), polka-dot batfish (*Ogcocephalus radiatus*), tidewater silverside (*Menidia beryllina*), lined seahorse (*Hippocampus erectus*), dusky pipefish (*Syngnathus floridae*), chain pipefish (*Syngnathus louisianae*), pigfish (*Orthopristis chrysoptera*), pinfish, spot (*Leiostomus xanthurus*), scrawled cowfish (*Lactophrys quadricornis*), southern puffer (*Sphoeroides nephelus*), and striped burrfish (*Chilomycterus schoepfi*) (NUS Corporation, 1978). Among the 45 invertebrate taxa impinged, the pink shrimp, iridescent swimming crab (*Portunus gibbesii*), false arrow crab (*Metaporhaphis calcarata*), and blue crab (*Callinectes sapidus*) were most numerous (NUS Corporation, 1978). Invertebrates impinged every month included brief squid (*Lolliguncula brevis*), pink shrimp, blue crab, stone crab, mantis shrimp (*Squilla empusa*), roughneck shrimp (*Trachypenaeus constrictus*), bigclaw snapping shrimp (*Alpheus heterochaelis*), Florida grass shrimp (*Palaemon floridanus*), iridescent swimming crab, Atlantic mud crab (*Panopeus herbstii*), longnose spider crab (*Libinia dubia*), and false arrow crab (NUS Corporation, 1978).

Table 4.5-3 provides the estimated annual number of the selected important species (discussed in Section 2.2.5) impinged between March 13, 1977, and March 13, 1978 (NUS Corporation, 1978). Other impinged species that were numerically abundant included: scaled sardine (911,895 at CR-3 and 1,166,696 impinged at all three units); sea catfish (159,327 at CR-3 and 203,846 at all units); Atlantic thread herring (67,677 at CR-3 and 86,587 at all units); scrawled cowfish (22,625 at CR-3 and 28,947 at all units); silver jenny (16,235 at CR-3 and 20,772 at all units); and ocellated flounder (11,310 at CR-3 and 14,470 at all units); iridescent swimming crab (63,099 at CR-3 and 129,095 at all units; false arrow crab (44,487 at CR-3 and 91,016 at all units); roughneck shrimp (*Rimapenaeus constrictus*) (17,265 at CR-3 and 35,322 at all units); Florida grass shrimp (9,168 at CR-3 and 18,756 at all units); Gulf grassflat crab (*Dyspanopeus texana*) (6,938 at CR-3 and 14,194 at all units); and bigclaw snapping shrimp (3,798 at CR-3 and 7,770 at all units) (NUS Corporation, 1978).

For the 316 Demonstration study (SWEC, 1985), estimated yearly impingement totaled 647,435 fish and 1,319,341 invertebrates for CR-1 through CR-3. Estimated annual numbers impinged at each unit were as follows:

- CR-1 – 64,987 (10 percent of fish) and 196,985 invertebrates (14.9 percent of invertebrates)
- CR-2 – 280,012 fish (43.2 percent of fish) and 282,302 invertebrates (21.4 percent of invertebrates)
- CR-3 – 302,436 fish (46.7 percent of fish) and 840,054 invertebrates (63.7 percent of invertebrates)

As was the case for the NUS Corporation (1978) study, annual impingement for the 316 Demonstration study (SWEC, 1985) was much higher than projected by the AEC (1973), particularly for invertebrates. Significantly higher rates of impingement occurred during lower temperatures and there was also a correlation of barge traffic with increased impingement

(SWEC, 1985). The major differences between the SWEC (1985) and NUS Corporation (1978) studies were the absence of a major influx of scaled sardines and Atlantic thread herring in the SWEC (1985) study and the increase in the number of invertebrates impinged in the SWEC (1985) study.

Impingement samples included 130 taxa of fishes and 53 taxa of invertebrates (SWEC, 1985). Nearly 61 percent of total impingement occurred at CR-3 (SWEC, 1985). The most commonly impinged fishes (for all units) were bay anchovy (18.3 percent), polka-dot batfish (14.6 percent), and bighead searobin (*Prionotus tribulus*) (13 percent); and the most abundant invertebrates were pink shrimp (44.7 percent), blue crab (24.2 percent), and false arrow crab (9.9 percent) (SWEC, 1985). Table 4.5-3 provides the numbers of the selected important fish and shellfish species impinged at CR-3 and for all units combined. The four selected important invertebrate species represent 83.2 percent of the total number of the 13 selected important species impinged annually and 42.3 percent of all organisms impinged (SWEC, 1985).

Table 4.5-3. Comparison of the Estimated Number of Selected Important Fish and Shellfish Species Impinged Per Year in 1977/1978, 1983/1984, and 2007/2008

	Impingement Collection Period		
	1977/1978	1983/1984	2006/2007
Species	CR-3 (all units)[(a)]	CR-3 (all units)[(a)]	CR-3 (all units)[(a)]
Bay anchovy (*Anchoa mitchilli*)	314,790 (402,097)	64,518 (87,978)	129,020 (138,865)
Pigfish (*Orthopristis chrysoptera*)	--b	956 (3,697)	53,669 (66,783)
Pinfish (*Lagodon rhomboides*)	164,805 (210,856)	6,189 (15,235)	27,446 (33,489)
Polka-dot batfish (*Ogocephalus radiatus*)	67,096 (85,844)	40,728 (74,483)	60,454 (87,548)
Red drum (*Sciaenops ocellatus*)	0 (0)	8 (8)	0 (0)
Silver perch (*Bairdiella chrysoura*)	147,019 (188,100)	6,214 (12,000)	68,889 (85,809)
Spot (*Leiostomus xanthurus*)	34,422 (44,040)	12,744 (28,094)	0 (0)
Spotted seatrout (*Cynoscion nebulosus*)	--	1,607 (2,804)	1,267 (1,432)
Striped mullet (*Mugil cephalus*)	--	362 (1,120)	30 (108)
Blue crab (*Callinectes sapidus*)	35,811 (73,264)	255,518 (383,560)	26,511 (31,567)
Brief squid (*Lolliguncula brevis*)	12,753 (26,090)	55,715 (86,965)	44,430 (54,316)
Florida stone crab (*Menippe mercenaria*)	--	608 (1,535)	4,960 (7,950)
Pink shrimp (*Farfantepenaeus duorarum*)	140,706 (287,860)	391,457 (640,887)	114,442 (149,710)

(a) Includes CR-1, CR-2, and CR-3
(b) -- = Number of individuals impinged not provided in report

Sources: NUS Corporation, 1978; SWEC, 1985; Ager et al., 2008

An EPA fact sheet on the CREC NPDES permit prepared in 1993 (as cited in Golder Associates, Inc., 2006) stated that the results of the 316 Demonstration study (SWEC, 1985) showed that impingement at the CREC has an adverse impact to the aquatic resources of Crystal Bay. The applicant and the EPA determined that a combination of seasonal flow reduction and stock enhancement through rearing and stocking of recreationally important species would be the most prudent methods to mitigate impingement losses (Progress Energy, 2008a). The subsequent NPDES permit for the CREC (CR-1 through CR-3) stipulated that cooling water withdrawals would be limited to 1,318,000 gpm over the period May 1 through

October 31 and 1,132,792 gpm from November 1 through April 30 (Progress Energy, 2008a). The 15 percent withdrawal reduction from November 1 through April 30 minimizes impacts to fall, winter, and early spring spawners including pinfish, Atlantic croaker, Gulf flounder, Gulf menhaden, striped mullet, and spot (Golder Associates, 2007b). The flow reductions at the CREC began in 1992.

The logic behind fish stocking is that releasing a large number of larvae, juvenile, or adult fish or shellfish into a water body may directly compensate for the mortality associated with impingement and entrainment (EPRI, 2003). As part of the negotiated settlement with the EPA to mitigate impacts of the CREC once-through cooling system, FPC opened the Crystal River Mariculture Center in 1991. Initial cultures included red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), striped mullet, and pink shrimp. Subsequent species cultured at the Mariculture Center included pigfish, silver perch, blue crab, and stone crab. To date, releases of pigfish to Crystal Bay have not occurred. Total releases made from 1992 through 2009 for the other seven species are as follows (Progress Energy, 2010a):

- Red drum – 947,394 fingerlings and 1,375,500 larvae
- Silver perch – 39,942 first feeding larvae
- Spotted seatrout - 1,131,813 fingerlings and 715,000 larvae
- Striped mullet – 525,000 first feeding larvae
- Blue crab – 93,746,281 zoea stage I
- Pink shrimp – 415,102
- Stone crab – 32,347,962 zoea stage I

Releases of fish and shellfish produced at the Mariculture Center occur in areas of the Gulf for which they are best suited, based on time of year and water quality conditions (Progress Energy, 2008a).

Since the negotiated settlement with the EPA, one impingement study has occurred at the CREC from December 2006 to November 2007 (Ager et al., 2008). For all three units, estimated annual impingement numbers totaled 945,631 fish and 341,780 invertebrates (Ager et al., 2008). Estimated annual impingement numbers at each unit were as follows:

- CR-1 – 40,930 fish (4.3 percent of fish) and 35,165 invertebrates (10.3 percent of invertebrates)
- CR-2 – 83,566 fish (8.8 percent of fish) and 50,178 invertebrates (14.7 percent of invertebrates)
- CR-3 – 821,423 fish (86.9 percent of fish) and 256,468 invertebrates (75 percent of invertebrates)

Consistent with the other impingement studies at the CREC (NUS Corporation, 1978), (SWEC, 1985), annual impingement was much higher than predicted by the AEC (1973). Ager et al.

(2008) observed peak impingement to occur in February and March 2007, with 69 percent of all fishes impinged during this period and 46 percent of all organisms (based on total biomass) impinged during these 2 months.

The most abundant fish species impinged were Atlantic thread herring (21.6 percent), bay anchovy (14.7 percent), and scaled sardines (11.4 percent). The most abundant invertebrates impinged were pink shrimp (43.8 percent), Atlantic brief squid (15.9 percent), and false arrow crab (10.5 percent) (Ager et al., 2008). Table 4.5-3 provides the number of the 13 selected important fish and shellfish species impinged at CR-3 and for all units combined.

Impinged species that were numerically abundant included: Atlantic thread herring (194,141 at CR-3 and 204,060 at all units); scaled sardine (104,005 at CR-3 and 107,731 at all units); blueback herring (*Alosa aestivalis*) (63,478 at unit CR-3 and 63,478 at all units); spotted mojarra (*Eucinostomus argenteus*) (16,763 at CR-3 and 30,800 at all units); striped mojarra (*Eugerres plumieri*) (15,965 at CR-3 and 19,871 at all units); false arrow crab (27,756 at CR-3 and 36,767 at all units); iridescent swimming crab (22,889 at CR-3 and 33,957 at all units); and mantis shrimp (6,796 at CR-3 and 9,820 at all units) (Ager et al., 2008).

Ager et al. (2008) determined that fish densities near the entrance to the intake canal were 7 to 62 times greater than observed in the immediate vicinity of the CREC intakes; while invertebrate densities were 2 to 19 times greater near the entrance of the intake canal compared to the immediate area of the intakes. Ager et al. (2008) concluded that, overall, the extended intake canal appears to offer an impingement reduction of about 95 percent for all three units and a 94 percent reduction for CR-3.

Both NUS Corporation (1978) and SWEC (1985) made several comparisons of impingement of select species (e.g., blue crab and pink shrimp) to commercial catches. Estimated impingement at the CREC was generally 1 percent or less of local commercial catches and so was not competing with or impacting commercial catches (NUS Corporation, 1978), (SWEC, 1985). Table 4.5-4 presents comparisons of annual impingement biomass determined by Ager et al. (2008) and commercial catches reported by the Florida Fish and Wildlife Conservation Commission (FWC) (2011) for several of the selected important species. Evident from Table 4.5-4 is that for commercially important species (e.g., striped mullet, blue crab, Florida stone crab, and pink shrimp), impingement losses at CR-3 are only a small percentage of commercial catches. For these four species, impingement losses ranged from less than 0.001 percent (striped mullet) to 0.04 percent (pink shrimp) of commercial catch for the west coast of Florida. For species of lower commercial importance (e.g., pinfish, spotted seatrout, and squid), impingement losses at CR-3 were up to 2 percent of the commercial catch for the west coast of Florida.

Table 4.5-4. Comparison of the Estimated Biomass of Selected Fish and Shellfish Species Impinged at the Crystal River Energy Complex to Commercial Catches

	Pounds Impinged[a]		Pounds Harvested[a]	
Species	**CR-3**	**CREC[b]**	**Citrus County**	**Florida West Coast**
Pinfish (*Lagodon rhomboides*)	784	953	4937	76,924
Spot (*Leiostomus xanthurus*)	0	0	1	4429
Spotted seatrout (*Cynoscion nebulosus*)	69	85	58	5162
Striped mullet (*Mugil cephalus*)	46	62	236,368	5,540,254
All Fish Species	**32,840**	**42,437**	**413,932**	**30,644,493**
Blue crab (*Callinectes sapidus*)	2178	2795	743,882	6,114,553
Brief squid (*Lolliguncula brevis*)	668	896	0	34,843
Florida stone crab (*Menippe mercenaria*)	99	195	350,646[c]	5,846,631[c]
Pink shrimp (*Farfantepenaeus duorarum*)	2034	2776	1361	5,011,894
All Invertebrate Species	**5805**	**8434**	**1,603,490**	**29,105,797**

(a) To convert to kilograms, multiply by 0.45
(b) Includes CR-1, CR-2, and CR-3
(c) Weight of only the largest claw
Sources: Ager et al., 2008; FWC, 2011

The NPDES permit contains no requirements for the applicant to conduct impingement monitoring at CR-3 (FDEP, 2005a). As discussed in Section 2.1.6, Phase II of the planned CR-3 EPU should not alter the volume of water withdrawn at the entrance of the intake canal. Therefore, an increase in the number of organisms impinged at CR-3 due to the EPU is not expected. Studies conducted near the CREC since the late 1960s indicate that Crystal Bay near the CREC has maintained a diverse assemblage of fish and shellfish species. Impingement losses will continue at CR-3 during the license renewal term; with numbers of fish and shellfish impinged expected to be in the annual range of the 1.1 to 1.2 million organisms reported by NUS Corporation (1978), SWEC (1985), and Ager et al. (2008). CR-3 has an intake flow rate greater than that recommended by the EPA and its annual impingement numbers are much higher than the 250,000 estimated by the AEC (1973). Based on the preceding information, the Staff has determined that the potential impacts of impingement of fish and shellfish by CR-3 on the Crystal Bay aquatic community during the 20-year renewal period would be SMALL to MODERATE. Under the provisions of the CWA 316(b), the FDEP may impose further restrictions or require modifications to the cooling system to reduce the impact of impingement under the NPDES permitting process. The Site Certification Application for LNP was approved by the Governor’s Siting Board on August 11, 2009, and includes a requirement that the applicant shut down CR-1 and CR-2 by the end of 2020 (or by the end of the year when LNP begins operation) (Progress Energy, 2009m). This will lessen impingement impacts to Crystal Bay due to CREC operations.

4.5.4 Heat Shock

For plants with once-through cooling systems, such as CR-3, the effects of heat shock are a Category 2 issue that require a site-specific assessment for license renewal review. Impacts on fish and shellfish resources resulting from heat shock are a site-specific issue because of continuing concerns about acute thermal-discharge impacts and the possible need to modify thermal discharges in the future in response to changing environmental conditions (NRC, 1996). Heat shock may occur when the water temperature meets or exceeds the thermal tolerance of aquatic biota; duration of exposure to high water temperatures is a factor contributing to heat shock. Mobile organisms such as fish can typically avoid adverse effects from a thermal plume through behavioral avoidance (e.g., swimming away from the plume). The thermal plume may exclude some aquatic biota from a small area of habitat near the CREC discharge. The discharge of heated water into Crystal Bay can cause lethal or sublethal effects on resident fish and shellfish, influence food web characteristics and structure, and create barriers to nearshore/offshore or along shore movements of fish and shellfish. The Staff did not uncover any incidents of fish mortality reportedly due to heat shock at the CREC.

Information considered by the Staff for its assessment of heat shock included: (1) the type of cooling system, (2) evidence of CWA Section 316(a) variance or equivalent State documentation, and (3) any temperature excursions above the thermal limits. To perform this assessment, the Staff reviewed the applicant's ER (Progress Energy, 2008a) and related documents, including the CWA Section 316 Demonstration studies (SWEC, 1985), and visited the CREC site. The Staff also reviewed the applicant's NPDES permit; documents related to the planned EPU for CR-3; scientific articles, documents, technical reports, and compilations associated with the Crystal Bay area and with thermal impacts; and the thermal plume analysis prepared for the proposed LNP (NRC, 2010b), which will discharge its cooling tower blowdown to the CREC discharge canal. The Staff notes that the applicant's NPDES permit (No. FL0000159) was issued on May 9, 2005, with an expiration date of May 8, 2010 (FDEP, 2005a). The applicant submitted an application for renewal of its NPDES permit on October 28, 2009 (Progress Energy, 2009l). Since the applicant applied for its permit on time, the existing NPDES permit remains in effect until issuance of a new NPDES permit.

> **Heat Shock**
>
> Heat shock is an acute thermal stress caused by exposure to a sudden elevation of water temperature that adversely affects the metabolism and behavior of fish or other aquatic organisms and can lead to death. Heat shock is most likely to occur when an offline unit returns to service or when a station has a discharge canal.

At the CREC, CR-1, CR-2, and CR-3 have once-through cooling systems that withdraw water from and discharge water to the Gulf of Mexico; while CR-4 and CR-5 have closed-cycle systems that withdraw water from the CREC discharge canal and discharge their blowdown back to the discharge canal (Section 2.1.6). At operating design capacity, the discharge temperature rises from condenser passage from CR-1 through CR-3 are 14.9 °F (8.3 °C), 16.9 °F (9.4 °C), and 17.5 °F (9.7 °C), respectively (Mattson et al., 1988). Combined blowdown temperature from CR-4 and CR-5 is less than their combined intake flow. For example, at a combined intake temperature of 107.3 °F (41.8 °C), the combined blowdown temperature is 94.7 °F (34.8 °C) (Progress Energy, 2009n). Average intake temperature at the CREC is 85.6 °F (29.8 °C) in summer and 63.5 °F (17.5 °C) in winter; while the average discharge temperature at the point of discharge (POD) is 93.4 °F (34.1 °C) in summer and 78.1 °F (25.6 °C) in winter (Progress Energy, 2010b). Through NPDES Permit FL0000159, FDEP

(2005a) regulates the thermal limits of the combined discharge of CR-1 through CR-3 at the POD to Crystal Bay. The discharge temperature at the POD cannot exceed 96.5 °F (35.8 °C) as a 3-hour rolling average.

Various factors affect the thermal plume from the CREC. The north spoil bank of the intake canal prevents southward flow of the thermal plume, which also prevents recycling of heated effluent back into the intake canal (AEC, 1973). Tide-induced flow and water influx from the Withlacoochee River-Cross Florida Barge Canal area govern water flow patterns within the thermal mixing zone for the CREC (AEC, 1973). Hall et al. (1978) stated that in cases where cooling water discharges are relatively large in comparison to the dissipative capacity of the receiving body that a detrimental increase in temperature is likely to occur over a substantial area. Shallow, enclosed, and/or poorly mixed bodies of water are most vulnerable to heat loading (Hall et al., 1978). As an example, Hall et al. (1978) mentioned that the addition of CR-2 and CR-3 would increase the temperature of about 2 square kilometers (km^2) (494 ac or 200 ha) of Crystal Bay by about 9.9 °F (5.5 °C) and about 15 km^2 (3,707 ac or 1,500 ha) by 1.8 °F (1 °C). Table 4.5-4 tabulates AEC's (1973) predicted area of the thermal plume due to the addition of CR-3.

Table 4.5-4. Predicted Acreage of the Crystal River Energy Complex Thermal Plume Due to the Addition of Crystal River Unit 3 Nuclear Generating Plant

Temperature Increase above Ambient	Acres[a]		
	Flood Tide	Ebb Tide	Complete Tidal Cycle[b]
1 °F (0.6 °C)	2,860 (1,230)	3,770 (1,620)	4,600 (2,350)
2 °F (1.1 °C)	2,100 (870)	2,760 (1,140)	3,500 (1,700)
4 °F (2.2 °C)	1,350 (420)	1,750 (650)	2,300 (1,050)
6 °F (3.3 °C)	730 (200)	1,130 (360)	1,500 (510)
8 °F (4.4 °C)	400 (90)	740 (160)	950 (220)
10 °F (5.5 °C)	220 (-)[c]	430 (-)	500 (-)

[a] To convert to hectares, multiply by 0.4047.

[b] Numbers in parentheses are thermal plume area for CR-1 and CR-2 only.

[c] - = not provided.

Source: AEC, 1973

Prior to CR-3 operation, Grimes and Mountain (1971) reported that the thermal discharge from CR-1 and CR-2 resulted in a localized effect on Crystal Bay fishes—attracting them during late fall and early winter and repulsing them during summer. However, the occurrence of the four most abundant fish species near the CREC (pigfish, silver perch, spot, and pinfish) was not significantly different between thermally-affected and non-affected areas (Grimes and Mountain, 1971). Lyons et al. (1971) concluded that the salinity gradient (i.e., increasing from the Cross Florida Barge Canal to the CREC discharge canal dike) was more influential than temperature in determining local distribution of macroinvertebrates, which increased in diversity as salinity increased. However, Lyons et al. (1971) theorized that the thermal plume from the addition of CR-3 at the CREC may prove to be more influential than salinity in determining the distribution of macroinvertebrates.

In the final environmental statement (FES), the AEC (1973) concluded that a localized impact could be expected to occur to sessile marine invertebrates, attached algae and plants, some planktonic organisms, and possibly some fishes in the discharge area due to increase of temperature in the discharge effluent from 11.5 °F (6.4 °C) to about 14.5 °F (8.1 °C) and more notably to a more than doubling in the size of the thermal plume (Table 4.5-4). The AEC (1973) concluded that most adverse ecological impacts would occur when temperatures exceed 95 °F (35 °C); a condition that would occur about 53 percent of the time annually. Most biological and ecological effects were expected to occur within the 6 °F (3.3 °C) isotherm, an area that would cover about 1,500 ac (607 ha) over a complete tidal cycle with all three units operating (1,000 ac [405 ha] of which is contributed by operation of CR-3) (AEC, 1973).

During the combined CWA Section 316(a) and 316(b) Demonstration study (SWEC, 1985), the mean weekly POD water temperatures ranged from 63.2 °F (17.3 °C) (for the period January 1 through January 7, 1984) to 100.1 °F (37.8 °C) (for the period August 21 through August 27, 1983). For 9 weeks during the summers of 1983 and 1984, weekly temperatures at the POD ranged between 96.9 °F and 100.1 °F (36.1 °C and 37.8 °C) (SWEC, 1985). These summer discharge temperatures are above the temperature preference, and in some cases tolerance, of a number of aquatic organisms that occur in the area (Section 2.2.5). SWEC (1985) observed that the lowest densities of fish and invertebrates occurred in the sample transects most affected by thermal discharges. SWEC (1985) concluded that the thermal discharges from the CREC had an adverse impact on the benthic infaunal community within an area less than 400 ac (162 ha) and minimal benthic infaunal community alterations within an area less than 2,400 ac (971 ha). Table 4.5-5 presents SWEC's (1985) conclusions on CREC thermal discharge impacts on the selected representative fish and invertebrate species described in Section 2.2.5. In general, the thermal effects were limited to an area within about 2.2 mi (3.5 km) from the POD, which encompasses less than 2,400 ac (971 ha) (SWEC, 1985).

Table 4.5-5. Effects of the Crystal River Energy Complex Thermal Discharges on Selected Representative Species

Species	Thermal Discharge Effects
Bay anchovy (*Anchoa mitchilli*)	Preferred thermal area where temperatures were as much as 7.2 °F to 12.6 °F (4 °C to 7 °C) above ambient. Summer discharge temperatures did not prevent the species from occupying the thermal plume area. Young-of-the-year were more common in the thermal plume than thermally-unaltered areas except in spring. Those in the thermal plume did not weigh as much as equivalently-sized specimens in the control area. Growth rate was apparently faster in the thermal area than in the control area.
Pigfish (*Orthopristis chrysoptera*)	Avoided the thermal discharge area in spring and summer. Reproduction at the CREC probably occurs south of the intake canal.
Pinfish (*Lagodon rhomboides*)	Tended to avoid the thermal discharge area where temperatures were in excess of 3.6 °F (2 °C) above ambient.
Polka-dot batfish (*Ogocephalus radiatus*)	Ratio of females to males higher in discharge plume area and immature individuals less common in discharge plume area.
Red drum (*Sciaenops ocellatus*)	Data did not support any conclusions concerning thermal discharge impacts.
Silver perch (*Bairdiella chrysoura*)	Avoided higher temperature areas of the thermal plume area but utilized areas that were 3.6 °F to 5.4 °F (2 °C to 3 °C) above ambient.
Spot (*Leiostomus xanthurus*)	Appeared to use the outer portions of the thermal plume area, although may also use higher thermal portions in early spring.
Spotted seatrout (*Cynoscion nebulosus*)	Not excluded from the thermal plume area but appeared to utilize areas subject to temperatures only up to about 5.4 °F (3 °C) above ambient.
Striped mullet (*Mugil cephalus*)	Data did not support any conclusions concerning thermal discharge impacts.
Blue crab (*Callinectes sapidus*)	Avoided warmer portions of the thermal plume, particularly during the summer.
Brief squid (*Lolliguncula brevis*)	Data did not support any conclusions concerning thermal discharge impacts.
Florida stone crab (*Menippe mercenaria*)	Has a more offshore distribution that is associated with factor or factors other than thermal discharges.
Pink shrimp (*Farfantepenaeus duorarum*)	Avoided warmer portions of the thermal plume, particularly in August.

Source: SWEC, 1985

Hall et al. (1978) reported that temperatures 9 °F (5 °C) above ambient resulting from power plant operations in South Biscayne Bay caused the total disappearance of turtle grass (*Thalassia testudinum*) and elevations of 5.4 °F to 7.2 °F (3 °C to 4 °C) brought a 50 percent loss of turtle grass and depressed macroalgae populations by 30 percent. Mattson et al. (1988) found that the standing crop, productivity, and growth rates of seagrasses were lower in the thermally-impacted area near the POD at the CREC. The monitoring site exposed to the highest CREC temperature elevations routinely contained only shoal grass (*Halodule beaudettei*), while monitoring sites exposed to lower thermal discharge temperatures contained three to four seagrass species. Control stations, not exposed to CREC thermal discharges, contained 0 to 4 species of seagrasses (Mattson et al., 1988). Several environmental variables (e.g., salinity and substrates) affect the submergent macrophyte communities near the CREC. Therefore, Mattson et al. (1988) concluded that differences in seagrass communities between thermally-unimpacted and moderately impacted areas could not be attributed to just the thermal addition from the CREC (Mattson et al., 1988).

A fact sheet on the CREC NPDES permit prepared in 1993 by the EPA, abstracted in Golder Associates, Inc. (2006), stated that the results of the 316 Demonstration study (SWEC, 1985) showed that thermal discharges at the CREC have an adverse impact to the aquatic resources of Crystal Bay. These impacts included substantial damage to about 1,100 ac (445 ha) of Crystal Bay (FPC, undated). Therefore, the 1989 NPDES permit for CR-1, CR-2, and CR-3 included a requirement for the construction and operation of helper cooling towers, which became operational in 1993. The cooling tower requirement was primarily to mitigate thermal impacts to water quality and seagrasses (FPC, undated). Additional NPDES permit requirements included a seagrass monitoring and planting program, and a limitation on plant operations to maintain a 3-hour average temperature not to exceed 96.5 °F (35.8 °C) at the POD.

From May 1 through October 31, a portion of the heated discharge from the CREC flows through the helper cooling towers to meet the NPDES permitted 3-hour rolling average of 96.5 °F (35.8 °C) (FDEP, 2005a). During hot summers, the applicant occasionally reduces power at the coal-fired units (CR-1 and CR-2) to stay within NPDES permit thermal limits. In April 2006, the applicant received approval from the FDEP to install additional modular cooling towers. The 67 modular cooling towers allow CR-1 and CR-2 to operate most of the time during the warmest periods of the year without reducing power (Progress Energy, 2008a).

The Mote Marine Laboratory surveyed submerged aquatic vegetation (SAV) from 1993 through 1995 to determine the potential beneficial effect of the CREC helper cooling towers on the distribution of SAV in the thermal discharge area (FPC, undated). Results indicated that several new SAV beds occurred in areas that were completely barren of vegetation in 1993, although recruitment of seagrasses into barren areas was not extensive. Additionally, 8 of 15 surveyed seagrass beds showed some expansion beyond their original boundaries, but the percent coverage of SAV declined at 10 of 15 sites surveyed (FPC, undated), (Marshall, 2002).

In 2001, the Coastal Seas Consortium, Inc. resurveyed the same area surveyed by the Mote Marine Laboratory to determine what changes in SAV beds occurred since 1995 (Marshall, 2002). Seagrass beds first began at a point 245 ft (74.6 m) from the POD, and shoal grass had spread throughout the area most affected by thermal discharges. The occurrence of shoal grass seemed to be only constrained by rocky bars, shelly substrates inappropriate for seagrass growth, and water depths too shallow or too deep for seagrass (Marshall, 2002). Marshall (2002) concluded that the helper cooling towers have altered the thermal regime to the degree that suitable conditions for seagrass survival, bed expansion, and reproduction exist. However, seagrass recolonization has not been dramatic since the helper cooling towers have become operational. The Seagrass Technical Advisory Committee suggested that light intensity, salinity variation, and suspended solids load could be more influential than temperature in affecting seagrass colonization; had temperature been the primary factor, a more dramatic recolonization of seagrass should have occurred after the cooling towers became operational (FPC, undated).

As discussed in Section 2.1.6, the scheduled completion of the CR-3 EPU has changed from 2011 to, supposedly, prior to the expiration of the next NPDES permit period. Original EPU plans called for the construction and operation of a new south cooling tower to mitigate increased thermal load resulting from the EPU. Golder Associates, Inc. (2007c) concluded that the use of the south cooling tower will ensure that the heat rejection rate from the three units will not exceed the allowable maximum rate of 10.91 billion British thermal units per hour (Btu/hour) at the POD and, therefore, the EPU will not change the shape or increase the extent of the thermal plume. Table 4.5-6 lists the projected summer operational discharges and temperatures for the CREC based on the CR-3 EPU.

Table 4.5-6. Projected Post-Uprate Summer Operational Discharges and Temperatures for the Crystal River Energy Complex

CREC Unit	Discharge Flow (gpm)[a]	Intake Temperature (°F)[b]	Discharge Temperature (°F)[b]
CR-1	310,001	91.0	101.7
CR-2	328,001	91.0	105.1
CR-3 (uprated)	680,001	91.0	110.9
CR-4 and CR-5 (combined)[c]	7,000	107.3	94.7
Harmon cooling towers (existing)	673,944	107.2	92.0
South cooling tower (new)	314,018	107.2	91.0
Point of discharge	1,291,212	--	95.4

(a) To convert to m^3/min multiply by 0.00455.

(b) High summer design values in August. To convert to °C: (°F-32) x 0.556.

(c) Net internal discharge to the CREC discharge canal from CR-4 and CR-5 cooling towers.

Source: Progress Energy, 2009n

The applicant stated that there would be no change to the existing CR-3 flow of 680,000 gpm (1,849 cfs or 3,142 m^3/s) as a result of the EPU but there would be an increase in the thermal load (increased temperature) (Progress Energy, 2009n). The new south cooling tower will allow CR-3 to operate similarly before and after the EPU, maintain compliance with the NPDES permit limitations, and allow for the removal of the rental modular cooling towers (Progress Energy, 2009n). As discussed in Section 2.1.6, the CR-3 EPU may be completed without, or prior to, the south cooling tower. In this case, derating of CR-1 and CR-2 may be required to meet the NPDES permit temperature requirement at the POD. Should the EPU occur before the end of the next NPDES permit period, the applicant will be required to conduct a CWA Section 316(a) Demonstration study, likely involving a 2-year study period initiated after completion of the EPU. The need for the study is to demonstrate compliance with CWA Section 316(a) in order to renew any applicable Section 316(a) variance (i.e., a variance from applicable thermal limitations to surface waters is allowed if the permittee demonstrates that the balanced indigenous community of aquatic organisms is protected and maintained). The applicant has proposed a plan of study (not yet approved by the FDEP) to assess the potential impacts of the thermal plume from current operation of the CREC on seagrasses, benthic macroinvertebrates, and other aquatic species, as appropriate (Progress Energy, 2007b).

The Staff has determined that the potential for acute heat shock during the license renewal term is unlikely because of the design, location, and operation of CR-3 (and the other units at the CREC). The plant discharges via a discharge canal to the Gulf of Mexico, a large body of water. In high-temperature plumes, mobile organisms are generally able to detect the limits to their survival and escape dangerous situations. For this reason, direct kills from heat shock are rare (Hall et al., 1978). Chronic thermal effects occur within less than 2,400 ac (971 ha) affected by the thermal discharges from the CREC. Most notable are impacts to seagrasses, although light intensity, salinity variation, and suspended solids load also influence seagrass habitats in the area of the thermal plume. The Staff concludes that thermal impacts could range from SMALL to MODERATE depending on the extent and magnitude of the thermal plume, the sensitivity of various aquatic species and the life stages likely to encounter the thermal plume, and the probability of an encounter occurring that could result in lethal or sublethal effects. The range of the impact level expresses the uncertainty resulting from the current lack of studies and data. Additional thermal studies or modeling and verification of the applicant's past thermal studies might generate data to refine or modify this impact level.

For the purpose of this SEIS, the Staff's conclusion that the thermal impact level could range from SMALL to MODERATE satisfies the NRC's National Environmental Policy Act (NEPA) obligations and is not meant to prejudice any determinations the FDEP may reach in response to new studies and information submitted to it by the applicant. The Site Certification Application for LNP was approved by the Governor's Siting Board on August 11, 2009, and includes a requirement that the applicant shut down CR-1 and CR-2 by the end of 2020 (or by the end of the year when LNP begins operation) (Progress Energy, 2009m). Shutting down CR-1 and CR-2 will lessen thermal impacts to Crystal Bay due to CREC operations.

4.5.5 Total Impacts on Aquatics Resources

Impingement, entrainment, and heat shock all act on the aquatic resources of Crystal Bay near the CREC. The purpose of this section is to provide perspective on the total impact of CREC cooling system operation on fish and other aquatic resources. The Staff concluded that the level of individual impacts associated with entrainment, impingement, and thermal discharges is SMALL to MODERATE; the Staff believes that the total impact from all of these stressors together on aquatic resources would also be SMALL to MODERATE through the period of CR-3 license renewal.

A fact sheet on the CREC NPDES permit prepared in 1993 by the EPA, abstracted in Golder Associates, Inc. (2006), determined that a reduction of plant flow by 15 percent during the months of November through April and the operation of a fish hatchery (the Mariculture Center) over the lifetime of the CREC would constitute minimization of the effects of the CREC cooling water intake on aquatic resources; and that the addition of helper cooling towers and limitation on temperature at the POD constituted minimization of environmental impacts of the cooling water discharge (the cost of installing closed-cycle cooling towers was considered to be wholly disproportionate to the environmental benefits to be derived).

The Atomic Safety and Licensing Appeal Board, in the "Yellow Creek" case, determined that the EPA has sole jurisdiction over the regulation of water quality with respect to the withdrawal and discharge of waters for nuclear power stations and that the NRC is prohibited from placing any restrictions or requirements upon the licensees of those facilities with regards to water quality (Tennessee Valley Authority [Yellow Creek Nuclear Plant, Units 1 and 2], ALAB-515, 8 NRC 702, 712-13 [1978]). Nevertheless, the Staff has identified a variety of measures that could mitigate potential impacts resulting from continued operation of the CR-3 cooling water system. These could include:

- behavioral barriers
- diversion devices
- alternative intake systems

- alternative intake screen systems
- closed-cycle systems
- variable-speed pumps
- cooling water flow adjustments
- scheduled outages
- fish return system
- habitat restoration or enhancement
- fish stocking

The Staff has not conducted an analysis of each of these measures relative to their applicability to CR-3. The following discussion provides only a brief overview of these technologies. Based on results of the 316 Demonstration (SWEC, 1985), several of these technologies were incorporated at the CREC and are components of the NPDES permit for CR-1, CR-2, and CR-3.

The design of behavioral barriers potentially causes fish to actively avoid entry into the intake area. These may include sound, light, or air bubbles (Clay, 1995). Sound barriers, which would be located at an intake structure, include low-frequency, infra-wave sound; pneumatic or mechanically generated low-frequency sounds; or transducer-generated sound. Light barriers may emit either a constant or strobe-type beam of light. Air bubble curtains produce a continuous, dense chain of bubbles. These barrier types may deter some species of fish from entering the intake structure. The effectiveness of behavioral barriers varies among species and behavioral technologies would also be ineffective on fish eggs, early larval stages, or other planktonic organisms. At the CREC, the effectiveness of behavioral barriers at the end of an intake canal; and in an area that would be subject to drift algae, suspended sediments, and biofouling organisms; would be limited and difficult to maintain.

Diversion devices, the most commonly used barriers, are physical structures, such as louvers, barrier nets, or chains and cables designed to guide fish away from a certain area, such as the intake (Clay, 1995). Louvers consist of a series of evenly spaced vertical slats that create localized turbulence that fish can detect and actively avoid. Louvers typically have a smaller spacing between the slats or bars than a standard trash rack. Barrier nets are simply nets placed across an intake channel to prevent fish from access to an intake structure. The design of a barrier net system has to finely balance the mesh size with the intake requirements. Chains or cables, vertically hung in an intake structure, form a physical and visible barrier to fish. However, like barrier nets, they may alter hydraulic flow patterns in an intake. These types of structures only affect those organisms that can actively respond and would not prevent entrainment of fish eggs, larvae, or other planktonic organisms. At the CREC, the effectiveness of diversion devices at the end of an intake canal; and in an area that would be subject to drift algae, suspended sediments, and biofouling organisms; would be limited and difficult to maintain.

Another type of mitigation measure may be an alternative intake system. An alternative surface water intake system could include an offshore intake structure with a velocity cap. Use of groundwater can also mitigate impacts on aquatic resources that result from the use of surface water as a cooling water source.

Alternate intake screen systems may include Ristroph traveling screens, wedge-wire screens, and/or fine-mesh screens. Ristroph screens are traveling screens fitted with fish buckets that collect fish and lift them out of the water where they are gently sluiced away prior to debris removal with a high-pressure spray. Several States approve Ristroph screens as the best technology available to mitigate impingement impacts. Studies have shown survival of species can exceed 90 percent when using the Ristroph screen (Pankratz, 2004). Wedge-wire screens, constructed of wire of triangular cross section so that the surface of the screen is smooth while the screen openings widen inwards, are widely used for hydropower diversion structures and essentially eliminate impingement and reduce larval entrainment. Fine-mesh screens are simply wire screens with the mesh sized to minimize ichthyoplankton entrainment. However, smaller mesh could result in more clogging and biofouling problems. Also, as flow rates through fine-mesh screens are low (e.g., as low as 0.02 ft/s [0.006 m/s]), a large area is required for this technology to ensure sufficient water is available to meet intake flow requirements (York et al., 2005). A fish return system would be required to make an alternate intake screen system practicable. The practicable alternative to using fine-mesh screens or returning fish to Salt Creek to reduce entrainment and impingement at the CREC is the reduction in intake flow, coupled with the Mariculture Center (Golder Associates Inc., 2007b).

Opportunities to reduce the effects of thermal discharges include relocation, design, and operation options (York et al., 2005). Closed-cycle systems recycle cooling water in a closed piping system and use evaporative cooling (such as in a cooling tower or pond) as a means of dissipating the heat from the condensers. Cooling towers could include wet, hybrid, or dry towers. Wet and hybrid cooling towers would still require withdrawal of water from Crystal Bay to make up for water losses due to blowdown and evaporation. However, the water withdrawal rate would be significantly lower than the current once-through cooling system. A dry cooling tower uses ambient air to dissipate heat, essentially acting as an automobile radiator. Thus, no makeup water is required for dry cooling. However, this results in lower plant efficiency, requiring more fuel to produce the same amount of electricity. Design options for reducing thermal effects (other than changing to a closed-cycle system) are mainly limited to changing the type of discharge outfall used to enhance mixing or using a cooling pond or helper tower to reduce the temperature of the discharge water. Relocating the discharge outfall to deeper water can enhance mixing of the thermal plume, reduce the area affected by the higher elevated temperatures, or remove the thermal plume from proximity to sensitive biological resources, such as seagrass beds (York et al., 2005). Due to the shallow nature of Crystal Bay, this mitigation measure would be impracticable. Helper cooling towers are in use at the CREC.

Cooling water flow adjustments through the plant is another type of mitigation strategy that may be applicable to CR-3. This could include the use of variable speed pumps and cooling water bypass flow. Variable speed pumps would reduce the intake flow during periods of peak entrainment or impingement. However, variable speed pumps would also decrease generating efficiency, and the thermal plume may increase in size. Another potential mitigation strategy may be to schedule outages for performing regular inspection, maintenance, and refueling during peak spawning seasons for those species that move to inshore areas to spawn. The 15 percent flow reduction at the CREC from November through April currently reduces entrainment and impingement. Cooling water bypass flow would reduce the cooling water flow rate through the condensers and add a corresponding amount of bypass flow into the discharge canal. This alternative may reduce entrainment mortality but not impingement.

A fish return system would provide some mitigation benefits. Impinged fish at the CREC are disposed of at a landfill. A sluiceway sending impinged fish to the discharge canal would not be effective, as many impinged fish are stunned, disoriented, or injured by the impingement and would be susceptible to thermal stress in the discharge canal and/or to re-impingement by the cooling tower intakes. Similarly, returning impinged fish to the nearby Salt Creek would introduce suspended solids that would impair the quality of that system.

Habitat restoration or enhancement and fish stocking are also potential mitigation strategies for some species affected by entrainment and impingement. However, these are compensatory measures as opposed to preventative measures, which are the preferred mitigation strategies of Federal and State resource agencies. Habitat restoration or enhancement can include: the creation, restoration, and banking of wetlands; planting of submerged aquatic vegetation; and construction of artificial habitats (e.g., reefs). The ultimate goals of creating, restoring, or banking of wetlands are to increase production, survival, and growth of selected species by providing or improving spawning, nursery, and foraging habitat availability or quality (EPRI, 2003). The Mariculture Center, discussed in Sections 4.5.2 and 4.5.3, provides mitigation for entrainment and impingement losses at the CREC. For heat shock, SAV plantings were required in past NPDES permits to mitigate thermal impacts that occurred prior to the use of helper cooling towers and a POD limit on temperature.

4.6 TERRESTRIAL RESOURCES

The issues related to terrestrial resources applicable to CR-3 are discussed below and listed in Table 4-6. With the exception of threatened or endangered species (discussed in Section 4.7), all terrestrial ecology issues are considered Category 1. The NRC did not find any new and significant information during the review of the applicant's ER (Progress Energy, 2008a), the site visit, or during the scoping process or review of public comments. Therefore, for plant operation during the license renewal term, there are no impacts to terrestrial resources beyond those discussed in the GEIS. For these Category 1 issues, the NRC concludes in the GEIS that the impacts are SMALL.

Table 4-6. Terrestrial Resources Issues. *Section 2.2.6 provides a description of the terrestrial resources at the CREC and in the surrounding area.*

Issues	GEIS Section	Category
Cooling tower impacts on crops and ornamental vegetation	4.3.4	1
Cooling tower impacts on native plants	4.3.5.1	1
Bird collisions with cooling towers	4.3.5.2	1
Cooling pond impacts on terrestrial resources	4.4.4	1
Power line right-of-way management (cutting and herbicide application)	4.5.6.1	1
Bird collisions with power lines	4.5.6.2	1
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3	1
Floodplains and wetland on power line right-of-way	4.5.7	1

4.7 THREATENED OR ENDANGERED SPECIES

The impact to threatened or endangered species is a site-specific (Category 2) issue and is discussed below and listed in Table 4-7.

Table 4-7. Threatened or Endangered Species Issue. *A description of the threatened or endangered species on or near the CREC site is provided in Section 2.2.7.*

Issue	GEIS Section	Category
Threatened or endangered species	4.1	2

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. § 1531, et seq.) requires each Federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any Federally-endangered or threatened species or to result in the destruction or adverse modification of any Federally-designated critical habitat of such species (NMFS, 2005). Sections 2.2.7.1 (Aquatic Species) and 2.2.7.2 (Terrestrial Species) describe the presence of Federally-threatened or endangered species or their critical habitat in the vicinity of CR-3 and its associated transmission lines.

When license renewal may affect a species protected under the ESA, the NRC is required to consult with appropriate agencies to determine whether threatened or endangered species are present and whether they or their critical habitat are likely to be adversely affected by continued operation of the nuclear plant during the license renewal term. On April 13, 2009, the NRC separately contacted the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) to request information on Federally-listed threatened and endangered species and the impacts of license renewal (NRC, 2009a), (NRC, 2009b). In response, the NMFS sent a list of species located along the entire Florida portion of the Gulf of Mexico under their jurisdiction on April 20, 2009 (NMFS, 2009). The NMFS has previously issued two Biological Opinions with the applicant and the NRC regarding sea turtle impingement at the CREC (NMFS, 1999), (NMFS, 2002). The NRC did not receive a response from the FWS. On June 8, 2009, the NRC requested information on species by the FWC that might be in the vicinity of CR-3 and its associated transmission lines (NRC, 2009c). The July 20, 2009, response received from the FWC included both Federally- and State-listed species that may be in the vicinity of the plant and the transmission lines (FWC, 2009).

4.7.1 Aquatic Species

Section 2.2.7.1 describes the Federally-threatened or endangered aquatic species near CR-3. Aquatic species that are Federally-listed as threatened or endangered and that occur in the vicinity of CR-3 are limited to two species of fish, five species of sea turtles, one crocodilian species, and one marine mammal. These species include the Gulf sturgeon (*Acipenser oxyrinchus desotoi*), smalltooth sawfish (*Pristis pectinata*), green turtle (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), American alligator (*Alligator mississippiensis*), and Florida manatee (*Trichechus manatus latirostris*). There are no Federally-designated critical habitats for these species in the action area (i.e., the area affected by CR-3's intake or discharge) (NMFS, 1999), (NMFS, 2002), (NMFS, 2009).

The Federally-endangered whale species that have been reported from the Gulf of Mexico include the humpback whale (*Megaptera novaengliae*), North Atlantic right whale (*Eubalaena* *glacialis*), and sperm whale (*Physeter macrocephalus*) (NMFS, 2002). Large whale species are not likely to occur in the inshore shallow waters near the CREC. Also, the NMFS does not believe that resident stocks of the whale species occur in the Gulf of Mexico. Therefore, the NMFS (2002) concluded that the potential for CREC operations affecting listed large whale species is discountable.

4.7.1.1 *Gulf Sturgeon and Smalltooth Sawfish*

Studies conducted at the CREC resulted in no observations or collections of Gulf sturgeons or smalltooth sawfish (Grimes and Mountain, 1971), (AEC, 1973), (NUS Corporation, 1978), (SWEC, 1985), (FPC, 2002), (Ager et al., 2008), (Progress Energy, 2008a). The NMFS (2002) does not believe that Gulf sturgeon would stray from mud and sand bottom foraging areas to enter the rocky bottomed substrates found within the CREC intake canal. Based on this information, the NMFS (2002) concluded that the chance of the operation of the CREC affecting the Gulf sturgeon is discountable.

The probability that CR-3 will entrain, impinge, or otherwise affect the smalltooth sawfish is very low. Smalltooth sawfish give birth to live pups that are nearly 2 ft (0.6 m) in length (Glenn, 2007); therefore, entrainment of this species would not be an issue. No impingement of smalltooth sawfish has occurred at the CREC (AEC, 1973), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008).

When work is performed in the intake or discharge canal (e.g., dredging in the coal barge turning basin within the intake canal), the applicant must comply with the “Sea Turtle and Smalltooth Sawfish Construction Conditions” that are part of the FDEP’s State Programmatic General Permit (FDEP, 2010b). The construction conditions, developed by the NMFS (2006), include the following wording:

> The permittee shall instruct all personnel associated with the project of the potential presence of these species and the need to avoid collisions with sea turtles and smalltooth sawfish. All construction personnel are responsible for observing water-related activities for the presence of these species.
>
> The permittee shall advise all construction personnel that there are civil and criminal penalties for harming, harassing, or killing sea turtles or smalltooth sawfish, which are protected under the Endangered Species Act of 1973.
>
> Siltation barriers shall be made of material in which a sea turtle or smalltooth sawfish cannot become entangled, be secured properly secured, and be regularly monitored to avoid protected species entrapment. Barriers may not block sea turtle or smalltooth sawfish entry to or exit from designated critical habitat without prior agreement from the National Marine Fisheries Service’s Protected Resources Division, St. Petersburg, Florida.
>
> All vessels associated with the construction project shall operate at “no wake/idle” speeds at all times while in the construction area and while in water depths where the draft of the vessel provides less than four-foot clearance from the bottom. All vessels will preferentially follow deep-water routes (e.g., marked channels) whenever possible.
>
> If a sea turtle or smalltooth sawfish is observed within 100 yards of the active daily construction/dredging operation or vessel movement, all appropriate precautions shall be implemented to ensure its protection. These precautions shall include cessation of operation of any moving equipment closer than 50 feet

> of a sea turtle or smalltooth sawfish. Operations of any mechanical construction equipment shall cease immediately if a sea turtle or smalltooth sawfish is seen within a 50-ft radius of the equipment. Activities may not resume until the protected species has departed the project area on its own volition.
>
> Any collision with and/or injury to a sea turtle or smalltooth sawfish shall be reported immediately to the National Marine Fisheries Service's Protected Resources Division … and the local authorized sea turtle stranding/rescue organization and the local authorized sea turtle stranding/rescue organization.
>
> Any special construction conditions, required of your specific project, outside these general conditions, if applicable, will be addressed in the primary consultation.

Based on the above, the Staff concludes that the operation of CR-3 for an additional 20 years associated with license renewal will not affect either Gulf sturgeon or smalltooth sawfish.

4.7.1.2 *Sea Turtles*

Sea turtles observed from the nearshore waters of the Gulf of Mexico in Citrus County include the green turtle, hawksbill, Kemp's ridley, leatherback, and loggerhead. However, the applicant reports no observations of leatherbacks at or near CR-3 (Progress Energy, 2008a).

The primary impact of CR-3 operations on sea turtles is impingement on the trash racks associated with its once-through cooling system. Most sea turtle rescues and recoveries at the CREC occur at CR-3. Only occasional entrapment of sea turtles occurs at CR-1 and CR-2. Prior to1998, monitoring of sea turtle strandings and mortalities were not continuous. Eight observed strandings of sea turtles on the CR-3 trash racks occurred from 1994 through 1997 (Progress Energy, 2008a). In 1998, the applicant initiated a continuous monitoring and rescue program to reduce sea turtle strandings and mortalities. During periods of high turtle concentrations (generally February to May), the trash racks are continuously inspected, while during periods of low sea turtle concentrations (generally June to January), they are monitored once every 2 hours (NMFS, 1999), (Progress Energy, 2008a).

The applicant's "AI-571 Sea Turtle Rescue and Handling Guidance" (Progress Energy, undated) contains procedures, that have been developed in conjunction with the NMFS, to ensure that sea turtles are safely removed from the bar racks, evaluated to determine whether they are alive or dead, identified to determine species and life stage, and examined for boat propeller wounds or other trauma (e.g., diseases). The Mariculture Center receives all obviously alive sea turtles rescued from the trash racks. The staff at the Mariculture Center tags and releases healthy sea turtles or transfers sick or injured sea turtles to a qualified center for treatment and rehabilitation. If recovered sea turtles are comatose or appear dead, resurrection is attempted. Dead sea turtles are necropsied.

In 1998, there were 40 live strandings, 8 non-causally related mortalities, and 5 causally related mortalities. Most of these were Kemp's ridleys (FPC, 2001). Table 4.7.1.2-1 summarizes sea turtle strandings at the CREC from 1999 to 2009. Most strandings were Kemp's ridley and green turtles. Loggerheads were also captured, but in lower numbers. Strandings from 1999 to 2009 included no leatherbacks and only one hawksbill. Some of the live rescues showed evidence of boat injuries or diseases (particularly fibropapilloma). Similarly, most of the non-causally related mortalities are due to either boat strikes or disease (Progress Energy, 2000), (Progress Energy, 2001), (Progress Energy, 2002), (Progress Energy, 2003), (Progress Energy, 2004), (Progress Energy, 2005b), (Progress Energy, 2006b), (Progress Energy, 2007c), (Progress Energy, 2008c), (Progress Energy, 2009o), (Progress Energy, 2010d). Causally-related mortalities of sea turtles due to CR-3 operations are primarily from drowning while impinged upon the bar racks (Progress Energy, 2005c), (Progress Energy, 2007d), (Progress Energy, 2008d), (Progress Energy, 2009p), (Progress Energy, 2009q) and more rarely on the intake screens (Progress Energy, 2007e).

The NMFS determines the incidental take[10] for listed sea turtles at the CREC. The biennial incidental take limits established in the 1999 Biological Opinion were 50 live takes, 8 dead turtles not causally related to plant operations, and 5 dead turtles causally related to plant operations (NMFS, 1999). The NMFS-authorized incidental take limit for the January 1, 2001, through December 31, 2002, biennial reporting period was almost exceeded by September 2001. The rapid recovery of Kemp's ridley in the Gulf of Mexico potentially accounted for this; as no changes in plant operations occurred at the CREC during this period. Recovery of the species has led to an increase in the numbers of juvenile and sub-adult Kemp's ridleys inhabiting the shallow coastal areas of the Gulf (FPC, 2002). The applicant consulted with the NMFS to request a modification to the existing take limit. In the 2002 Biological Opinion, the incidental take was modified to 75 turtles rescued alive from the bar racks annually and 3 dead turtles annually that are causally related to plant operations. Any exceedance of the amount of incidental take requires the Staff to immediately request reinitiation of formal consultation (NMFS, 2002). No limitation was set on the number of dead sea turtles captured that are not causally related to plant operations (NMFS, 2002). These include sea turtles that die from injuries or disease and that drift into the intake canal and ultimately become impinged on the bar racks.

Table 4.7.1.2-1. Sea Strandings at the Crystal River Energy Complex

Year	Number of Sea Turtles (live/non-plant mortalities/plant-related mortalities)					
	Green Turtle	Hawksbill	Kemp's Ridley	Leatherback	Loggerhead	Totals
1999	1/0/0	0/0/0	6/0/0	0/0/0	2/0/0	9/0/0
2000	5/2/0	1/0/0	6/3/0	0/0/0	1/0/0	13/5/1[(a)]
2001	8/1/0	0/0/0	53/2/1	0/0/0	1/0/0	62/3/1
2002	12/1/1	0/0/0	6/3/0	0/0/0	2/0/0	20/4/1
2003	1/0/0	0/0/0	2/0/0	0/0/0	0/0/0	3/0/0
2004	5/1/0	0/0/0	7/1/1	0/0/0	1/1/0	13/3/1
2005	2/1/0	0/0/0	2/0/0	0/0/0	1/0/0	5/1/0
2006	4/1/0	0/0/0	3/1/1	0/0/0	2/3/0	9/5/1
2007	2/0/1	0/0/0	1/1/0	0/0/0	0/0/0	3/1/1
2008	2/1/1	0/0/0	4/0/0	0/0/0	0/0/1	6/1/2
2009	5/2/0	0/0/0	5/0/2	0/0/0	1/0/0	11/2/2

(a) Skeletal remains of an unidentified sea turtle.

Sources: Progress Energy 2000, 2001, 2002, 2003, 2004, 2005b, 2006b, 2007c, 2008c, 2009o, 2010d

[10] Section 9 of the ESA defines take as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct"; and incidental take as "take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

The CREC currently operates under the restrictions of the August 8, 2002, Biological Opinion (NMFS, 2002). The Biological Opinion concluded that operation of the CREC is not likely to jeopardize the continued existence of the five sea turtle species. However, the NMFS anticipated that incidental takes would occur and, therefore, issued an Incidental Take Statement (ITS), pursuant to Section 7 of the ESA. The ITS contained reasonable and prudent measures, with implementing terms and conditions, to help minimize incidental take (NMFS, 2002). The 2002 Biological Opinion (or any approved revision or amendment to this Biological Opinion) would be in effect if the NRC renews the CR-3 license. In the 2002 Biological Opinion, the NMFS (2002) determined that operation of the CREC, when added to ongoing activities affecting the sea turtles in the area and cumulative effects, would not affect sea turtles in a way that reduces the number of animals born in a particular year, the reproductive success of adult sea turtles, or the number of young sea turtles that annually recruit into the adult breeding population.

Several other procedures minimize the potential for causally harming or killing sea turtles at the CREC. Biofouling of the bar racks may be attractive to sea turtles (i.e., provide a food source for some of the species). Also, biofouling can increase the velocity of water flowing through the bars which could increase the potential for impingement, particularly by sea turtles weakened by injury or disease. Removal and cleaning of the bar racks occurs about three to four times per year. Also, routine operation of the trash rake keeps the bar racks free of debris (FPC, 2002). When work is performed that could affect the intake or discharge canal (e.g., dredging in the coal barge turning basin within the intake canal), the applicant must comply with the “Sea Turtle and Smalltooth Sawfish Construction Conditions” (USACE, 2008). Section 4.7.1.1 above provided a listing of these conditions.

The measures taken by the applicant to monitor, rescue and resuscitate, and tag and release sea turtles effectively protects and minimizes the potential for power plant causally related mortalities at CR-3. In conjunction with the terms and conditions of the ITS, continued operation of CR-3 will not jeopardize sea turtle species.

4.7.1.3 *American Alligator*

The American alligator is common in Florida (Progress Energy, 2008a). Habitat for the American alligator is primarily freshwater, slow-moving streams and rivers; swamps and marshes; and ponds and lakes. It occurs in the swampy areas of the CREC and probably occurs in wetlands, ponds, and streams along the associated transmission lines (Progress Energy, 2008a). Use of aquatic-approved herbicides applied according to label instructions by licensed applicators or personnel under their supervision minimize any risks to American alligators or their prey species from transmission line maintenance (Progress Energy, 2009c). The Staff concludes that the operation of CR-3 and its associated transmission lines for an additional 20 years associated with license renewal will not affect the American alligator.

4.7.1.4 *Florida Manatee*

Manatees in northwestern Florida primarily use the headwaters of Homosassa and Crystal rivers as their winter, warmwater refuges (Rathbun et al., 1990). About 150 Florida manatees inhabit the Crystal River during winter. Some of these Florida manatees may occasionally visit the CREC discharge canal (FWS, 2008). The CREC discharge canal (like most warm industrial discharge areas) usually lacks vegetation necessary to maintain manatees over the winter months. As early as March, manatees leave the Homosassa and Crystal rivers and disperse into Waccasassa and Withlacoochee rivers, the CREC discharge canal, and the Cross Florida Barge Canal. Use of these areas primarily occurs during the spring and summer when manatees are en route from the principal winter to summer habitats. Summer habitats include the estuaries associated with the Suwannee, Crystal, Homosassa, and Chassahowitzka rivers (Rathbun et al., 1990). Up to five Florida manatees use the CREC discharge canal for short periods during cool weather, most heavily in spring as individuals disperse northward from Crystal River (FNAI, 2009). Use of the CREC discharge canal as a manatee layover area during this period would continue during the CR-3 license renewal period.

Isolated incidents of manatee impingement have occurred at Turkey Point and St. Lucie plants in Florida (Gunter et al., 2001), but similar incidents have not occurred at the CREC. No significant changes in the intake (e.g., intake flow rates and velocities) are expected from the CR-3 EPU (Section 2.1.6); therefore, incidents of manatee impingement causally related to CREC operations would not be expected during the license renewal period.

The applicant has implemented an FDEP-approved manatee protection plan that establishes a number of guidelines to minimize adverse impacts to Florida manatees at the intake and discharge areas (FDEP, 2002). The Manatee Protection Plan is in effect yearly during the winter period of November 13 through March 31. Key components of the plan include:

- Contact the Florida Marine Research Institute if an unplanned shutdown occurs that is expected to result in no thermal discharge for 24 hours or more.
- Under most circumstances, the FDEP and FWC's Bureau of Protected Species Management needs to be provided a schedule of any anticipated in-water work within the discharge canal.
- The observation of a distressed manatee in the intake or discharge canal requires notification of the FWC's Marine Pathology Laboratory and the FWS.
- Provide instruction to all personnel associated with in-water work about the potential presence of manatees and need to avoid boat collisions with them. All vessels need to have an observer onboard to identify the presence and location of manatees.
- All vessels need to operate at "no wake/idle" speeds and, whenever possible, follow routes of deep water.
- When a manatee observation occurs, the implementation of all precautions to ensure the protection of the manatee must occur. These precautions include the immediate shutdown of equipment, if necessary. Activities can only resume after the manatee has departed to a safe distance on its own volition.
- Any collision with and/or injury to a manatee needs to be immediately reported to the FWC and FWS.

When other work is performed in the intake or discharge canal (e.g., dredging in the coal barge turning basin within the intake canal), the applicant must also comply with the "Standard Manatee Conditions for In-Water Work – July 2009" that are part of the FDEP's State Programmatic General Permit (FDEP, 2010b). Several of the conditions for in-water work are similar to those of the Manatee Protection Plan listed above. Conditions unique to in-water work contain the following wording (FDEP, 2010b):

> Temporary signs concerning manatees shall be posted prior to and during all in-water project activities.
>
> Siltation or turbidity barriers shall be made of material which prevents the potential for entanglement of manatees, the barriers shall be properly secured, and the barriers shall be regularly monitored to avoid manatee entanglement or entrapment. Barriers must not impede manatee movement.
>
> All on-site project personnel are responsible for observing water-related activities for the presence of manatee(s). All in-water operations, including vessels, must be shutdown if a manatee(s) comes within 50 feet of the operation. Activities will not resume until the manatee(s) has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the manatee(s) has not reappeared within 50 feet of the operation. Animals must not be herded away or harassed into leaving.

As boat access to the discharge canal is restricted, manatees in the canal receive protection from boat collisions (CCBCC, 2009). Most of the shoreline areas in the area of the CREC are 25 mi/hr (40 km/hr) speed zones. The area within the discharge canal and area just north of the discharge dike is a slow speed zone (speed that makes little or no wake) from November 15 through April 30 and a 25 mi/hr (40 km/hr) speed zone the remainder of the year (FWC, 2002).

4.7.1.5 *Summary*

Other than the causally-related loss of a few sea turtles, current operations of CR-3 and vegetation management of the transmission lines do not affect any listed aquatic species. No significant changes in CR-3 operations and transmission line maintenance will occur during the license renewal period. Therefore, no adverse impacts to Federally-listed threatened or endangered aquatic species are expected during the license renewal period. The Staff concludes that the impact of CR-3 operations during the license renewal period would be SMALL for all Federally-listed aquatic species.

4.7.2 Terrestrial Species

Impacts to listed threatened and endangered species require consultation with appropriate agencies to determine whether such listed species are present and whether they would be adversely affected by continued operation of CR-3 during the license renewal term. Sections 2.2.6 and 2.2.7 of this SEIS discuss the characteristics and habitat of threatened and endangered species in the vicinity of the CREC site and associated transmission lines. Summaries of the habitat requirements of each listed species are provided below.

The Staff contacted the FWS, the FWC, and the Florida Natural Areas Inventory (FNAI) to request information that could assist the Staff in its assessment of the environmental impacts associated with license renewal. These letters are presented in Appendix D of this SEIS. The FWS previously responded to a request by the applicant to provide information regarding Federally-listed species that may be impacted by the proposed relicensing action. The FWS responded by letter dated October 28, 2008, and made recommendations to the applicant regarding maintenance activities in ROWs where there was a possibility of the occurrence of the eastern indigo snake (*Drymarchon corais couperi*), which is Federally-listed as threatened (FWS, 2008). The FWC responded to the Staff's request by letter dated July 22, 2009, and provided information on State-listed natural resources and their habitats potentially affected by the relicensing action at the CREC site and potentially affected by maintenance activities along the ROWs (FWC, 2009). The Staff did not receive a response from the FNAI.

Eleven Federally-listed animal species and eight plant species have been reported in the counties in which the CREC site is located or that are traversed by CR-3 transmission lines. Section 2.2.7.2 of this SEIS describes these Federally-listed species and their habitats in greater detail. The bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*), both formerly listed as endangered but since delisted, are also known to occur within the project area.

During the license-renewal term, Federally-listed and State-listed threatened or endangered species on the CREC site could be affected by any ground-disturbing activities that occurred in potentially suitable habitat of the species.

The following species could occur on the CREC site based on the presence of potentially suitable habitat and the current range of the species (see Section 2.2.7 for additional detail and supporting information):

- Eastern indigo snake. The species uses sandhills, flatwoods, hammocks, coastal scrub, dry glades, palmetto flats, prairie, riparian habitats, and wet fields. It could occur in suitable habitats on the CREC.

- Piping plover (*Charadrius melodus*). The piping plover has not been observed at the CREC site (Progress Energy, 2008a), but potentially suitable mud flats are present along the western shoreline of the site.

- Wood stork (*Mycteria americana*). This species is the only Federally-listed species that has been observed at the CREC site (Progress Energy, 2008a).

- Bald eagle. The species is no longer listed under the ESA but is still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Three bald eagle nests have been documented within the CREC site boundaries (FWC, 2009). Another bald eagle nest was recorded slightly north of the CREC site. Bald eagles are occasionally observed flying and foraging along Crystal Bay and perching in trees at the CREC (Progress Energy, 2008a).

A total of 18 plant and 14 animal species that are listed by the State of Florida as endangered, threatened, or species of special concern are known to occur in Citrus County, the location of the CREC. The habitats and potential occurrences of each species in the project area are presented in Table 2-6. There are only two State-listed species (discussed above) that are known to occur on the CREC site—the bald eagle (threatened) and the wood stork (endangered). The FWC indicated that 3 of these 14 animal species listed as threatened by the State of Florida can potentially occur at the CREC site—the gopher tortoise (*Gopherus polyphemus*), the eastern indigo snake, and the piping plover (FWC, 2009).

On the CREC site, the applicant currently reviews proposed projects prior to their start to determine if impacts to threatened and endangered species or other protected resources would occur. In a recent review of the laydown area for the south cooling tower, the applicant identified the habitats in the project area, performed a wetland delineation in accordance with the U.S. Army Corps of Engineers (USACE) 1987 Wetland Delineation Manual, surveyed the site for listed species, used geographic information system (GIS) data to determine if previous records of listed species occurred within 1 square mile (mi^2) of the project area, and performed a wetlands functional assessment (Golder Associates, Inc., 2009). A consistent application of this review process would ensure that impacts to listed species and their habitats were minimized during the license renewal term.

The maintenance of transmission line ROWs during the license renewal term could also affect species and their habitats as regular vegetation management is conducted and occasional repairs to or replacement of transmission infrastructure occurs.

The following Federally-listed species could occur along the transmission lines associated with CR-3:

- Florida bonamia (*Bonamia grandiflora*). Nearest known location is about 14 mi (23 km) northeast of the Central Florida transmission corridor where it occurs in bare sunny sand areas.

- Brooksville bellflower (*Campanula robinsiae*). Nearest known location is about 8 mi (13 km) east of the Lake Tarpon transmission line where it occurs in wet prairie and along the edges of ponds.

- Florida golden aster (*Chrysopsis floridana*). This species is known from several central Florida counties including Pinellas County, which is crossed by the Lake Tarpon transmission line, where it occurs in open, sunny areas in sand pine-evergreen oak scrub vegetation on fine sand.

- Longspurred mint (*Dicerandra cornutissima*). This species has been found in Marion and Sumter Counties, which are crossed by the Central Florida transmission line, where it occurs in open areas in sand pine scrub or oak scrub, and in the ecotones between these and turkey oak communities. The FNAI database indicates the occurrence of this species in the vicinity of the Central Florida transmission line.

- Scrub buckwheat (*Eriogonum longifolium* var. *gnaphalifolium*). The species is known from seven counties in central Florida, two of which (Marion and Sumter) are crossed by the Central Florida transmission line. The species occurs in sandhill, oak-hickory scrub on yellow sands, high pineland between scrub and sandhill, and turkey oak barrens.

- Cooley's water willow (*Justicia cooleyi*). The species is native to the Brooksville Ridge in north central Hernando County approximately 8 mi (13 km) east of the Lake Tarpon transmission line, where it is found in hardwood forests on uplands or hills, but also on low rises in wet hammocks or swamps.

- Britton's beargrass (*Nolina brittoniana*). This species has been recorded in Marion County, which is crossed by the Central Florida transmission line, and in

Hernando and Pasco Counties, which are crossed by the Lake Tarpon transmission line. It occurs in scrub, sandhill, scrubby flatwoods, and xeric hammocks.

- Eastern indigo snake. The species uses sandhill, flatwoods, hammocks, coastal scrub, dry glades, palmetto flats, prairie, riparian habitats, and wet fields. The eastern indigo snake could occur in suitable habitats on any of the CR-3 transmission line corridors. In the 1970s and 1980s, it was recorded in the Withlacoochee State Forest in the general vicinity of the Lake Tarpon transmission line.

- Florida scrub-jay (*Aphelocoma coerulescens*). This species occurs in fire-dominated open canopied oak scrub habitat on well-drained soils. The scrub-jay could occur in suitable habitat along the CR-3 transmission lines; the FWS observed several scrub-jays along the transmission lines from 1992–1996. The Central Florida transmission line crosses oak scrub habitat in Marion County very close to the Citrus County line.

- Peregrine falcon. The species is no longer Federally-listed under the ESA. The species could occur as a transient through the areas of the CR-3 transmission lines.

- Whooping crane (*Grus americana*). Whooping cranes cross the project area during migration to wintering grounds in Florida. Half of the experimental population is expected to overwinter at St. Marks National Wildlife Refuge along the Gulf coast south of Tallahassee, Florida, and the remainder is expected to migrate southward to the Chassahowitzka National Wildlife Refuge, just south of the CREC site. Based on FWS tracking data, both transmission lines also appear to be within the daily activity areas of wintering cranes.

State-listed species that are known to occur along the Central Florida transmission line corridor include the longspurred mint (endangered; Marion County), the Florida scrub-jay (threatened; Citrus and Marion Counties), and the whooping crane (species of special concern; Citrus County), which flies over both transmission line corridors during migration and overwinters approximately 6 mi (9.6 km) east of the CREC in the immediate vicinity of the Central Florida transmission line. The FWC indicated that six additional species State-listed as threatened can potentially occur along the Central Florida transmission line corridor: the gopher tortoise, the eastern indigo snake, the short-tailed snake (*Stilosoma extenuatum*), the southeastern American kestrel (*Falco sparverius paulus*), the Florida sandhill crane (*Grus canadensis pratensis*), and the Florida black bear (*Ursus americanus floridanus*) (FWC, 2009).

State-listed species known to occur along the Lake Tarpon transmission line corridor include pondspice (*Litsea aestivalis*; endangered; Pasco County), scrub stylisma (*Stylisma abdita*; endangered; Citrus County), eastern indigo snake (threatened; Citrus County), Florida scrub-jay (threatened; Pasco and Pinellas Counties), southeastern American kestrel (threatened; Citrus, Hernando, and Pasco Counties), the bald eagle (threatened; known to nest along the line in Pasco County), and the whooping crane (species of special concern; Citrus County). The FWC indicated that four additional species that are State-listed as threatened can potentially occur along the Lake Tarpon transmission line corridor: the gopher tortoise, the short-tailed snake (*Stilosoma extenuatum*), the Florida sandhill crane, and the Florida black bear (FWC, 2009).

Many of the species that could occur along the transmission lines, especially the listed plant species, prefer open, disturbed, or early succession habitats similar to those that are common along maintained transmission ROWs. Continued maintenance of the ROW in an early successional state should favor these species.

The FWS, in response to a letter from the applicant describing their application for license renewal, expressed some concern for the eastern indigo snake, specifically with regard to their occurrence in transmission line ROWs (FWS, 2008). No other terrestrial species were mentioned in the FWS letter. The FWS recommended that any maintenance activity along the ROWs such as mowing, grubbing, disking, or burning should be conducted using the Standard Protection Measures for the Eastern Indigo Snake (FWS, 2004).

These guidelines (as modified in the FWS letter) recommend:

- establishment of an eastern indigo snake protection/education plan for construction personnel

- only individuals who have been authorized by a Section 10(a)(1)(A) permit issued by the FWS or the State of Florida are permitted to come into contact with an eastern indigo snake

The FWS stated in its letter that FWS approval of the protection/education plan for the snake was equivalent to a "may effect, not likely to adversely affect" determination for this species (FWS, 2008).

The applicant established the following activities to protect the eastern indigo snake during ROW maintenance (Progress Energy, 2010c). All ROW maintenance personnel receive training on eastern indigo snakes. Signs are not posted because ROW maintenance activities do not typically occur within a given area for more than one day, but two educational pamphlets (in Spanish and English) are provided to maintenance personnel. The pamphlets include: (1) color photos of the eastern indigo snake; (2) a description of the eastern indigo snake, its habits, and protection under Federal law; (3) instructions not to injure, harm, harass, or kill this species, and a description of legal restrictions on take and potential legal consequences of take; and (4) instructions to stop work upon seeing an eastern indigo snake, and to wait until the snake leaves the area before resuming work. The pamphlets provide telephone numbers of personnel to be contacted to report living or dead eastern indigo snakes. If any eastern indigo snakes are found, FPC personnel are directed to contact the FWS. These activities are generally consistent with the FWS guidelines. The NRC encourages FPC to seek concurrence on these measures from the FWS.

Impacts to the Florida scrub-jay could occur if maintenance of the transmission ROW resulted in the removal of existing oak scrub habitat. It is the applicant's policy to remove trees and other vegetation that could come into contact with conductors both from within and adjacent to the ROW. Consistent application of this policy has kept and will continue to keep the ROW and adjacent areas open and in early successional habitat, thus minimizing any adverse impacts to the scrub-jay.

There is a possibility for impact to whooping cranes as they fly through the area on their way to the Chassahowitzka National Wildlife Refuge. These birds could accidentally strike either the conductors or towers of either transmission line. The probability of an accidental collision by migrating cranes is not known, but no collisions have been reported for any of the cranes in this population. Based on FWS tracking data, both transmission lines appear to be within the daily activity areas of wintering cranes and could warrant mitigation such as line markers. Any such mitigation should be developed in consultation with the FWS. It should be noted that the FWS did not express concern for the whooping crane in their correspondence with the applicant on the effects of license renewal on listed species (FWS, 2008).

The Staff encourages the applicant to report the existence of any Federally- or State-listed endangered or threatened species within or near the transmission line ROWs to the FWC and/or FWS if any such species are identified during the license renewal term. In particular, if any evidence of injury to or mortality of migratory birds or threatened or endangered species is observed within the corridor during the license renewal period, the Staff encourages the applicant to promptly report this to the FWS and FWC. Additionally, the Staff encourages the applicant to continue reporting information concerning wood stork use and any other listed species of the CREC to the FWC and FWS.

Operation of the CR-3 site and its associated transmission lines is not expected to adversely affect any threatened or endangered species during the license renewal term. Therefore, the Staff concludes that adverse impacts on threatened or endangered species during the license renewal term would be SMALL. Mitigation measures currently in place at the CR-3 site minimize the effects of plant operation on terrestrial species. The Staff believes these current mitigation measures are adequate. The applicant should develop an eastern indigo snake protection/education plan for ROW maintenance personnel and submit that plan to the FWS for approval.

4.8 HUMAN HEALTH

The human health issues applicable to CR-3 are discussed below and listed in Table 4-8 for Category 1, Category 2, and uncategorized issues.

Table 4-8. Human Health Issues. *Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 contains more information on these issues.*

Issues	GEIS Section	Category
Microbiological organisms (occupational health)	4.3.6	1
Noise	4.3.7	1
Radiation exposures to the public (license renewal term)	4.6.1, 4.6.2	1
Occupational radiation exposures (license renewal term)	4.6.3	1
Electromagnetic fields – acute effects (electric shock)	4.5.4.1	2
Electromagnetic fields – chronic effects	4.5.4.2	Uncategorized

4.8.1 Generic Human Health Issues

The NRC did not find any new and significant information during its review of the applicant's ER (Progress Energy, 2008a), the site visit, or the scoping process. Therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS for these Category 1 issues, and the NRC concludes in the GEIS that the impacts are SMALL. The information presented below is a discussion of selected radiological programs conducted at CR-3.

4.8.1.1 *Radiological Environmental Monitoring Program*

The applicant conducts a radiological environmental monitoring program (REMP) to assess the radiological impact, if any, to its employees, the public, and the environment in the environs around the plant site. The environmental assessment process began before CR-3 began commercial operation. The operational REMP began on January 1, 1977, just before initial criticality, which was achieved on January 14, 1977. The REMP provides measurements of radiation and of radioactive materials for the exposure pathways and the radionuclides which lead to the highest potential radiation exposures to the public. The REMP supplements the radioactive effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than those calculated using the radioactive effluent release measurements and transport models (Progress Energy, 2009r).

The REMP is conducted by the State of Florida Department of Health, Bureau of Radiation Control. An annual radiological environmental operating report is issued, which contains a discussion of the results of the monitoring program. The report contains data on the monitoring performed for the most recent year and graphs which trend the data from prior years. The REMP collects samples of environmental media in order to measure the radioactivity levels that may be present. The media samples are representative of the radiation exposure pathways that may impact the public. The REMP measures the aquatic, terrestrial, and atmospheric environment for radioactivity, as well as the ambient radiation. Ambient radiation pathways include radiation from buildings and plant structures, and airborne material that may be released from the plant. In addition, the REMP measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). Thermoluminescent dosimeters (TLDs) are used to measure ambient radiation. The atmospheric environmental monitoring consists of sampling and analyzing the air for particulates and radioiodine. Terrestrial environmental monitoring consists of analyzing samples of broadleaf vegetation, citrus, and watermelon. The aquatic environmental monitoring consists of analyzing samples of seawater, groundwater, drinking water, and shoreline sediment. An annual land use census is conducted to determine if the REMP needs to be revised to reflect changes in the environment or population that might alter the radiation exposure pathways. The applicant has an onsite groundwater protection program designed to monitor the onsite plant environment for early detection of leaks from plant systems and pipes containing radioactive liquid (Progress Energy, 2009m). Additional information on the groundwater protection program is contained in Chapter 2.

The Staff reviewed the applicant's annual radiological environmental operating reports for 2004 through 2008 to look for any significant impacts to the environment or any unusual trends in the data (Progress Energy, 2005a), (Progress Energy, 2006a), (Progress Energy, 2007a), (Progress Energy, 2008b), (Progress Energy, 2009i). No unusual trends were observed and the data showed that there was no measurable impact to the environment from operations at CR-3.

4.8.1.2 *Radioactive Effluent Release Program*

All nuclear plants were licensed with the expectation that they would release radioactive material to both the air and water during normal operation. However, NRC regulations require that radioactive gaseous and liquid releases from nuclear power plants must meet radiation dose-based limits specified in 10 CFR Part 20, and the as low as is reasonably achievable (ALARA) criteria in Appendix I to 10 CFR Part 50. Regulatory limits are placed on the radiation dose that members of the public can receive from radioactive material released by a nuclear power plant. In addition, nuclear power plants are required to file an annual report with the NRC which lists the types and quantities of radioactive effluents released into the environment. The radioactive effluent release and radiological environmental monitoring reports are available for review by the public through the Agencywide Documents Access and Management System (ADAMS) electronic reading room available through the NRC Web site.

The Staff reviewed the annual radioactive effluent release reports for 2004 through 2008 (Progress Energy, 2005d), (Progress Energy, 2006c), (Progress Energy, 2007f), (Progress Energy, 2008f), (Progress Energy, 2009s). The review focused on the calculated doses to a member of the public from radioactive effluents released from CR-3. The doses were compared to the radiation protection standards in 10 CFR 20.1301 and the ALARA dose design objectives in Appendix I to 10 CFR Part 50.

Dose estimates for members of the public are calculated based on radioactive gaseous and liquid effluent release data, and atmospheric and aquatic transport models. The 2008 annual radioactive material release report (Progress Energy, 2009s) contains a detailed presentation of the radioactive discharges and the resultant calculated doses. The following summarizes the calculated hypothetical maximum dose to a member of the public, located outside the CR-3 site boundary, from radioactive gaseous and liquid effluents released during 2008:

- The maximum whole-body dose to an offsite member of the public from radioactive liquid effluents was 2.08 E-05 milliroentgen equivalent man (mrem) (2.08 E-07 millisievert [mSv]), which is well below the 3 mrem (0.03 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum organ (GI-tract) dose to an offsite member of the public from radioactive liquid effluents was 6.76 E-05 mrem (6.76 E-07 mSv), which is well below the 10 mrem (0.1 mSv) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum air dose at the site boundary from gamma radiation in gaseous effluents was 9.11 E-05 millirad (mrad) (9.11 E-07 milligray [mGy]), which is well below the 10 mrad (0.1 mGy) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum air dose at the site boundary from beta radiation in gaseous effluents was 3.26 E-04 mrad (3.26 E-06 mGy), which is well below the 20 mrad (0.2 mGy) dose criterion in Appendix I to 10 CFR Part 50.

- The maximum organ (thyroid) dose to an offsite member of the public from radioactive iodine and radioactive material in particulate form was 1.79 E-03 mrem (1.79 E-05 mSv), which is well below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

Based on its review of CR-3's doses to members of the public from radioactive effluents, the Staff found that CR-3 is operating in compliance with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50 and 10 CFR Part 20.

Routine plant operational and maintenance activities currently performed would continue during the license renewal term. Based on the past performance of the radioactive waste system to maintain the dose from radioactive effluents to be ALARA, similar performance is expected during the license renewal term.

In late 2009, the applicant shut down CR-3 for a planned steam generator replacement refueling outage. The old steam generators were placed into a newly constructed onsite concrete shielded storage facility. During the outage, NRC inspectors performed a radiation safety inspection of the steam generator replacement outage work. The inspection looked at the safety controls in place and the monitoring performed to protect the plant workers and members of the public from radiation. No radiation safety findings (i.e., violations of NRC regulations) of significance were reported (NRC, 2010a).

The applicant informed the NRC that it intends to increase the licensed reactor core thermal power level by approximately 15.5 percent from the current licensed 2,609 megawatts-thermal (MWt) to 3,014 MWt. The change requires NRC approval prior to its implementation. As part of its review process, the Staff will perform a thorough evaluation of the safety and radiological issues associated with the proposed action to verify that all regulatory requirements are met. The applicant's evaluation of the radioactive effluents and resulting offsite doses to the public shows that the radiation doses would increase in approximate proportion to the proposed power increase (i.e., approximately 15 percent) (Progress Energy, 2009m). A 15 percent increase in the radiation doses from radioactive effluents would still be well within the NRC's radiation dose limits in 10 CFR Part 20 and the ALARA criteria in Appendix I to 10 CFR Part 50.

The radiological impacts from the current operation of CR-3, including those from foreseeable changes to the plant, are not expected to change significantly. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the impacts from radioactive effluents would be SMALL.

4.8.2 Microbiological Organisms – Public Health

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 lists the effects of thermophilic microbiological organisms on public health as a Category 2 issue that applies to nuclear plants that use a cooling pond, lake, or canal or discharge to a small river. As discussed in Section 2.1.6, CR-3 has a once-through heat dissipation system that withdraws water from, and discharges it to, Crystal Bay in the Gulf of Mexico. Since the plant does not use cooling ponds, lakes, or canals or discharge to a small river, this issue does not apply to CR-3.

4.8.3 Electromagnetic Fields – Acute Effects

Based on the GEIS, the Commission found 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 is generally 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 Staff found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) criteria (IEEE, 1997), 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 impact of the proposed action on the potential shock hazard from the transmission lines, 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.

There are two 500-kilovolt (kV) lines that were specifically constructed to distribute power from CR-3 to the electric grid: Lake Tarpon and Central Florida. The applicant analyzed these transmission lines and identified the lines which had the highest potential for current-induced electric shock for the largest anticipated truck, vehicle, or equipment under the line. The applicant then calculated the electric field strength and induced current using a computer code, ACDCLINE, produced by the Electric Power Research Institute. The analysis showed that the maximum induced current values for both lines are in compliance with the NESC and are below the NESC limit of 5 milliamperes. The maximum induced current was calculated to be 4.9 milliamperes, which corresponded with a section of the Central Florida line (Progress Energy, 2008a).

The applicant has surveillance and maintenance procedures that require periodic inspections of their transmission lines to ensure that the lines continue to meet the NESC standards. These procedures include routine aerial inspections that include checks for encroachments, broken conductors, broken or leaning structures, and signs of trees burning, any of which would be evidence of ground clearance problems. Periodic ground inspections include examination for clearance at questionable locations, integrity of structures, and surveillance for dead or diseased trees that might fall on the transmission lines (Progress Energy, 2008a).

In the GEIS, the Staff found that electrical shock is of SMALL significance for transmission lines that are operated in conformance with the NESC criteria. Based on a review of the information provided in the applicant's ER, the Staff concludes that the transmission lines associated with CR-3 meet NESC criteria for limiting hazards, and thus the potential impact from electric shock during the renewal term is SMALL and no additional mitigation is warranted.

4.8.4 Electromagnetic Fields – Chronic Effects

In the GEIS, the chronic effects of 60-hertz (Hz) electromagnetic fields from power lines were not designated as Category 1 or 2, and will not be until a 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 report by NIEHS (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 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 Staff to change its position with respect to the chronic effects of electromagnetic fields. The Staff considers the GEIS finding of "not applicable" still appropriate and will continue to follow developments on this issue.

4.9 SOCIOECONOMICS

The socioeconomic issues applicable to CR-3 are presented in Table 4.9-1 for Category 1, Category 2, and one uncategorized issue (environmental justice). Section 2.2.8 of this SEIS describes the socioeconomic conditions near CR-3.

Table 4.9-1. Socioeconomic Issues. *Section 2.2.9 describes the socioeconomic conditions near CR-3.*

Issues	GEIS Section	Category
Housing impacts	4.7.1	2
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	1
Public services: public utilities	4.7.3.5	2
Public services: education (license renewal term)	4.7.3.1	1
Offsite land use (license renewal term)	4.7.4	2
Public services: transportation	4.7.3.2	2
Historic and archaeological resources	4.7.7	2
Aesthetic impacts (license renewal term)	4.7.6	1
Aesthetic impacts of transmission lines (license renewal term)	4.5.8	1
Environmental justice	Not addressed[a]	Uncategorized[a]

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

4.9.1 Generic Socioeconomic Issues

The applicant's ER, scoping comments, and other available data records on CR-3 were reviewed and evaluated for new and significant information. The review included a data gathering site visit to CR-3. No new and significant information was identified during this review that would change the conclusions presented in the GEIS. Therefore, for these Category 1 issues, impacts during the license renewal term are not expected to exceed those discussed in the GEIS. For CR-3, the Staff incorporates the GEIS conclusions by reference in this SEIS. Impacts for Category 2 issues and the uncategorized issue (environmental justice) are discussed in Sections 4.9.2 through 4.9.7.

4.9.2 Housing Impacts

Appendix C of the GEIS presents a population characterization method based on two factors, sparseness and proximity (NRC, 1996; Section C.1.4). Sparseness measures population density within 20 mi (32 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 (NRC, 1996; Table C.1). A matrix is used to rank the population category as low, medium, or high (NRC, 1996; Figure C.1).

According to the 2000 census, an estimated 89,491 people lived within 20 mi (32 km) of CR-3, which equates to a population density of 125 persons per mi^2 (Progress Energy, 2008a). This translates to a Category 4 ("least sparse") population density using the GEIS measure of sparseness (greater than or equal to 120 persons per mi^2 within 20 mi). An estimated 825,847 people live within 50 mi (80 km) of CR-3 with a population density of 170 persons per mi^2 (Progress Energy, 2008a). Applying the GEIS proximity measures, CR-3 is classified as proximity Category 2 (no city with 100,000 or more persons and between 50 and 190 persons per mi^2 within 50 mi). Therefore, according to the sparseness and proximity matrix presented in the GEIS, rankings of sparseness Category 4 and proximity Category 2 result in the conclusion that CR-3 is located in a medium 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 a medium or high population area where growth control measures are not in effect. Since CR-3 is located in a medium population area and Citrus County is not subject to growth control measures that would limit housing development; any changes in employment at CR-3 would have little noticeable effect on housing availability in the county. The recent replacement of CR-3 steam generators required a one-time increase of approximately 900 workers in addition to the normal number of refueling outage workers for up to 74 days at CR-3 (Progress Energy, 2008a). These workers increased the demand for temporary (rental) housing units in the vicinity of CR-3 beyond what is normally experienced during refueling outages. Given the short duration of the replacement activity and the availability of housing in the region, there was little or no noticeable (long-term) effect on rental housing availability or employment related housing impacts.

Since the applicant has no plans to add non-outage employees during the license renewal period, employment levels at CR-3 would remain relatively constant with no additional demand for permanent housing during the license renewal term. Based on this information, there would be no additional impact on housing during the license renewal term beyond what has already been experienced.

4.9.3 Public Services: Public Utility Impacts

Impacts on public utility services (e.g., water, sewer) are considered SMALL if the public utility has the ability to respond to changes in demand and would have no need to add or modify facilities. Impacts are considered MODERATE if service capabilities are overtaxed during periods of peak demand. Impacts are considered LARGE if additional system capacity is needed to meet ongoing demand.

Analysis of impacts on the public water and sewer systems considered both plant demand and plant-related population growth. Section 2.1.7 describes the CR-3 permitted withdrawal rate and actual use of water. As previously discussed in Section 2.2.8.2, CR-3 has an onsite groundwater well system that provides potable water for drinking and does not require water from a municipal system. The additional number of refueling outage workers needed to replace the CR-3 steam generators caused a short-term increase in the amount of public water and sewer services used in the immediate vicinity of CR-3. However, since the region has excess capacity, there were little or no water supply impacts.

Since the applicant has no plans to add non-outage employees during the license renewal period, employment levels at CR-3 would remain relatively unchanged with no additional demand for public water services. Public water systems in the region are adequate to meet the demand of residential and industrial customers in the area. Therefore, there would be no additional impact to public water services during the license renewal term beyond what is currently being experienced.

4.9.4 Offsite Land Use

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 notes that, "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal." Section 4.7.4 of the GEIS defines the magnitude of land use changes as a result of plant operation during the license renewal term as SMALL when there would be little new development and minimal changes to an area's land use pattern, as MODERATE when there would be considerable new development and some changes to the land use pattern, and LARGE when there would be 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 pre-established 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 10 to 20 percent of the community's total revenue, new tax-driven land use changes would be MODERATE. If the plant's tax payments are greater than 20 percent 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 pre-established pattern of development or has not provided adequate public services to support and guide development.

4.9.4.1 *Population-Related Impacts*

As discussed in Section 4.9.2, the applicant recently replaced the CR-3 steam generators. Since CR-3 is in a medium population area, any changes in employment would have little or no noticeable effect on land use in the region. The additional number of workers and short duration of the replacement activity would not have caused any permanent changes in population-related offsite land use in the immediate vicinity of CR-3.

Since the applicant has no plans to add non-outage employees during the license renewal period, there would be no plant operations-driven population increase or noticeable change in land use conditions in the vicinity of CR-3. Therefore, there would be no additional population-related offsite land use impacts during the license renewal term beyond those already being experienced.

4.9.4.2 *Tax-Revenue-Related Impacts*

As discussed in Chapter 2, the applicant pays annual real estate taxes to Citrus County. For the 4-year period from 2005 through 2008, tax payments to Citrus County represented between 4.6 and 5.3 percent of the county's total revenue collections. Since the applicant started making payments to local jurisdictions, population levels and land use conditions in Citrus 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.

However, the recent replacement of the existing steam generators at CR-3 could increase the assessed value of CR-3 and, as a result, property tax payments to Citrus County. These impacts, however, occurred under the current license period prior to the license renewal term. Nevertheless, it is expected that any increase in assessed value would be small, because the improvement was made to replace existing equipment. Since the applicant's tax payments to Citrus County are a small percentage (around 5 percent per year) of the total annual county property tax revenue, CR-3's incremental contribution to the county's property tax revenue, even with an increased assessment, is expected to remain small with little or no noticeable effect on offsite land use.

Since the applicant has no plans to add non-outage employees during the license renewal period, employment levels at CR-3 would remain relatively unchanged. There would be no increase in the assessed value of CR-3, and annual property tax payments to Citrus County would also remain relatively unchanged throughout the license renewal period. Based on this information, there would be no additional tax-revenue-related offsite land use impacts during the license renewal term beyond those already being experienced.

4.9.5 Public Services: Transportation Impacts

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.

NRC regulations require all applicants 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. The additional number of workers and truck material deliveries needed to support the recent replacement of the CR-3 steam generators during a recent refueling outage would have temporarily increased the amount of traffic on roads in the immediate vicinity of CR-3. As previously discussed in Section 2.2.8.2, major commuting routes to CR-3, including U.S. Highway (US) 19, are mostly semi-urban and uncongested. According to the applicant, increased traffic volumes entering and leaving CR-3 during refueling outages, which occur at intervals of approximately 24 months, have not degraded the level of service capacity on local roads (Progress Energy, 2008a). Based on this information and because of the short duration of the replacement activity (up to 74 days), and given that the steam generator replacement occurred during a normal refueling outage, there were little or no noticeable changes in level of service transportation impacts beyond what is experienced during normal refueling outages.

Since the applicant has no plans to add non-outage employees during the license renewal period, traffic volume and levels of service on roadways in the vicinity of CR-3 would not change. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

4.9.6 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to take into account the potential 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* (NRHP). The criteria for eligibility include: (1) association with significant events in history; (2) association with the lives of persons significant in the past; (3) embodiment of distinctive characteristics of type, period, or construction; and (4) association with or potential to yield important information on history or prehistory (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 (ACHP) in 36 CFR Part 800.

The issuance of a renewed operating license for a nuclear power plant is a Federal undertaking that could possibly affect either known or potential historic properties located on or near the plant 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 (APE). If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office (SHPO) 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.

The applicant contacted the Florida SHPO by letter in September 2008 regarding license renewal (Progress Energy, 2008e). In its letter, the applicant stated that continued operation of CR-3 would not have an adverse effect on any historic or cultural property in the region. The applicant further stated that neither the license renewal nor steam generator replacement would require significant land disturbance or construction of new facilities.

In accordance with 36 CFR 800.8(c), the NRC contacted the Florida SHPO, the ACHP, and Federally-recognized Native American tribes to initiate Section 106 consultation. These letters are presented in Appendix D of this SEIS. To date, no known sites of significance to Native Americans have been identified within the APE.

The Florida SHPO stated that license renewal would likely have no effect on historic properties. However, the SHPO also stated that if prehistoric or historic artifacts were encountered at any time within the project area, all subsurface activities in the vicinity of the find should cease and their office should be notified (Gaske, 2009).

An NRC review of records in the Florida Master Site File found that 20 archaeological sites are present within the project APE. All of the recorded sites consist of shell middens located along the coast line within the CREC property and are not likely to be impacted by license renewal activities. Although 63 recorded sites have been found along the transmission lines, most (53) have been determined to be ineligible for listing on the NRHP; the status of nine sites is currently unknown, and one site is now listed on the NRHP. Five of the nine sites were recommended not eligible by the archaeological contractor, but these sites were not evaluated for concurrence by the Florida SHPO, according to the Florida Master Site File. The presence of these sites has been disclosed to the applicant for future management.

In 2004, the applicant issued a corporate procedure ("Archaeological and Cultural Resources," EVC SUBS 00105) for the protection of archaeological resources and consultation with the SHPO. These corporate procedures apply to any ground disturbance within the CREC and along the transmission lines. The applicant's environmental compliance procedures were reviewed during the site visit. These procedures were developed to ensure the consideration and protection of archaeological resources at CR-3. Although archaeological sites within the CREC would not be impacted by license renewal activities, these sites should be avoided during future plant maintenance and operations activities. Currently, there is no cultural resource management plan or monitoring program in place for these sites. There is evidence of public use of the coastal areas on the applicant's property, although, to date, no evidence of unauthorized excavation or looting has been reported. A Cultural Resources Management Plan, established in consultation with the Florida SHPO, is recommended for ensuring proper management of existing archaeological resources within the CREC and along the transmission lines. Lands not previously surveyed should be investigated by a qualified archaeologist prior to any future ground-disturbing activity. The recent CR-3 steam generator replacement did not adversely impact any historic properties or archaeological sites on or in the vicinity of CR-3 because all of the replacement-related activity took place away from known archaeological sites within the developed industrial portions of the plant site.

Based on a review of Florida SHPO files, published literature, and information provided by the applicant, the NRC concludes that potential impacts from license renewal of CR-3 on historic and archaeological resources would be SMALL. This conclusion is based on the results of archaeological surveys conducted prior to initial plant construction and during subsequent expansion activities. The locations of existing archaeological sites within the CREC, including areas of high potential for additional discoveries, are located away from plant maintenance and operations activities in the protected area. This conclusion is also based on the environmental protection procedures in use by CR-3 environmental staff during the environmental site visit.

4.9.7 Environmental Justice

Under Executive Order (E.O.) 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing, as appropriate, disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued a *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 *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 employed 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 employed 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 employed 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 CR-3 during the renewal term. In assessing the impacts, the following CEQ (1997) definitions of minority individuals and populations and low-income population were used:

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.

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.

Low-income population. 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.

4.9.7.1 *Minority Population in 2000*

According to 2000 census data, 14.3 percent of the population (115,214 individuals) residing within a 50-mi (80-km) radius of CR-3 identified themselves as minority individuals (USCB, 2011). The largest minority group was Black or African American (57,214 individuals or 7.1 percent), followed by Hispanic (39,499 individuals or about 4.9 percent). Approximately 7 percent of the Citrus County population was minority, with Hispanic (2.7 percent) the largest minority group, followed by Black or African American (2.3 percent).

The 50-mi (80-km) radius around CR-3 consists of each county with at least one census block group located within the 50-mi (80-km) radius. The population demographic data from these counties were added together to derive average regional percentages. Of the 483 census block groups located wholly or partly within the 50-mi (80-km) radius of CR-3, 33 block groups were determined to have minority population percentages that exceeded the State percentage by 20 percentage points or more. The largest number of minority block groups was Black or African American, with 32 block groups that exceeded the regional percentage of 20 percent or more. These block groups are concentrated in urban areas with high population densities in Marion County. The closest high density minority population to CR-3 is located in Crystal River, Florida. Figure 4.9.7-1 shows minority block groups within a 50-mi (80-km) radius of CR-3 based on 2000 census data.

According to American Community Survey 2009 estimates, minority populations in Citrus County increased by approximately 6,700 persons and comprised 10.6 percent of the total population (see Table 2.2.8.5-3). Most of this increase was due to an estimated increase of Hispanic or Latinos (over 2,800 persons), an increase in population of 89.8 percent from 2000. The next largest increase in minority population was Black or African American, an estimated additional 1,980 persons or an increase of 73.2 percent from 2000, followed by Asian, an estimated 1,200 persons or an increase of 135.4 percent from 2000 (USCB, 2011).

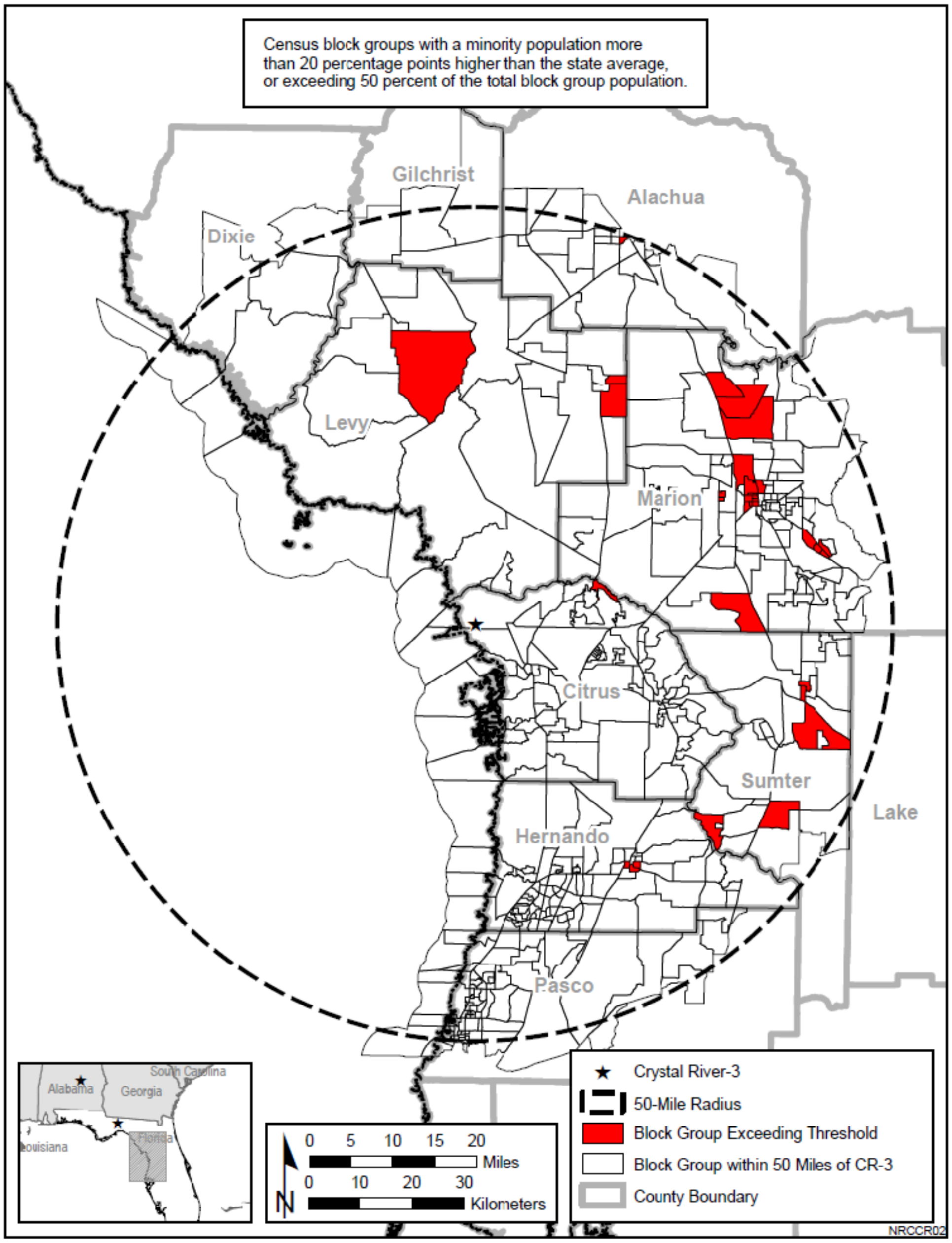

Figure 4.9.7-1. Minority Block Groups in 2000 within a 50-mile (80-kilometer) Radius of Crystal River Unit 3 Nuclear Generating Plant (Source: USCB, 2011)

4.9.7.2 *Low-Income Population in 2000*

According to 2000 census data, 101,398 individuals (12.9 percent) residing within a 50-mi (80-km) radius of CR-3 were identified as living below the Federal poverty threshold (USCB, 2011). The 1999 Federal poverty threshold was $17,029 for a family of four. In addition, according to the 2000 census, 9 percent of families and 12.5 percent of individuals in the State of Florida and 8.5 percent of families and 11.7 percent of individuals in Citrus County were living below the Federal poverty threshold (USCB, 2011).

Census block groups were considered low-income block groups if the percentage of households below the Federal poverty threshold exceeded the State average by 20 percent or more. Based on 2000 census data, there were 22 block groups within the 50-mi (80-km) radius of CR-3 that exceeded the State average for low-income households by 20 percentage points or more. Most of the census block groups with low-income populations exceeding the State average were located in Marion County. The nearest low-income population to CR-3 is located in Crystal River, Florida. Figure 4.9.7-2 shows low-income block groups within a 50-mi (80-km) radius of CR-3 based on 2000 census data.

According to American Community Survey 2009 estimates, the median household income for Florida was $44,736, while 14.9 percent of the State population and 10.7 percent of families were living below the 1999 Federal poverty threshold. Citrus County had a lower median household income ($38,128) and slightly higher percentages, 15.9 percent of individuals and 11 percent of families living below the poverty level, when compared to the State.

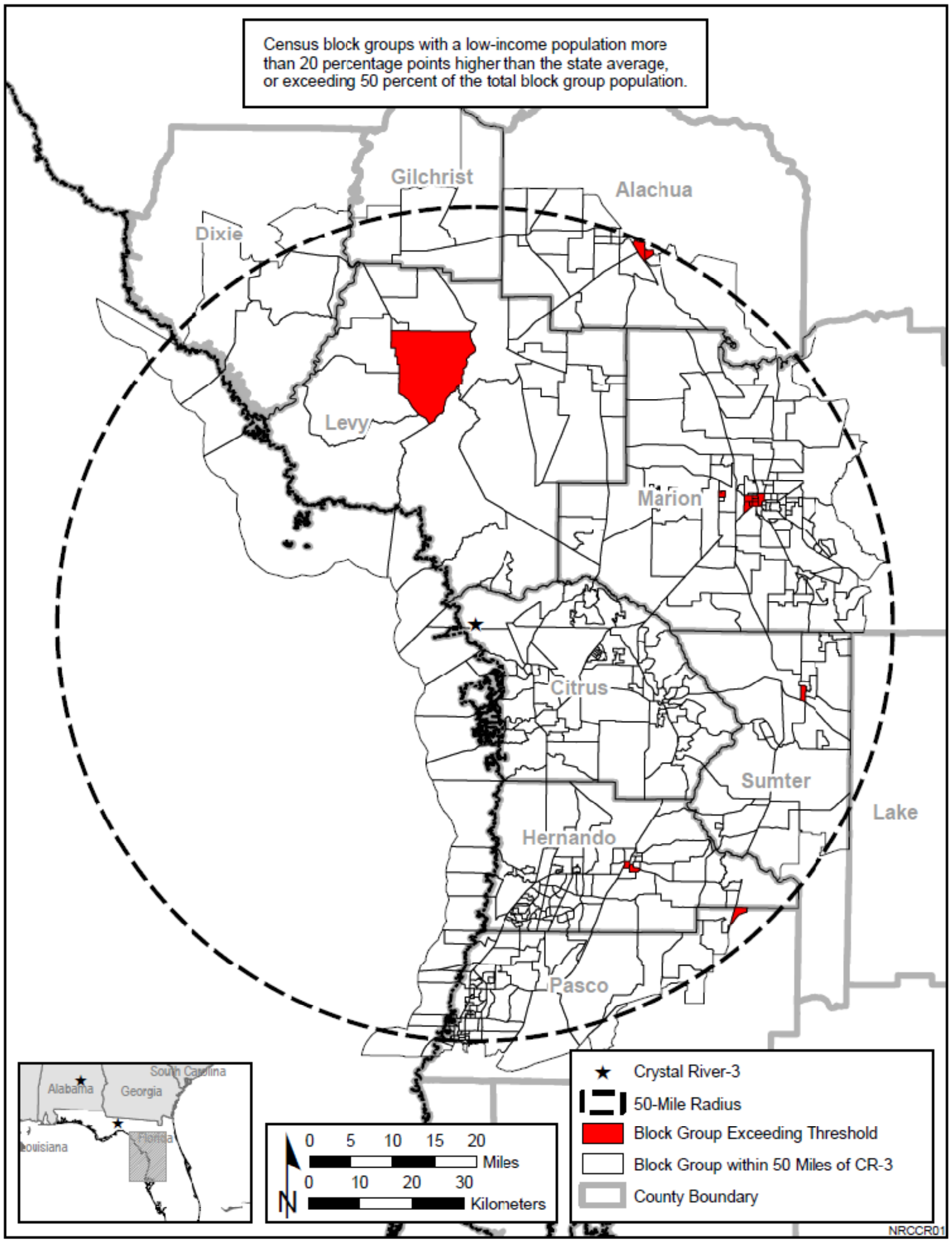

Figure 4.9.7-2. Low-Income Block Groups in 2000 within a 50-mile (80-kilometer) Radius of Crystal River Unit 3 Nuclear Generating Plant (Source: USCB, 2011)

4.9.7.3 *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 indentifies the minority and low-income populations residing within a 50-mi (80-km) radius of CR-3. This area of impact is consistent with the impact analysis for public and occupational health and safety, which also focuses on populations within a 50-mi (80-km) radius of the plant. As previously discussed for the other resource areas in Chapter 4, the analyses of impacts for most resource areas indicated that the impact from license renewal would be SMALL.

Potential impacts to minority and low-income populations would mostly consist of radiological effects; however, radiation doses from continued operations associated with this license renewal are expected to continue at current levels and would remain within regulatory limits. Chapter 5 of this SEIS discusses the environmental impacts from postulated accidents that might occur during the license renewal term, which include both design-basis accidents. The Commission has generically determined that impacts associated with such accidents are SMALL because nuclear plants are designed to successfully withstand design-basis accidents. In addition, the recent CR-3 steam generator replacement would have had little or no noticeable effect on minority and/or low-income populations in the region because CR-3 is located in a medium population area and because of the short duration (74 days) of the replacement activity.

Therefore, based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5, it is not likely there would be any disproportionately high and adverse impacts to minority and low-income populations from the continued operation of CR-3 during the license renewal term.

As part of addressing environmental justice associated with license renewal, the NRC also assessed the potential radiological risk to special population groups from exposure to radioactive material received through their unique consumption and interaction with the environment patterns including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of airborne radioactive material released from the plant during routine operation.

4.9.7.4 *Subsistence Consumption of Fish and Wildlife*

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.

Section 4-4 of E.O. 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 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 CR-3 site were considered.

The following is a summary discussion of the Staff's evaluation from Section 4.8.2 of the REMPs that assess the potential impacts for subsistence consumption of fish and wildlife near the CR-3 site.

The applicant has a comprehensive REMP at CR-3 to assess the impact of site operations on the environment. To assess the impact of the nuclear power plant on the environment, samples of environmental media are collected and analyzed for radioactivity. Two types of samples are taken. The first type, control samples, are collected from areas that are beyond measurable influence of the nuclear plant. These samples are used as reference data. Normal background radiation levels, or radiation present due to causes other than nuclear power generation, can be compared to the environment surrounding the nuclear plant. Indicator samples are the second sample type obtained. These samples show how much radiation or radioactivity is contributed to the environment by the nuclear power plant. Indicator samples are taken from areas close to the station where any contribution would be at the highest concentration. An effect would be indicated if the radioactive material detected in an indicator sample was significantly larger than the background level or control sample.

Samples of environmental media are collected from the aquatic and terrestrial pathways in the vicinity of CR-3. The aquatic pathways include fish and oysters, surface waters, groundwater, and shoreline sediment. The terrestrial pathways include airborne particulates and radioiodine, broadleaf vegetation, food products (watermelon and citrus), and direct radiation. During 2009, analyses performed samples of environmental media showed no significant or measurable radiological impact above background levels from CR-3 operations (Progress Energy, 2010e).

Based on the radiological environmental monitoring data from CR-3, the Staff finds 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 water, local food, fish, and wildlife.

4.10 EVALUATION OF NEW AND POTENTIALLY SIGNIFICANT INFORMATION

New and significant information is: (1) information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or (2) information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

In preparing to submit its application to renew the CR-3 operating license, FPC developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for CR-3 would be properly reviewed before submitting the ER and to ensure that such new and potentially significant information would be identified, reviewed, and assessed during the NRC review period. FPC reviewed the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to CR-3. This review was performed by personnel from CR-3 and its support organization that were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

The NRC also has a process for identifying new and significant information. That process is described in detail in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC, 1999b). The search for new information includes: (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies; and (5) review of the technical literature. New information discovered by the Staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of the issue that are not affected by the new information.

The Staff has not identified any new and significant information on environmental issues listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, related to the operation of CR-3 during the period of license renewal. The Staff also determined that information provided during the public comment period did not identify any new issues that require site-specific assessment. The Staff reviewed the discussion of environmental impacts in the GEIS (NRC, 1996) and conducted its own independent review (including the public scoping meetings held in April 2009) to identify new and significant information.

4.11 CUMULATIVE IMPACTS

The Staff considered potential cumulative impacts in the environmental analysis of continued operation of CR-3 during the 20-year license renewal period. Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE cumulative 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 individual impact could be important if it contributes to or accelerates the overall resource decline.

For the purposes of this cumulative analysis, past actions are those before the receipt of the license renewal application. Present actions are those related to the resources at the time of current operation of the power plant, and future actions are those that are reasonably foreseeable through the end of plant operation including the period of extended operation. Therefore, the analysis considers potential impacts through the end of the current license terms as well as the 20-year renewal license term. The geographic area over which past, present, and reasonably foreseeable actions would occur is dependent on the type of action considered.

To evaluate cumulative impacts, the incremental impacts of the proposed action, as described in Sections 4.1 through 4.9, are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non Federal) or person undertakes such actions. The Staff used the information given in the ER; responses to requests for additional information; information from other Federal, State, and local agencies; scoping comments; and information gathered during the visits to the CR-3 site to note other past, present, and reasonably foreseeable future actions. To be considered in the cumulative analysis, the Staff determined if the project would occur within the geographic areas of interest and within the period of extended operation, was reasonably foreseeable, and if there would be potential overlapping effect with the proposed project. For past actions, consideration within the cumulative impacts assessment is resource and project-specific. In general, the effects of past actions are included in the description of the affected environment in Chapter 2, which serves as the baseline for the cumulative impacts analysis. However, past actions that continue to have an overlapping effect on a resource potentially affected by the proposed action are considered in the cumulative analysis. Other actions and projects that were noted during this review and considered in the Staff's independent analysis of the potential cumulative effects are described in Table 4.11-1.

Table 4.11-1. Other Projects and Actions Considered in the Cumulative Analysis for Crystal River Unit 3 Nuclear Generating Plant

Project Name	Summary of Project	Location	Status
Energy Projects			
Operation and decommissioning of CR-1, CR-2, CR-4, and CR-5	CR-1, CR-2, CR-4, and CR-5 are fossil-fuel power plants. Operations began in 1966, 1969, 1982, and 1984, respectively.	Adjacent to CR-3	Operational. The State of Florida's Siting Board's Condition of Certification for LNP would require Progress Energy Florida, Inc. to discontinue the operations of two fossil-fuel units by December 31, 2020, assuming the licensing, construction, and commencement of operation of LNP occurs in a timely manner (FDEP, 2011).
Extended power uprate of CR-3	The CR-3 EPU would increase the thermal and electrical output of the plant (Progress Energy, 2008a). The uprate could require an increase in circulating water flow of up to 150,000 gpm (567.8 m^3/min) (Golder Associates, Inc., 2007a).	CR-3	Proposed. The application submitted to State of Florida was approved in August 2008. The USACE issued a public notice on May 25, 2010 (USACE, 2010). A Federal application is expected to be submitted to the NRC in 2011.
LNP, Units 1 and 2	Progress Energy Florida, Inc. proposes to construct and operate two new AP1000 pressurized water reactor nuclear units. Each unit would have a core power rating of 3,400 MW(t). The units would use a closed-cycle, wet-cooling system that uses mechanical draft cooling towers for heat dissipation.	Approximately 9 mi northeast of CR-3	Proposed. NRC's draft EIS was published in August 2010 (NRC, 2010b).
Inglis Lock bypass channel spillway hydropower project	2-MW hydroelectric project at the existing Inglis Lock bypass spillway. This project would include construction of an intake structure, intake and discharge channels, turbines, and a transmission line.	Approximately 5 mi northeast of CR-3	Proposed. In 2009, an application was submitted to the Federal Energy Regulatory Commission (FERC), and FERC accepted the application in 2010 (75 FR 10230), (Inglis Hydropower, 2009).
Florida Gas Transmission Company, LLC (FGT) Phase VIII Expansion Project	Construction and expansion of natural gas pipelines, new compressor, meter, regulator stations, and other ancillary facilities.	Various counties in Alabama and Florida, including Levy, Citrus, and Hernando; route passes approximately 2 mi east of CR-3	Completion expected by spring 2011 (FERC, 2009), (Panhandle Energy, 2011).

Project Name	Summary of Project	Location	Status
Non-Energy Projects			
Construction of an independent spent fuel storage installation (ISFSI) at CR-3	The ISFSI will provide additional storage of spent nuclear fuel in dry casks.	On the CREC site, east of the CR-3 containment building	Under construction (Progress Energy, 2009m), (NRC, 2010c).
Tarmac King Road Limestone Mine	A 9,400-ac aggregate mining site. The mining site would be 4,900 ac (including 900 ac set aside for wetlands); with the remaining 4,500 ac donated to the State of Florida for preservation.	The southern border of the site is about 8 mi north-northeast of CR-3	Proposed. A permit application was submitted to the USACE in September 2007. Construction is expected to begin in 2011, and operations are expected to begin in 2013 (KRM, 2010).
Holcim Mine	Limestone quarry	1 mi north of CR-3	Operational
Inglis Quarry	Limestone quarry	3 mi north of CR-3	Operational
Crystal River Quarries – Red Level	Limestone quarry	3 mi east of CR-3	Operational
Crystal River Quarries – Lecanto	Limestone quarry	16 mi east-southeast of CR-3	Operational
Gulf Hammock Quarry	Limestone quarry	19 mi north of CR-3	Operational
Cross Florida Barge Canal/Marjorie Harris Carr Cross Florida Greenway	The Cross Florida Barge Canal would connect the Gulf of Mexico to the Atlantic Ocean. Partial construction was completed in 1971.	3 mi north of CR-3	Operational and open to barge traffic downstream of Lake Rousseau. Construction to complete the canal was suspended in January 1971. No restart date has been published.
Parks, Forests, and Preserves	Numerous State and national parks, forests, preserves, and recreational areas within a 50-mi radius of CR-3	50-mi radius of CR-3	No industrial developments are expected in these areas.
Commercial forest management	Commercial logging operations	Throughout the region surrounding CR-3	Operational
Concrete companies	Two ready-mix concrete plants	Northern portion of Levy County	Operational
Construction of new housing units, commercial buildings, roads, bridges, and other development	Construction of housing units and associated commercial buildings such as the proposed Port District near Inglis; roads, bridges, and railroads, such as the US-19 bridge and highway expansions; construction of water- and/or wastewater-treatment and distribution facilities and associated pipelines, as described in local land use planning documents.	About 3 mi north of CR-3 and throughout the region.	Proposed. Construction would occur in the future, as described in local land use planning documents (FDOT, 2011), (Citrus County, 2009).

4.11.1 Cumulative Impacts on Water Resources

The following sections address the incremental impacts from the continued operation of CR-3 in combination with other past, present, and future actions—including those at the CREC—that could contribute to adverse cumulative impacts to water resources over the next 20 years. For this analysis, the geographic regions of concern include the Upper Floridan aquifer system in the immediate vicinity of the CREC site and Citrus County (groundwater) and Crystal Bay in the Gulf of Mexico (surface water). Cumulative impacts to water resources in the regions of concern result mainly from: (1) withdrawals of groundwater and surface water and the changes these cause to the hydrologic regime and (2) releases of contaminants and thermal loads that affect the quality of local water resources.

4.11.1.1 *Groundwater Use*

Groundwater supplies about 98 percent of all water used in Citrus County (SFWMD, 2006a). The Upper Floridan aquifer system is the major source of groundwater in Citrus County. It supplies water for potable (public supply and private wells), agricultural irrigation, recreational (golf courses and landscaping), industrial, and mining uses (SFWMD, 2006a). The SFWMD estimates that groundwater use in the potable supply, the largest water use category comprising about 88 percent of the total, will increase by about 16 percent between 2010 and 2020 in Citrus County, based on projected population increases of about 18 percent over the same period, to an average usage of about 32.6 mgpd in 2020. Groundwater use for agricultural irrigation and recreation would increase by about 24 and 15 percent, respectively, to an average usage of about 4.2 and 6.1 mgpd in 2020, respectively. Accounting for increases in all water use categories, the SFWMD projects a combined average usage of about 47.5 mgpd in 2020 (the last year for which the SFWMD makes projections). Assuming the same rate of category increases between 2020 and 2030, the combined average usage would be about 54.5 mgpd in 2030.

The CREC currently maintains 14 onsite production wells (as listed in Table 2.1.7-1), completed in the Upper Floridan aquifer and metered as required by the State of Florida Conditions of Certification (FDEP, 2010a). Three of these wells—SPW-3, SPW-4, and SPW-5—supply water to the south treatment plant, a portion of which (about 49 percent) serves CR-3. From 2001 through 2009, only eight of these wells were operational: PW-1 through PW-4, serving the north treatment plant; SPW-3 through SPW-5, serving the south treatment plant; and PW-1A/1B, providing water for ash processes. During this period, the combined average annual pump rate for these wells was about 1,144 gpm (1.65 mgpd). Although water demand at the CREC increased by 22 percent between 2001 and 2009, the maximum water demand (1,252 gpm or 1.80 mgpd in 2009) was below the 2 mgpd authorized by the FDEP and the SFWMD (FDEP, 2010a), (SFWMD, 2007). Compared to the average annual demand for groundwater in Citrus County (estimated at 27.764 mgpd in 2008) (SFWMD, 2009), the plant's groundwater usage between 2001 and 2009 was low (i.e., less than 7 percent of the total groundwater consumed in Citrus County).

Six additional wells became operational in late 2009 to supply water to the flue gas desulfurization (FGD) system as part of the Crystal River Units 4 and 5 Clean Air Interstate Rule Compliance and Electrostatic Precipitator Rebuild Project (referred to here as the Units 4 and 5 Clean Air Project). Three of these wells (PW-5 through PW-7) were deactivated wells that were reactivated; the other three (PW-8 through PW-10a) were installed in 2009. On August 7, 2008, the FDEP issued a modification to the Conditions of Certification that allows an annual average pumping rate of 4.309 mgpd for wells PW-1 through PW-10a (FDEP, 2008a). This allowance together with the annual average pumping rate of 1 mgpd allowed by the SFWMD (2007) for wells SPW-3 through SPW-5 and PW-1A/B have increased the total authorized annual average usage rate to 5.309 mgpd. While this figure represents a maximum limit and not actual water usage, it comprises about 19 percent of the total groundwater consumed in Citrus County in 2008 and about 11 percent of the total groundwater consumption projected by the SFWMD for Citrus County in 2020. The Conditions of Certification require the applicant to monitor the effects of groundwater withdrawal once the pumping rate reaches 3 mgpd and prepare a mitigation plan for adverse impacts if they occur. It also requires the applicant to develop alternative freshwater sources to offset some or all of the groundwater pumped. Citrus County is currently outside of the Water Use Caution Areas (WUCAs) designated by the SFWMD as areas where water resources are or are expected to become critical within the next 20 years (the largest of these is the Southern WUCA, to the south of Citrus County) (SFWMD, 2006b).

Drawdown calculations for groundwater withdrawal for CR-3 were made assuming a homogeneous, isotropic aquifer with negligible recharge and gradient and an average pump rate of 227 gpm (0.33 mgpd) from a single well (SPW-3) located about 330 ft from the CREC's southern property line. The maximum predicted drawdown at the southern property line was estimated to be less than 1 ft (0.3 m) over the 20-year renewal period for CR-3 (Progress Energy, 2009m). This value does not take into account the effects of withdrawals from all the onsite production wells operating at the CREC (with an average pump rate of 1,144 gpm or 1.65 mgpd between 2001 and 2009) or the additional production wells installed in 2009 to supply water to the FGD system as part of the Units 4 and 5 Clean Air Project. The applicant is currently conducting aquifer tests and a drawdown study for the operation of all 14 wells at the request of the State of Florida.

An important trend potentially affecting groundwater supplies over the next 20 years is global climate change. Global climate change can affect groundwater supplies by changing patterns of recharge, storage, and stream discharge through increased evaporation rates and greater variations in the seasonal patterns of precipitation (Roosmalen et al., 2007), (Florida Oceans and Coastal Council, 2009).

Because the additional production wells installed at the CREC are new, no annual data combining usage rates for all 14 wells currently exist. However, the Staff concludes that cumulative impacts due to groundwater usage by CR-3 in combination with the projected increase in groundwater usage for Citrus County (including the increased usage authorized by the State of Florida for the Units 4 and 5 Clean Air Project) would be SMALL to MODERATE, depending on the findings of monitoring and testing currently in progress. The incremental contribution on groundwater quality from continued license renewal would be SMALL, as described in Section 4.3. Karst environments in coastal areas, such as that in west-central Florida, present special challenges to users since overpumping causes changes in groundwater flow direction that can affect the quality of water in residential and public wells (e.g., salinity increases). Overpumping can also reduce groundwater discharge to individual springs, streams, rivers, and wetlands, causing changes in water levels and flow regimes which in turn can adversely affect aquatic resources. Section 4.11.2 provides a discussion of the impacts these changes may have to aquatic resources.

4.11.1.2 *Surface Water Use*

The CREC is located on Crystal Bay, a shallow embayment of the Gulf of Mexico, between the mouths of the Withlacoochee River to the north and the Crystal River to the south. There is little surface drainage in the region and most of the water in these rivers is derived from groundwater in the Upper Floridan aquifer. Cooling water for CR-3 is withdrawn from Crystal Bay via the plant's intake canal by circulating pumps with a total flow capacity of about 979.2 mgpd and discharged back to Crystal Bay via a common discharge canal (see Figure 2.1-4). The CREC does not withdraw any of its cooling water from rivers or streams.

Proposed actions at the CREC with the potential to contribute to cumulative impacts in Crystal Bay due to water usage include the proposed CR-3 EPU (Progress Energy, 2009n); the addition of the LNP blowdown to the CREC discharge canal, scheduled to begin in 2018 (Unit 1) and 2020 (Unit 2); and the shutdown of coal-fired CR-1 and CR-2 by the end of 2020 (a condition of the LNP site certification) (Progress Energy, 2009m).

Currently, the combined condenser flow for CR-1, CR-2, and CR-3 is limited by the NPDES permit to 1,898 mgpd during the summer period (May 1 to October 31) and 1,613 mgpd during the winter period (November 1 to April 30). Helper cooling towers withdraw water from the combined discharge of CR-1, CR-2, and CR-3 to help the plant meet the NPDES daily maximum discharge temperature limit of 96.5 °F (35.8 °C) at the final point of discharge to Crystal Bay (FDEP, 2005a). The proposed EPU would increase the heat produced by CR-3 which in turn would increase the heat rejection to the site discharge canal. To accommodate this increase in discharge temperature, the facility would increase the circulating water flow rate through CR-3 by up to 150,000 gpm (216 mgpd) or by 11 percent (in summer) to 13 percent (in winter) (Golder Associates, Inc., 2007a). The proposed new south helper cooling tower would withdraw heated water from the discharge canal and, once cooled, return it back to the discharge canal. A portion of this water could also be discharged to the intake canal to maintain the existing intake flow rate from Crystal Bay. This would result in no net increase of water usage from the bay. In addition, LNP blowdown would increase the volume of water discharged to the site discharge canal by about 61,000 gpm (87.8 mgpd) (NRC, 2010b). The eventual shutdown of CR-1 and CR-2, however, would reduce the volume of cooling water withdrawn from the intake canal—effectively reducing the net usage of Crystal Bay water at the CREC by the end of 2020.

Because Crystal Bay is a large water body and present and future water usage is relatively small and regulated by the State of Florida, the Staff concludes that cumulative impacts due to surface water usage by CR-3 in combination with other uses of water in Crystal Bay would be SMALL and no additional mitigation is warranted.

4.11.1.3 *Groundwater Quality*

The Upper Floridan aquifer is the primary source of water for the first magnitude springs in Citrus County. Recharge occurs through the infiltration of rainfall and seepage of surface water from Lake Tsala Apopka and the Withlacoochee River and is highest along the Brooksville Ridge where drainage occurs through sinkholes and other karst features. Because the aquifer is generally unconfined in Citrus County, recharge rates are fairly high. This condition also makes the aquifer highly susceptible to contamination from runoff carrying fertilizers, wastewater, and pollutants from roads and parking lots (SFWMD, 2006a).

Although there are no cooling ponds for CR-3, the CREC has several surface impoundments, some of which are lined, associated with the coal-fired CR-1, CR-2, CR-4, and CR-5 which could potentially contaminate groundwater below the site. These include the ash storage area, the coal storage area, the runoff collection system, the FGD settling ponds, and a stormwater pond (north plant area); and the domestic wastewater treatment plant and percolation pond system (south plant area). Groundwater monitoring and corrective actions (if needed) are conducted in accordance with the requirements outlined in the plant's industrial wastewater facility permit FLA016960 (FDEP, 2008b).

An important trend potentially affecting groundwater quality in the Upper Floridan aquifer system over the next 20 years is global climate change. Saltwater intrusion due to rising sea levels can degrade groundwater quality in low-lying coastal areas such as Citrus County putting public drinking water supplies at risk (Florida Oceans and Coastal Council, 2009). The CREC lies within the transition zone where water composition reflects a mixture of freshwater and saltwater. The landward extent of the transition zone (defined by Trommer [1993] as the 25-mg/L line of equal chloride concentration) is currently about 9 mi (14 km). Chloride concentrations in the CREC production wells are greater than 250 mg/L (Florida Power, 2005).

Because groundwater quality at the CREC is monitored in accordance with the State of Florida's industrial wastewater facility permit and the CREC already lies within the transition zone where groundwater composition reflects a mixture of freshwater and saltwater, the Staff concludes that cumulative impacts to groundwater quality in the Upper Floridan aquifer in the vicinity of the CREC would be SMALL and no additional mitigation is warranted. It is probable, however, that the transition zone will migrate further landward as a result of sea level rise (potentially due to global climate change) over the 20-year renewal period.

4.11.1.4 *Surface Water Quality*

The quality of west-central Florida coastal waters like Crystal Bay is generally good but coastal estuarine systems are becoming degraded by nonpoint (indirect) discharges of pollution from sources such as stormwater/urban runoff, seepage from onsite sanitary sewage disposal, sewage treatment plant effluent, residential use of pesticides, herbicide and fertilizers, and facilities (marina/docking) and activities associated with commercial and leisure boating (SFWMD, 2006a).

Surface water discharges to the CREC discharge canal (from CR-3 and the four coal-fired units) currently include once-through condenser cooling water, treated nuclear auxiliary cooling water, treated coal pile rainfall runoff, intake screen wash water, and treated radioactive and nonradioactive waste (south plant area); and internal overflow drainage from the sedimentation ponds at the ash and coal storage areas (north plant area) via the CR-4 and CR-5 discharge canal, which discharges to the site discharge canal. These discharges are regulated by two NPDES permits which specify limits for water quality parameters (Tables 2.1.7-5 and 2.1.7-6) and temperature at the POD from the site discharge canal to the Gulf of Mexico (not to exceed 96.5 °F (35.8 °C) as a 3-hour rolling average).

Proposed actions at the CREC with the potential to contribute to cumulative impacts to water quality (temperature and salinity) in Crystal Bay include the proposed CR-3 EPU (Progress Energy, 2009n); the addition of LNP blowdown to the CREC discharge canal, scheduled to begin in 2018 (Unit 1) and 2020 (Unit 2); and the shutdown of coal-fired CR-1 and CR-2 by the end of 2020 (a condition of the LNP site certification) (Progress Energy, 2009m).

The proposed EPU would increase the heat produced by CR-3 which in turn would increase the heat rejection to the site discharge canal. To accommodate this increase in discharge temperature, the facility would increase the circulating water flow rate through CR-3 (Golder Associates, Inc., 2007a). The proposed new south helper cooling tower would withdraw heated water from the discharge canal and, once cooled, return it back to the discharge canal. While there would still be an increase in temperature relative to ambient conditions at the point of discharge to Crystal Bay, the maximum projected temperature (95.6 °F [35.3 °C] during summer months) would be below the NPDES permitted limit of 96.5 °F (35.8 °C) (Progress Energy, 2009n). In addition, the eventual shutdown of CR-1 and CR-2 would reduce the volume of heated cooling water released to the site discharge canal—effectively reducing water temperatures in the site discharge canal.

Discharges of LNP blowdown to the site discharge canal would elevate water salinity to about 36.6 practical salinity units (psu) (in summer) and 36.3 psu (in winter), a small to negligible increase (about 4 to 5 percent) over ambient conditions (assumed to be 35.0 psu) at the point of discharge to Crystal Bay (Progress Energy, 2009n).

An important trend potentially affecting water quality in Crystal Bay over the next 20 years is global climate change. Ocean water temperature could increase as much as 3.6 °F (2 °C) over the next 100 years, resulting in adverse effects to coastal and marine environments already stressed by pollutants from land-based sources (Florida Oceans and Coastal Council, 2009). Increases in average sea level and shoreline retreat are also predicted over this period. Such changes would increase the risk of erosion, storm surge damage, and flooding along the west-central coast of Florida (GCRP, 2009). Section 4.11.2 provides a discussion of the impacts these changes may have to aquatic resources.

Although surface water discharges from the CREC are monitored in accordance with the State of Florida's NPDES permit, the Staff concludes that cumulative impacts to water quality (temperature and salinity) in Crystal Bay would be MODERATE because of other factors such as nonpoint sources of pollution and the potential increase in ocean water temperatures over the next 20 years. The incremental contribution from continued license renewal on surface water quality would be SMALL, as described in Section 4.3.

4.11.2 Cumulative Impacts on Aquatic Resources

This section addresses the direct and indirect effects of CR-3 license renewal on aquatic resources when added to the aggregate effects of past, present, and reasonably foreseeable future actions. The aquatic resources described in Section 2.2.5 and the Federally-listed aquatic threatened or endangered species described in Section 2.2.7.1 are the result of both past and current actions. The primary effects on aquatic resources from an additional 20 years of CR-3 operation will primarily occur from impingement, entrainment, and heat shock. The Staff concluded that the overall impacts of CR-3 license renewal on both aquatic biota (Section 4.5) and aquatic threatened or endangered species (Section 4.7.1) would be SMALL to MODERATE.

Three suites of cumulative impacts are identifiable when considering power-plant-related stressors: (1) those from the power plant (e.g., interaction of entrainment, impingement, and thermal discharges); (2) those due to effects of closely located power plants; and (3) those due to multiple activities in the area (York et al., 2005). The CREC is the only electrical generating facility in Citrus County (CCBCC, 2009); however, it is comprised of five generating units. Two generating units are proposed for LNP in Levy County. Operation of LNP will begin in 2016 or later (Progress Energy, 2009n). Other stressors that contribute to cumulative impacts are discussed below.

The geographic boundaries for assessing cumulative aquatic impacts are somewhat variable and depend on the specific aquatic resource. The estuary area of Crystal Bay between Withlacoochee River and Crystal River and the offshore areas of the Gulf of Mexico within Citrus and Levy Counties generally bound the potentially affected area. However, for some resources and stressors, a much larger area is considered. This area may include much of the Gulf of Mexico (e.g., due to the recent Deepwater Horizon oil spill) to North America and beyond (in the case of global warming). In large part, stressors outside the area influenced by operation of the CREC affect Federally-listed species that migrate throughout the Gulf of Mexico and the Atlantic Ocean (NMFS, 2002).

In the introduction to Section 4.11, the Staff identified a variety of actions and projects that could contribute to cumulative impacts. The FWC (2005) detailed 32 stressors that could affect aquatic resources (Table 4.11.2-1).

Table 4.11.2-1. Aquatic Resource Stressors

Channel modification/shipping lanes	Incompatible industrial operations
Chemicals and toxins	Incompatible recreational activities
Climate variability	Incompatible resource extraction
Conversion to agriculture	Incompatible wildlife and fisheries management strategies
Conversion to housing and urban development	Industrial spills
Coastal development	Invasive animals
Conversion to recreation areas	Invasive plants
Dam operations	Key predator/prey loss
Disruption of longshore transport of sediments	Management of nature (e.g., beaches)
Fishing gear impacts	Nutrient loads - agriculture
Groundwater withdrawal	Nutrient loads - urban
Harmful algal blooms	Roads, bridges, and causeways
Inadequate stormwater management	Shoreline hardening
Incompatible fire	Surface water diversion
Incompatible fishing pressure	Surface and groundwater withdrawal
Incompatible forestry practices	Vessel impacts

Source: FWC, 2005

The main stressors that can cause cumulative impacts on aquatic resources within Crystal Bay include the following:

- the continued operation of the CREC, as modified by the EPU of CR-3, discharge of LNP blowdown into the CREC discharge canal, and potential decommissioning of CR-1 and CR-2
- preconstruction, construction, and operation of LNP
- continued withdrawal of water for various human uses
- fishing (commercial and recreational) and boating
- residential, commercial, and industrial development
- water quality degradation
- invasive species

- disease
- climate change

Each of these may influence the structure and function of Crystal Bay in a way that could result in observable changes to its aquatic resources. The following is a brief discussion of how the stressors listed above could contribute to cumulative impacts on aquatic resources (including Federally-listed species) of Crystal Bay.

Continued Operation of CR-3 and Other CREC Units

Changes in the operation of the CREC since the late 1980s have had a potential influence on aquatic resources in Crystal Bay. The first is the alteration in discharge temperatures to meet the NPDES permit limit of 96.5 °F (35.8 °C) (as a 3-hour rolling limit) at the POD from the CREC. This has lessened the maximum discharge temperature at the POD during a portion of the summer and, thus, the potential size of the thermal plume. For example, the POD temperature averaged 100.1 °F (37.8 °C) the week of August 21, 1983; while most other weeks of August 1983 and 1984, and the week of September 4, 1983, averaged above 96.5 °F (35.8 °C) (SWEC, 1985). The second operational change has been in water withdrawals for operation of the CREC. The NPDES permit limits the combined flow through CR-1 through CR-3 to 1,318,000 gpm from May 1 through October 31 and 1,132,792 gpm from November 1 through April 30 (FDEP, 2005a). The FDEP established these limitations to decrease entrainment and, to a lesser extent, impingement at the CREC.

The CR-3 EPU will increase the thermal and electrical output of the plant (Progress Energy, 2008a). The EPU could require an increase in circulating water flow of up to 150,000 gpm (567.8 m^3/min) (Golder Associates, 2007b). However, the new south cooling tower, a component of the EPU, may discharge an equivalent amount of water flow back into the intake canal resulting in no net increase water withdrawn from the intake canal. Alternatively, there may be no increase above the current circulating water flow, but there will be an increase in the thermal load (Progress Energy, 2009n). Under either operating scenario, the Staff does not expect increases in entrainment and impingement due to the EPU. The applicant reported that, following the EPU, the maximum summer temperature at the CREC POD to Crystal Bay will be 95.4 °F (35.2 °C) at an ambient Crystal Bay temperature of 91 °F (32.8 °C) (Progress Energy, 2009n). This will be within the 3-hour rolling limit of 96.5 °F (35.8 °C) allowed in the NPDES permit (FDEP, 2005a).

Impacts to aquatic resources from the operation of the other units at the CREC will be similar to those over the past several decades. The Governor's Siting Board approved the Site Certification Application for LNP on August 11, 2009. It includes a requirement that CR-1 and CR-2 cease operation by the end of 2020 (assuming timely licensing and construction of LNP) (Progress Energy, 2009m). If CR-1 and CR-2 cease operations, they would no longer contribute to entrainment, impingement, or thermal impacts.

The Staff concludes that CREC operation will continue to be a contributor to cumulative impacts on aquatic resources.

Preconstruction, Construction, and Operation of LNP

Preconstruction and construction of LNP and its associated transmission lines and other offsite facilities would result in the permanent and temporary loss of about 773 ac (313 ha) of wetlands. Some of these wetlands would provide spawning, nursery, and feeding habitats for some

Crystal Bay fish and shellfish species. The applicant has committed to mitigate the loss or impairment of functions in all wetlands affected by the LNP project.

Operational impacts from LNP would include impingement and entrainment of aquatic organisms. LNP will have closed-cycle cooling, requiring a net intake of 85,278 gpm (322.8 m^3/min). Discernable impacts on aquatic organisms from entrainment and impingement will be minor (NRC, 2010b). Combined blowdown from the LNP units will increase the discharge to the CREC discharge canal by about 61,000 gpm (230 m^3/min). With the addition of LNP blowdown, the maximum summer temperature at the POD will be 95.6 °F (35.3 °C) (Progress Energy, 2009n). This will be within the 3-hour rolling limit of 96.5 °F (35.8 °C) allowed in the NPDES permit (FDEP, 2005a).

Chemical contaminants in the LNP discharge will mix with, and be highly diluted by, the CREC discharge (Progress Energy, 2010c). The combined discharges to Crystal Bay from the CREC and LNP will be subject to review and approval of the FDEP and would have to meet NPDES requirements (Progress Energy, 2010c).

The Staff concluded that both the NRC-authorized construction activities and the impacts of operation of LNP on aquatic resources would be SMALL (NRC, 2010b). The Staff concludes that operation of LNP will be a contributor to cumulative impacts on aquatic resources.

Continued Water Withdrawals

Surface and groundwater withdrawals can have a greater impact on individual springs, streams, rivers, and wetlands associated with Crystal Bay than to the bay itself. Water withdrawals can reduce stream flow, increase salinity, alter temperature regimes, and reduce wetted areas. These changes can have adverse impacts to areas used for spawning or nursery habitats by aquatic organisms. Groundwater withdrawals for human use threaten natural springs that provide warm water refuges for Florida manatees (Laist and Reynolds, 2005). Total projected average daily water use for Citrus County in 2020 is 47.5 mgpd (180,000 m^3/day); a 6.1 mgpd (23,100 m^3/day) increase over that projected for 2010. This use includes public supply (21.2 mgpd [80,250 m^3/day]), rural (11.4 mgpd [43,200 m^3/day]), agriculture (4.2 mgpd [15,900 m^3/day]), industrial (chemical manufacturing, food processing, power generation, and miscellaneous) (2.6 mgpd [9,800 m^3/day]), mining (2 mgpd [7,600 m^3/day]), and recreation (mostly golf course and large scale landscaped areas) (6.1 mgpd [2,300 m^3/day]) (CCBCC, 2009). The Staff concludes that water withdrawals will continue to be a contributor to cumulative impacts on aquatic resources.

Fishing and Boating

Many fish and shellfish species in Crystal Bay, including those that have been identified as representative species in studies at the CREC, are commercially or recreationally important and are thus subject to the effects of fishing pressure. In many cases, commercial or recreational catches are regulated by Federal or State agencies, but losses of some species (including Federally-threatened or endangered species) continue to occur as the result of bycatch or illegal capture. The extent and magnitude of fishing pressure and their relationship to overall cumulative impacts to aquatic resources of Crystal Bay are difficult to determine because of the large geographic scale of, and the natural variation in fish and shellfish populations within, the Gulf of Mexico. Normal use of fishing gear and discarded or lost fishing gear poses a threat to aquatic biota (FWC, 2005). Losses of Gulf sturgeon, smalltooth sawfish, and sea turtles have occurred as a result of recreational fishing (Bester, 2009), (NMFS, 2002), (NMFS, 2005).

The 2010 commercial finfish and shellfish landings for Citrus and Levy Counties were 491,471 lb (222,928 kg) of finfish, 1,113,817 lb (505,219 kg) of invertebrates (excluding shrimp), and 431,641 lb (195,789 kg) of shrimp. Among the representative species considered in Section 4.5, commercial landings for Citrus and Levy Counties reported by FWC (2011) totaled:

- Pinfish – 360 lb (163 kg)
- Spotted seatrout – 24 lb (11 kg)
- Striped mullet – 232,040 lb (105,252 kg)
- Blue crab – 847,216 lb (384,291 kg)
- Pink shrimp – 830 lb (376 kg)
- Stone crab (claws) – 204,720 lb (92,859 kg)

Among these species, commercial landings for only striped mullet, blue crab, and stone crab occurred in both counties; whereas, for the other species, landings occurred only from Citrus County. No commercial landings of red drum are currently allowed; no commercial landings in either county occurred for spot or brief squid; and no separate categories of catch are provided for bay anchovy, pigfish, or polka-dot batfish (FWC, 2011).

Boating has adversely affected aquatic resources along the Gulf coast, including Crystal Bay. Impacts from boating can range from scarring of seagrass beds to injury or death to Federally-listed species such as the smalltooth sawfish, Gulf sturgeon, sea turtles, and the Florida manatee (FWC, 2005), (FWS and NMFS, 2009). Loss of seagrass from boat propellers can adversely impact other trophic levels of aquatic biota and waterfowl that inhabit or make use of these ecologically important habitats (FWC, 2005). Increases in recreational boating will increase the likelihood of future watercraft scarring of seagrass beds and collisions with the Federally-listed fish, sea turtle, and manatee species. Marina and docking facilities can introduce petroleum products, human waste, and hull anti-fouling paints to the water column and sediments; which can be detrimental to aquatic resources (CCBCC, 2009). The suspension of sediments and increased influx of detached seagrasses and drift algae caused by barge traffic within the CREC intake canal temporarily increases impingement at the facility (NUS Corporation, 1978), (SWEC, 1985). After LNP becomes operational, CR-1 and CR-2 will cease operations as part of the FDEP's Conditions of Certification, and the number of barge shipments to the CREC will decrease.

The Staff concludes that fishing and boating will continue to be a contributor to cumulative impacts on aquatic resources.

Residential, Commercial, and Industrial Development

In addition to the CREC and LNP, other existing or proposed residential, commercial, or industrial developments could impact the aquatic resources of Crystal Bay. The NRC (2010b) identified a number of existing and proposed projects in the Citrus-Levy County area including the proposed Inglis Lock bypass channel spillway hydropower project, existing limestone mines and the proposed Tarmac King Road Limestone Mine, commercial forestry operations, and future urbanization. The proposed Port District is a planned waterfront development that could include residential, commercial, and industrial uses. Stressors to aquatic biota that can occur from these projects and actions include habitat loss and alteration, erosion and sedimentation, shoreline hardening, chemical contamination, and incompatible recreational activities.

The Staff concludes that residential, commercial, and industrial development will continue to be a contributor to cumulative impacts on aquatic resources.

Water Quality Degradation

The Staff considered the potential cumulative impacts from thermal and chemical releases, including increases in total dissolved solids in the combined CREC and LNP discharge. Thermal and chemical releases from the CREC comply with NPDES permit requirements (FDEP, 2005a). The FDEP will take cumulative thermal and chemical releases from the CREC and the proposed LNP, as well as from other industrial sites discharging to the Crystal Bay, into consideration before approving an NPDES permit for LNP. The FDEP reviews and approves NPDES permits. Through the NPDES program, flows of industrial effluents to Crystal Bay and its associated streams and rivers are regulated in a manner that preserves water quality and protects aquatic resources through implementation of best technologies available and other mitigative measures. Given the lack of other discharges into the immediate area of the CREC discharge, it is likely that the cumulative impacts from the combined discharge would be minimal. Thus, thermal and chemical releases from these facilities would only have a localized impact on aquatic resources. Therefore, the contributions to thermal and chemical releases to Crystal Bay from the combined operation of the CREC and LNP would be SMALL to MODERATE for most aquatic resources and SMALL for Federally-listed species.

Cumulative effects of non-point sources (e.g., urban and stormwater runoff, boating activities, sewage disposal facilities, and agricultural runoff) may be the largest stressor to estuaries and spring-fed river systems in Citrus County (CCBCC, 2009). Pesticides used to control aquatic plants and mosquitoes may be contributing directly or indirectly to degrading water quality (FWC, 2005), (CCBCC, 2009). Fertilizers, wastewater, nutrient loads, and road and parking lot pollutants have affected aquifers and springs in the county (CCBCC, 2009). These sources of non-point pollution can adversely affect a number of aquatic habitats such as coastal tidal rivers or streams, springs, tidal marshes, bivalve reefs, subtidal unconsolidated marine and estuarine sediment, and submerged aquatic vegetation (FWC, 2005).

Long life spans predispose species such as the Gulf sturgeon to long-term and repeated exposure to contaminants that could lead to potential bioaccumulation of toxicants (FWS and NMFS, 2009). The Florida Department of Health (2009) lists consumption guidelines for most marine and estuarine fish from Florida due to low to medium levels of mercury. For most species, the recommended limit is one meal per week to one meal per month for women of childbearing age and young children; and one to two meals per week for all other individuals (Florida Department of Health, 2009).

Industrial spills can cause habitat disturbance, altered water quality, altered species composition, and sediment contamination (FWC, 2005). Some industrial spills may have little residual effects and the affected resource may recover quickly. However, some spills, particularly petroleum hydrocarbon spills, can have disastrous, widespread effects that can last decades (FWC, 2005). Petroleum spills have proven to be disastrous to marine organisms (e.g., seagrass beds) either due to direct toxicity or indirectly through habitat destruction and contamination.

Marine debris can be disastrous to many marine and estuarine organisms, particularly some of the Federally-listed species such as sea turtles and the Florida manatee. Ingestion of or entanglement of sea turtles and manatees in marine debris can be fatal.

The Staff concludes that water quality degradation in Crystal Bay and its wetlands and tributaries will continue to be a contributor to cumulative impacts on aquatic resources.

Invasive Species

The presence of invasive species can benefit some endemic species. For example, hydrilla (*Hydrilla verticillata*) provides a food resource for the Florida manatee within the King's Bay area of Crystal River (CCBCC, 2009). However, the introduction of new species most often is a source of critical stress on endemic species or their habitats.

Estuaries and sheltered coastal areas are among the most susceptible to invasive species, especially those that have suffered prior disturbance by navigation, industrial development, and urbanization (Ray, 2005). Shipping introduces the most invasive species to estuarine and marine systems. Such species may be capable of attaching to hard surfaces (e.g., ship hulls) or found in ballast water. The aquarium trade is also a source of introduced species (Ray, 2005). Ray (2005) reported that 74 nonindigenous estuarine and marine species occur in the Gulf of Mexico.

A number of species may pose serious threats to marine and freshwater habitats in Florida. Some of these are parasites and/or pathogens of native species (FWC, 2005). Ray (2005) considered the Australian spotted jellyfish (*Phylloriza punctata*), green mussel (*Perna viridis*), green porcelain crab (*Petrolisthes armatus*), and lionfish (*Pterios volitan*) to be the invasive species of most concern in the eastern Gulf of Mexico. The green mussel can clog intake pipes, interfere with shellfish culture, displace local fauna, and possibly harbor algal species that cause toxic shellfish poisoning (Ray, 2005). The University of Florida (2007) expects the green mussel to spread throughout Florida. The green porcelain crab has the potential to directly and indirectly affect oyster beds (Ray, 2005), (Masterson, 2007b). The Australian spotted jellyfish is a threat to fisheries and fisheries restoration operations as it feeds on zooplankton and fish larvae and can foul fishing nets (Ray, 2005), (Masterson, 2007a). The lionfish can negatively affect coral reef fishes through consuming or competing with various species. If lionfish decrease population densities of important herbivorous species such as parrotfish, seaweeds and macroalgae could overgrow corals. Currently, observations of lionfish from the Gulf of Mexico are limited (Schofield et al., 2010).

The Staff concludes that invasive and nuisance species will continue to be a contributor to cumulative impacts on aquatic resources.

Disease

Aquatic biota are subject to a number of diseases. Among the most prevalent are red tide and fibropapillomatosis. Red tide, the common name for the harmful bloom of the marine algae *Karenia brevis*, produces a brevetoxin that can cause mortality to hundreds of fish species (including Federally-threatened or endangered species) (FWS and NMFS, 2009). The trigger for red tide could include excess nutrients and other pollutants (FWC, 2005). Fibropapillomatosis, a disease characterized by internal and external tumors, occurs in all sea turtle species. Many of the sea turtles collected from the CREC bar racks suffer from this disease (Section 4.7.1).

The Staff concludes that disease will continue to be a contributor to cumulative impacts on aquatic resources.

Climate Change

The potential cumulative effects of climate change on Crystal Bay, whether from natural cycles or related anthropogenic activities, could result in a variety of changes that would affect aquatic resources. The environmental factors of significance that could affect estuary systems include sea level rise, temperature increases, salinity changes, and wind and water circulation changes (Kennedy, 1990). Changes in sea level could result in effects to nearshore communities, including the reduction or redistribution of submerged aquatic vegetation, changes in marsh communities, and influences to other wetland areas adjacent to nearshore systems. Water temperature changes could affect spawning patterns or success, or influence the distribution of important species (e.g., cold water species may move northward while the ranges of warm water species expand). Changes in salinity could influence the spawning and distribution of important species and the range of invasive species. Fundamental changes in precipitation could 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. Some fisheries and aquaculture enterprises might benefit from climate change, while others might suffer (Kennedy, 1990). However, climate change could increase the frequency of red tide blooms, with adverse impacts to many fish species (FWS and NMFS, 2009).

The Florida Oceans and Coastal Council (2009) concluded that the predicted effects of climate change would not benefit oceanic and estuarine aquatic resources. Climate change effects to aquatic resources could include:

- adverse impacts to corals, clams, shrimp, and other organisms with calcium carbonate shells or skeletons due to increased acidity
- more frequent die-offs of sponges, seagrasses, and other organisms could occur as sea surface temperatures increase
- increased exceedance of thermal tolerance and increases in the rate of disease in corals
- geographic range of marine species will shift northward and may drastically alter marine and estuarine community composition
- Florida coastal waters may become more favorable for invasive species

- increase in the incidence of harmful algal blooms
- increased stormwater runoff and transport of nutrients could contribute to hypoxia (low oxygen)
- sea level rises could alter the integrity of natural communities in estuaries, tidal wetlands, and tidal rivers

The Staff concludes that climate change will continue to be a contributor to cumulative impacts on aquatic resources.

<u>Total Cumulative Impacts on Aquatic Resources</u>

Based on the Staff's review, multiple stressors affect the aquatic resources of Crystal Bay. Management actions may address the impacts of some of the stressors (e.g., cooling system operations, fishing pressure, and water quality). Although the impacts associated with cumulative impacts cannot be quantified, cumulative impacts on aquatic resources have stressed, and will continue to stress, aquatic resources, including Federally-threatened and endangered species. Under some unlikely scenarios (e.g., a major oil spill followed by a hurricane), destabilizing effects could occur, although evidence of this is not available at this time. The Staff finds the level of cumulative impact to be MODERATE for the purposes of this SEIS.

4.11.3 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in adverse cumulative impacts to terrestrial resources, including wildlife populations, upland habitats, wetlands, riparian zones, invasive species, protected species, and land use. For purposes of this analysis, the geographic area considered in the evaluation includes the region of the CREC site and the in-scope transmission line ROWs (i.e., the Central Florida line terminating at the Central Florida Substation near Leesburg and the Lake Tarpon line terminating at the Lake Tarpon Substation near Tarpon Springs).

Cumulative impacts to terrestrial resources in the region may result from the following: land disturbance (clearing, grading, and excavation); modification of habitats; alteration of drainage patterns; surface runoff and erosion; transport of chemicals; air emissions; surface water and groundwater withdrawals and changes in hydrologic regimes; draining of wetlands; fragmentation of habitats; spread of invasive species; disturbance of animals from noise and human presence; and vehicle-related mortality. Many of these impacts are directly related to the area of land that has been developed to accommodate various human activities and population.

Much of Citrus County is still rural in nature, and a large percentage of the land area is undeveloped. The western quarter of the county along the coastline is primarily undeveloped tidal marsh. Agricultural land (mostly improved pasture), occupies about 20 percent of unincorporated areas. However, the county has experienced rapid population growth over the last two decades from an influx of retirees, a growing tourism industry, and expansion of the construction, wholesale and retail trade, and service sectors (Section 2.2.8.3). Residential and commercial developments as well as other land uses are located throughout the county, but mostly away from the coast. The greatest concentrations of residential development are located adjacent to the incorporated cities of Inverness and Crystal River, and the unincorporated areas of Homosassa Springs and Beverly Hills. Commercial development is concentrated along US-19, SR-44, US-41, and on CR- 491 near the urbanized areas of Crystal River, Inverness, Homosassa Springs, Beverly Hills, and Hernando.

Conservation land in Citrus County occupied 105 mi^2 in 2004, while the amount of inland water subject to conservation restrictions was 195 mi^2 (Section 2.2.8.3). Conservation areas in Citrus County include Federally-managed lands (Chassahowitzka National Wildlife Refuge, Crystal River National Wildlife Refuge, State lands (Crystal River Preserve State Park, Withlacoochee State Forest, Marjorie Harris Carr Cross Florida Greenway), and lands managed by the SFWMD (Flying Eagle Preserve, Pott's Preserve, Chassahowitzka Riverine Swamp Sanctuary, Two-Mile Prairie, the McGregor-Smith Boy Scout Reservation, and the Annutteliga Hammock).

CR-3 was built on an established power plant site that was occupied at the time of CR-3 construction by two coal-fuel fired plants (CR-1 and CR-2) (AEC, 1973). Two additional coal-fired plants (CR-4 and CR-5) were built on the site after CR-3. Now, approximately 1,062 ac (430 ha) of the 4,738-ac (1,917-ha) CREC site are developed and maintained for operation of CR-1, CR-2, CR-3, CR-4, and CR-5 (Section 2.2.6). The site is situated at the interface between coastal tidal marshes and the drier hardwood hammock and pine flatwood habitats. CREC facilities (including those associated with CR-3) were developed predominantly on hardwood hammock habitat, and much of the area adjacent to the CREC site is undeveloped wetland habitat and extensive areas of pine plantations. About 900 ac (360 ha) of quarry lakes also occur in the vicinity.

CR-3-associated transmission lines originally were built within an existing transmission line corridor already partly occupied by existing lines from the site (AEC, 1973). At the time of their construction, the corridors ran through a variety of habitat types including forest, farmland, commercial, rural residential, and uninhabited areas. Although impacts were not documented, development of these corridors would have contributed to the fragmentation of existing contiguous habitats and would have resulted in subsequent changes to the wildlife and plant species in the vicinity of the corridors. Maintenance of ROWs has likely had past impacts and is expected to result in present and future impacts on terrestrial habitats. These impacts may include bio-uptake of potentially harmful chemicals, prevention of the natural successional stages of the surrounding vegetative community because of ROW maintenance, an increase in the abundance of edge species, a decrease in the abundance of interior forest species, and an increase in some invasive species populations.

The applicant does not manage invasive species on its land holdings; therefore, a potential exists for these species to be inadvertently introduced on or in the vicinity of the CREC site or its associated transmission line ROWs. Introduction of these species could contribute to the establishment of invasive species populations, which could compete with native species and degrade areas of terrestrial habitat. As noted by the FDEP, Florida is particularly prone to invasions of invasive nonnative plant and animal species because of the existing widespread destruction and disturbance of native habitats, Florida's tropical climate, and extensive waterways (FDEP, 1994).

As stated previously, the CREC supports four coal-fired power plants (CR-1, CR-2, CR-4, and CR-5). Coal-fired plants are a major source of air pollution in the United States, as they release sulfur dioxide, NO_x, mercury, carbon dioxide, and particulates. NO_x and sulfur dioxides can combine with water to form acid rain, which can lead to erosion and changes in soil pH levels. Mercury can deposit on soils and surface water, which may then be taken up by both terrestrial and aquatic plant and animal species, and poses the risk of bioaccumulation. For these reasons, and their close proximity to CR-3, the coal-fired units on the CREC site are likely to contribute to cumulative impacts on terrestrial resources in the vicinity of the CREC site and surrounding area.

The applicant has proposed construction and operation of LNP, and the draft EIS for the combined license (COL) was issued in August 2010 (NRC, 2010b). Preconstruction and construction impacts on the LNP site would result in the permanent and temporary loss of about 777 ac (314 ha) of habitat, including approximately 403 ac (163 ha) of wetland losses. About 2,037 ac (824 ha) of additional habitat would be disturbed to build the associated transmission lines and other offsite facilities, including about 370 ac (150 ha) of additional wetlands. The applicant has committed to mitigating for the loss or impairment of functions in all wetlands affected by the LNP project. In the LNP COL EIS, the Staff concluded that the impact from LNP preconstruction and construction activities would result in MODERATE impacts on terrestrial resources.

Potential operational impacts from the proposed LNP project would include salt drift from vapor plumes, groundwater withdrawal, bird collisions with tall structures, increased noise and traffic, nighttime lights, and transmission line operation. These impacts would be similar to, and additive with, the continued operation of CR-3 and other CREC facilities. In the LNP COL EIS, the Staff concluded that the impact from LNP operations would result in SMALL to MODERATE impacts on terrestrial resources.

The LNP review team concluded that the combined incremental contribution to cumulative impacts of LNP construction and operations would be MODERATE. The geographic region of interest for the LNP review and the CR-3 review are essentially the same.

Other future actions within the geographic area of interest that would contribute to cumulative impacts on terrestrial resources would include the proposed Tarmac King Road Limestone Mine, the Inglis Lock bypass channel spillway hydropower project, the proposed expansion of the FGT pipeline, and the proposed US-18 bridge upgrade. Other future actions or conditions that would contribute to cumulative impacts on terrestrial resources would include building and/or upgrading of transmission lines and other utilities; other new road development and expansion; continued industrial and urban development throughout the geographic area of interest; increased outdoor recreation; nonpoint source runoff from activities such as agriculture, forestry, and ranching; and global climate change.

There are a number of protected species that are known to occur on or in the vicinity of the CREC site or CR-3-associated transmission lines (Section 2.2.7), and these species may be affected by other existing projects in the area as well as by future projects. These species' protected status reflect their rarity, and in many cases, their rarity results from the cumulative effect of past and present actions. Operation of the CR-3 site and its associated transmission lines is not expected to adversely affect any of these threatened or endangered species during the license renewal term (Section 4.7).

Climate change could contribute to cumulative impacts to terrestrial resources on and around the CREC site. Average temperatures in the southeast are projected to continue to warm through the end of this century, especially during the summer (GCRP, 2009). Rainfall in winter and spring is projected to decrease along the Gulf coast and, together with increased temperatures, is expected to lead to an increase in the frequency, duration, and intensity of droughts that could lead to the drying of lakes, ponds, and wetlands and the loss of riparian species (GCRP, 2009). Sea level rise could result in the rapid loss of coastal marsh and saltwater intrusion into coastal forests (GCRP, 2009), thus eliminating breeding and foraging habitat for wildlife. Global climate change could also cause shifts in species ranges and migratory corridors as well as changes in ecological processes (NRC, 2010b).

On the basis of the information and evaluations in Sections 2.2.6, 2.2.7, 2.2.8.3, 4.6, and 4.7, the Staff concludes that the incremental contribution of CR-3 license renewal to cumulative impacts on terrestrial resources would be SMALL. The Staff believes that the cumulative impacts of other past, present, and reasonably foreseeable future actions on terrestrial resources during the CR-3 license renewal term would be MODERATE. This finding is consistent with the findings of the LNP COL environmental review team. The LNP COL review team's determination was based on the extent of expected wetland losses and habitat fragmentation from ongoing and planned development projects, continued widespread manipulation of habitats for commercial forest management, and anticipated losses of habitat for important species. As the geographic region of interest for the LNP review and the CR-3 review are essentially the same, these same conclusions would apply to cumulative impacts in the CR-3 geographic region.

4.11.4 Cumulative Human Health Impacts

This section addresses the direct and indirect effects of license renewal on human health when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. For the purpose of this analysis, the geographic area considered is the area included within a 50-mi (80-km) radius of the CR-3 site.

The NRC and EPA established radiological dose limits for the protection of the public and workers from both acute and long-term exposure to radiation and radioactive materials. As discussed in Section 4.8.1, the doses resulting from the operation of CR-3 are below regulatory limits and the impacts of these exposures would be SMALL.

EPA regulations in 40 CFR Part 190 limit the annual cumulative radiation dose to members of the public from all sources in the nuclear fuel cycle, including nuclear power plants, fuel fabrication facilities, waste disposal facilities, and transportation of fuel and waste to 25 mrem (0.25 mSv). The Staff's review of radioactive releases from CR-3 shows that the annual radiation dose to the public has been less than 1 mrem (0.01 mSv). This dose is within the NRC's and EPA's radiation protection standards. In addition, as discussed in Section 4.8.1, the applicant conducts a REMP around its site. The program measures radiation and radioactive materials in the environment from CR-3 and all other sources. As discussed in Section 4.8.1, the Staff reviewed the historical radiological environmental monitoring results for CR-3 and found no significant environmental impact associated with the operation of the plant. There are currently no other uranium fuel cycle facilities within a 50-mi (80-km) radius of CR-3 that can contribute to the cumulative radiological impacts. However, the NRC is reviewing an application for the construction and operation of two nuclear power reactors at a site in Levy County, Florida. The proposed nuclear facility is approximately 8 mi (12.9 km) northeast of CR-3. Also, CR-3 is constructing an ISFSI on the plant site. In addition to these new facilities, the applicant is planning to increase the power level of CR-3 by approximately 15 percent. These new facilities and the EPU would contribute to the cumulative radiological impacts in the vicinity of the CR-3 site. However, as discussed above, the cumulative radiological impacts from all uranium fuel cycle facilities in proximity to each other are limited to the radiation protection standards in 10 CFR Part 20 and 40 CFR Part 190.

Based on the Staff's review of CR-3's radioactive effluent and environmental monitoring data and the expected continued compliance with Federal radiation protection standards, the cumulative radiological impacts from the operation of CR-3, including its planned EPU and its ISFSI, during the renewal term would be SMALL. The NRC and the State of Florida would regulate any future development or actions, such as the construction and operation of the proposed LNP, in the vicinity of the CR-3 site that could contribute to cumulative radiological impacts. Therefore, the Staff concludes that the cumulative radiological impacts to human health from the continued operation of CR-3, including the additional nuclear facilities discussed above, during the license renewal term would be SMALL.

The Staff determined that the electric-field-induced currents from the CR-3 transmission lines are below the NESC criteria for preventing acute electric shock from induced currents. Therefore, the CR-3 transmission lines do not appreciably affect the overall potential for acute electric shock from induced currents within the analyzed geographic area. With respect to chronic effects of electromagnetic fields, the Staff considers the GEIS finding of "not applicable" to be appropriate for CR-3. Therefore, the Staff concludes that the cumulative impacts of the continued operation of CR-3 and its transmission lines would be SMALL.

4.11.5 Cumulative Socioeconomic Impacts

This section addresses socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at CR-3 in addition to the aggregate effects of other past, present, and reasonably foreseeable future actions. The primary geographic area of interest considered in this cumulative analysis is Citrus County where approximately 83 percent of CR-3 employees reside. This area is where the economy, tax base, and infrastructure would most likely be affected since CR-3 workers and their families reside, spend their income, and use their benefits within this county.

As discussed in Section 4.9 of this SEIS, the continued operation of CR-3 during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already being experienced. Since the applicant has no plans to hire additional non-outage workers during the license renewal term, overall expenditures and employment levels at CR-3 would remain relatively constant, with no additional demand for permanent housing, public utilities, and public services. In addition, since employment levels and tax payments would not change, there would be no population and tax-revenue-related land use impacts. Based on this and other information presented in Chapter 4 of this SEIS, there would be no additional contributory effect on socioeconomic conditions in the future from the continued operation of CR-3 during the license renewal term beyond what is already being experienced.

<u>Extended Power Uprate</u>

The applicant has notified the NRC that it intends to increase the licensed core thermal power level of CR-3 from 2,609 MWt to 3,014 MWt (Progress Energy, 2009m). EPU-related plant modifications would occur during two refueling outages. Potential socioeconomic impacts from the EPU include temporary increases in the size of the workforce at CR-3 and associated increased demand for public services, housing, and increased traffic in the region. The EPU could also increase tax payments due to increased power generation and assessed value.

Approximately 740 additional workers would be on site in addition to 540 refueling outage workers during the first of two outages needed to implement the EPU. Approximately 850 workers would return to complete plant modifications for the EPU during the fall 2011 refueling outage. The volume of construction and worker vehicles on roads and the demand for rental housing and other commercial and public services would increase beyond what is normally experienced during refueling outages. Due to the short duration of EPU-related plant modification activities, there would be little or no noticeable long-term effect on sales and income tax revenues generated by temporary workers residing in Citrus County. Therefore, there would be no significant adverse socioeconomic impacts from EPU-related plant modifications and operations under EPU conditions in the vicinity of CR-3. The contributory cumulative effect on socioeconomic conditions of this action could be SMALL to MODERATE in the immediate vicinity of CR-3 during the two outages.

Independent Spent Fuel Storage Installation

The applicant has announced plans to begin building an ISFSI for storage of spent fuel in early 2010. Potential socioeconomic impacts from the ISFSI include temporary increases in the size of the workforce at CR-3 and associated increased demand for public services, housing, and increased traffic in the region. The ISFSI could also increase tax payments due to increased power generation and assessed value.

The maximum number of ISFSI workers on site is expected to be around 60, during the summer of 2011. Approximately 35 workers would be from the Crystal River area. The rest would come from outside of the area. The project is expected to be completed by June 2012 (Progress Energy, 2009m). The volume of construction and worker vehicles on roads and the demand for rental housing and other commercial and public services would increase during the construction of the ISFSI. The contributory cumulative effect on socioeconomic conditions of this action could be SMALL in the immediate vicinity of CR-3.

Levy Nuclear Plant, Units 1 and 2

Progress Energy Florida, Inc. submitted a combined operating license application (COLA) to the NRC for two new nuclear units at a site in southern Levy County, Florida, on July 30, 2008. The 5,200-ac site is approximately 8 mi (12.9 km) northeast of CR-3. Current plans call for two 1,100-MW units of the Westinghouse AP-1000 type pressurized water reactors. The facility would employ closed-cycle cooling with makeup water from the Cross Florida Barge Canal (now the canal within the Marjorie Harris Carr Cross Florida Greenway) and blowdown piped to the Crystal River discharge canal (Progress Energy, 2009m).

The contributory cumulative effect on socioeconomic conditions from the construction of these units could be MODERATE to LARGE in the immediate vicinity of the proposed LNP site. These impacts would be caused by the short-term increased demand for rental housing and other commercial and public services by construction workers during the years of plant construction. During peak construction periods, there would be a noticeable increase in the volume of construction vehicles on roads in the immediate vicinity of the LNP site. The cumulative long-term operations impacts of this action during the operation of the proposed new power plant would be SMALL to MODERATE. These impacts would be caused by the increased demand for permanent housing and other commercial and public services, such as schools, police and fire, and public water and electric services by operations workers during plant operations. During shift changes, there would be a noticeable increase in the number of commuter vehicles on roads in the immediate vicinity of the proposed LNP site.

LNP site preparation is scheduled to begin in 2012 or 2013, and would take approximately 18 months. Construction activity would last approximately 3 to 4 years, with a 1 year stagger between units. LNP 1 would be completed in 2018 or 2019 and LNP 2 in 2019 or 2020.

Table 4.11.5-1 shows the estimated workforce over the first 8 years of operation, with the peak workforce projected to be 3,300 workers in 2016 (NRC, 2010b).

Table 4.11.5-1. Projected Workforce at Levy Nuclear Plant during the First 8 Years of Operation

Year	Number of Workers
2012	750
2013	100
2014	1,950
2015	3,100
2016	3,300
2017	2,900
2018	1,250
2019	100

Source: NRC, 2010b

Historic and Archaeological Resources

It does not appear likely that the proposed license renewal would adversely affect cultural resources at CR-3. Any ground-disturbing activities that might be conducted during the license renewal term are unlikely to result in the loss of historic and archaeological resources, given existing earthmoving procedures to protect presently undiscovered resources and the presence of known historic and archaeological resources in coastal areas that are not likely to be disturbed. Prior to any ground-disturbing activity in an undisturbed area, it is expected that the applicant would evaluate the potential for impacts on historic and archaeological resources according to their procedures (EVC-SUBS-00105) and in consultation with the SHPO and appropriate Native American Tribes, as required under Section 106 of the NHPA. In the vicinity of CR-3 and its transmission lines, some projects have the potential to affect historic and archaeological resources, such as new or expanded road systems or pipeline construction; however, linear projects have some flexibility in the siting process and can typically avoid significant cultural resources, minimizing the potential for impact.

The NRC has also evaluated the impacts of the reasonably foreseeable construction and operation of two nuclear reactors at the LNP site and an EPU at CR-3 and has concluded that impacts from those projects on historic and archaeological resources would be SMALL (NRC, 2010b). Therefore, the Staff concludes that when combined with these past, present, and reasonably foreseeable future actions, the incremental contribution to a cumulative impact on historic and archaeological resources by continued operation of CR-3 during the license renewal period would be SMALL and would not result in the loss of historic and cultural resources.

Environmental Justice

The environmental justice cumulative impact analysis assesses the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from past, present, and reasonably foreseeable future actions, including CR-3 operations during the renewal term. 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 the risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed 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 presented in Chapter 4 of this SEIS. Minority and low-income populations are subsets of the general public residing in the area and all would be exposed to the same hazards generated from CR-3 operations. As previously discussed in this chapter, the impact from license renewal for most resource areas (e.g., land, air, water, and human health) would be SMALL.

As discussed in Section 4.9.7 of this SEIS, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of CR-3 during the license renewal term. Since the applicant has no plans to hire additional non-outage workers during the license renewal term, employment levels at CR-3 would remain relatively constant with no additional demand for housing or increased traffic. Based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5, it is not likely there would be any disproportionately high and adverse contributory effect on minority and low-income populations from the continued operation of CR-3 during the license renewal term.

Potential impacts to minority and low-income populations from the CR-3 EPU and ISFSI and LNP Units 1 and 2 would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Radiation doses from plant operations after the EPU are expected to continue at current levels and, along with the ISFSI at CR-3, be well below regulatory limits.

Noise and dust impacts would be short-term and limited to onsite activities at CR-3 and LNP. Minority and low-income populations residing along site access roads could experience increased commuter vehicle traffic during shift changes. Increased demand for rental housing during the refueling outages that would include EPU-related plant modifications and ISFSI at CR-3 and LNP site could disproportionately affect low-income populations. However, due to the short duration of the EPU- and ISFSI-related work and the availability of rental housing, impacts to minority and low-income populations would be short-term and limited. According to American Community Survey 2009 estimates, there were approximately 16,600 vacant housing units in Citrus County.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the EPU and ISFSI at CR-3 would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of CR-3. The contributory cumulative effect on minority and low-income populations from the construction and operation of LNP Units 1 and 2 would be SMALL in the immediate vicinity of the proposed LNP site (NRC, 2010b).

4.11.6 Cumulative Impacts on Air Quality

This section addresses the direct and indirect effects of license renewal on air quality resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions within the region of interest. The geographic region of interest for cumulative air impact assessment is the West Central Florida Intrastate Air Quality Control Region, which includes

Citrus County and surrounding counties (see 40 CFR 81.96 for the geographic area encompassed by the West Central Florida Intrastate Air Quality Control Region). As discussed in Section 2.2.1, air quality throughout the entire State of Florida is currently in conformance with primary (i.e., health-based) NAAQS. In Section 4.2, the Staff determined that impact to ambient air quality from the continued operation of CR-3 under the auspices of a renewed operating license would be SMALL. Table 4.11-1 lists those past, current, and reasonably anticipated future activities that were assessed by the Staff in determining the potential cumulative impacts to ambient air quality within the region of interest.

The Staff recently completed and published a draft environmental impact statement (EIS) in support of the Commission’s licensing decision for the LNP in nearby Levy County (NRC, 2010b). As part of the alternatives analysis for that proposed new reactor (Chapter 9 of the draft EIS), the Staff analyzed the impacts of two new AP1000 nuclear units at the CREC site and conducted a cumulative air quality impact analysis for that alternative. The Staff has determined that the cumulative air quality impact analysis for the LNP alternative is applicable to the cumulative air quality impact analysis supporting the CR-3 license renewal decision with only minor modifications. The results of the analysis presented for the alternative location at the Crystal River site are summarized below, with appropriate adjustments to ensure its applicability to the CR-3 license renewal decision being addressed in this SEIS.

Among the projects identified in Table 4.11-1, operation of the coal-fired power plants and associated activities at the CREC represent the most significant sources of criteria pollutants and fugitive dust. See Section 4.2 for a more detailed discussion. By comparison, the other facilities listed in Table 4.11-1 represent only minor and, in some instances, temporary impacts to ambient air quality. The Staff believes that it is reasonable to assume that: (1) the Title V permit issued for the CREC which applies to the operation of all stationary sources at the CREC contains appropriate limits to pollutant emissions from all CREC stationary sources and requires the application of best management practices designed to minimize releases of air pollutants, and (2) the applicant will continue to operate the CREC in a manner consistent with those permit limitations. An overall reduction in cumulative air quality impact can be anticipated with the shutdown of CR-1 and CR-2 once LNP becomes operational. Other projects and activities listed in Table 4.11-1 are expected to be conducted in conformance with best management practices as they are defined for those activities and in compliance with the terms of operating permits that have been or are expected to be issued for some of the stationary sources of air pollution associated with those other projects or activities. No new project has been identified in the region of interest that is likely to have the potential to degrade ambient air quality to a significant degree during its construction and operation.

Construction and operation of LNP would be a source of criteria pollutant and fugitive dust releases during construction (including construction of a 13-mi [21-km] pipeline that will deliver cooling tower blowdown water to the CREC throughout the LNP operating period). LNP would be a minor source of criteria pollutants once operational. The EPU of CR-3 would be a minor and temporary source of criteria pollutants and fugitive dust during EPU activities. The Inglis Lock bypass channel spillway hydropower plant would be a minor source of criteria pollutants and fugitive dust during construction of the hydroelectric plant and associated transmission lines. The FGT Phase VIII Expansion Project would be a minor source of criteria pollutants and fugitive dust during pipeline and compressor station construction and a minor source of criteria pollutants during operation. The Tarmac King Road Limestone Mine, once operational, would be a possible source of criteria pollutants and fugitive dust. The nearby operational mines (Holcim Mine, Inglis Quarry, Crystal River Quarries – Red Level, Crystal River Quarries – Lecanto, and Gulf Hammock Quarry) are sources of criteria pollutants and fugitive dust. The

Cross Florida Barge Canal/Marjorie Harris Carr Cross Florida Greenway is a possible source of criteria pollutants from barge activities. Controlled burns undertaken as part of forest management programs in nearby parks, forests, and preserves would result in temporary and localized increases in ambient particulate concentrations. No schedule for such burns is available. Criteria pollutants and fugitive dust releases will result from commercial forest management. The two nearby concrete plants release criteria pollutants and fugitive dust during operation. Construction of new housing units, commercial buildings, roads, bridges, and other development will result in the release of criteria pollutants and fugitive dust. Also, increased traffic volumes will result in criteria pollutants.

In April 2009, the EPA published the official U.S. inventory of the greenhouse gas (GHG) emissions that identifies and quantifies the primary anthropogenic sources and sinks of GHGs. The EPA GHG inventory is an essential tool for addressing climate change and participating with the United Nations Framework Convention on Climate Change to compare the relative global contribution of different emission sources and GHGs to climate change. The EPA estimates that energy-related activities in the United States account for three-quarters of human-generated GHG emissions, mostly in the form of carbon dioxide emissions from burning fossil fuels. More than half of the energy-related emissions come from major stationary sources like power plants, and approximately one-third comes from transportation. Industrial processes (production of cement, steel, and aluminum), agriculture, forestry, other land use, and waste management are also important sources of GHG emissions in the United States (EPA, 2009).

Section 6.2 presents an evaluation of the GHG emissions of the nuclear fuel cycle and provides comparisons to GHG emissions of similarly sized coal- and natural gas-fired power plants. The impacts of GHG emissions are not sensitive to the location of the source. Consequently, those same GHG “footprints” would result from the operation of those power plants regardless of their locations. In a report issued by the U.S. Global Climate Change Research Program (GCRP), it was determined that as much as 87 percent of GHG emissions are the result of generating electricity and heat using carbonaceous fuels (GCRP, 2009). The GCRP also makes the following observations for the southeast portion of the United States (including the CREC): since 1970, annual average temperature has risen about 2 °F (1.1 °C); since 1901, average autumn precipitation for the region has increased by 30 percent while precipitation in South Florida has declined; while precipitation in South Florida is projected to continue to decline over this century, rainfall from Atlantic hurricanes is projected to increase; sea level rise and the likely increase in hurricane intensity represent the most serious consequences projected, leading to more frequent and more extensive coastal inundation and shoreline retreats, especially along the central Gulf coast as the rate of sea level rise accelerates; the salinity of estuaries will increase, affecting coastal ecosystems[11]; the overall risk of major hurricanes will be exacerbated by climate-induced changes.

The Staff concludes that continued operation of the listed sources would have a noticeable effect on air quality, primarily as a result of the operation of the coal-burning units at the CREC. The Staff further concludes that continued operation of existing sources, the establishment of the new sources identified in Table 4.11-1 and additional anticipated area urban and industrial development would not result in the degradation of ambient air quality to the extent that the region would be determined to be in nonattainment for any NAAQS. Such a level of

[11] More specifically for the CREC, an increase in salinity of estuaries will alter the specific heat capacity of the seawater now being used for steam cycle cooling at the CREC, resulting in a decrease in the performance of the existing cooling systems.

degradation of air quality is even more unlikely after CR-1 and CR-2 shut down in 2020. Restart of CR-3 after the EPU, startup of the LNP reactors, and startup of the hydroelectric plant at Inglis Lock may allow for reduced reliance on the coal-fired power plants at the CREC for baseload power, further reducing the likelihood of degradation of regional ambient air quality.

4.11.7 Summary of Cumulative Impacts

The Staff considered the potential impacts resulting from the operation of CR-3 during the period of extended operation and other past, present, and reasonably foreseeable future actions near CR-3. The preliminary determination is that the potential cumulative impacts would range from SMALL to LARGE, depending on the resource. Table 4.11.7-1 summarizes the cumulative impacts on resources areas.

Table 4.11.7-1. Summary of Cumulative Impacts on Resources Areas

Resource Area	Cumulative Impact
Water Resources	The Staff concludes that cumulative impacts due to groundwater usage by CR-3 in combination with the projected increase in groundwater usage for Citrus County (including the increased usage authorized by the State of Florida for the Units 4 and 5 Clean Air Project) would be SMALL to MODERATE, depending on the findings of monitoring and testing currently in progress. Although surface water discharges from the CREC are monitored in accordance with the State of Florida's NPDES permit, the Staff concludes that cumulative impacts to water quality (temperature and salinity) in Crystal Bay would be MODERATE because of other factors such as nonpoint sources of pollution and the projected increase in ocean water temperatures over the next 20 years. Cumulative impacts to surface water use and groundwater quality would be SMALL.
Aquatic Ecology	Based on the Staff's review, multiple stressors affect the aquatic resources of Crystal Bay. Management actions may address the impacts of some of the stressors (e.g., cooling system operations, fishing pressure, and water quality). Although the impacts associated with cumulative impacts cannot be quantified, cumulative impacts on aquatic resources have stressed, and will continue to stress, aquatic resources, including Federally-threatened and endangered species. Under some unlikely scenarios, (e.g., a major oil spill followed by a hurricane), destabilizing effects could occur, although evidence of this is not available at this time. The Staff finds the level of cumulative impact to be MODERATE for the purposes of this SEIS.
Terrestrial Ecology	Construction of LNP would result in MODERATE impacts to terrestrial ecology (NRC, 2010b). The NRC determined that cumulative impacts would be MODERATE, although the incremental contribution from the proposed license renewal would be SMALL and would not adversely affect terrestrial resources.
Human Health	Based on the Staff's review of CR-3's radioactive effluent and environmental monitoring data and the expected continued compliance with Federal radiation protection standards, the cumulative radiological impacts from the operation of CR-3, including its planned EPU and its ISFSI, during the renewal term would be SMALL. The NRC and the State of Florida would regulate any future development or actions, such as the construction and operation of the proposed LNP, in the vicinity of the CR-3 site that could contribute to cumulative radiological impacts. Therefore, the Staff concludes that the cumulative radiological impacts to human health from the continued operation of CR-3, including the additional nuclear facilities discussed above, during the license renewal term would be SMALL. The Staff determined that the potential for acute electric shock from the CR-3 transmission lines would be SMALL.

Resource Area	Cumulative Impact
Socioeconomics	The contributory cumulative effect on socioeconomic conditions of the EPU at CR-3 could be SMALL to MODERATE in the immediate vicinity of CR-3 during the two outages. The contributory cumulative effect on socioeconomic conditions of the ISFSI could be SMALL in the immediate vicinity of CR-3. The contributory cumulative effect on socioeconomic conditions from the construction of LNP could be MODERATE to LARGE in the immediate vicinity of the proposed LNP site and SMALL to MODERATE during operations (NRC, 2010b).
Environmental Justice	Based on the analysis of human health and environmental impacts presented in this SEIS, the EPU and ISFSI at CR-3 would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of CR-3. The contributory cumulative effect on minority and low-income populations from the construction and operation of LNP Units 1 and 2 would be SMALL in the immediate vicinity of the proposed LNP site (NRC, 2010b).
Cultural Resources	The NRC evaluated the impacts of the reasonably foreseeable construction and operation of two nuclear reactors at the LNP site and an EPU at CR-3 and has concluded that impacts from those projects on historic and archaeological resources would be SMALL (NRC, 2010b). Therefore, the NRC concludes that when combined with these past, present, and reasonably foreseeable future actions, the incremental contribution to a cumulative impact on historic and archaeological resources by continued operation of CR-3 during the license renewal period would be SMALL and would not result in the loss of historic and cultural resources.
Air Quality	Cumulative impacts on air quality resources were estimated based on the information provided by FPC and the independent evaluation of the NRC review team. Other past, present, and reasonably foreseeable future activities in the region of interest have been identified and incorporated into the NRC review team's assessment. The NRC concludes that the cumulative impact to ambient air quality from the continued operation of CR-3 and other sources of criteria pollutants in the region of interest would be MODERATE. The NRC review team also concludes that the cumulative impact to GHG emissions from the continued operation of CR-3 and the other identified sources of GHG emissions in the region of interest would also be SMALL.

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This chapter describes the environmental impacts from postulated accidents that the Crystal River Unit 3 Nuclear Generating Plant (CR-3) might experience during the period of extended operation. A more detailed discussion of this assessment can be found in Appendix F. The term "accident" refers to any unintentional event outside the normal plant operational envelope that results in a release, or the potential for release, of radioactive materials into the environment. Two classes of postulated accidents are evaluated in NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statements for License Renewal of Nuclear Power Plants* (GEIS) (NRC, 1996), (NRC, 1999), prepared by the U.S. Nuclear Regulatory Commission (NRC), as listed in Table 5-1. These two classes include:

- design-basis accidents (DBAs)
- severe accidents

Table 5-1. Issues Related to Postulated Accidents. *Two issues related to postulated accidents are evaluated under the National Environmental Policy Act of 1969 (NEPA) in the license renewal review: design-basis accidents and severe accidents.*

Issues	GEIS Section	Category
Design-basis accidents	5.3.2; 5.5.1	1
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	2

Generic issues (Category 1 issues, see Chapter 1) rely on the analysis provided in the GEIS and are discussed briefly (NRC, 1996), (NRC, 1999).

5.1 DESIGN BASIS ACCIDENTS

As part of the process for receiving 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 (Staff) reviews the application to determine whether or not the plant design meets NRC 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 Staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. Some 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 of the *Code of Federal Regulations* (CFR) Parts 50 and 100.

The environmental impacts of DBAs are evaluated during the initial licensing process. Before a license renewal is issued, the DBA assessment must demonstrate that the plant can withstand these accidents. The results of these evaluations are found in license documentation, such as the applicant's final safety analysis report (FSAR), the safety evaluation report (SER), 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 events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for the period of extended operation, 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 period of extended operation, 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 significance level of the environmental impacts of DBAs are SMALL for all plants because the plants were designed to successfully withstand these accidents. For the purposes of license renewal, DBAs have been designated as a Category 1 issue. The early resolution of the DBAs makes them a part of the current licensing basis of the plant. The current licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal.

No new and significant information related to DBAs was identified during the review of the CR-3 environmental report (ER) (Progress Energy, 2008), the site visit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS.

5.2 SEVERE ACCIDENTS

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the 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 period of extended operation.

Severe accidents initiated by external phenomena, such as tornadoes, floods, earthquakes, fires, and sabotage, have not traditionally been discussed in quantitative terms in FESs, and were not specifically considered for the CR-3 site in the GEIS (NRC, 1996). However, the GEIS did evaluate existing impact assessments performed by the Staff 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 performed a discretionary analysis 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 Staff concludes 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 (NRC, 1996).

Based on information in the GEIS, the Staff found that:

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

The Staff identified no new and significant information related to postulated accidents during the review of the CR-3 ER (Progress Energy, 2008), the site visit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the Staff reviewed severe accident mitigation alternatives (SAMAs) for the CR-3. The results of the review are discussed in Section 5.3.

5.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

Section 51.53(c)(3)(ii)(L) requires that license renewal applicants 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 CR-3; therefore, the remainder of Chapter 5 addresses those alternatives.

5.3.1 Introduction

This section presents a summary of the SAMA evaluation for CR-3 conducted by Florida Power Corporation (FPC) and the Staff's review of that evaluation. The Staff performed its review with contract assistance from Pacific Northwest National Laboratory. The Staff's review is available in full in Appendix F; the SAMA evaluation is available in full in CR-3's ER.

The SAMA evaluation for CR-3 was conducted with a four-step approach. In the first step, FPC quantified the level of risk associated with potential reactor accidents using the plant-specific probabilistic risk assessment (PRA) and other risk models.

In the second step, FPC examined the major risk contributors and identified possible ways (SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. FPC identified 25 potential SAMAs for CR-3. FPC performed an initial screening to determine if any SAMAs could be eliminated because they are not applicable at CR-3 due to design differences, or were judged to have a low benefit relative to the cost of implementation. This screening reduced the list of potential SAMAs to 15.

In the third step, FPC 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 was also 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). FPC concluded in its ER that several of the SAMAs evaluated are potentially cost-beneficial (Progress Energy, 2008). However, in response to Staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, several additional potentially cost-beneficial SAMAs were identified (Progress Energy, 2009a), (Progress Energy, 2009b).

The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal under 10 CFR Part 54. FPC's SAMA analyses and the NRC's review are discussed in more detail below.

5.3.2 Estimate of Risk

FPC submitted an assessment of SAMAs for CR-3 as part of the ER (Progress Energy, 2008). This assessment was based on the most recent CR-3 PRA 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 CR-3 individual plant examination (IPE) (FPC, 1993) and individual plant examination of external events (IPEEE) (FPC, 1996), (FPC, 1997).

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately $5.0x10^{-6}$ per year. The CDF value is based on the risk assessment for internally-initiated events. FPC did not include the contributions from external events within the CR-3 risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 2. The breakdown of CDF by initiating event is provided in Table 5-2.

Table 5-2. Crystal River Unit 3 Nuclear Generating Plant Core Damage Frequency for Internal Events

Initiating Event	CDF (per year)	Percent Contribution to CDF
Small break loss-of-coolant accident (LOCA)	$1.5x10^{-6}$	30
Transients	$9.9x10^{-7}$	20
Reactor vessel rupture	$5.0x10^{-7}$	10
Internal flooding	$4.0x10^{-7}$	8
Steam generator tube rupture (SGTR)	$3.5x10^{-7}$	7
Loss of AC buses	$3.3x10^{-7}$	7
Loss of offsite power (LOOP)	$3.0x10^{-7}$	6
Large break LOCA	$1.7x10^{-7}$	3
Loss of direct current (DC) power	$1.5x10^{-7}$	3
Loss of main feedwater	$1.2x10^{-7}$	2
Medium break LOCA	$1.1x10^{-7}$	2
Interfacing system LOCA (ISLOCA)	$5.1x10^{-8}$	1
Total CDF (internal events)	**$5.0x10^{-6}$**	**100**

As shown in this table, small LOCAs and transients (reactor trips, loss of intake, and loss of makeup) are the dominant contributors to the CDF.

FPC estimated the dose to the population within 50 miles (80 kilometers) of the CR-3 site to be approximately 4.0 person-sievert (Sv) (40 person-rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-3. Containment bypass events (such as SGTR-initiated accidents or ISLOCA accidents) and small early containment failures dominate the population dose risk at CR-3.

Table 5-3. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose (Person-Rem[(a)] Per Year)	Percent Contribution
Containment intact	0.04	1
Late containment failure	0.04	1
Large early containment failure	0.02	<1
Small early containment failure	0.37	9
Containment bypass accident, small leakage rate	2.68	67
Containment bypass accident, large leakage rate	0.83	21
Total	**3.98**	**100**

(a) One person-rem = 0.01 person-Sv

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

5.3.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, FPC searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, FPC considered insights from the plant-specific PRA, and SAMA analyses performed for other operating plants that have submitted license renewal applications. FPC identified 25 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures, and training.

FPC removed 10 of the SAMAs from further consideration because they are not applicable at CR-3 due to design differences, or were judged to have a low benefit compared to the cost of implementation. A detailed cost-benefit analysis was performed for each of the 15 remaining SAMAs.

The Staff concludes that FPC used a systematic and comprehensive process for identifying potential plant improvements for CR-3, and that the set of potential plant improvements identified by FPC is reasonably comprehensive and, therefore, acceptable.

5.3.4 Evaluation of Risk Reduction and Costs of Improvements

FPC evaluated the risk-reduction potential of the remaining 15 SAMAs. In response to a Staff inquiry, FPC also evaluated the risk-reduction potential of the 10 SAMAs eliminated in the initial screening (Progress Energy, 2009a). The SAMA evaluations were performed using realistic assumptions with some conservatism.

FPC developed plant-specific costs of implementing the 25 candidate SAMAs. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications. In response to a Staff inquiry, FPC stated that CR-3 engineering personnel reviewed each SAMA to assess the work scope associated with implementing each SAMA and then the implementation cost was estimated by benchmarking the SAMA work scope to other projects of similar scope.

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

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

The Staff concludes that the risk reduction and the cost estimates provided by FPC are sufficient and appropriate for use in the SAMA evaluation.

5.3.5 Cost-Benefit Comparison

The cost-benefit analysis performed by FPC was based primarily on NUREG/BR-0184 (NRC, 1997) and was executed consistent with this guidance. NUREG/BR-0058 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). FPC provided both sets of estimates (Progress Energy, 2008).

In the baseline analysis contained in the ER (using a 3 percent discount rate), FPC identified one potentially cost-beneficial SAMA. Based on the consideration of analysis uncertainties (multiplying benefits by 2.18), FPC identified three additional potentially cost-beneficial SAMAs. In response to Staff inquiries, FPC provided the results of a revised baseline analysis, multiplying the internal events benefits by 12 to account for the additional external events benefits. The revised baseline analysis resulted in the identification of four additional potentially cost-beneficial SAMAs. FPC also provided a revised uncertainty analysis using a multiplier of 12 to account for external events benefits, and an additional multiplier of 2.18 to account for analysis uncertainties, which resulted in the identification of four additional potentially cost-beneficial SAMAs.

The potentially cost-beneficial SAMAs for CR-3 are:

- SAMA 4 – Automate start of auxiliary feedwater pump FWP-7 when required to supply feedwater to the once-through steam generators (OTSGs) in the event the automated emergency feedwater (EFW) system is unavailable (cost-beneficial in revised analysis, with uncertainties).
- SAMA 5 – Improve availability of auxiliary feedwater pump FWP-7 to supply feedwater to the OTSGs in the event that other EFW pumps are unavailable (cost-beneficial in revised analysis, with uncertainties).
- SAMA 8 – Provide a temporary pump to provide a backup supply of cooling water in lieu of raw water pump in the event it is unavailable (cost-beneficial in revised analysis, with uncertainties).
- SAMA 9 – Proceduralize additional responses to DHV-11 and DHV-12 in the event remote opening of these valves fails (cost-beneficial in revised analysis).
- SAMA 10 – Proceduralize additional responses to MUV-23, MUV-24, MUV-25, and MUV-26 failures in the event of a common mode failure of all four of these motor-operated valves (MOVs) (cost-beneficial with uncertainties).
- SAMA 15 – Provide control room capability to realign power to makeup pump 1B remotely in lieu of local manual operation (cost-beneficial in revised analysis, with uncertainties).
- SAMA 33 – Proceduralize manual operation of DHV-42 and DHV-43 in the event remote operation of these MOVs fails (cost-beneficial in revised analysis).
- SAMA 34 – Improve procedures for manual operation of EFW valves in order to maintain acceptable steam generator water levels in the event the automatic level control system fails.
- SAMA 35 – Update power-operated relief valve (PORV) controls to open automatically when operator action was previously required to open the PORV (cost-beneficial in revised analysis).
- SAMA 38 – Additional condensate storage tank (CST) replacement water sources are aligned through operator actions to provide backup for the EFW system when the CST is rendered unavailable (cost-beneficial in revised analysis).
- SAMA 49 – Upgrade fire barriers in battery charger room 3A (cost-beneficial with uncertainties).
- SAMA 51 – Upgrade or improve engineering analysis to qualify the emergency feedwater initiation and control (EFIC) cabinets to a higher temperature, thereby increasing the reliability of the EFIC system (cost-beneficial with uncertainties).

In response to Staff inquiries, FPC identified two additional cost-beneficial SAMAs related to improvements to upgrade the fire compartment barriers in 4.16 kilovolt (kV) switchgear bus rooms 3A and 3B (Progress Energy, 2009b).

FPC indicated that they plan to further evaluate all of these SAMAs using the appropriate CR-3 design process, and have included these items in CR-3's corrective action program (Progress Energy, 2008), (Progress Energy, 2009a), (Progress Energy, 2010).

The Staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than the associated benefits.

5.3.6 Conclusions

The Staff reviewed FPC's analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by FPC are reasonable and sufficient for the license renewal submittal.

Based on its review of the SAMA analysis, the Staff concurs with FPC'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 FPC is warranted. However, none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal under 10 CFR Part 54.

5.4 REFERENCES

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6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE AND WASTE MANAGEMENT

6.1 THE URANIUM FUEL CYCLE AND WASTE MANAGEMENT

This chapter addresses issues related to the uranium fuel cycle and waste management during the period of extended operation. The uranium cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC, 1996), (NRC, 1999) based, in part, on the generic impacts provided in Title 10, Section 51.51(b), of the *Code of Federal Regulations* (10 CFR 51.51(b)), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 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."

Table 6-1. Issues Related to the Uranium Fuel Cycle and Waste Management. *There are nine generic issues related to the fuel cycle and waste management. There are no site-specific issues.*

Issues	GEIS Sections	Category
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	1
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
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	1
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6; 6.6	1
Mixed waste storage and disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4; 6.6	1
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6	1
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6	1
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1	1

The staff of the U.S. Nuclear Regulatory Commission (NRC or the Staff) did not find any new and significant information related to the uranium fuel cycle and waste management during its review of the Crystal River Unit 3 Nuclear Generating Plant (CR-3) environmental report (ER) (Progress Energy, 2008), the site visit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these Category 1 issues, the GEIS concludes that the impacts are SMALL, except for the offsite radiological collective impacts from the fuel cycle and from high-level waste and spent fuel disposal, which the NRC has concluded to be acceptable.

6.2 GREENHOUSE GAS EMISSIONS

This section discusses the potential impacts from greenhouse gases (GHGs) emitted from the uranium fuel cycle. The GEIS does not directly address these emissions, and its discussion is limited to an inference that substantial carbon dioxide (CO_2) emissions may occur if coal- or oil-fired alternatives to license renewal are carried out.

6.2.1 Existing Studies

Since the development of the GEIS, the relative volumes of GHGs emitted by nuclear and other electricity generating methods have been widely studied. However, estimates and projections of the carbon footprint of the nuclear power lifecycle vary depending on the type of study done. Additionally, considerable debate also exists among researchers on the relative effects of nuclear and other forms of electricity generation on GHG emissions. Existing studies on GHG emissions from nuclear power plants generally take two different forms:

(1) qualitative discussions of the potential to use nuclear power to reduce GHG emissions and mitigate global warming

(2) technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle or entire nuclear power plant lifecycle and comparisons to the operational or lifecycle emissions from other energy generation alternatives

6.2.1.1 *Qualitative Studies*

The qualitative studies consist primarily of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, or politically workable means of achieving global GHG reductions. Studies found by the Staff during the subsequent literature search include the following:

- Evaluations to determine if investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider, 2000), (IAEA, 2000), (NEA and OECD, 2002). Ultimately, the parties to the Kyoto Protocol did not approve nuclear power as a component under the Clean Development Mechanism due to safety and waste disposal concerns (NEA and OECD, 2002).

- Analyses developed to assist governments, including the United States, in making long-term investment and public policy decisions in nuclear power (Keepin, 1988), (Hagen et al., 2001), (MIT, 2003).

Although the qualitative studies sometimes reference and critique the existing quantitative estimates of GHGs produced by the nuclear fuel cycle or lifecycle, 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 typically not directly applicable to an evaluation of GHG emissions associated with the proposed license renewal for a given nuclear power plant.

6.2.1.2 *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 and were useful to the Staff's efforts in addressing relative GHG emission levels. Examples of these studies include—but are not limited to—Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), Parliamentary Office of Science and Technology (POST) (2006), AEA Technology (AEA) (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparing these studies and others like them is difficult because the assumptions and components of the lifecycles the authors evaluate vary widely. Examples of areas in which differing assumptions make comparing the studies difficult include the following:

- energy sources that may be used to mine uranium deposits in the future
- reprocessing or disposal of spent nuclear fuel
- current and potential future processes to enrich uranium and the energy sources that will power them
- estimated grades and quantities of recoverable uranium resources
- estimated grades and quantities of recoverable fossil fuel resources
- estimated GHG emissions other than CO_2, including the conversion to CO_2 equivalents per unit of electric energy produced
- performance of future fossil fuel power systems
- projected capacity factors for alternative means of generation
- current and potential future reactor technologies

In addition, studies may vary with respect to whether all or parts of a power plant's lifecycle are analyzed. That is, a full lifecycle analysis will typically address plant construction, operations, resource extraction (for fuel and construction materials), and decommissioning, whereas, a partial lifecycle analysis primarily focus on operational differences.

In the case of license renewal, a GHG analysis for that portion of the plant's lifecycle (operation for an additional 20 years) would not involve GHG emissions associated with construction because construction activities have already been completed at the time of relicensing. In addition, the proposed action of license renewal would also not involve additional GHG emissions associated with facility decommissioning because decommissioning must occur whether the facility is relicensed or not. However, in some of the above-mentioned studies, the specific contribution of GHG emissions from construction, decommissioning, or other portions of a plant's lifecycle cannot be clearly separated from one another. In such cases, an analysis of GHG emissions would overestimate the GHG emissions attributed to a specific portion of a plant's lifecycle. Nonetheless, these studies supply some meaningful information with respect to the relative magnitude of the emissions among nuclear power plants and other forms of electric generation, as discussed in the following sections.

In Tables 6.2-1, 6.2-2, and 6.2-3, the Staff presents the results of the above-mentioned quantitative studies to supply a weight-of-evidence evaluation of the relative GHG emissions that may result from the proposed license renewal as compared to the potential alternative use of coal-fired, natural gas-fired, and renewable generation. Most studies from Mortimer (1990) onward suggest that uranium ore grades and uranium enrichment processes are leading determinants in the ultimate GHG emissions attributable to nuclear power generation. These studies show that the relatively lower order of magnitude of GHG emissions from nuclear power, when compared to fossil-fueled alternatives (especially natural gas), could potentially disappear if available uranium ore grades drop sufficiently while enrichment processes continued to rely on the same technologies.

6.2.1.3 *Summary of Nuclear Greenhouse Gas Emissions Compared to Coal*

Considering that coal fuels the largest share of electricity generation in the United States and that its burning results in the largest emissions of GHGs for any of the likely alternatives to nuclear power generation, including CR-3, most of the available quantitative studies 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 (and, in some cases, the nuclear lifecycle), as compared to an equivalent coal-fired plant, are presented in Table 6.2-1. The following chart does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-1. Nuclear Greenhouse Gas 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% 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 et al. (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—>1,000 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%.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8 to 24 g C_{eq}/kWh Coal—950 to 1,250 g C_{eq}/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones (2007)	Author did not evaluate nuclear versus coal.

g C_{eq}/kWh = grams of carbon equivalent per kilowatt-hour

6.2.1.4 *Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas*

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent natural gas-fired plant, are presented in Table 6.2-2. The following chart does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-2. Nuclear Greenhouse Gas Emissions Compared to Natural Gas

Source	GHG Emission Results
Mortimer (1990)	Author did not evaluate nuclear versus natural gas.
Andseta et al. (1998)	Authors did not evaluate nuclear versus natural gas.
Spadaro et al. (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.

6.2.1.5 *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 6.2-3. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because of the large variation in efficiencies due to their different sources and locations. For example, 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 (if used at all). Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources. As noted in Section 6.2.1.2, the following chart does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-3. Nuclear Greenhouse Gas 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 et al. (1998)	Authors did not evaluate nuclear versus renewable energy sources.
Spadaro et al. (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)	Authors 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.

Solar PV = solar photovoltaic

6.2.2 Conclusions: Relative Greenhouse Gas Emissions

The sampling of data presented in Tables 6.2-1, 6.2-2, and 6.2-3 demonstrates the challenges of any attempt to determine the specific amount of GHG emissions attributable to nuclear energy production sources, as different assumptions and calculation methods will yield differing results. The differences and complexities in these assumptions and analyses will further increase when they are used to project future GHG emissions. Nevertheless, several conclusions can be drawn from the information presented.

First, the various studies show a general consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation (e.g., the GHG emissions from a complete nuclear fuel cycle currently range from 2.5 to 55 grams of carbon equivalent per kilowatt-hour (g C_{eq}/kWh), as compared to the use of coal plants (264 to 1,250 g C_{eq}/kWh) and natural gas plants (120 to 780 g C_{eq}/kWh). The studies also give 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 wide, but the general conclusion is that current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as from these renewable energy sources.

Second, the studies show no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors about the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists about future GHG emissions associated with coal and natural gas for electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources and is 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.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed CR-3 relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The Staff bases this conclusion on the following rationale:

- As shown in Tables 6.2-1 and 6.2-2, the current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.

- CR-3 license renewal will involve continued GHG emissions due to 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).

- Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the CR-3 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 among the proposed CR-3 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 of all types. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same order of magnitude. 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 CR-3 at some point during the period of extended operation.

The Staff also supplies an additional discussion about the contribution of GHG emissions to cumulative air quality impacts in Section 4.11.5 of this SEIS.

6.3 REFERENCES

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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 (Staff's) evaluation of the environmental impacts of decommissioning—presented in NUREG-0586, Supplement 1—notes a range of impacts for each environmental issue.

Additionally, the incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the license renewal term are discussed in NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC, 1996), (NRC, 1999). 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 Category 2 designation. Section 1.4 in Chapter 1 explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE. The Staff analyzed site-specific issues (Category 2) for Crystal River Unit 3 Nuclear Generating Plant (CR-3) and assigned them a significance level of SMALL, MODERATE, LARGE, or not applicable to CR-3 because of site characteristics or plant features. There are no Category 2 issues related to decommissioning.

7.1 DECOMMISSIONING

Table 7-1 lists the Category 1 issues in Table B-1 of Title 10 of the *Code of Federal Regulations* (CFR) Part 51, Subpart A, Appendix B that are applicable to CR-3 decommissioning following the renewal term.

Decommissioning would occur whether CR-3 were shut down at the end of its current operating license or at the end of the period of extended operation. There are no site-specific issues related to decommissioning.

Table 7-1. Issues Related to Decommissioning

Issues	GEIS Sections	Category
Radiation doses	7.3.1; 7.4	1
Waste management	7.3.2; 7.4	1
Air quality	7.3.3; 7.4	1
Water quality	7.3.4; 7.4	1
Ecological resources	7.3.5; 7.4	1
Socioeconomic impacts	7.3.7; 7.4	1

A brief description of the 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 NRC noted that "[d]oses 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 person-rem [roentgen equivalent man] (1 person-mSv [millisievert]) caused by buildup of long lived radionuclides during the license renewal term."

Waste Management. Based on information in the GEIS, the NRC noted that "[d]ecommissioning 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."

Air Quality. Based on information in the GEIS, the NRC noted that "[a]ir 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."

Water Quality. Based on information in the GEIS, the NRC noted that "[t]he 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."

Ecological Resources. Based on information in the GEIS, the NRC noted that "[d]ecommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts."

Socioeconomic Impacts. Based on information in the GEIS, the NRC noted that "[d]ecommissioning 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 applicant stated in its environmental report that it is not aware of any new and significant information on the environmental impacts of CR-3 license renewal (Progress Energy, 2008). The Staff has not found any new and significant information during its independent review of the environmental report, the site visit, the scoping process, or its evaluation of other available information. Therefore, the Staff concludes that there are no impacts related to these issues, beyond those discussed in the GEIS. For all of these issues, the 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.

7.2 REFERENCES

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8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The National Environmental Policy Act of 1969 (NEPA) requires the consideration of a range of reasonable alternatives to the proposed action in an environmental impact statement (EIS). In this case, the proposed action is whether to issue a renewed license for Crystal River Unit 3 Nuclear Generating Plant (CR-3), which will allow the plant to operate for 20 years beyond its current license expiration date. A license is just one of a number of conditions that a licensee must meet in order to operate its nuclear plant. State regulatory agencies and the owners of the nuclear power plant ultimately decide whether the plant will operate, and economic and environmental considerations play a primary role in this decision. The U.S. Nuclear Regulatory Commission's (NRC's) responsibility is to ensure the safe operation of nuclear power facilities and not to formulate energy policy or encourage or discourage the development of alternative power generation.

The license renewal process is designed to assure safe operation of the nuclear power plant and protection of the environment during the license renewal term. Under the NRC's environmental protection regulations in Part 51 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 51), which implement Section 102(2) of the NEPA, renewal of a nuclear power plant operating license requires the preparation of an EIS.

To support the preparation of these EISs, the NRC prepared the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, in 1996 (NRC, 1996). The 1996 GEIS for license renewal was prepared to assess the environmental impacts associated with the continued operation of nuclear power plants during the license renewal term. The intent was to determine which environmental impacts would result in essentially the same impact at all nuclear power plants, and which ones could result in different levels of impacts at different plants and would require a plant-specific analysis to determine the impacts. For those issues that could not be generically addressed, the NRC will develop a plant-specific supplemental environmental impact statement (SEIS) to the GEIS.

NRC regulations 10 CFR 51.71(d) implementing the NEPA for license renewal require that a SEIS consider the following:

> Consider and weigh the environmental effects of the proposed action [license renewal]; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental effects and consideration of the economic, technical, and other benefits and costs of the proposed action.

In this chapter, the potential environmental impacts of alternatives to license renewal for CR-3 are examined as well as alternatives that may reduce or avoid adverse environmental impacts from license renewal, when and where these alternatives are applicable.

While the 1996 GEIS reached generic conclusions regarding many environmental issues associated with license renewal, it did not determine which alternatives are reasonable or reach conclusions about site-specific environmental impact levels. As such, the NRC must evaluate environmental impacts of alternatives on a site-specific basis.

As stated in Chapter 1, alternatives to the proposed action of license renewal for CR-3 must meet the purpose and need for issuing a renewed license; they must:

> provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision makers (NRC, 1996).

The NRC ultimately makes no decision about which alternative (or the proposed action) to carry out because that decision falls to the appropriate energy-planning decisionmakers to decide. Comparing the environmental effects of these alternatives will help the NRC decide whether the adverse environmental impacts of license renewal are great enough to deny the option of license renewal for energy-planning decisionmakers (10 CFR 51.95(c)(4)). If the NRC acts to issue a renewed license, all of the alternatives, including the proposed action, will be available to energy-planning decisionmakers. If the NRC decides not to renew the license (or takes no action at all), then energy-planning decisionmakers may no longer elect to continue operating CR-3 and will have to resort to another alternative—which may or may not be one of the alternatives considered in this section—to meet their energy needs now being satisfied by CR-3.

In evaluating alternatives to license renewal, energy technologies or options currently in commercial operation are considered, as well as some technologies not currently in commercial operation but likely to be commercially available by the time the current CR-3 operating license expires. The current CR-3 operating license will expire on December 3, 2016, and an alternative must be available (constructed, permitted, and connected to the grid) by the time the current CR-3 license expires.

Alternatives that cannot meet future system needs and do not have costs or benefits that justify inclusion in the range of reasonable alternatives were eliminated from detailed study. The remaining alternatives were evaluated and are discussed in-depth in this section. Each alternative eliminated from detailed study is briefly discussed in Section 8.4 and a basis for its removal is provided. Eighteen discrete potential alternatives to the proposed action were considered and then narrowed to the two discrete alternatives and one combination alternative considered in Sections 8.1 through 8.3.

The 1996 GEIS presents an overview of some energy technologies but does not reach any conclusions about which alternatives are most appropriate. Since 1996, many energy technologies have evolved significantly in capability and cost, while regulatory structures have changed to either promote or impede development of particular alternatives.

As a result, the analyses include updated information from sources like the Energy Information Administration (EIA), other organizations within the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), industry sources and publications, and information submitted by the applicant in its environmental report (ER).

The evaluation of each alternative considers the environmental impacts across seven impact categories: (1) air quality, (2) groundwater use and quality, (3) surface water use and quality, (4) ecology, (5) human health, (6) socioeconomics, and (7) waste management. A three-level standard of significance—SMALL, MODERATE, or LARGE—is used to show the intensity of environmental effects for each alternative that is evaluated in-depth. The order of presentation is not meant to imply an increasing or decreasing level of impact, nor does it imply that an energy-planning decisionmaker would select one or another alternative.

Sections 8.1 through 8.3 describe the environmental impacts of alternatives to license renewal. These alternatives include a supercritical coal-fired plant in Section 8.1, a natural gas-fired combined-cycle power plant in Section 8.2, and a combination of alternatives in Section 8.3 that includes some natural gas-fired capacity and energy conservation. In Section 8.4, alternatives considered but eliminated from detailed study are briefly discussed. Finally, in Section 8.5, environmental effects that may occur if the NRC takes no action and does not issue a renewed license for CR-3 are described. Section 8.6 summarizes the impacts of each of the alternatives considered in detail.

8.1 SUPERCRITICAL COAL-FIRED GENERATION

Although the GEIS indicates that an 850-megawatt-electric (MW[e]) coal-fired power plant (a plant equivalent in capacity to CR-3) could require 1,537 acres (ac) (622 hectares [ha]) and thus would not fit on the existing CR-3 site, many coal-fired power plants with larger capacities have fit on smaller sites. In the ER, the applicant indicated that onsite construction of a coal-fired alternative would be preferred over an offsite location. The NRC believes this to be reasonable and, as such, will consider a coal-fired alternative located on the current CR-3 site.

Coal-fired generation accounts for a greater share of U.S. electrical power generation than any other fuel (EIA, 2010). Furthermore, the EIA projects that coal-fired power plants will account for the greatest share of capacity additions through 2030—more than natural gas, nuclear, or renewable generation options. While coal-fired power plants are widely used and likely to remain widely used, future coal capacity additions may be affected by perceived or actual efforts to limit greenhouse gas (GHG) emissions. For now, the coal-fired alternative is a feasible, commercially available option that could provide electrical generating capacity after CR-3's current license expires.

Supercritical technologies are increasingly common in new coal-fired plants. Supercritical plants operate at higher temperatures and pressures than most existing coal-fired plants (beyond water's "critical point," where boiling no longer occurs and no clear phase change occurs between steam and liquid water). Operating at higher temperatures and pressures allows this coal-fired alternative to operate at a higher thermal efficiency than many existing coal-fired power plants do. While supercritical facilities are more expensive to construct, they consume less fuel for a given output and so reduce environmental impacts. Based on technology forecasts from the EIA, a new supercritical coal-fired plant beginning operation in 2016 would operate at a heat rate of 9,069 British thermal units per kilowatt hour (Btu/kWh), or approximately 38 percent thermal efficiency (EIA, 2009a).

In a supercritical coal-fired power plant, burning coal heats pressurized water. As the supercritical steam/water mixture moves through plant pipes to a turbine generator, the pressure drops and the mixture flashes to steam. The heated steam expands across the turbine stages, which then spin and turn the generator to produce electricity. After passing through the turbine, any remaining steam is condensed back to water in the plant's condenser.

In most modern U.S. facilities, condenser cooling water circulates through cooling towers or a cooling pond system (either of which are closed-cycle cooling systems). Older plants often withdraw cooling water directly from existing rivers, lakes, or estuaries and discharge heated water directly to the same body of water (called open-cycle cooling). The new facility could continue to use the existing CR-3 intake structure with a once-through cooling system, so long as a shut-down CR-3 could continue to receive sufficient water to maintain cooling and provided that no modifications would be necessary to the intake structure and associated pumps in order to provide cooling water for the new facility. Alternatively, the new facility could include the construction of a closed-cycle cooling system, such as a new natural draft cooling tower. A coal-fired alternative using closed-cycle cooling was evaluated because it will result in lower impacts—primarily to aquatic ecology—over the life of the alternative.

After construction of the facility, including a new natural draft cooling tower, the plant would withdraw makeup water from and discharge blowdown (water containing concentrated dissolved solids and biocides) back to the Gulf of Mexico.

In order to replace the 850 net MW(e) that CR-3 currently supplies, the coal-fired alternative would need to produce roughly 904 gross megawatts (MW), using about 6 percent of power output for onsite power usage (Progress Energy, 2008). Onsite electricity demands include scrubbers, cooling tower, coal-handling equipment, lights, communication, and other onsite needs. A supercritical coal-fired power plant equivalent in capacity to CR-3 would require less cooling water than CR-3 both because of the switch from open-cycle to closed-cycle cooling and because the plant operates at a higher thermal efficiency.

This 850-MW(e) power plant would consume 4.87 million tons (2.21 million metric tons [MT]) of coal annually assuming an average heat content of 8,844 British thermal units per pound (btu/lb) (EIA, 2009a). The EIA reported that most coal consumed in Florida originates in Kentucky. Given current coal mining operations in the State of Kentucky, the coal used in this alternative would be mined in either surface or underground mines, then mechanically processed and washed before being transported—via an existing rail spur—to the power plant site. Limestone for scrubbers would also arrive by rail. This coal-fired alternative would then produce roughly 214,500 tons (195,000 MT) of ash and roughly 168,000 tons (152,000 MT) of scrubber sludge annually. As noted above, much of the coal ash and scrubber sludge could be reused depending on local recycling and reuse markets.

Environmental impacts from the coal-fired alternative will be greatest during construction. Site crews will clear the plant site of vegetation, prepare the site surface, and begin excavation before other crews begin actual construction on the plant and any associated infrastructure. Because this alternative will be constructed at the CR-3 site, it is not likely that new transmission lines or a new rail spur will be necessary.

8.1.1 Air Quality

Air quality impacts from coal-fired generation can be substantial because it emits significant quantities of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide (CO), and hazardous air pollutants (HAPs) such as mercury. However, many of these pollutants can be effectively controlled by various technologies.

CR-3 is located in Citrus County, Florida. There are no areas designated by the EPA as nonattainment or maintenance for any of the criteria pollutants in the 50-mile (mi) (81-kilometer [km]) vicinity of CR-3.

A new coal-fired generating plant would qualify as a new major-emitting industrial facility and would be subjected to Prevention of Significant Deterioration of Air Quality Review under the requirements of the Clean Air Act (CAA), adopted by the Florida Department of Environmental Protection (FDEP) Division of Air Resource Management in Chapter 62-204 of the Florida Administrative Code (FAC) (FDEP, 2009a). A new coal-fired generating plant would need to comply with the new source performance standards for coal-fired plants set forth in

40 CFR Part 60, Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), sulfur dioxide (SO_2) (40 CFR 60.43(a)), and NO_x (40 CFR 60.44(a)). Regulations issued by the FDEP adopt the EPA's CAA rules (with modifications) to limit power plant emissions of SO_x, NO_x, particulate matter, and HAPs, among other matters. The new coal-fired generating plant would qualify as a Class I major source as identified in Chapter 62-213 of the FAC and would be required to obtain Class I major source permits from the FDEP, which the EPA may also elect to review prior to issuance of the permits (FDEP, 2009a).

Section 169A of the CAA establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. The EPA issued a new regional haze rule in 1999 (EPA, 1999). The rule specifies that for each mandatory Class I Federal area located within a State, the State must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide an improvement in visibility for the most-impaired days over the period of implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). Five regional planning organizations (RPOs) collaborate on the visibility impairment issue, developing the technical basis for these plans. The State of Florida is among 10 member States (Florida, Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia), including the Eastern Band of Cherokee Indians, of the Visibility Improvement State and Tribal Association of the Southeast (VISTAS), along with tribes, Federal agencies, and other interested parties, that identifies regional haze and visibility issues and develops strategies to address them. The visibility protection regulatory requirements, contained in 40 CFR Part 51, Subpart P, include the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Class I Federal area (40 CFR Part 51, Subpart P, §51.307). If a coal-fired plant were located close to a mandatory Class I Federal area, additional air pollution control requirements would be imposed. There are three mandatory Class I Federal areas in the State of Florida and the closest is Chassahowitzka Wilderness Area, which is located about 20 mi south from CR-3. The other two mandatory Class I Federal areas in Florida are the Everglades National Park (265 mi south of CR-3) and St. Marks Wilderness Area (116 mi northwest of CR-3).

Florida is also subject to the Clean Air Interstate Rule (CAIR), which has outlined emissions reduction goals for both SO_2 and NO_x for the year 2015. The CAIR will aid Florida sources in reducing SO_2 emissions by 308,000 tons (or 65 percent), and NO_x emissions by 192,000 tons (or 76 percent) (EPA, 2010).

Based on published EIA data, EPA emission factors, and on performance characteristics for this alternative and likely emission controls, the following emissions were projected:

- Sulfur oxides (SO_x) – 3,200 tons (2,900 MT) per year
- Nitrogen oxides (NO_x) – 610 tons (550 MT) per year
- Total suspended particles (TSP) – 107 tons (97 MT) per year
- Particulate matter (PM) PM_{10} – 25 tons (22 MT) per year
- Particulate matter (PM) $PM_{2.5}$ – 0.11 tons (0.10 MT) per year

- Carbon monoxide (CO) – 608.77 tons (552.28 MT) per year

8.1.1.1 *Sulfur Oxides*

The coal-fired alternative at the CR-3 site would likely use wet, limestone-based scrubbers to remove SO_x. The EPA indicates that this technology can remove more than 95 percent of SO_x from flue gases. Total SO_x emissions after scrubbing would be 3,200 tons (2,900 MT) per year. SO_x emissions from a new coal-fired power plant would be subject to the requirements of Title IV of the CAA. Title IV was enacted to reduce emissions of SO_2 and NO_x, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. The EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances, but are required to have allowances to cover their SO_2 emissions. Owners of new units must, therefore, purchase allowances from owners of other power plants or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, provided a new coal-fired power plant is able to purchase sufficient allowances to operate, it would not add to net regional SO_2 emissions, although it might do so locally.

8.1.1.2 *Nitrogen Oxides*

A coal fired alternative at the CR-3 site would most likely employ various available NO_x-control technologies, which can be grouped into two main categories: combustion modifications and post-combustion processes. Combustion modifications include low-NO_x burners, over-fire air, and operational modifications. Post-combustion processes include selective catalytic reduction (SCR) and selective non-catalytic reduction. An effective combination of the combustion modifications and post-combustion processes allow the reduction of NO_x emissions by up to 95 percent (EPA, 1998a). The applicant indicated in its ER that it would use a combination of low-NO_x burners, over-fire air, SCR, and selective non-catalytic reduction technologies in order to reduce NO_x emissions from this alternative. Assuming the use of such technologies at the CR-3 site, NO_x emissions after scrubbing are estimated to be 610 tons (550 MT) annually.

Section 407 of the CAA establishes technology-based emission limitations for NO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants as indicated in 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (EPA, 1998b), limits the discharge of any gases that contain nitrogen oxides (NO_2) to 200 nanograms (ng) of NO_x per joule (J) of gross energy output (equivalent to 1.6 pounds per megawatt hour [lb/MWh]), based on a 30-day rolling average. Based on the projected emissions, the proposed alternative would easily meet this regulation.

8.1.1.3 *Particulates*

The new coal-fired power plant would use fabric filters to remove particulates from flue gases. The applicant indicated that fabric filters would remove 99.9 percent of particulate matter (Progress Energy, 2008). The EPA notes that filters are capable of removing in excess of 99 percent of particulate matter and that SO_2 scrubbers further reduce particulate matter emissions (EPA, 2008). Based on the EPA's emission factors, the new supercritical coal-fired plant would emit 107 tons (97 MT) per year and approximately 25 tons (22 MT) per year of particulate matter having an aerodynamic diameter less than or equal to 10 microns (PM_{10}) annually. In addition, coal burning would also result in approximately 0.11 tons (0.10 MT) per year of particulate emissions with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$). Coal-handling equipment would introduce fugitive dust emissions when fuel is being transferred to onsite storage and then reclaimed from storage for use in the plant. During the construction of a coal-fired plant, onsite activities would also generate fugitive dust. Vehicles and motorized equipment would create exhaust emissions during the construction process. However, these impacts would be intermittent and short-lived and to minimize dust generation, construction crews would use applicable dust-control measures. Operation of a new natural draft cooling tower would result in additional particulate draft.

8.1.1.4 *Carbon Monoxide*

Based on EPA emission factors (EPA, 1998a), the total CO emissions would be approximately 610 tons (550 MT) per year.

8.1.1.5 *Hazardous Air Pollutants*

Consistent with the D.C. Circuit Court's February 8, 2008, ruling that vacated its Clean Air Mercury Rule (CAMR,) the EPA is in the process of developing mercury emissions standards for power plants under the CAA (Section 112) (EPA, 2009a). Before the CAMR, the EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of HAPs (EPA, 2000b). The EPA determined that coal plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA, 2000b). The EPA concluded that mercury is the HAP of greatest concern and that: (1) a link exists between coal combustion and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects resulting from mercury exposures caused by the consumption of contaminated fish (EPA, 2000b). On February 6, 2009, the Supreme Court dismissed the EPA's request to review the 2008 Circuit Court's decision and also denied a similar request by the Utility Air Regulatory Group later that month (EPA, 2009a).

8.1.1.6 *Carbon Dioxide*

A coal-fired plant would also have unregulated carbon dioxide (CO_2) emissions during operations as well as during mining, processing, and transportation, which the GEIS indicates could contribute to global warming. The coal-fired plant would emit between 5,401,000 tons (4,905,000 MT) and 5,603,000 tons (5,083,000 MT) of CO_2 per year, depending on the type and quality of the coal burned.

8.1.1.7 *Summary of Air Quality*

While the GEIS analysis mentions global warming from unregulated CO_2 emissions and acid rain from SO_x and NO_x emissions as potential impacts, it does not quantify emissions from coal-fired power plants. However, the GEIS analysis does imply that air impacts would be substantial (NRC, 1996). The above analysis shows that emissions of air pollutants, including SO_x, NO_x, CO, and particulates, exceed those produced by the existing nuclear power plant, as well as those of the other alternatives considered in this section. Operational emissions of CO_2 are also much greater under the coal-fired alternative. Adverse human health effects such as cancer and emphysema have also been associated with air emissions from coal combustion and are discussed further in Section 8.1.5.

The NRC analysis for a coal-fired alternative at the CR-3 site indicates that impacts from the coal-fired alternative would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Therefore, the appropriate characterization of air impacts from a coal-fired plant located at CR-3 site would be MODERATE. Existing air quality would result in varying needs for pollution control equipment to meet applicable local requirements, or varying degrees of participation in emissions trading schemes.

8.1.2 Groundwater Use and Quality

If the onsite coal-fired alternative continued to use groundwater for drinking water and service water, the need for groundwater at the plant would be minor. Total usage would likely be less than CR-3 because fewer workers would be onsite and the coal-fired unit would have fewer auxiliary systems requiring service water. No effect on groundwater quality would be apparent.

Construction of a coal-fired plant could have a localized effect on groundwater due to temporary dewatering and run-off control measures. Because of the temporary nature of construction and the likelihood of reduced groundwater usage during operation, the impact of the coal-fired alternative would be SMALL.

8.1.3 Surface Water Use and Quality

The coal-fired plant alternative would withdraw approximately 10,000 gallons per minute (gpm) (0.6 cubic meters per second [m^3/s]) from the Gulf of Mexico (Crystal Bay), with an average rate of about 14.4 million gallons per day (gpd) and a consumption factor of about 0.55 percent (DOE, 2008). This is less surface water than CR-3 withdraws and, as such, the impact of surface water use would be SMALL. A new coal-fired plant would be required to obtain a National Pollutant Discharge and Elimination System (NPDES) permit from the FDEP for regulation of industrial wastewater, stormwater, and other discharges. Assuming the plant operates within the limits of this permit, the impact from any cooling tower blowdown, site runoff, and other effluent discharges on surface water quality would be SMALL.

8.1.4 Aquatic and Terrestrial Ecology

8.1.4.1 *Aquatic Ecology*

The number of fish and other aquatic resource organisms affected by impingement, entrainment, and thermal impacts will be smaller than that associated with license renewal because water consumption from and blowdown to the Gulf of Mexico would be lower. Some temporary impacts to aquatic organisms might occur due to any construction that might occur or due to any effluent discharges to the river, but these activities would be monitored by the FDEP under the project's NPDES permit. Due to the assumed switch from open-cycle to closed-cycle cooling, the number of affected organisms would be less than for license renewal. The levels of impact for impingement, entrainment, and thermal effects would therefore be SMALL for this alternative.

8.1.4.2 *Terrestrial Ecology*

As indicated in the applicant's ER, constructing the coal-fired alternative onsite will affect 135 ac (55 ha) of land (Progress Energy, 2008). Coal-mining operations will also affect terrestrial ecology in offsite coal mining areas, although most of the land is likely already disturbed by mining operations. Onsite and offsite land disturbances form the basis for impacts to terrestrial ecology.

Onsite impacts to terrestrial ecology will be moderate because the majority of the construction would require the clearing of areas that are currently woodlands. These construction activities may fragment or destroy habitats and could affect food supply and habitat of native wildlife and migratory waterfowl, however, these impacts are not expected to be destabilizing.

Any onsite or offsite waste disposal by landfilling will also affect terrestrial ecology at least through the period when the disposal area is reclaimed. Deposition of acid rain resulting from NO_x or SO_x emissions, as well as the deposition of other pollutants, can also affect terrestrial ecology. Given the emission controls discussed in Section 8.1.1, air deposition impacts may be noticeable, but are not likely to be destabilizing. Primarily because of the potential habitat disturbances, impacts to terrestrial resources from a coal-fired alternative would be MODERATE and would occur mostly during construction.

8.1.5 Human Health

Coal-fired power plants introduce worker risks from coal and limestone mining, coal and limestone transportation, and coal combustion and scrubber waste disposal. In addition, there are public risks from inhalation of stack emissions (as addressed in Section 8.1.1) and the secondary effects of eating foods grown in areas subject to deposition from plant stacks.

Human health risks of coal-fired power plants are described, in general, in Table 8-2 of the GEIS (NRC, 1996). Cancer and emphysema, as a result of the inhalation of toxins and particulates, are identified as potential health risks to occupational workers and members of the public (NRC, 1996). The human health risks of coal-fired power plants, both to occupational workers and to members of the public, are greater than those of the current CR-3 due to exposures to chemicals such as mercury; SO_x; NO_x; radioactive elements such as uranium and thorium contained in coal and coal ash; and polycyclic aromatic hydrocarbon (PAH) compounds, including benzo(a)pyrene.

Regulations restricting emissions—enforced by the EPA or State agencies—have acted to significantly reduce potential health effects but have not entirely eliminated them. These agencies also impose site-specific emission limits as needed to protect human health. Even if the coal-fired alternative were located in a nonattainment area, emission controls and trading or offset mechanisms could prevent further regional degradation; however, local effects could be visible. Many of the byproducts of coal combustion responsible for health effects are largely controlled, captured, or converted in modern power plants (as described in Section 8.1.1), although some level of health effects may remain.

Aside from emission impacts, the coal-fired alternative introduces the risk of coal pile fires and for those plants that use coal combustion liquid and sludge waste impoundments, the release of the waste due to a failure of the impoundment. Although there have been several instances of this occurring in recent years, these types of events are still relatively rare.

Overall, given extensive health-based regulation, human health impacts would be SMALL.

8.1.6 Socioeconomics

8.1.6.1 *Land Use*

The GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a new supercritical coal-fired power plant on the CR-3 site.

The applicant indicated that approximately 135 ac (55 ha) of land would be needed to support a coal-fired alternative capable of replacing CR-3. This amount of land use includes power plant structures and associated coal delivery and waste disposal infrastructure. The applicant indicated that the site has an existing rail spur, however, an additional 118 ac (48 ha) of land area may be needed for waste disposal. The applicant indicated that this waste disposal could be accommodated onsite, but would require 118 ac (48 ha) of woodlands to be cleared (Progress Energy, 2008). Given the existence of other coal-fired power plant units at the Crystal River Energy Complex (CREC), land use impacts from construction would be SMALL to MODERATE.

Offsite land use impacts would occur from coal mining in addition to land use impacts from the construction and operation of the new power plant. Scaling from GEIS estimates, approximately 19,000 ac (7,700 ha) of land could be affected by mining coal and waste disposal to support the coal-fired alternative during its operational life (NRC, 1996). However, most of the land in existing coal-mining areas has already experienced some level of disturbance. The elimination of the need for uranium mining to supply fuel for CR-3 would partially offset this offsite land use impact. Scaling from GEIS estimates, approximately 850 ac (344 ha) of land would be used for uranium mining, and processing would no longer be needed. Based on this information, overall land use impacts would be MODERATE.

8.1.6.2 *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 new coal-fired power plant 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 in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the coal-fired power plant alternative were evaluated in order to measure their possible effects on current socioeconomic conditions.

Based on GEIS estimates, a peak construction workforce of up to 2,000 workers could be required to construct the coal-fired alternative at CR-3. During the construction period, the communities surrounding the plant site could experience increased demand for rental housing and public services. The relative economic contributions of these relocating workers to local business and tax revenues would vary over time. After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services.

In addition, the rental housing market could experience increased vacancies and decreased prices. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site, because the workforce would need to relocate closer to the construction site. Although the ER indicates that Citrus County, where CR-3 is located, is mostly rural in nature, the site is only 70 mi from the Tampa, Florida, metropolitan area. Therefore, these effects may be somewhat lessened because workers could commute to the site from these areas instead of relocating closer to the construction site. During the construction period, worker relocation to the surrounding communities would not be expected due to the site’s proximity to Tampa. Based on the site’s proximity to a metropolitan area, construction impacts would be SMALL.

The applicant estimated an operational workforce of less than 100 workers for the 850-MW(e) alternative based on GEIS estimates (Progress Energy, 2008). The applicant's estimate appears reasonable and is consistent with trends calling for decreased workforces at power facilities. Even at a rural site like CR-3, impacts are unlikely to be large due to its close proximity to Tampa. Therefore, operations impacts would likely be SMALL.

8.1.6.3 *Transportation*

During construction, up to 2,000 workers would be commuting to the site. In addition to commuting workers, trucks would transport construction materials and equipment to the worksite increasing the amount of traffic on local roads, while trains would transport some of the largest components to the plant site. The increase in vehicular traffic on roads would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Trains would likely be used to deliver large components to the CR-3 site given its existing rail spur. Transportation impacts are likely to be MODERATE during construction.

Transportation impacts would be greatly reduced after construction, but would not disappear during plant operations. The maximum number of plant operating personnel commuting to CR-3 would be approximately 100 workers. Frequent deliveries of coal and limestone by rail would add to the overall transportation impact. Onsite coal storage would make it possible to receive several trains per day. Limestone delivered by rail could also add traffic (though considerably less traffic than that generated by coal deliveries). Overall, the coal-fired alternative would have a SMALL to MODERATE impact on transportation conditions in the region around the CREC during plant operations.

8.1.6.4 *Aesthetics*

The aesthetics impact analysis focuses on the degree of contrast between the coal-fired alternative and the surrounding landscape and the visibility of the coal plant.

The coal-fired alternative would be up to 200 feet (ft) (61 meters [m]) tall with an exhaust stack up to 500 ft (152 m) and may be visible off site in daylight hours. The coal-fired plant could, therefore, be somewhat taller than the current CR-3 reactor building, which stands at 157 ft (49 m). However, the CREC currently includes four fossil-powered units, with two 600-ft (183-m) and two 500-ft (152-m) exhaust stacks. Noise and light from plant operations, as well as lighting on plant structures, may also be detectable off site.

Overall, because a new coal-fired plant would be consistent with the CREC's current aesthetic impacts, the aesthetic impacts associated with the coal-fired alternative would likely be SMALL.

8.1.6.5 *Historic and Archeological Resources*

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities.

Based on its review of the Florida Master Site File, published literature, and information provided by the applicant, the NRC concludes that potential impacts of a new coal-fired alternative on historic and archaeological resources would be SMALL. This conclusion is based on the results of archaeological surveys conducted prior to initial plant construction and during subsequent expansion activities. The locations of existing archaeological sites within the CREC, including areas of high potential for additional discoveries, are located away from plant maintenance and operations activities in the protected area. This conclusion is also based on the existing archaeological and cultural resources and environmental protection procedures in use by CR-3 environmental staff as noted during the environmental site visit. Lands not previously surveyed should be investigated by a qualified archaeologist prior to any ground disturbing activity associated with a new coal-fired alternative at the site.

8.1.6.6 *Environmental Justice*

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new coal-fired power plant. 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 exceed the environmental impacts 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 discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing in the vicinity of CR-3, and all are exposed to the same hazards generated from constructing and operating a new, natural gas-fired, combined-cycle power plant. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to Section 4.9.7, "Environmental Justice."

Potential impacts to minority and low-income populations from the construction and operation of a new coal-fired power plant at CR-3 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. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic.

However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of CR-3 could affect low-income populations. Given the close proximity to the Tampa metropolitan area, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a coal-fired power plant alternative at the CR-3 site would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of CR-3.

8.1.7 Waste Management

Coal combustion generates several waste streams including ash (a dry solid) and sludge (a semi-solid byproduct of emission control system operation). The 850-MW(e) power plant would generate annually a total of 250,000 tons (227,000 MT) of dry solid ash and scrubber sludge. About 230,000 tons (209,000 MT) of this waste would be recycled. Disposal of the remaining waste from the 40-year operation of this alternative would require approximately 87 ac (35 ha). Disposal of the remaining waste could noticeably affect land use and groundwater quality, but would require proper siting in accordance with Chapter 62-701, “Solid Waste Management Facilities,” of the FAC and the implementation of the required monitoring and management practices in order to minimize these impacts (FDEP, 2009a). After closure of the waste site and revegetation, the land could be available for other uses.

In May 2000, the EPA issued a “Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels” (EPA 2000a) stating that it would issue regulations for disposal of coal combustion waste under Subtitle D of the Resource Conservation and Recovery Act. The EPA has not yet issued these regulations.

The impacts from waste generated during operation of this coal-fired alternative would be MODERATE; the impacts would be clearly visible, but would not destabilize any important resource.

The impacts from waste generated during the construction stage would be short-lived. The amount of the construction waste is small compared to the amount of waste generated during the operational stage and most could be recycled. Overall, the impacts from waste generated during the construction stage would be SMALL.

Therefore, the overall waste management impacts from construction and operation of this alternative would be MODERATE.

Table 8-1. Summary of Environmental Impacts of the Supercritical Coal-Fired Alternative Compared to Continued Operation of Crystal River Unit 3 Nuclear Generating Plant

	Supercritical Coal-Fired Generation	Continued CR-3 Operation
Air Quality	MODERATE	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL to MODERATE

Human Health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL
Waste Management	MODERATE	SMALL

8.2 NATURAL GAS COMBINED-CYCLE GENERATION

This section evaluates the environmental impacts of natural gas-fired combined-cycle generation at the CR-3 site.

Natural gas fueled 21 percent of electric generation in the United States in 2008, accounting for the second greatest share of electrical power after coal (EIA, 2010). Like coal-fired power plants, natural gas-fired plants may be affected by perceived or actual action to limit GHG emissions, although they produce markedly fewer GHGs per unit of electrical output than coal-fired plants. Natural gas-fired power plants are feasible, commercially available options for providing electrical generating capacity beyond CR-3's current license expiration.

Combined-cycle power plants differ significantly from coal-fired and existing nuclear power plants. Combined-cycle power plants derive the majority of their electrical output from a gas-turbine cycle, and then generate additional power—without burning any additional fuel—through a second, steam-turbine cycle. The first, gas turbine stage (similar to a large jet engine) burns natural gas, which turns a driveshaft that powers an electric generator. The exhaust gas from the gas turbine is still hot enough to boil water to steam. Ducts carry the hot exhaust to a heat recovery steam generator, which produces steam to drive a steam turbine and produce additional electrical power. The combined-cycle approach is significantly more efficient than any one cycle on its own; thermal efficiency can exceed 60 percent. Since the natural gas-fired alternative derives much of its power from a gas turbine cycle and because it wastes less heat than either the coal-fired alternative or the existing CR-3, it requires significantly less cooling.

To replace the 850-MW(e) power that CR-3 generates, two General Electric (GE) S107H combined-cycle generating units were considered. While any number of commercially available combined-cycle units could be installed in a variety of combinations to replace the power currently produced by CR-3, the S107H was selected for its high efficiency and to minimize environmental impacts. Other manufacturers, like Siemens, offer similar high-efficiency models. This gas-fired alternative produces a net 400 MW(e) per unit. Two units produce a total of 800 MW(e), or nearly the same output as the existing CR-3.

The combined-cycle generating units operate at a heat rate of 5,690 Btu/kWh, or nearly 60 percent thermal efficiency (GE, 2007). Allowing for onsite power usage, including cooling towers and site lighting, the gross output of these units would be roughly 830 MW(e). As noted above, this gas-fired alternative would require much less cooling water than CR-3 because it operates at a higher thermal efficiency and requires much less water for steam cycle condenser cooling. This alternative would likely make use of the site's existing once-through cooling system.

Onsite visible structures would include the gas turbine buildings and heat-recovery steam generators (which may be enclosed in a single building), two exhaust stacks, an electrical switchyard, and, if necessary, equipment associated with a natural gas pipeline, such as a compressor station. While GEIS estimates indicate that this 830-MW(e) plant would require 90 ac (36 ha), the applicant indicated that a natural gas alternative of comparable size (850 MW[e]) would require only 33 ac (13 ha) (Progress Energy, 2008).

This 830-MW(e) power plant would consume 34 billion cubic feet (ft^3) (964 million m^3) of natural gas annually assuming an average heat content of 1,029 Btu/ft^3 (EIA, 2009b). Natural gas would be extracted from the ground through wells, then treated to remove impurities (like hydrogen sulfide), and blended to meet pipeline gas standards, before being piped through the interstate pipeline system to the power plant site. This gas-fired alternative would produce relatively little waste, primarily in the form of spent catalysts used for emissions controls.

Environmental impacts from the gas-fired alternative will be greatest during construction. Site crews will clear vegetation from the site, prepare the site surface, and begin excavation before other crews begin actual construction on the plant and any associated infrastructure, including a 10-mi pipeline spur to serve the plant and electricity transmission infrastructure connecting the plant to existing transmission lines. Constructing the gas-fired alternative on the CR-3 site would allow the gas-fired alternative to make use of the existing electric transmission system.

8.2.1 Air Quality

CR-3 is located in Citrus County, Florida, which is in EPA Region 4. There are currently no nonattainment or maintenance areas for any criteria pollutants in the State of Florida.

A new gas-fired generating plant developed at the CR-3 site would qualify as a new major-emitting industrial facility and would be subjected to Prevention of Significant Deterioration of Air Quality Review under requirements of the CAA, adopted by the FDEP Division of Air Resource Management in Chapter 62-204 of the FAC (FDEP, 2009b). The natural gas-fired plant would need to comply with the standards of performance for stationary gas turbines set forth in 40 CFR Part 60, Subpart GG.

Subpart P of 40 CFR Part 51 contains the visibility protection regulatory requirements, including the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Class I Federal area (40 CFR Part 51, Subpart P, §51.307). If a gas-fired alternative were located close to a mandatory Class I Federal area, additional air pollution control requirements would imply. There are three mandatory Class I Federal areas in the State of Florida and the closest is Chassahowitzka Wilderness Area, which is located about 20 mi south from CR-3. The other two mandatory Class I Federal areas in Florida are the Everglades National Park (265 mi south of CR-3) and St. Marks Wilderness Area (116 mi northwest of CR-3).

The following emissions are projected for a gas-fired alternative based on data published by the EIA, EPA, and on performance characteristics for this alternative and its emissions controls:

- Sulfur oxides (SO_x) – 60 tons (54 MT) per year
- Nitrogen oxides (NO_x) – 192 tons (177 MT) per year
- Carbon monoxide (CO) – 40 tons (36 MT) per year
- Total suspended particles (TSP) – 34 tons (30 MT) per year

- Particulate matter (PM) PM_{10} – 34 tons (30 MT) per year
- Carbon dioxide (CO_2) – 2,050,000 tons (1,860,000 MT) per year

A new natural gas-fired plant would have to comply with Title IV of the CAA reduction requirements for SO_2 and NO_x, which are the main precursors of acid rain and the major causes of reduced visibility. Title IV establishes maximum SO_2 and NO_x emission rates from the existing plants and a system of the SO_2 emission allowances that can be used, sold, or saved for future use by new plants.

8.2.1.1 *Sulfur and Nitrogen Oxides*

As stated above, the new natural gas-fired alternative would produce 60 tons (54 MT) per year of SO_x and 192 tons (177 MT) per year of NO_x based on the use of the dry low NO_x combustion technology and the use of SCR in order to significantly reduce NO_x emissions.

The new plant would be subjected to the continuous monitoring requirements of SO_2, NO_x, and CO_2 specified in 40 CFR Part 75. The natural gas-fired plant would emit approximately 2.1 million tons (approximately 1.9 million MT) per year of unregulated CO_2 emissions. In response to the Consolidated Appropriations Act of 2008, the EPA has proposed a rule that requires mandatory reporting of GHG emissions from large sources that would allow collection of accurate and comprehensive emissions data to inform future policy decisions (EPA, 2009b). The EPA proposes that suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 MT or more per year of GHG emissions submit annual reports to the EPA. The gases covered by the proposed rule are CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE). In June 2008, Florida Governor Charlie Crist signed legislation to create the "Florida Climate Protection Act," which requires electric utilities in the State to report GHG emissions. The Act also authorizes the FDEP to design a cap-and-trade program to reduce GHG emissions, which is in development.

8.2.1.2 *Particulates*

The new natural gas-fired alternative would produce 34 tons (30 MT) per year of TSP, all of which would be emitted as PM_{10}.

8.2.1.3 *Hazardous Air Pollutants*

In December 2000, the EPA issued regulatory findings (EPA, 2000b) on emissions of HAPs from electric utility steam-generating units, which identified that natural gas-fired plants emit HAPs such as arsenic, formaldehyde, and nickel, and stated that:

> the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

8.2.1.4 *Carbon Monoxide*

Based on EPA emission factors (EPA, 1998a), total CO emissions would be approximately 40 tons (36 MT) per year.

8.2.1.5 *Construction Impacts*

Activities associated with the construction of the new natural gas-fired plant at the CR-3 site would cause some additional air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material handling equipment. Emissions from workers' vehicles and motorized construction equipment would be temporary. The construction crews would employ dust-control practices in order to control and reduce fugitive dust, which would be temporary in nature. The impact of vehicle exhaust emissions and fugitive dust from operation of earth-moving and material handling equipment would be SMALL.

Based on this information, the overall air-quality impacts of a new natural gas-fired plant located at the CR-3 site would be SMALL to MODERATE.

8.2.2 Groundwater Use and Quality

If the onsite natural gas-fired plant alternative continued to use groundwater for drinking water and service water, the need for groundwater at the plant would be minor. Total usage would likely be much less than CR-3 because fewer workers would be onsite and the gas-fired alternative would have fewer auxiliary systems requiring service water.

No effects on groundwater quality would be apparent except during the construction phase due to temporary dewatering and run-off control measures. Because of the temporary nature of construction and the likelihood of reduced groundwater usage during operation, the impact of the gas-fired alternative would be SMALL.

8.2.3 Surface Water Use and Quality

The natural gas-fired plant alternative would withdraw approximately 2,100 gpm (0.1 m^3/s) from the Gulf of Mexico (Crystal Bay), with an average rate of about 3 million gpd and a consumption factor of about 0.22 percent (DOE, 2008), much less than the 680,000 gpm (40 m^3/s) currently used on average by CR-3 (Progress Energy, 2008), as well as the amount needed for the coal-fired alternative. Because the consumptive loss of this alternative is less than that of the current CR-3, the impact of surface water use would be SMALL.

A new gas-fired plant would be required to obtain an NPDES permit from the FDEP for regulation of industrial wastewater, stormwater, and other discharges. Assuming the plant operates within the limits of this permit, the impact from cooling tower blowdown, site runoff, and other effluent discharges on surface water quality would be SMALL.

8.2.4 Aquatic and Terrestrial Ecology

8.2.4.1 *Aquatic Ecology*

Section 2.2.5 describes the aquatic ecology of the CR-3 site, which is associated with the Gulf of Mexico. Impacts on the aquatic ecology from the CR-3 site are associated with construction or the use of water from the Gulf of Mexico during operation of a new gas-fired generating plant. A new gas-fired generating plant at the CREC would use the existing CR-3 intake and discharge structures for cooling a new plant. The gas-fired alternative would require less cooling water to be withdrawn from the Gulf of Mexico than CR-3, and the thermal discharge would concurrently be smaller than CR-3. Therefore, the number of fish and other aquatic organisms affected by impingement, entrainment, and thermal impacts would be less for a gas-fired alternative than for those associated with license renewal.

Some temporary impacts to aquatic organisms might occur due to any construction or effluent discharge to the ocean, but the FDEP would monitor these activities under the project's NPDES permit. Although the number of affected organisms would be substantially less than for license renewal, the NRC level of impact for license renewal is already small, and so the levels of impact for impingement, entrainment, and thermal effects would also be SMALL.

8.2.4.2 *Terrestrial Ecology*

Constructing the natural gas alternative will require 33 ac (13 ha) of land. These land disturbances form the basis for impacts to terrestrial ecology.

Onsite impacts to terrestrial ecology will be minimal because the applicant indicated that 33 ac (13 ha) of previously disturbed land is available at the site, reducing the potential impacts that would have resulted from the clearing of areas on the property that are currently woodlands. Gas extraction and collection will also affect terrestrial ecology in offsite gas fields, although much of this land is likely already disturbed by gas extraction, and the incremental effects of this alternative on gas field terrestrial ecology are difficult to gauge.

Construction of the 10-mi gas pipeline could lead to a disturbance of up to 61 ac (55 ha) of lands for the 50-ft-wide corridor. If woodlands are disturbed for this construction, it may fragment surrounding habitat and increase edge habitat, which may have adverse impacts on forest interior dwelling species, including migratory songbirds, as well as any threatened and endangered species in the affected area. However, the applicant indicated in the ER that the new pipeline would be routed along existing, previously disturbed right-of-ways (to the extent practical), so it is unlikely that a significant amount of forested land would be affected. Some wetlands may be disturbed where the existing right-of-ways cannot be used. Because of the relatively small potential for undisturbed land to be affected, impacts from construction of the pipeline are expected to be small.

Based on this information, impacts to terrestrial resources would be SMALL.

8.2.5 Human Health

Like the coal-fired alternative discussed above, a gas-fired plant would emit criteria air pollutants, but generally in smaller quantities (except NO_x, which requires additional controls to reduce emissions). Human health effects of gas-fired generation are generally low, although Table 8-2 of the GEIS (NRC, 1996) indicated cancer and emphysema as potential health risks from gas-fired plants. NO_x emissions contribute to ozone formation, which in turn contributes to human health risks. Emission controls on this gas-fired alternative maintain NO_x emissions well below air quality standards established for the purposes of protecting human health, and emissions trading or offset requirements mean that overall NO_x in the region will not increase. Health risks to workers may also result from handling spent catalysts that may contain heavy metals.

Overall, human health risks to occupational workers and to members of the public from gas-fired power plant emissions sited at CR-3 would be less than the risks described for the coal-fired alternative and, therefore, would likely be SMALL.

8.2.6 Socioeconomics

8.2.6.1 *Land Use*

As discussed in Section 8.1.6, the GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a two unit, natural gas-fired combined-cycle power plant at the CR-3 site.

The applicant indicated that approximately 33 ac (13 ha) of land would be needed to support a natural gas-fired alternative to replace CR-3 (Progress Energy, 2008). This amount of onsite land use would include other plant structures and associated infrastructure, excluding land for natural gas wells and collection stations. Onsite land use impacts from construction would be SMALL.

In addition to onsite land requirements, land would be required off site for natural gas wells and collection stations. Scaling from GEIS estimates, approximately 3,000 ac (1,215 ha) would be required for wells, collection stations, and a 10-mi pipeline to bring the gas to the plant. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside the United States and be delivered as liquefied gas.

The elimination of uranium fuel for CR-3 could partially offset offsite land requirements. Scaling from GEIS estimates, approximately 850 ac (344 ha) would not be needed for mining and processing uranium during the operating life of the plant. Overall land use impacts from a gas-fired power plant would be SMALL to MODERATE.

8.2.6.2 *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 new natural gas-fired power plant could affect regional employment, income, and expenditures. Two types of job creation would result: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the natural gas fired power plant alternative were evaluated in order to measure their possible effects on current socioeconomic conditions.

The socioeconomic impacts from constructing and operating a gas-fired plant would have little noticeable effect. Compared to the coal-fired alternative, the small size of the construction and operations workforce would have little or no socioeconomic impact.

Based on GEIS estimates, a peak construction workforce of up to 1,000 workers could be required to construct the gas-fired alternative at CR-3. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site, because the workforce would need to relocate closer to the construction site. Although the ER indicates that Citrus County where CR-3 is located is mostly rural in nature, the site is only 70 mi from the Tampa, Florida, metropolitan area. Therefore, these effects may be somewhat lessened because workers could commute to the site from these areas instead of relocating closer to the construction site. During the construction period, worker relocation to the surrounding communities would not be expected due to the site's proximity to Tampa. Based on the site's proximity to a metropolitan area, construction impacts would be SMALL.

The GEIS estimates an operational workforce of about 125 workers for a gas-fired alternative of this size, although current trends are calling for decreased workforces at power facilities. Even at a rural site like CR-3, impacts are unlikely to be large due to its close proximity to Tampa. Socioeconomic impacts associated with the operation of a gas-fired power plant at CR-3 would be SMALL.

8.2.6.3 *Transportation*

Transportation impacts associated with construction and operation of a two unit gas-fired power plant would consist of commuting workers and truck deliveries of construction materials to the CR-3 site. During construction, up to 1,000 workers would be commuting to the site. In addition to commuting workers, trucks would transport construction materials and equipment to the worksite increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Some plant components are likely to be delivered by train via the existing onsite rail spur. Trains would likely be used to deliver large components to the CR-3 site given its existing rail spur. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact. Transportation impacts are likely to be MODERATE during construction.

Transportation impacts would be greatly reduced after construction, but would not disappear during plant operations. The maximum number of plant operating personnel commuting to CR-3 would be approximately 125 workers. Frequent deliveries of coal and limestone by rail would add to the overall transportation impact. Onsite coal storage would make it possible to receive several trains per day. Limestone delivered by rail could also add traffic (though considerably less traffic than that generated by coal deliveries). Because fuel for the plant is transported by pipeline, a new gas-fired plant would have to be supported by the current gas pipeline system. If the required capacity is not available, any upgrades to the current pipeline system could have additional transportation impacts on the Southeast region. Overall, the gas-fired alternative would have a SMALL to MODERATE impact on transportation conditions in the region around the CREC during plant operations.

8.2.6.4 *Aesthetics*

The aesthetics impact analysis focuses on the degree of contrast between the natural gas-fired alternative and the surrounding landscape and the visibility of the gas-fired plant.

The two gas-fired units would be approximately 100 ft (30 m) tall, with an exhaust stack up to 500 ft (152 m) and may be visible off site in daylight hours. However, the gas-fired plant would be shorter than the current CR-3 reactor building, which stands at 157 ft (49 m). Also, the CREC currently includes four fossil-powered units, with two 600-ft (183-m) and two 500-ft (152-m) exhaust stacks. Noise and light from plant operations, as well as lighting on plant structures, may be detectable off site as well. Pipelines delivering natural gas fuel could be audible off site near gas compressors.

Overall, because a new coal-fired plant would be consistent with the CREC's current aesthetic impacts, the aesthetic impacts associated with the gas-fired alternative would likely be SMALL.

8.2.6.5 *Historic and Archaeological Resources*

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities.

Based on its review of the Florida Master Site File, published literature, and information provided by the applicant, the NRC concludes that potential impacts of a new gas-fired alternative on historic and archaeological resources would be SMALL. This conclusion is based on the results of archaeological surveys conducted prior to initial plant construction and during subsequent expansion activities. The locations of existing archaeological sites within the CREC, including areas of high potential for additional discoveries, are located away from plant maintenance and operations activities in the protected area. This conclusion is also based on the existing archaeological and cultural resources and environmental protection procedures in use by CR-3 environmental staff as noted during the environmental site visit. Lands not previously surveyed should be investigated by a qualified archaeologist prior to any ground disturbing activity associated with a new gas-fired alternative at the site.

8.2.6.6 *Environmental Justice*

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new gas-fired power plant. 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 exceed the environmental impacts 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 discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing in the vicinity of CR-3, and all are exposed to the same hazards generated from constructing and operating a new natural gas-fired combined-cycle power plant. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to Section 4.9.7, “Environmental Justice.”

Potential impacts to minority and low-income populations from the construction and operation of a new natural gas-fired combined-cycle power plant at CR-3 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. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic.

However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of CR-3 could affect low-income populations. Given the close proximity to the Tampa metropolitan area, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a gas-fired power plant alternative at the CR-3 site would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of CR-3.

8.2.7 Waste Management

During the construction stage of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed onsite or shipped to an offsite waste disposal facility. Because the alternative would be constructed on the previously disturbed CR-3 site, the amounts of wastes produced during land clearing would be reduced.

During the operational stage, spent SCR catalysts used to control NO_x emissions from the natural gas-fired plants would make up the majority of the waste generated by this alternative.

According to the GEIS (NRC, 1996), a natural gas-fired plant would generate minimal waste and the waste impacts would therefore be SMALL for a natural gas-fired alternative located at the CR-3 site.

Table 8-2. Summary of Environmental Impacts of the Natural Gas Combined-Cycle Generation Alternative Compared to Continued Operation of Crystal River Unit 3 Nuclear Generating Plant

	Natural Gas Combined-Cycle Generation	Continued CR-3 Operation
Air Quality	SMALL to MODERATE	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL to MODERATE
Human Health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL

Waste Management	SMALL	SMALL

8.3 COMBINATION ALTERNATIVE

This section evaluates the environmental impacts of a combination of alternatives, which will include a portion of the combined-cycle gas-fired capacity identified in Section 8.2 and a conservation capacity component. This alternative requires new construction of two single gas-fired units installed at the CR-3 site.

The applicant has a demand-side management (DSM) program. By the start of 2014, it plans to reduce summer peak load by 128 MW(e) and winter peak load by 400 MW(e). The goal is to reduce annual energy consumption by an additional 190 gigawatt hour (GWh) (to date, this program has successfully reduced annual consumption by 115 GWh). As of December 2007, the applicant had a total summer capacity resource of 1,922 MW.

In this alternative, about 24 percent of CR-3's output—200 MW(e)—would be replaced by conservation. Inclusion of this conservation component of the alternative is based on Florida's energy efficiency goals and the applicant's DSM program (FDEP, 2006). A combined-cycle power plant made up of two 280-MW(e) GE S7001FB units will provide 560 net MW(e) (GE, 2007). The only major construction would occur at the current CR-3 site where the combined-cycle gas-fired power plant would be constructed. No construction is necessary for the conservation portion.

The appearance of the gas-fired facility would be similar to that of the full gas-fired alternative considered in Section 8.2, though each unit would be smaller than the units considered in Section 8.2. This unit would require about 70 percent of the space necessary for the alternative considered in Section 8.2 and that all construction effects—as well as operational aesthetic, fuel-cycle, air quality, socioeconomic, land use, environmental justice, and water consumption effects—will scale accordingly.

8.3.1 Air Quality

CR-3 is located in Citrus County, Florida, which is in EPA Region 4. All counties in the State of Florida are in attainment for all criteria pollutants. The FDEP is responsible for managing and monitoring air quality in the State of Florida.

This alternative is a combination of two 280-MW natural gas-fired combined-cycle generating units, constructed onsite, and a 200-MW equivalent of conservation/DSM. The alternative would be similar in air quality impacts to the gas-fired alternative considered in Section 8.2, but would emit lower levels of pollutants. The conservation portion would have little to no effect on air quality.

A new gas-fired generating plant developed at the CR-3 site would qualify as a new major-emitting industrial facility and would be subjected to Prevention of Significant Deterioration of Air Quality Review under the requirements of the CAA, adopted by the FDEP Division of Air Resource Management in Chapter 62-204 of the FAC (FDEP, 2009a). The natural gas-fired plant would need to comply with the standards of performance for stationary gas turbines set forth in 40 CFR Part 60, Subpart GG.

Subpart P of 40 CFR Part 51 contains the visibility protection regulatory requirements, including the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Class I Federal area (40 CFR Part 51, Subpart P, §51.307). If a gas-fired alternative were located close to a mandatory Class I Federal area, additional air pollution control requirements would imply. There are three mandatory Class I Federal areas in the State of Florida and the closest is Chassahowitzka Wilderness Area, which is located about 20 mi south from CR-3. The other two mandatory Class I Federal areas in Florida are the Everglades National Park (265 mi south of CR-3) and St. Marks Wilderness Area (116 mi northwest of CR-3).

The following emissions for the gas-fired portion of this alternative were projected based on data published by the EIA, EPA, and on performance characteristics for this alternative and its emissions controls:

- Sulfur oxides (SO_x) – 44 tons (40 MT) per year
- Nitrogen oxides (NO_x) – 141 tons (128 MT) per year
- Carbon monoxide (CO) – 29 tons (27 MT) per year
- Total suspended particles (TSP) – 34 tons (31 MT) per year
- Particulate matter (PM) PM_{10} – 25 tons (22 MT) per year
- Carbon dioxide (CO_2) – 1,580,000 tons (1,435,000 MT) per year

The natural gas-fired component of this alternative would produce 35 tons (31 MT) per year of TSP, all of which would be emitted as PM_{10}.

In December 2000, the EPA issued regulatory findings (EPA, 2000a) on emissions of HAPs from electric utility steam-generating units, which identified that natural gas-fired plants emit HAPs such as arsenic, formaldehyde, and nickel and stated that:

> the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

The natural gas-fired plant would have to comply with Title IV of the CAA reduction requirements for SO_2 and NO_x, which are the main precursors of acid rain and major causes of reduced visibility. Title IV establishes maximum SO_2 and NO_x emission rates from the existing plants and a system of the SO_2 emission allowances that can be used, sold, or saved for future use by the new plants.

As stated above, the new natural gas-fired unit would produce 44 tons (40 MT) per year of SO_x and 141 tons (128 MT) per year of NO_x based on the use of the dry low NO_x combustion technology and the use of dry, low-NO_x burners and SCR in order to significantly reduce NO_x emissions.

The natural gas-fired component of this alternative would be subjected to the continuous monitoring requirements of SO_2, NO_x, and CO_2 specified in 40 CFR Part 75. The natural gas-fired plant would emit approximately 1.6 million tons (approximately 1.4 million MT) per year of unregulated CO_2 emissions. In response to the Consolidated Appropriations Act of 2008, the

EPA has proposed a rule that requires mandatory reporting of GHG emissions from large sources, applicable to the presented alternative, in the United States that would allow collection of accurate and comprehensive emissions data to inform future policy decisions. The EPA proposes that suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 MT or more per year of GHG emissions submit annual reports to the EPA (EPA, 2009b). The gases covered by the proposed rule are CO_2, CH_4, N_2O, HFC, PFC, SF_6, and other fluorinated gases including NF_3 and HFE. In June 2008, Florida Governor Charlie Crist signed legislation to create the "Florida Climate Protection Act," which requires electric utilities in the State to report GHG emissions. The Act also authorizes the FDEP to design a cap-and-trade program to reduce GHG emissions, which is in development.

Activities associated with the construction of the new natural gas-fired plant at the CR-3 site would cause some additional air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material handling equipment. Emissions from workers' vehicles and motorized construction equipment would be temporary. The construction crews would employ dust-control practices in order to control and reduce fugitive dust, which would be temporary in nature. The impact of vehicle exhaust emissions and fugitive dust from operation of the earth-moving and material handling equipment would be SMALL.

The overall air quality impacts of the combination alternative consisting of a natural gas-fired plant located at the CR-3 site and energy conservation would be SMALL to MODERATE.

8.3.2 Groundwater Use and Quality

If the onsite gas-fired plant continued to use groundwater for drinking water and service water, the total usage would likely be much less than CR-3 uses because fewer workers would be onsite and the gas-fired unit would have fewer auxiliary systems requiring service water. The current annual average withdrawal rate for CR-3 is about 227 gpm (Section 2.1.7.1) and pumping tests indicate this rate would not cause an effect on nearby supply wells. A reduction in this withdrawal rate means that impacts of the combination alternative would remain SMALL.

8.3.3 Surface Water Use and Quality

Using a combined alternative with conservation and wind power as major components will reduce the amount of surface water consumed for cooling purposes as compared to the proposed action and other alternatives considered in this section. The maximum consumptive use would be reduced from the amount of surface water consumed by the open-cycle cooling system currently in use by CR-3. The impact of this withdrawal would be SMALL.

8.3.4 Aquatic and Terrestrial Ecology

8.3.4.1 *Aquatic Ecology*

Section 2.2.5 describes the aquatic ecology of the CR-3 site, which is associated with the Gulf of Mexico. Impacts on the aquatic ecology from the CR-3 site are associated with construction or the use of water from the Gulf of Mexico during operation of the gas-fired portion of the combination alternative. A new gas-fired generating plant would use the existing CR-3 intake and discharge structures for cooling a new plant. The gas-fired portion of the alternative would require less cooling water to be withdrawn from the Gulf of Mexico than CR-3, and the thermal discharge would concurrently be smaller than CR-3. Therefore, the number of fish and other aquatic organisms affected by impingement, entrainment, and thermal impacts would be less for a gas-fired alternative than for those associated with license renewal.

Some temporary impacts to aquatic organisms might occur due to any construction or effluent discharge to the ocean, but the FDEP would monitor these activities under the project's NPDES permit. The number of affected organisms would be substantially less than for license renewal, so the levels of impact for impingement, entrainment, and thermal effects would be SMALL.

8.3.4.2 *Terrestrial Ecology*

The gas-fired component of this alternative would use existing disturbed land at the CR-3 site. This alternative would also require land offsite for the gas pipeline.

This alternative would use the existing plant site land, switchyard, the existing once-through cooling system, and transmission line system for construction of the gas-fired unit. Scaling from the applicant's previous estimation of a slightly larger gas-fired plant, approximately 24 ac (10 ha) of land would be required on the CR-3 site to support a 580-MW(e) natural gas plant.

Impacts to terrestrial ecology from onsite construction of the smaller two gas-fired units would be less than the impacts described for the two-unit gas-fired alternative. The impacts to farmland onsite would be approximately two-thirds of the impacts of the two-unit natural gas plant alternative. These onsite impacts are expected to be minor. Impacts to terrestrial ecology from offsite construction of the gas pipeline for a single gas-fired unit would be the same as for the two gas-fired unit alternative previously discussed (Progress Energy, 2008).

Based on this information, impacts to terrestrial resources would be SMALL.

8.3.5 Human Health

The human health risks from a combination of alternatives include the already discussed combined-cycle gas-fired plant. The GEIS (NRC, 1996) notes that the environmental impacts of the conservation/DSM alternative are likely to be centered on indoor air quality. This is due to increased weatherization of homes in the form of extra insulation and reduced air turnover rates from the reduction in air leaks. However, the actual impact from the conservation alternative is highly site-specific and not yet well-established. The human health risks from the combination of alternatives are uncertain, but considered to be SMALL given that the construction and operation of the facilities are expected to comply with health-based Federal and State safety and emission standards.

8.3.6 Socioeconomics

8.3.6.1 *Land Use*

The analysis of land use impacts for the combination alternative focuses on the amount of land area that would be affected by the construction and operation of a two-unit natural gas-fired power plant at the CR-3 site and demand-side energy conservation.

Land use impacts of an energy efficiency alternative would be SMALL. Quickly replacing and disposing of old inefficient equipment could generate waste material and potentially increase the size of landfills. However, given the time for program development and implementation, the cost of replacements, and the average life of equipment, the replacement process would probably be more gradual. Older equipment would likely be replaced by more efficient equipment as it fails (especially in the case of frequently replaced items, like light bulbs). In addition, many items (like home appliances or industrial equipment) have substantial recycling value and would likely not be disposed of in landfills.

Based on the applicant's estimates, approximately 24 ac (10 ha) would be needed to support the two-unit natural gas-fired portion of the combination alternative. Land use impacts from construction of the natural gas-fired power plant at CR-3 would be SMALL.

In addition to onsite land requirements, land would be required off site for natural gas wells and collection stations. Scaling from GEIS estimates, the natural gas-fired power plant at CR-3 could require 2,000 ac (810 ha) for wells, collection stations, and pipelines to bring the gas to the facility. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside of the United States and be delivered as liquefied gas.

For these reasons, overall land use impacts from the combination alternative would be SMALL.

8.3.6.2 *Socioeconomics*

As previously discussed, 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 new single natural gas-fired power plant at CR-3 could affect regional employment, income, and expenditures. Two types of jobs would be created: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power generating operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the natural gas-fired power plant component were evaluated in order to measure their possible effects on current socioeconomic conditions.

Based on GEIS projections and a workforce of 1,200 for a 1,000-MW(e) plant, two 280-MW(e) units at CR-3 would require a peak estimated construction workforce of up to 700 workers. The number of additional workers would cause a short-term increase in the demand for services and temporary (rental) housing in the region around the construction site.

After construction, some local communities may be temporarily affected by the loss of the construction jobs and associated loss in demand for business services. The rental housing market could also experience increased vacancies and decreased prices. The impact of construction on socioeconomic conditions would be SMALL.

Following construction, a two-unit gas-fired power plant at CR-3 could provide up to 90 jobs. Given the small number of operations workers at these facilities, socioeconomic impacts associated with the operation of the natural gas-fired power plant at CR-3 would be SMALL.

Socioeconomic effects of an energy efficiency program would be SMALL. As noted in the GEIS, the program would likely employ additional workers. Lower income families could benefit from weatherization and insulation programs. This effect would be greater than the effect for the general population because low-income households experience home energy burdens more than four times larger than the average household (OMB, 2007).

8.3.6.3 *Transportation*

Transportation impacts would be SMALL because the number of employees commuting to the CR-3 site, where the gas-fired portion is located, would be small.

Construction and operation of a natural gas-fired power plant would increase the number of vehicles on roads in the vicinity of this facility. During construction, cars and trucks would deliver workers, materials, and equipment to the worksites. The increase in vehicular traffic would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Pipeline construction and modifications to existing natural gas pipeline systems could also have an impact.

During plant operations, transportation impacts would almost disappear. Given the small number of operations workers at this facility, levels of service impacts on local roads from the operation of the natural gas-fired power plant at the CR-3 site would be SMALL.

8.3.6.4 *Aesthetics*

The aesthetics impact analysis focuses on the degree of contrast between the power plant and the surrounding landscape and the visibility of the power plant.

The two natural gas-fired units located at CR-3 could be approximately 100 ft (30 m) tall, with an exhaust stack up to 500 ft (152 m) tall. This is likely to be less noticeable than the current CR-3 reactor building at 157 ft (49 m). Also, the CREC currently includes four fossil-powered units, with two 600-ft (183-m) and two 500-ft (152-m) exhaust stacks. Noise and light from plant operations, as well as lighting on plant structures, may also be detectable off site. Pipelines delivering natural gas fuel could be audible off site near gas compressors.

Overall, because a new gas-fired plant would be consistent with the CREC's current aesthetic impacts, the aesthetic impacts associated with the gas-fired alternative would likely be SMALL.

Impacts from energy efficiency programs would be SMALL. Some noise impacts could occur in instances of energy efficiency upgrades to major building systems, though this impact would be intermittent and short-lived.

8.3.6.5 *Historic and Archaeological Resources*

Based on its review of agency files, published literature, and information provided by the applicant, the potential impacts of a new gas-fired alternative on historic and archaeological resources would be SMALL. This conclusion is based on the results of archaeological surveys conducted prior to initial plant construction and during subsequent expansion activities. The locations of existing archaeological sites within the CREC, including areas of high potential for additional discoveries, are located away from plant maintenance and operations activities in the protected area. This conclusion is also based on the existing archaeological and cultural resources and environmental protection procedures in use by CR-3 environmental staff as noted during the environmental site visit. Lands not previously surveyed should be investigated by a qualified archaeologist prior to any ground disturbing activity associated with a new gas-fired alternative at the site.

A conservation alternative would not affect land use or historical or cultural resources on site or elsewhere in the State.

8.3.6.6 *Environmental Justice*

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new gas-fired power plant. 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 exceed the environmental impacts 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 discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing in the vicinity of CR-3, and all are exposed to the same hazards generated from constructing and operating a new natural gas-fired combined-cycle power plant. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to Section 4.9.7, "Environmental Justice."

Potential impacts to minority and low-income populations from the construction and operation of a new natural gas-fired combined-cycle power plant at CR-3 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. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic.

However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of CR-3 could affect low-income populations. Given the close proximity to the Tampa metropolitan area, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a gas-fired power plant alternative at the CR-3 site would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of CR-3. For these reasons, impacts from the construction and operation of a gas-fired power plant alternative would likely be SMALL.

Weatherization programs could target low-income residents as a cost-effective energy efficiency option since low-income populations tend to spend a larger proportion of their incomes paying utility bills (according to the Office of Management and Budget, low-income populations experience energy burdens more than four times as large as those of average households [OMB, 2007]). Impacts to minority and low-income populations from energy efficiency programs would be SMALL, depending on program design and enrollment.

8.3.7 Waste Management

During the construction stage of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed onsite, or shipped to the offsite waste disposal facility. During the operational stage, spent SCR catalysts, which are used to control NO_x emissions from the natural gas-fired plants, would make up the majority of the waste generated by this alternative.

There will be an increase in wastes generated during installation or implementation of conservation measures, such as appropriate disposal of old appliances, installation of control devices, and building modifications. New and existing recycling programs would help to minimize the amount of generated waste.

The overall waste impacts from the combination of the natural gas-fired unit constructed onsite and conservation are SMALL.

Table 8-3. Summary of Environmental Impacts of the Combination Alternative Compared to Continued Operation of Crystal River Unit 3 Nuclear Generating Plant

	Combination Alternative	Continued CR-3 Operation
Air Quality	SMALL to MODERATE	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL to MODERATE
Human Health	SMALL	SMALL
Socioeconomics	SMALL	SMALL
Waste Management	SMALL	SMALL

8.4 ALTERNATIVES CONSIDERED BUT DISMISSED

This section presents alternatives to license renewal that were eliminated from detailed study due to technical reasons, resource availability, or current commercial limitations. The NRC believes that these limitations would continue to exist when the existing CR-3 license expires. Under each of the following technology headings, the NRC explains why it dismissed each alternative from further consideration.

8.4.1 Offsite Coal- and Gas-Fired Capacity

While it is possible that coal- and gas-fired alternatives like those considered in Sections 8.1 and 8.2, respectively, could be constructed at sites other than CR-3, greater impacts would occur from the construction of support infrastructure offsite, like intake and discharge structures, transmission lines, roads, and railway spurs that are already present and available for use on the CR-3 site. Further, the community around CR-3 is already familiar with the appearance of a power facility and it is an established part of the region’s aesthetic character. Workers skilled in power plant operations would also be available in this area. The availability of these factors is only likely to be available on other recently industrial sites. In cases where recently industrial sites exist, other remediation may also be necessary in order to make the site ready for redevelopment. In short, an existing power plant site would present the best location for a new power facility.

8.4.2 Coal-Fired Integrated Gasification Combined-Cycle

The integrated gasification combined-cycle (IGCC) is an emerging technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. While utilities across the United States have considered or are considering plans for IGCC coal-fired power plants, few IGCC facilities have been constructed. Only a few IGCC plants are operating at utility scale. Operating at higher thermal efficiencies than supercritical pulverized coal (SCPC) boilers, IGCC plants can produce electrical power with less air pollutants and solid wastes than SCPC boilers. To date, however, IGCC technologies have had limited application and have been plagued with operational problems such that their effective, long-term capacity factors are often not high enough for them to reliably serve as baseload units. All facilities constructed in the United States to date have been smaller than CR-3. The technology, however, is commercially available and essentially relies on a gasifier stage and a combined-cycle turbine stage. Existing combined-cycle gas turbines (like the ones considered in Section 8.2) could be used as a part of an IGCC alternative. Emissions would likely be slightly greater than those from the gas-fired alternative, but significantly lower than those from the coal-fired alternative. In addition, an IGCC alternative would require slightly less onsite space than the coal-fired alternative in Section 8.1 and operate at a higher thermal efficiency. Depending on gasification technology employed, it would likely use a similar quantity of water. Currently, no IGCC projects have been approved in the State of Florida. In 2005, Florida Power and Light attempted to move ahead with plans to build an IGCC power plant in St. Lucie County, Florida, but was denied the necessary permits by the St. Lucie County Commission. The Orlando Utilities Commission and Southern Company recently canceled plans to build an IGCC plant in Orange County, Florida, citing the increasing likelihood of a carbon pollution tax in the State. Tampa Electric Company also suspended plans to build a 630-MW IGCC plant, citing Florida Governor Charlie Crist's efforts to reduce CO_2 emissions in the State.

The EIA indicates that IGCC and other advanced coal plants may become increasingly common in coming years. Though current operational problems that compromise reliability and uncertainties about construction time periods and commercial viability in the near future, the IGCC is an unlikely alternative to CR-3 license renewal (EIA, 2009a). For plants whose licenses expire later, IGCC (with or without carbon capture and storage) may prove to be a viable alternative.

8.4.3 New Nuclear

In its ER, the applicant indicated that it is unlikely that a nuclear alternative could be sited, constructed, and operational by the time the CR-3 operating license expires December 3, 2016 (Progress Energy, 2008). A potential plant would require additional time and resources to develop an application. Progress Energy Florida, Inc. has already submitted a proposal for a new nuclear plant 8 mi (13 km) north of the CR-3 site in Levy County, Florida. It remains unknown whether this new plant will be licensed by the 2016 timeframe. Progress Energy Florida, Inc. has already indicated that, if licensed, this two-reactor nuclear site will be constructed to offset the loss of the two oldest coal-fired units in the CREC upon their retirement.

Given the relatively short time remaining on the current CR-3 operating license, new nuclear generation was not evaluated as an alternative to license renewal.

8.4.4 Energy Conservation/Energy Efficiency

Though often used interchangeably, energy conservation and energy efficiency are different concepts. Energy efficiency typically means deriving a similar level of service by using less energy, while energy conservation simply indicates a reduction in energy consumption. Both fall into a larger category known as DSM. DSM measures—unlike the energy supply alternatives discussed in previous sections—address energy end uses. DSM can include measures that do the following:

- shift energy consumption to different times of the day to reduce peak loads
- interrupt certain large customers during periods of high demand
- interrupt certain appliances during high demand periods
- replace older, less efficient appliances, lighting, or control systems
- encourage customers to switch from gas to electricity for water heating and other similar measures that utilities use to boost sales

Unlike other alternatives to license renewal, the GEIS notes that conservation is not a discrete power generating source; it represents an option that States and utilities may use to reduce their need for power generation capability (NRC, 1996).

A 2007 study conducted on the energy efficiency potential of Florida concluded that by 2023, the State could reduce its energy consumption by 30 percent (Elliot et al., 2007). Florida Governor Charlie Crist has recently passed energy efficiency and Leadership in Energy and Environmental Design (LEED) standards for all newly constructed or renovated buildings, as well as created an Action Team on Energy and Climate Change. The resulting *2006 Energy Plan* briefly outlines conservation goals, which have been set for the seven Florida utilities subject to the 1980 Florida Energy and Efficiency Conservation Act: Progress Energy Florida, Florida Power & Light, Gulf Power, Tampa Electric Company (TECO), Florida Public Utilities Company, JEA (formerly Jacksonville Electric Authority), and Orlando Utilities Commission.

As of August 2009, Progress Energy is also seeking a Federal grant from the DOE to invest in smart grid technology in Florida that will allow customers to have more control over their energy usage and promote conservation. The smart grid technology lets both utility companies and customers continuously monitor and adjust their electricity use, as well as the flexibility to integrate renewable energy sources such as solar and wind power. Progress Energy is already committed to investing $320 million in this technology to be used in both Progress Energy Carolinas and Progress Energy Florida.

Currently, Progress Energy has a DSM program with the goal to reduce annual energy consumption by an additional 190 GWh. To date, this program has successfully reduced annual consumption by 115 GWh. Using the lower conservation number, 128 MW(e), conservation/energy efficiency could offset roughly 15 percent of CR-3's output. Because the current conservation practices are not enough to offset the loss of CR-3, and the future of smart grid technology (as well as the amount of energy conservation it will actually contribute) is uncertain, energy conservation/efficiency was not evaluated as an alternative to license renewal except as a component of the combination alternative.

8.4.5 Purchased Power

In its ER, the applicant indicated that, while not currently available, purchased electrical power was not ruled out as an alternative by the 2016 timeframe. The State of Florida relies heavily on purchased power (about 117 terawatt-hours [TWh] worth), and purchased power accounts for 17 percent of Progress Energy's current electricity supply in the State (EIA, 2010), (Progress Energy, 2008). If any current electricity purchase contracts in the State expire prior to 2016, there may be power available for Progress Energy to purchase as an alternative, however, there are no guaranteed available power sources to replace the 850 gross MW(e) that CR-3 currently provides. It is unlikely that the Florida power grid would be able to support additional electricity imports, as it is already one of the more congested transmission paths in the country, with transmission lines congested between 40 to 80 percent of the year (Rewey and Cromarty, 2006). Because of this congestion, as well as tax regulations in the area, trading into the Southeast electricity market is very difficult. In its ER, the applicant recognized that it is likely that a new capacity would have to be built for a purchased-power alternative to become available.

The potential for purchased power to offset a portion of the electricity generated by CR-3, however, because of the lack of assured available purchased electrical power for the 2016 to 2036 timeframe of CR-3 license renewal, was not evaluated as an alternative to license renewal.

8.4.6 Wind Power (Onshore/Offshore)

Wind power, by itself, is not suitable for large baseload capacity. As discussed in Section 8.3.1 of the GEIS, wind has a high degree of intermittency and low average annual capacity factors (up to 30 to 40 percent). Wind power, in conjunction with energy storage mechanisms or another readily dispatchable power source, like hydropower, could serve as a means of providing baseload power. However, current energy storage technologies are too expensive for wind power to serve as a large baseload generator.

The American Wind Energy Association (AWEA) reports that a total of 25,369 MW of wind energy capacity was installed in the United States at the end of 2008, with 8,545 MW installed just in 2008 (AWEA, 2009). Texas is by far the leader in installed capacity with 2,671 MW, followed by Iowa (1,600 MW), Minnesota (456 MW), Kansas (450 MW), and New York (407 MW). The AWEA indicates that Florida currently ranks 45th among the States in installed wind power capacity (0 MW), and 46th among the States in potential capacity. No projects are currently under construction (AWEA, 2010).

Wind energy potential in Florida is largely Class 1, with some sites registering Class 2 at best. At the current stage of wind energy technology development, wind regimes of Class 3 or higher are required to produce utility-scale amounts of electricity. The National Renewable Energy Laboratory (NREL, 2010) estimates that the State of Florida has a wind energy potential of 0.4 MW of installed capacity with annual generation of 1 GWh (considering sites with capacity factors greater than or equal to 30 percent at an 80-m height).

Although offshore wind farms could be considered an alternative in this area, much of the Florida coasts have been designated as Marine Protected Areas, which means that the amount of area required for an offshore wind farm is unlikely to be available. Also, considering the current capacity factor of about 35 percent, to date the largest offshore farm that has been permitted in the United States is not even a third of the size that would be required to offset CR-3.

Based on this available information, wind power was not evaluated as a suitable alternative to renewing the CR-3 operating license.

8.4.7 Solar Power

Solar technologies, photovoltaic (PV) and solar thermal (also known as concentrated solar power [CSP]), use the sun's energy to produce electricity at a utility scale. In PV systems, the energy contained in photons of sunlight incident on special PV materials results in the production of direct current (DC) electricity which is aggregated, converted to alternating current (AC), and connected to the high-voltage transmission grid. CSP technologies produce electricity by capturing the sun's heat energy. Two types of CSP technology that have had the greatest utility-scale applications are the parabolic trough and the power tower; both involve capturing the sun's heat and converting it to steam which powers a conventional Rankine cycle engine. Although relatively benign in many respects, solar technology requires substantial land areas and CSP technologies require roughly the same amount of water for cooling of the steam cycle as many other thermoelectric technologies. Establishing adequate cooling for CSP facilities is often problematic since geographic areas with the highest-value direct normal isolation required for CSP are often in remote desert areas with limited or no water availability.

As with other forms of renewable energy, the potential of solar technologies to serve as reliable baseload power alternatives to CR-3 depends on the value, constancy, and accessibility of the solar resource. Both PV and CSP are growing worldwide, especially for various off-grid applications or to augment grid-provided power at the point of consumption; however, discrete baseload applications still have technological limitations. Although thermal storage can markedly increase the value of CSP-derived power for baseload applications by providing energy storage capabilities, low energy conversion efficiencies and the inherent weather-dependent intermittency of solar power limit its application as baseload power in all but geographic locations with the highest solar energy values.

Currently, the CR-3 site receives between 4.5 and 5.0 kWh per square meter per day, for solar collectors oriented at an angle equal to the installation's latitude (NREL, 2008). Since flat-plate PVs tend to be roughly 24 percent efficient, a solar-powered alternative will require at least 13,450 ac (5,440 ha) of collectors to provide an amount of electricity equivalent to that generated by CR-3. A solar thermal power alternative (assuming an efficiency of 32 percent) would similarly require about 21,250 ac (8,600 ha). Space between parcels and associated infrastructure increase this land requirement. This amount of land, while large, is consistent with the land required for coal and natural gas fuel cycles.

Progress Energy does have current and projected solar power initiatives totaling 330 kW in the State of Florida; however, these are limited to research and demonstration projects, educational programs, and small-scale electricity generation (Progress Energy, 2008). By its nature, solar power is intermittent (i.e., it does not work at night and cannot serve baseload when the sun is not shining), and the efficiency of collectors varies greatly with weather conditions. A solar-powered alternative will require energy storage or backup power supply to provide electric power at night. Given the challenges in meeting baseload requirements, solar power was not evaluated as an alternative to license renewal of CR-3.

8.4.8 Wood Waste

In 1999, DOE researchers estimated that Florida has biomass fuel resources consisting of forest, mill, agricultural, and urban residues, as well as energy crop potential. Excluding potential energy crops, DOE researchers projected that Florida had 17,046,408 tons (15,465,000 MT) of plant-based biomass available at $50 per ton delivered (costs are in 1995 dollars) (Walsh et al., 2000). The Bioenergy Feedstock Development Program at Oak Ridge National Laboratory estimated that each air-dry pound of wood residue produces approximately 6,400 Btu of heat (ORNL, 2007). Assuming 33 percent conversion efficiency, using all biomass available in Florida at $50 per ton—the maximum price the researchers considered—would generate roughly 0.003 TWh (3,295 MWh) of electricity.

Walsh et al. (2000) go on to note that these estimates of biomass capacity contain substantial uncertainty and that potential availability does not mean biomass will actually be available at the prices indicated or that resources will be usably free of contamination. Some of these plant wastes already have reuse value and would likely be more costly to deliver because of competition. Others, such as forest residues, may prove unsafe and unsustainable to harvest on a regular basis (the majority of biomass capacity in Florida comes from forest residues, with very little potential from agricultural residues). The available resource potential is likely less than the estimate totals in Walsh et al., and the total resource is not likely to be sufficient to substitute for the electrical power generation provided by CR-3. As a result, a wood-fired alternative was not evaluated as an alternative to CR-3 license renewal.

8.4.9 Hydroelectric Power

According to researchers at Idaho National Energy and Environmental Laboratory, Florida has an estimated 43 MW of undeveloped nameplate potential hydroelectric resources at 13 sites throughout the State (INEEL, 1997), (INEEL, 1998). Most of these sites have a potential capacity of less than 1 MW(e), with about 41 percent of the undeveloped hydroelectric power potential in Florida contained within the Florida Apalachicola River basin. Given that the available hydroelectric potential in the State of Florida constitutes less than the power generating capacity of CR-3, hydropower was not evaluated as an alternative to license renewal.

8.4.10 Wave and Ocean Energy

Wave and ocean energy has generated considerable interest in recent years. Differential heating of the earth's water and land surfaces results in wind, which acts on the ocean's surface to create waves. The gravitational pull of the moon also helps to create waves. Ocean waves, currents, and tides represent kinetic and potential energies. The total annual average wave energy off the U.S. coastlines at a water depth of 197 ft (60 m) is estimated at 2,100 TWh (MMS, 2006). Wave currents and tides are often predictable and reliable; ocean currents flow consistently, while tides can be predicted months and years in advance with well-known behavior in most coastal areas. Four principal wave energy conversion technologies have been developed to date to capture the potential or kinetic energy of waves: point absorbers, attenuators, overtopping devices, and terminators. All have similar approaches to electricity generation but differ in size, anchoring method, spacing, interconnection, array patterns, and water depth limitations. Point absorbers and attenuators both allow waves to interact with a floating buoy, subsequently converting its motion into mechanical energy to drive a generator. Overtopping devices and terminators are also similar in their function. Overtopping devices trap some portion of the incident wave at a higher elevation than the average height of the surrounding sea surface, thus giving it higher potential energy, which is then transferred to power generators. Terminators allow waves to enter a tube, compressing air trapped at the top of the tube, which is then used to drive a generator.

Capacities of point absorbers range from 80 to 250 kW, with capacity factors as high as 40 percent; attenuator facilities have capacities of as high as 750 kW. Overtopping devices have design capacities as high as 4 MW, while terminators have design capacities ranging from 500 kW to 2 MW and capacity factors as high as 50 percent (MMS, 2007).

The most advanced technology for capturing tidal and ocean current energy is the submerged turbine. Underwater turbines share many design features and functions with wind turbines, but because of the greater density of water compared to air, they have substantially greater power generating potential than wind turbines of comparable sized blades. However, only a small number of prototypes and demonstration units have been deployed to date. Underwater turbine "farms" are projected to have capacities of 2 to 3 MW, with capacity factors directly related to the constancy of the current with which they interact.

The environmental impacts of wave energy conversion technologies are still largely undefined and, while expected to be generally benign, could vary substantially with site-specific circumstances. Also, large-scale deployment of wave energy conversion technologies could compete with other activities already occurring in offshore locations, including commercial and recreational fishing and commercial shipping. Although real-world examples are limited, the potential cost of commercial-scale wave energy conversion-derived power is estimated to range from \$0.09 to \$0.11 per KWh (MMS, 2006). The relatively modest power capacities and relatively high costs of resulting power, coupled with the fact that all wave energy conversion technologies are in their infancy, support the conclusion that wave energy conversion technologies are not feasible alternatives for renewing the CR-3 operating license.

8.4.11 Geothermal Power

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal electric generation is limited by the geographical availability of geothermal resources (NRC, 1996). Florida does have some potential for geothermal energy production; however, this potential is only estimated at less than 40 MW (Green and Nix, 2006). Because the geothermal potential in the State of Florida constitutes less than the generating capacity of CR-3, geothermal energy was not evaluated as a reasonable alternative to license renewal at CR-3.

8.4.12 Municipal Solid Waste

Municipal solid waste combustors use three types of technologies—mass burn, modular, and refuse-derived fuel. Mass burning is currently the method used most frequently in the United States and involves no (or little) sorting, shredding, or separation. Consequently, toxic or hazardous components present in the waste stream are combusted, and toxic constituents are exhausted to the air or become part of the resulting solid wastes. Currently, approximately 89 waste-to-energy plants operate in the United States. These plants generate approximately 2,700 MW(e), or an average of 30 MW(e) per plant (Integrated Waste Services Association, 2007). More than 28 average-sized plants will be necessary to provide the same level of output as the other alternatives to CR-3 license renewal.

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant will be approximately the same as that for a coal-fired power plant. Additionally, waste-fired plants have the same or greater operational impacts than coal-fired technologies (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at coal-fired facilities or at wood-waste facilities because of the need for specialized waste separation and handling equipment (NRC, 1996).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term as energy prices increase; however, it is possible that municipal waste combustion facilities may become attractive again.

Regulatory structures that once supported municipal solid waste incineration no longer exist. For example, the Tax Reform Act of 1986 made capital-intensive projects such as municipal waste combustion facilities more expensive relative to less capital-intensive waste disposal alternatives such as landfills. In addition, the 1994 Supreme Court decision C&A Carbone, Inc. v. Town of Clarkstown, New York, struck down local flow control ordinances that required waste to be delivered to specific municipal waste combustion facilities rather than landfills that may have had lower fees. In addition, environmental regulations have increased the capital cost necessary to construct and maintain municipal waste combustion facilities.

Given the small average installed size of municipal solid waste plants and the unfavorable regulatory environment, municipal solid waste combustion was not considered a feasible alternative to CR-3 license renewal.

8.4.13 Biofuels

In addition to wood and municipal solid waste fuels, there are other concepts for biomass-fired electric generators, including direct burning of energy crops, conversion to liquid biofuels, and biomass gasification. When used here, “biomass fuels” include crop residues, switchgrass grown specifically for electricity production, forest residues, methane from landfills, methane from animal manure management, primary wood mill residues, secondary wood mill residues, urban wood wastes, and methane from domestic wastewater treatment. The feasibility of the use of biomass fuels for baseload power is dependent on their geographic distribution, available quantities, constancy of supply, and energy content. A variety of technical approaches have been developed for biomass-fired electric generators, including direct burning, conversion to liquid biofuels, and biomass gasification.

None of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload power plant such as CR-3. Although Progress Energy has recently agreed to purchase the 117-MW(e) output from a new biomass plant to be built in central Florida (which will be the world’s first commercial-sale, closed-loop biomass facility), this output is only a fraction of the CR-3 capacity (Progress Energy, 2008). For this reason, biomass-derived fuel power plants are not considered feasible alternatives to CR-3 license renewal.

8.4.14 Oil-Fired Power

The EIA projects that oil-fired plants will account for no new generation capacity constructed in the United States during the 2010 to 2030 time period. Further, the EIA does not project that oil-fired power will account for any significant additions to capacity (EIA, 2010). Florida's electric power industry has historically relied on oil-fired plants; however, in recent years the Florida Public Service Commission (FPSC) has implemented new policies to encourage alternatives that reduce the State's dependence on oil for electricity generation (FDEP, 2006). Oil-fired generation has decreased in Florida from 55 percent of the Statewide electricity production in 1973 to 11.3 percent in 2006 (EIA, 2009a). Florida utilities forecast a further decline to only 7 percent by the year 2014 (FDEP, 2006).

The variable costs of oil-fired generation tend to be greater than those of the nuclear or coal-fired operations, and oil-fired generation tends to have greater environmental impacts than natural gas-fired generation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive (EIA, 2010). The high cost of oil has prompted a steady decline in its use for electricity generation. Thus, oil-fired power generation was not evaluated as an alternative to CR-3 license renewal.

8.4.15 Fuel Cells

Fuel cells oxidize fuels without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air (or oxygen) over a cathode and separating the two by an electrolyte. The only byproducts (depending on fuel characteristics) are heat, water, and CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

At the present time, fuel cells are not economically or technologically competitive with other alternatives for electricity generation. The EIA projects that fuel cells may cost $5,374 per installed kW (total overnight costs) (EIA, 2009b), or 3.5 times the construction cost of new coal-fired capacity and 7.5 times the cost of new, advanced gas-fired, combined-cycle capacity. In addition, fuel cell units are likely to be small in size (the EIA reference plant is 10 MW(e)). While it may be possible to use a distributed array of fuel cells to provide an alternative to CR-3, it would be extremely costly to do so and would require many units. Accordingly, fuel cells were not evaluated as an alternative to CR-3 license renewal.

8.4.16 Delayed Retirement

The applicant indicated in its ER that the 444-MW(e) Bartow plant in St. Petersburg (which is slated for retirement) is being uprated by replacing oil-fired boilers with a natural gas-fueled, combined-cycle power block (Progress Energy, 2008). This uprate will increase the plant's output by 800 MW, but the upgrades require major construction in order to meet the current air contaminant emissions restrictions. Another facility currently scheduled for retirement, the 129 MW(e) Suwannee River plant in Live Oak, is being reviewed for similar upgrades.

Both the Bartow uprate and the potential Suwannee River uprate, however, have already been considered by the applicant as part of its plan to meet future energy needs. As a result, delayed retirement is not a feasible alternative to license renewal. Other generation capacity may be retired prior to the expiration of the CR-3 license, but this capacity is likely to be older, less efficient, and without modern emissions controls.

8.5 NO-ACTION ALTERNATIVE

This section examines environmental effects that would occur if the NRC takes no action. No action in this case means that the NRC does not issue a renewed operating license for CR-3 and the license expires at the end of the current license term, in December 2016. If the NRC takes no action, the plant would shutdown at or before the end of the current license. After shutdown, plant operators would initiate decommissioning according to 10 CFR 50.82.

This section addresses only those impacts that arise directly as a result of plant shutdown. The environmental impacts from decommissioning and related activities have already been addressed in several other documents, including NUREG-0586, Supplement 1, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (NRC, 2002); Chapter 7 of the license renewal GEIS (NRC, 1996); and Chapter 7 of this SEIS. These analyses either directly address or bound the environmental impacts of decommissioning whenever the applicant ceases operating CR-3.

Even with a renewed operating license, CR-3 will eventually shut down, and the environmental effects addressed in this section will occur at that time. Since these effects have not otherwise been addressed in this SEIS, the impacts will be addressed in this section. As with decommissioning effects, shutdown effects are expected to be similar whether they occur at the end of the current license or at the end of a renewed license.

8.5.1 Air Quality

When the plant stops operating, there would be a reduction in emissions from activities related to plant operation such as use of diesel generators and employee vehicles. As discussed in Chapter 4, these emissions would have a SMALL impact on air quality during the renewal term. Therefore, if the emissions decrease, the impact to air quality would also decrease and would be SMALL.

8.5.2 Groundwater Use and Quality

The use of groundwater would diminish as plant personnel are removed from the site and operations cease. Some consumption of groundwater may continue as a small staff remains onsite to maintain facilities prior to decommissioning. Overall impacts would be less than during operations and would remain SMALL.

8.5.3 Surface Water Use and Quality

The rate of consumptive use of surface water would decrease as the plant is shut down and the reactor cooling system continues to remove the heat of decay. Wastewater discharges would also be reduced considerably. Shutdown would reduce the already SMALL impact on surface water resources and quality.

8.5.4 Aquatic and Terrestrial Resources

8.5.4.1 *Aquatic Ecology*

If the plant were to cease operating, impacts to aquatic ecology would decrease, as the plant would withdraw and discharge less water than it does during operations. Shutdown would reduce the already SMALL impacts to aquatic ecology.

8.5.4.2 *Terrestrial Ecology*

Terrestrial ecology impacts would be SMALL. No additional land disturbances on or off site would occur.

8.5.5 Human Health

Human health risks would be smaller following plant shutdown. The plant, which is currently operating within regulatory limits, would emit less gaseous and liquid radioactive material to the environment. In addition, following shutdown, the variety of potential accidents at the plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. As discussed in Chapters 4 and 5 of this SEIS, the impacts of continued plant operation and accidents during plant operation on human health would be SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and variety of accidents decrease following shutdown, the risks to human health following plant shutdown would be SMALL.

8.5.6 Socioeconomics

8.5.6.1 *Land Use*

Plant shutdown would not affect onsite land use. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines connected to CR-3 would remain in service after the plant stops operating. Maintenance of most existing transmission lines would continue as before. Impacts on land use from plant shutdown would be SMALL.

8.5.6.2 *Socioeconomics*

Plant shutdown would have an impact on socioeconomic conditions in the region around CR-3. Plant shutdown would eliminate approximately 540 jobs and would reduce tax revenue in the region. The loss of these contributions, which may not entirely cease until after decommissioning, would have a MODERATE impact. See Appendix J to NUREG-0586, Supplement 1 (NRC, 2002), for additional discussion of the potential socioeconomic impacts of plant decommissioning.

8.5.6.3 *Transportation*

Traffic volumes on the roads in the vicinity of CR-3 would be reduced after plant shutdown. Most of the reduction in traffic volume would be associated with the loss of jobs at the plant. Deliveries to the plant would be reduced until decommissioning. Transportation impacts would be SMALL as a result of plant shutdown.

8.5.6.4 *Aesthetics*

Plant structures and other facilities would remain in place until decommissioning. Noise caused by plant operation would cease. Aesthetic impacts of plant closure would be SMALL.

8.5.6.5 *Historic and Archaeological Resources*

Impacts from the no-action alternative would be SMALL, since CR-3 would be shut down. A separate environmental review would be conducted for decommissioning. That assessment will address the protection of known historic and archaeological resources at CR-3.

8.5.6.6 *Environmental Justice*

Termination of power plant operations would not disproportionately affect minority and low-income populations outside of the immediate vicinity of CR-3. Impacts to all other resource areas would be SMALL to MODERATE. Minority and low-income populations are generally concentrated in urban areas. Thus, impacts from plant shutdown would be SMALL. See Appendix J of NUREG-0586, Supplement 1 (NRC, 2002), for additional discussion of these impacts.

8.5.7 Waste Management

If the no-action alternative were implemented, the generation of high-level waste would stop and generation of low-level and mixed waste would decrease. Waste management impacts from implementation of the no-action alternative are expected to be SMALL.

Table 8-4. Summary of Environmental Impacts of No Action Compared to Continued Operation of Crystal River Unit 3 Nuclear Generating Plant

	No Action	Continued CR-3 Operation
Air Quality	SMALL	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL to MODERATE
Human Health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL
Waste Management	SMALL	SMALL

8.6 ALTERNATIVES SUMMARY

In this chapter, the following alternatives to CR-3 license renewal were considered: supercritical coal-fired generation, natural gas combined-cycle generation, and a combination alternative. No action by the NRC and the effects it would have were also considered. The impacts for all alternatives are summarized in Table 8-5.

The coal-fired alternative is not an environmentally preferable alternative due to impacts to air quality from NO_x, SO_x, particulate matter, PAHs, CO, CO_2, and mercury (and the corresponding human health impacts), as well as construction impacts to aquatic, terrestrial, and potential historic and archaeological resources.

The gas-fired alternative would have slightly lower air emissions, and waste management and socioeconomic impacts would be lower than the coal-fired alternative.

The combination alternative would have lower air emissions and waste management impacts than both the gas-fired and coal-fired alternatives.

In conclusion, the environmentally preferred alternative in this case is the license renewal of CR-3. All other alternatives capable of meeting the needs currently served by CR-3 entail equal or potentially greater impacts than the proposed action of license renewal of CR-3. Because the no-action alternative necessitates the implementation of one or a combination of alternatives, all of which have greater impacts than the proposed action, the no-action alternative would have environmental impacts greater than or equal to the proposed license renewal action.

Table 8-5. Summary of Environmental Impacts of Proposed Action and Alternatives

	Impact Area						
Alternative	Air Quality	Groundwater	Surface Water	Aquatic and Terrestrial Resources	Human Health	Socioeconomics	Waste Management
License renewal of CR-3	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL	SMALL
Supercritical coal-fired generation	MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	MODERATE
Natural gas combined-cycle generation	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Combination alternative	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
No-action alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

8.7 REFERENCES

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40 CFR Part 51. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans."

40 CFR Part 60. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 60, "Standards of Performance for New Stationary Sources."

40 CFR Part 75. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 75, "Continuous Emission Monitoring."

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9.0 CONCLUSION

This draft supplemental environmental impact statement (SEIS) presents the preliminary results of the environmental review conducted for a renewed operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3), as required by Part 51 of Title 10 of the *Code of Federal Regulations* (10 CFR Part 51), the U.S. Nuclear Regulatory Commission's (NRC's) regulations that implement the National Environmental Policy Act (NEPA). This chapter presents preliminary conclusions and recommendations from the site-specific environmental review of CR-3 and summarizes the environmental issues that were identified during the review.

9.1 ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL

The review of environmental impact issues in this SEIS leads to the preliminary conclusion that issuing a renewed operating license for CR-3 would have environmental impacts that range from SMALL to MODERATE. The site-specific review included 12 Category 2 issues and 2 uncategorized issues. Section 1.4 in Chapter 1 explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE.

The direct and indirect environmental impacts from continued operation of CR-3 are SMALL for all resource areas with the exception of aquatic ecology, which ranges from SMALL to MODERATE. The basis for this conclusion is discussed in Section 4.5.

The cumulative effects of past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes them, were also considered. The cumulative impacts of renewing CR-3's operating license, described in Section 4.11, would be SMALL to MODERATE depending on the resource. There would be MODERATE cumulative impacts to water resources, aquatic ecology, terrestrial ecology, socioeconomics, and air quality. All other resource areas would experience SMALL cumulative impacts.

9.2 COMPARISON OF ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL AND ALTERNATIVES

In the conclusion to Chapter 8, the NRC determined that environmental impacts from license renewal are generally less than the impacts of alternatives to license renewal. In comparing possible environmental impacts from supercritical coal-fired generation, natural gas combined-cycle generation, and a combination alternative (natural gas and conservation) to environmental impacts from license renewal, the NRC found that renewal of the CR-3 operating license results in the least environmental impact. Therefore, the environmentally preferred alternative in this case is the license renewal of CR-3. All other alternatives capable of meeting the needs currently served by CR-3 entail equal or potentially greater impacts than the proposed action of license renewal of CR-3.

9.3 RESOURCE COMMITMENTS

9.3.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out any of the energy alternatives considered in this SEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological materials from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with Environmental Protection Agency (EPA) emissions standards, though the alternative of operating a fossil-fueled power plant in some areas may worsen existing attainment issues. Chemical and radiological emissions would not be expected to exceed the National Emission Standards for hazardous air pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to radiation and hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste, would also be unavoidable. In comparison, hazardous and nonhazardous wastes would also be generated at non-nuclear power generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, power plant operators would be expected to carry out all activities and optimize all operations in a way that generates the smallest amount of waste possible.

9.3.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment, as described in Chapters 4, 5, 6, 7, and 8. “Short-term” is the period of time that continued power generating activities take place.

Power plant operations require short-term use of the environment and commitment of resources and, also, commit certain resources (e.g., land and energy) indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including license renewal, than under the no-action alternative because of the continued generation of electrical power and the continued use of generating sites and associated infrastructure. During operations, all energy alternatives require similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from power plant operations introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but they are not expected to impact air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired.

Continued employment, expenditures, and tax revenues generated during power plant operations directly benefit local, regional, and State economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste requires an increase in energy and consumes space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities are committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

9.3.3 Irreversible and Irretrievable Commitments of Resources

Resources are irreversibly committed when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use. An irreversible and irretrievable commitment of resources for electrical power generation includes the commitment of land, water, energy, raw materials, and other natural and man-made resources required for power plant operations. In general, the commitment of capital, energy, labor, and material resources are also irreversible.

The implementation of any of the energy alternatives considered in this SEIS would entail the irreversible and irretrievable commitment of energy, water, chemicals, and, in some cases, fossil fuels. These resources would be committed during the license renewal term and over the entire lifecycle of the power plant and would be irretrievable.

Energy expended would be in the form of fuel for equipment, vehicles, and power plant operations and electricity for equipment and facility operations. Electricity and fuel would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are readily available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

9.4 RECOMMENDATIONS

The NRC staff's preliminary recommendation is that the adverse environmental impacts of license renewal for CR-3 are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on the following:

- the analysis and findings in NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*
- the environmental report submitted by Florida Power Corporation
- consultation with Federal, State, and local agencies
- the NRC's environmental review
- consideration of public comments received during the scoping process

10.0 LIST OF PREPARERS

Members of the Office of Nuclear Reactor Regulation prepared this draft supplemental environmental impact statement (SEIS) with assistance from other U.S. Nuclear Regulatory Commission (NRC) organizations and with contract support from Argonne National Laboratory and Pacific Northwest National Laboratory.

Table 10-1 provides a list of NRC staff that participated in the development of the SEIS. Argonne National Laboratory provided contract support for terrestrial, socioeconomic, aquatic ecology, cultural resources, air quality, and hydrology, presented primarily in Chapters 2, 4, and 8. Pacific Northwest National Laboratory provided contract support for the severe accident mitigation alternatives (SAMAs) analysis which is presented in Chapter 5 and Appendix F.

Table 10-1. List of Preparers

Name	Affiliation	Function or Expertise
	NRC	
Bo Pham	Nuclear Reactor Regulation	Branch Chief
Andrew Imboden	Nuclear Reactor Regulation	Branch Chief
Rob Kuntz	Nuclear Reactor Regulation	Project Manager
Elaine Keegan	Nuclear Reactor Regulation	Project Manager
Daniel Doyle	Nuclear Reactor Regulation	Project Manager
Stephen Klementowicz	Nuclear Reactor Regulation	Radiation Protection; Human Health
Allison Travers	Nuclear Reactor Regulation	Alternatives
Richard Bulavinetz	Nuclear Reactor Regulation	Terrestrial Ecology
Jeffrey Rikhoff	Nuclear Reactor Regulation	Socioeconomics; Land Use; Environmental Justice
Jennifer Davis	Nuclear Reactor Regulation	Historic and Archaeological Resources
Dennis Logan	Nuclear Reactor Regulation	Aquatic Ecology
Dennis Beissel	Nuclear Reactor Regulation	Hydrology
Ekaterina Lenning	Nuclear Reactor Regulation	Solid Waste
Michelle Moser	Nuclear Reactor Regulation	Cumulative Impacts
Robert Palla	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
Tina Ghosh	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
	Lab Contractor[(a)]	
Kirk LaGory	Argonne National Laboratory	Terrestrial
William Metz	Argonne National Laboratory	Socioeconomics, Land Use, and Environmental Justice
Timothy Allison	Argonne National Laboratory	Socioeconomics, Land Use, and Environmental Justice
William Vinikour	Argonne National Laboratory	Aquatic Ecology
Konstance Wescott	Argonne National Laboratory	Historic and Archaeological Resources
Ron Kolpa	Argonne National Laboratory	Air Quality

Name	Affiliation	Function or Expertise
Terri Patton	Argonne National Laboratory	Hydrology
	SAMA Contractor[(b)]	
Steve Short	Pacific Northwest National Laboratory	Severe Accident Mitigation Alternatives
Garill Coles	Pacific Northwest National Laboratory	Severe Accident Mitigation Alternatives
Bruce Schmitt	Pacific Northwest National Laboratory	Severe Accident Mitigation Alternatives

(a) Argonne National Laboratory is operated by UChicago Argonne, LLC for the U.S. Department of Energy.

(b) Pacific Northwest National Laboratory is operated by Battelle for the U.S. Department of Energy.

11.0 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THE SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT ARE SENT

Name and Title	Company and Address
EIS Filing Section	U.S. Environmental Protection Agency 1200 Pennsylvania Ave NW Washington, D.C. 20004
Mr. Sam Mueller NEPA Coordinator	U.S. Environmental Protection Agency Region 4 61 Forsyth St SW Atlanta, GA 30303
Mr. Reid Nelson Director, Office of Federal Agency Programs	Advisory Council on Historic Preservation 1100 Pennsylvania Ave NW, Ste 803 Old Post Office Bldg Washington, D.C. 20004
Mr. Frederick P. Gaske Director and State Historic Preservation Officer	Florida Department of State Division of Historical Resources 500 S Bronough St Tallahassee, FL 32399-0250
Mr. Willard S. Steele Tribal Historic Preservation Officer	Seminole Indian Tribe 34725 W Boundary Rd Clewiston, FL 33440
Mr. Billy Cypress Chairman	Miccosukee Tribe of Florida PO Box 440021 Tamiami Station Miami, FL 33144
Mr. Leonard Harjo Principal Chief	Seminole Nation of Oklahoma PO Box 1498 Wewoka, OK 74884
Mr. Sam D. Hamilton Regional Director	U.S. Fish & Wildlife Service Southeast Regional Office 1875 Century Blvd NE, Ste 400 Atlanta, GA 30345
Dr. Roy E. Crabtree Regional Administrator	National Marine Fisheries Service Southeast Region 263 13th Ave S St. Petersburg, FL 33701
Mr. William A. Passetti Chief	Department of Health Bureau of Radiation Control 2020 Capital Cir, SE, Bin #C21 Tallahassee, FL 32399-1741
Ms. Deborah Getzoff Director	Florida Department of Environmental Protection Southwest District 13051 N Telecom Parkway Temple Terrace, FL 33637
Mr. Gary Knight Director	Florida Natural Areas Inventory 1018 Thomasville Rd, Ste 200-C Tallahassee, FL 32303

Name and Title	Company and Address
Mr. James Kraus Refuge Manager	Crystal River National Wildlife Refuge 1502 SE Kings Bay Dr Crystal River, FL 34429
Dr. Robbin Trindell Biological Administrator	Florida Fish & Wildlife Conservation Commission Habitat & Species Conservation Imperiled Species Management 620 S Meridian St MS-6A Tallahassee, FL 32399-1600
Attorney General	Department of Legal Affairs The Capitol Tallahassee, FL 32304
Mr. Craig Fugate Director	Division of Emergency Preparedness Department of Community Affairs 2740 Centerview Dr Tallahassee, FL 32399-2100
Regional Administrator	U.S. Nuclear Regulatory Commission Region II Marquis One Tower 245 Peachtree Center Ave NE Ste 1200 Atlanta, GA 30303
Senior Resident Inspector	Crystal River Unit 3 U.S. Nuclear Regulatory Commission 6745 N Tallahassee Rd Crystal River, FL 34428
Chairman	Board of County Commissioners Citrus County 110 N Apopka Ave Inverness, FL 34450-4245
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Mr. Jon A. Franke Vice President	Crystal River Nuclear Plant (NA1B) 15760 West Power Line Street Crystal River, FL 34428-6708
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Mr. Daniel R. Westcott Superintendent, Licensing & Regulatory Programs	Crystal River Nuclear Plant 15760 West Power Line Street Crystal River, FL 34428-6708
Mr. Stephen J. Cahill Director, Engineering	Crystal River Nuclear Plant (NA2C) 15760 West Power Line Street Crystal River, FL 34428-6708
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Mr. Mark Rigsby Manager, Support Services - Nuclear	Crystal River Nuclear Plant (SA2C) 15760 West Power Line Street Crystal River, FL 34428-6708

Name and Title	Company and Address
Mr. Mike Heath License Renewal Supervisor	Brunswick Nuclear Plant PO Box 10429 Southport, NC 28461-0429
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Mr. Dixie M. Hollins	Hollinswood Ranch PO Box 277 Crystal River, FL 34423
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APPENDIX A.
COMMENTS RECEIVED ON THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT ENVIRONMENTAL REVIEW

A. COMMENTS RECEIVED ON THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT ENVIRONMENTAL REVIEW

A.1. Comments Received During Scoping

The scoping process began on April 6, 2009, with the publication in the *Federal Register* of the U.S. Nuclear Regulatory Commission's (NRC's) Notice of Intent to conduct scoping (NRC, 2009a). The scoping process included two public meetings, which were both held at the Plantation Inn in Crystal River, Florida, on April 16, 2009. Approximately 30 members of the public attended the meetings. After the NRC staff (Staff) prepared statements pertaining to the license renewal process, the meetings were open for public comments. Of these attendees, eight gave oral statements that were recorded and transcribed by a certified court reporter. Transcripts of the entire meetings are publicly available (NRC, 2009b), (NRC, 2009c). In addition to the comments received during the public meetings, one comment was also received via e-mail. Following the scoping process, the Staff issued its Scoping Summary Report on March 21, 2011, to summarize the process and comments received (NRC, 2011).

Each commenter was given a unique identifier so that every comment could be traced back to its author. Table A-1 lists the individuals who made comments applicable to the environmental review and the Commenter ID associated with each person's set of comments. The individuals are listed in the order in which their comments were received. To maintain consistency with the Scoping Summary Report, the unique identifier used in that report for each set of comments is retained in this appendix.

Specific comments were categorized and consolidated by topic. Comments with similar specific objectives were combined to capture the common essential issues raised by participants. Comments fall into one of the following general groups:

- Specific comments that address environmental issues within the purview of the NRC environmental regulations related to license renewal. These comments address Category 1 (generic) or Category 2 (site-specific) issues or issues not addressed in NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants* (NRC, 1996), (NRC, 1999). They also address alternatives to license renewal and related Federal actions.

- General comments in support of, or opposed to, nuclear power or license renewal or on the renewal process, the NRC's regulations, and the regulatory process. These comments may or may not be specifically related to the Crystal River Unit 3 Nuclear Generating Plant (CR-3) license renewal application.

- Comments that do not note new information for the NRC to analyze as part of its environmental review.

- Comments that address issues that do not fall within, or are specifically excluded from, the purview of NRC environmental regulations related to license renewal. These comments typically address issues such as the need for power, emergency preparedness, security, current operational safety issues, and safety issues related to operation during the renewal period.

Table A-1. Individuals Providing Comments During the Scoping Period

Commenter	Affiliation (If Stated)	Comment Source	Commenter ID	ADAMS Accession Number
Paul Roberts		E-mail	A	ML101390392
Bert Henderson		Afternoon Scoping Meeting	B	ML091460259
Ginger Bryant	Citrus County School Board	Afternoon Scoping Meeting	C	ML091460259
Brent Tolan	Progress Energy	Afternoon Scoping Meeting	D	ML091460259
Andy Vukmir		Afternoon Scoping Meeting	E	ML091460259
Emily Casey		Evening Scoping Meeting	F	ML091460260
Gary Maidhof	Director, Citrus County Department of Development Services	Evening Scoping Meeting	G	ML091460260
Mark Klutho		Evening Scoping Meeting	H	ML091460260
Dixie Hollins	Citrus County Chamber of Commerce	Evening Scoping Meeting	I	ML091460260

Comments received during scoping that are applicable to this environmental review are presented in Section A.1.1 along with the Staff's response. The comments received during scoping that are general or outside the scope of the environmental review for CR-3 are not included here, but can be found in the Scoping Summary Report (NRC, 2011).

The comment below can be tracked to the commenter and the source document through the ID letter and comment listed in Table A-1. Except where indicated, the comment below is the Staff's attempt to provide a direct quotation from the commenter; original formatting was not necessarily maintained during this process.

A.1.1. Comments Related to Alternatives to License Renewal of Crystal River Unit 3 Nuclear Generating Plant (ALT)

Comment F-2-ALT: However, what I really feel like we should be doing, is decentralizing the power, such as solar on homes, solar on schools. Then maybe not only would we not need a nuclear power plant, but another thing that Citrus County has, that I find quite annoying, is if you look on the [U.S. Environmental Protection Agency] website for air quality, we have very poor air quality. And you go on there, you find out, well, what are they monitoring. There [are] two or three small businesses that they are monitoring, but mostly it's the big conglomerate that's out there, four coal plants and one nuclear power plant. Now, they've mentioned everything that's in the air quality that they monitor, and it just doesn't really look too good to have this poor of air quality in Citrus County, and then other counties with larger population have better air quality than we do. So I would like to not have a nuclear power plant, and for us to be going with renewables. I think that's the way to go. We are at a point in time where we need to really make some tough decisions. Which way is it? Are we going to take the business as usual road, or are we going to use new technology and go with renewables? No, I'm not against Progress Energy making money. So if it takes changing the way you make money to be able to do that, then that's fine. You know, just not getting it from the ratepayers. But that's a whole 'nother thing. I don't want that interpreted as not to pay power bills. Now, don't get me wrong about that. So what I would really like for you all to be doing is be very progressive and go with the renewable energies. That's what I'd like to see. However, if we do have CR-3, then we would like to see more outside monitoring. And, I think that's really all I have to say at this time. Preferably the renewables and solar energy is the way to go here, with, you know, solar on every rooftop, including the schools. And for any flat top roofs that has businesses -- and it doesn't have to be that way anymore. That's one thing I wanted to say. It doesn't have to be those big solar panels anymore. There's technologies that are out there now, and that's changing constantly. So I think that would really be the way to go. And that's really all I have to say. Thank you.

Response: *This comment addresses alternatives to license renewal of CR-3 and a request for additional monitoring.*

In Chapter 8, the Staff evaluated the following alternatives to CR-3 license renewal:

- *a new supercritical coal-fired plant*
- *a new natural gas-fired combined-cycle plant*
- *a combination alternative that includes some natural gas-fired capacity and energy conservation*
- *not renewing the CR-3 operating license (the "no-action alternative")*

Solar power was considered as an alternative but dismissed because of its challenges as a baseload power supply, as discussed in Section 8.4.7.

Air quality issues, including monitoring, are discussed in Chapters 2 and 4. There were no Category 2 issues associated with air quality. See Section 1.4 in Chapter 1 for a discussion of Category 1 and Category 2 issues. In Section 4.8.1.1 in Chapter 4, the Staff discusses the radiological environmental monitoring program at CR-3 that samples and analyzes various environmental media for radioactivity. In Section 4.11 in Chapter 4, the Staff discusses the potential cumulative environmental impacts associated with the continued operation of CR-3 when combined with other past, present, and reasonably foreseeable future actions.

A.2. References

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volumes 1 and 2, Washington, D.C., May 1996, Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML040690705 and ML040690738.

NRC (U.S. Nuclear Regulatory Commission). 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, D.C., August 1999, ADAMS Accession No. ML040690720.

NRC (U.S. Nuclear Regulatory Commission). 2009a. "Crystal River Unit 3 Nuclear Generating Plant; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process," *Federal Register*, Vol. 74, No. 64, April 6, 2009, pp. 15523–15525, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 2009b. Transcript of April 16, 2009, Scoping Meeting: Afternoon Session, ADAMS Accession No. ML091460259.

NRC (U.S. Nuclear Regulatory Commission). 2009c. Transcript of April 16, 2009, Scoping Meeting: Evening Session, ADAMS Accession No. ML091460260.

NRC (U.S. Nuclear Regulatory Commission). 2011. "Environmental Impact Statement Scoping Process Summary Report; Crystal River Unit 3 Nuclear Generating Plant," ADAMS Accession No. ML110490462.

APPENDIX B.
NATIONAL ENVIRONMENTAL POLICY ACT ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

B. NATIONAL ENVIRONMENTAL POLICY ACT ISSUES FOR LICENSE RENEWAL OF NUCLEAR POWER PLANTS

Table B-1. Summary of Issues and Findings. *This table is taken from Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51. Data supporting this table are contained in NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Throughout this supplemental environmental impact statement (SEIS), "Generic" issues are also referred to as Category 1 issues, and "Site-specific" issues are also referred to as Category 2 issues.*

Issue	Type of Issue	Finding
	Surface Water Quality, Hydrology, and Use	
Impacts of refurbishment on surface water quality	Generic	SMALL. 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	Generic	SMALL. Water use during refurbishment will not increase appreciably or will be reduced during plant outage.
Altered current patterns at intake and discharge structures	Generic	SMALL. 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.
Altered salinity gradients	Generic	SMALL. Salinity gradients 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.
Altered thermal stratification of lakes	Generic	SMALL. Generally, lake stratification 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.
Temperature effects on sediment transport capacity	Generic	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Scouring caused by discharged cooling water	Generic	SMALL. Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.
Eutrophication	Generic	SMALL. Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Discharge of chlorine or other biocides	Generic	SMALL. 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	Generic	SMALL. Effects are readily controlled through National Pollutant Discharge Elimination System (NPDES) permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.
Discharge of other metals in wastewater	Generic	SMALL. 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

Issue	Type of Issue	Finding
		term.
Water use conflicts (plants with once-through cooling systems)	Generic	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using makeup water from a small river with low flow)	Site-specific	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).
		Aquatic Ecology
Refurbishment	Generic	SMALL. 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.
Accumulation of contaminants in sediments or biota	Generic	SMALL. 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	Generic	SMALL. 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	Generic	SMALL. Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations, or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.
Thermal plume barrier to migrating fish	Generic	SMALL. 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	Generic	SMALL. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.
Premature emergence of aquatic insects	Generic	SMALL. 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)	Generic	SMALL. 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	Generic	SMALL. 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.

Issue	Type of Issue	Finding
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	Generic	SMALL. 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)	Generic	SMALL. 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.
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See § 51.53(c)(3)(ii)(B).
Impingement of fish and shellfish	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See § 51.53(c)(3)(ii)(B).
Heat shock	Site-specific	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See § 51.53(c)(3)(ii)(B).
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Generic	SMALL. Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impingement of fish and shellfish	Generic	SMALL. The impacts of impingement have not been found to be a problem at operating nuclear power plants with this type of cooling system and are not expected to be a problem during the license renewal term.
Heat shock	Generic	SMALL. Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Groundwater Use and Quality		
Impacts of refurbishment on groundwater use and quality	Generic	SMALL. 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

Issue	Type of Issue	Finding
		be a problem during the license renewal term.
Groundwater use conflicts (potable and service water; plants that use <100 gallons per minute [gpm])	Generic	SMALL. Plants using less than 100 gpm are not expected to cause any groundwater use conflicts.
Groundwater use conflicts (potable and service water, and dewatering plants that use >100 gpm)	Site-specific	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gpm may cause groundwater use conflicts with nearby groundwater users. See § 51.53(c)(3)(ii)(C).
Groundwater use conflicts (plants using cooling towers withdrawing makeup water from a small river)	Site-specific	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other groundwater or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).
Groundwater use conflicts (Ranney wells)	Site-specific	SMALL, MODERATE, OR LARGE. Ranney wells can result in potential groundwater depression beyond the site boundary. Impacts of large groundwater withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See § 51.53(c)(3)(ii)(C).
Groundwater quality degradation (Ranney wells)	Generic	SMALL. Groundwater quality at river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of reactor cooling water. However, the lower quality infiltrating water would not preclude the current uses of groundwater and is not expected to be a problem during the license renewal term.
Groundwater quality degradation (saltwater intrusion)	Generic	SMALL. Nuclear power plants do not contribute significantly to saltwater intrusion.
Groundwater quality degradation (cooling ponds in salt marshes)	Generic	SMALL. Sites with closed-cycle cooling ponds may degrade groundwater quality. Because water in salt marshes is brackish, this is not a concern for plants located in salt marshes.
Groundwater quality degradation (cooling ponds at inland sites)	Site-specific	SMALL, MODERATE, OR LARGE. Sites with closed-cycle cooling ponds may degrade groundwater quality. For plants located inland, the quality of the groundwater in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See § 51.53(c)(3)(ii)(D).
		Terrestrial Ecology
Refurbishment impacts	Site-specific	SMALL, MODERATE, OR LARGE. 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. See § 51.53(c)(3)(ii)(E).
Cooling tower impacts on crops and ornamental vegetation	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation 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.
Cooling tower impacts on native	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling

Issue	Type of Issue	Finding
plants		tower operation 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.
Bird collisions with cooling towers	Generic	SMALL. These collisions 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.
Cooling pond impacts on terrestrial resources	Generic	SMALL. Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.
Power line right-of-way management (cutting and herbicide application)	Generic	SMALL. The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.
Bird collisions with power lines	Generic	SMALL. Impacts are expected to be of small significance at all sites.
Impacts of electromagnetic fields on flora and fauna	Generic	SMALL. 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 wetland on power line right-of-way	Generic	SMALL. 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.
Threatened or Endangered Species		
Threatened or endangered species	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or 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. See § 51.53(c)(3)(ii)(E).
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	Site-specific	SMALL, MODERATE, OR LARGE. 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. See § 51.53(c)(3)(ii)(F).
Air quality effects of transmission lines	Generic	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
Land Use		
Onsite land use	Generic	SMALL. 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.

Issue	Type of Issue	Finding
Power line right-of-way	Generic	SMALL. Ongoing use of power line rights-of-way would continue with no change in restrictions. The effects of these restrictions are of small significance.
Human Health		
Radiation exposures to the public during refurbishment	Generic	SMALL. 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	Generic	SMALL. Occupational doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risk from all causes, including radiation, is in the mid-range for industrial settings.
Microbiological organisms (occupational health)	Generic	SMALL. Occupational health impacts are expected to be controlled by the continued application of accepted industrial hygiene practices to minimize worker exposures.
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Site-specific	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants, except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).
Noise	Generic	SMALL. 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.
Electromagnetic fields – acute effects (electric shock)	Site-specific	SMALL, MODERATE, OR LARGE. 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 at the site. See § 51.53(c)(3)(ii)(H).
Electromagnetic fields – chronic effects	Uncategorized	UNCERTAIN. Biological and physical studies of 60-Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a consensus scientific view has not been reached.
Radiation exposures to public (license renewal term)	Generic	SMALL. Radiation doses to the public will continue at current levels associated with normal operations.
Occupational radiation exposures (license renewal term)	Generic	SMALL. 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.
Socioeconomic Impacts		
Housing impacts	Site-specific	SMALL, MODERATE, OR LARGE. 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

Issue	Type of Issue	Finding
		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. See § 51.53(c)(3)(ii)(I).
Public services: public safety, social services, and tourism and recreation	Generic	SMALL. Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
Public services: public utilities	Site-specific	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See § 51.53(c)(3)(ii)(I).
Public services: education (refurbishment)	Site-specific	SMALL, MODERATE, OR LARGE. Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors. See § 51.53(c)(3)(ii)(I).
Public services: education (license renewal term)	Generic	SMALL. Only impacts of small significance are expected
Offsite land use (refurbishment)	Site-specific	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See § 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term)	Site-specific	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See § 51.53(c)(3)(ii)(I).
Public services: transportation	Site-specific	SMALL, MODERATE, OR LARGE. 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 the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).
Historic and archaeological resources	Site-specific	SMALL, MODERATE, OR LARGE. 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. See § 51.53(c)(3)(ii)(K).
Aesthetic impacts (refurbishment)	Generic	SMALL. No significant impacts are expected during refurbishment.
Aesthetic impacts (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Aesthetic impacts of transmission lines (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.

Issue	Type of Issue	Finding
Postulated Accidents		
Design-basis accidents	Generic	SMALL. The NRC staff has concluded that the environmental impacts of design-basis accidents are of small significance for all plants.
Severe accidents	Site-specific	SMALL. 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. See § 51.53(c)(3)(ii)(L).
Uranium Fuel Cycle and Waste Management		
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	Generic	SMALL. Offsite impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases, including radon-222 and technetium-99, are small.
Offsite radiological impacts (collective effects)	Generic	The 100-year environmental dose commitment to the U.S. population from the fuel cycle, high-level waste, and spent fuel disposal 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 United States. 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 effects which will not ever be mitigated (for example no cancer cure in the next 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 the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment 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 (Generic).

Issue	Type of Issue	Finding
Offsite radiological impacts (spent fuel and high-level waste disposal)	Generic	For the high-level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if it is assumed that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards," 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 milliroentgen equivalent man (millirem) 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 millirem 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 millirem per year. The lifetime individual risk from 100 millirem annual dose limit is about $3x10^{-3}$. 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 Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 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 the population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve 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, the Environmental Protection Agency's (EPA) generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to the 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 the amount of radioactive material released over 10,000 years. The cumulative release limits are based on the EPA's population impact goal of 1,000 premature cancer deaths worldwide for a 100,000 metric ton (MTHM) repository. Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission

Issue	Type of Issue	Finding
		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 in Category 1 (Generic).
Nonradiological impacts of the uranium fuel cycle	Generic	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.
Low-level waste storage and disposal	Generic	SMALL. 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 onsite 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.
Mixed waste storage and disposal	Generic	SMALL. 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.
Onsite spent fuel	Generic	SMALL. 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.
Nonradiological waste	Generic	SMALL. 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.
Transportation	Generic	SMALL. 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 the NRC up to 62,000 megawatt days per metric ton 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

Issue	Type of Issue	Finding
		met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.
		Decommissioning
Radiation doses	Generic	SMALL. 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 the buildup of long-lived radionuclides during the license renewal term.
Waste management	Generic	SMALL. 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.
Air quality	Generic	SMALL. 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.
Water quality	Generic	SMALL. 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.
Ecological resources	Generic	SMALL. Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	Generic	SMALL. Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year license renewal period, but they might be decreased by population and economic growth.
		Environmental Justice
Environmental justice	Uncategorized	NONE. The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

APPENDIX C.
APPLICABLE REGULATIONS, LAWS, AND AGREEMENTS

C. APPLICABLE REGULATIONS, LAWS, AND AGREEMENTS

The Atomic Energy Act (42 U.S.C. § 2021) authorizes the U.S. Nuclear Regulatory Commission (NRC) to enter into an agreement with any State to assume regulatory authority for certain activities. For example, in accordance with Section 274 of the Atomic Energy Act, as amended, beginning on July 1, 1964, the State of Florida assumed regulatory responsibility over certain byproduct materials, source materials, and special nuclear materials in quantities not sufficient to form a critical mass. The Florida Agreement State Program is administered by the Bureau of Radiation Control in the Department of Health.

In addition to carrying out some Federal programs, State legislatures develop their own laws. State statutes supplement, as well as implement, Federal laws for protection of air, water quality, and groundwater. State legislation may address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

The Clean Water Act (CWA) allows for primary enforcement and administration through State agencies, provided the State program is at least as stringent as the Federal program. The State program must conform to the CWA and delegation of authority for the Federal National Pollutant Discharge Elimination System (NPDES) Program from the U.S. Environmental Protection Agency (EPA) to the State. The primary mechanism to control water pollution is the requirement for direct dischargers to obtain an NPDES permit, or in the case of States where the authority has been delegated from the EPA (which is the case in Florida), a State Pollutant Discharge Elimination System (SPDES) permit, under the CWA.

One important difference between Federal regulations and certain State regulations is the definition of waters regulated by the State. Certain State regulations may include underground waters, while the CWA only regulates surface waters.

C.1. State Environmental Requirements

Crystal River Unit 3 Nuclear Generating Plant (CR-3) is subject to Federal and State requirements for its environmental program. Those requirements are briefly discussed below. Table C-1 lists the principal Federal and State environmental regulations and laws that are applicable to the review of license renewal applications for nuclear power plants.

1 **Table C-1. Federal and State Environmental Requirements**

Law/Regulation	Requirements
	Current Operating License and License Renewal
10 CFR Part 51. *Code of Federal Regulations* (CFR), Title 10, *Energy*, Part 51	“Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.” This part contains environmental protection regulations applicable to NRC’s domestic licensing and related regulatory functions.
10 CFR Part 54	“Requirements for Renewal of Operating Licenses for Nuclear Power Plants.” This part focuses on managing adverse effects of aging rather than noting all aging mechanisms. The rule is intended to ensure that important systems, structures, and components will maintain their intended function during the period of extended operation.
10 CFR Part 50	“Domestic Licensing of Production and Utilization Facilities.” Regulations issued by the NRC under the Atomic Energy Act of 1954, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242), to provide for the licensing of production and utilization facilities. This part also gives notice to all persons who knowingly supply—to any licensee, applicant, contractor, or subcontractor—components, equipment, materials, or other goods or services, that relate to a licensee’s or applicant’s activities subject to this part, that they may be individually subject to NRC enforcement action for violation of § 50.5.
	Air Quality Protection
Clean Air Act (CAA) (42 U.S.C. § 7401 et seq.)	The CAA is a comprehensive Federal law that regulates air emissions. Under the CAA, Federal actions cannot thwart State and local efforts to remedy long-standing air quality problems that threaten public health issues associated with the six criteria air pollutants (i.e., ozone, nitrogen dioxide, sulfur dioxide, particulate matter, carbon monoxide, and lead).
	Water Resources Protection
Clean Water Act (CWA) (33 U.S.C. § 1251 et seq.); Section 403.0885, State of Florida Statutes (FS), Florida Administrative Code (FAC) 62-620 (Wastewater Facility and Activities Permitting)	The NPDES permit is required for plant industrial, sanitary, and stormwater discharges to Crystal Bay. The permit requires the compliance of each point source with authorized discharge levels, monitoring requirements, and other appropriate requirements (e.g., daily flows). The State of Florida permitting program was established in accordance with Section 402 of the CWA, as amended. The Florida Department of Environmental Protection (FDEP) is the responsible State agency for NPDES permitting.
Safe Drinking Water Act (SDWA) (PL 93-523); Section 403.861, FS; FAC 62-550 (Drinking Water Standards, Monitoring and Reporting)	Adopts SDWA Primary and Secondary Drinking Water Standards for public water systems in the State of Florida.
Section 403.861, FS; FAC 62-555 (Permitting, Construction, Operation and Maintenance of Public Water Systems)	Regulates the location and permitting of public water system wells.
Section 403.061, FS; FAC 62-520 (Groundwater Classes, Standards, and Exemptions)	Provides water quality classifications for groundwaters in the State of Florida, including the Upper Floridan aquifer, and establishes water quality criteria and monitoring requirements and exemptions.
Section 373.223, FS; FAC 40E-20 (General Water Use Permit)	Regulates groundwater pumping rates from select site production wells under Water Use Permit No. 2004695.004, issued by the Southwest Florida Water Management District (SFWMD).
Section 403.061, FS; FAC 62-302 (Surface Water Quality Standards)	Provides water quality classification for surface waters in the State of Florida, including Crystal Bay, and establishes water quality criteria for these classifications. Identifies specially protected waters.

Law/Regulation	Requirements
Florida Electrical Power Siting Act, Section 403.511, FS; FAC 62-17 (Electrical Power Plant Siting)	Authorizes Florida Siting Board (part of the FDEP) to issue the Site Certification for generating units at the Crystal River Energy Complex (CREC). Site certification specifies environmental conditions and requirements (e.g., groundwater pumping rates from select site production wells) that must be met by Progress Energy Florida, Inc.
Section 403.0885, FS; FAC 62-620 (Wastewater Facility and Activities Permitting)	Regulates industrial wastewater effluent limitations and monitoring requirements for the percolation ponds system under Industrial Wastewater Facility Permit FLA016960, issued by the FDEP.
Sections 373 and 403, FS; FAC 62-640 (Biosolids)	Regulates the management, use, and land application of biosolids for the Domestic Wastewater Treatment Facility under Domestic Wastewater Facility Permit FLA118753, issued by the FDEP.
Coastal Zone Protection	
Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. § 1451-1464); Section 380, FS Part II (Florida Coastal Management Act of 1978)	Authorizes development of the Florida Coastal Management Program and designates the FDEP as the lead agency. The program is based on existing Florida laws and rules; its objective is to ensure that Federal actions (including non-Federal actions requiring Federal permits) are consistent with the Florida laws that protect and enhance natural, cultural, and economic resources and sustain coastal communities. It authorizes the State to determine the acceptability of Federal actions that affect the State's coastal zone (a process called "Federal consistency"). The FDEP reports this finding for the CREC in the Conditions of Certification.
Waste Management and Pollution Prevention	
Resource Conservation and Recovery Act (RCRA) (42 U.S.C. § 6901 et seq.)	Before a material can be classified as a hazardous waste, it must first be a solid waste as defined under the RCRA. Hazardous waste is classified under Subtitle C of the RCRA. Parts 261 and 262 of 40 CFR contain all applicable generators of hazardous waste regulations. Part 261.5(a) and (e) contains requirements for conditionally exempt small quantity generators (CESQGs). Part 262.34(d) contains requirements for small quantity generators (SQGs). Parts 262 and 261.5(e) contain requirements for large quantity generators (LQGs).
Pollution Prevention Act (42 U.S.C. § 13101 et seq.)	The Pollution Prevention Act formally established a national policy to prevent or reduce pollution at its source whenever possible. The Act supplies funds for State and local pollution prevention programs through a grant program to promote the use of pollution prevention techniques by business.
Endangered Species	
Endangered Species Act (ESA) (16 U.S.C. § 1531 et seq.)	The ESA forbids any government agency, corporation, or citizen from taking (harming or killing) endangered animals without an Endangered Species Permit.
Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.)	To minimize adverse impacts of proposed actions on fish and wildlife resources and habitat, the Fish and Wildlife Coordination Act requires that Federal agencies consult with government agencies regarding activities that affect, control, or modify waters of any stream or bodies of water. It also requires that justifiable means and measures be used in modifying plans to protect fish and wildlife in these waters.
Historic Preservation	
National Historic Preservation Act (NHPA) (16 U.S.C. § 470 et seq.)	The NHPA directs Federal agencies to consider the impact of their actions on historic properties. The NHPA also encourages State and local preservation societies.

U.S.C. = *United States Code*

C.2. Operating Permits and Other Requirements

Table C-2 lists the permits and licenses issued by Federal, State, and local authorities for activities at CR-3.

Table C-2. Licenses and Permits. *Existing environmental authorizations for CR-3 operations.*

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
U.S. Nuclear Regulatory Commission	Atomic Energy Act (42 U.S.C. § 2011, et seq.), 10 CFR Part 50	License to Operate	DPR-72	Issued: 12/03/1976 Expires: 12/03/2016	Operation of CR-3
U.S. Department of Transportation	49 U.S.C. § 5108, 49 CFR Part 107, Subpart G	Registration	060908 551 067Q	Issued: 06/09/2010 Expires: 06/09/2011	Hazardous materials shipments
U.S. Army Corps of Engineers	Section 10 of River and Harbor Act of 1899 (33 U.S.C. § 403)	Permit	SAJ-2008-02893	Issued: 11/12/2008 Expires: 11/12/2013	Maintenance dredging in front of the Gulf intake structure
Florida Department of Environmental Protection	Clean Water Act (33 U.S.C. § 1251 et seq.), Pollution Prevention Act (42 U.S.C. § 13109–13109) FL Rule 62-302.520(1), FAC 62-620, NPDES	NPDES Permit	FL0000159	Issued: 05/09/2005 Expires: 05/08/2010 (See Note 1)	Industrial wastewater discharges to the Gulf of Mexico from Units 1, 2, and 3
Florida Department of Environmental Protection	Clean Water Act (33 U.S.C. § 1251 et seq.), Pollution Prevention Act (42 U.S.C. § 13109-13109), FL Rule 62-302.520(1), FAC 62-620, NPDES	Permit	FLA0169690	Issued: 01/09/2007 Expires: 01/08/2012	Treatment of industrial wastewater by land application system
Florida Department of Environmental Protection	Clean Air Act (42 U.S.C. § 7401 et seq.), FS Chapter 403, FAC 62-4, 62-213, and 62-214	Title V Permit	0170004-015-AV	Issued: 12/28/2009 Expires: 12/31/2014	Title V air operation permit for the CREC
Florida Fish and Wildlife Conservation Commission	FAC 68B-8	Special Activity License	SAL-10-0107-SCR	Issued: 06/25/2010 Expires: 06/24/2011	Harvest of broodstock and release of broodstock and captive-bred marine organisms for stock enhancement mitigation
Florida Department of Aquaculture and Consumer Services	Florida Aquaculture Policy Act, FS Chapter 597	Certificate	AQ0119007	Issued: N/A Expires: 06/30/2011	Aquaculture certification for production of marine fish
Florida Department of Environmental Protection	FAC 62-761 and 62-762	Registration	9103099	Issued: 06/03/2010 Expires: 06/30/2011	Storage tank registration

Agency	Authority	Requirement	Number	Issue or Expiration Date	Activity Covered
Florida Fish and Wildlife Conservation Commission	Migratory Bird Treaty Act 16 U.S.C. § 703–712, FAC 68A	Migratory Bird Nest Permit	LSNR-09-0334	Issued: 08/07/2009 Expires: 12/31/2012	Inactive nest removal
Florida Department of Environmental Protection	Federal Safe Drinking Water Act, FS Chapter 403, Part IV	Wastewater Permit	FLA118753-003-D W3P	Issued: 04/22/2009 Expires: 04/21/2014	Operation of Units 1, 2, and 3 sewage treatment plant
Southwest Florida Water Management District	FS Chapter 373, FAC 40D-2	Water Withdrawal Permit	20004695.004	Issued: 11/26/2007 Expires: 11/26/2017	Groundwater withdrawal for Units 1, 2, and 3
Florida Department of Environmental Protection	Federal Safe Drinking Water Act, FS Chapter 403, Part IV	Wastewater Permit	FLA01909-002-D W4P	Issued: 10/06/2009 Expires: 10/05/2014	Nuclear training center domestic wastewater system
State of Tennessee Department of Environment and Conservation – Division of Radiological Health	Tennessee Department of Environment and Conservation Rule 1200-2-10.32	Tennessee Radioactive Waste License for Delivery	T-FL001-L11	Issued: 01/01/2011 Expires: 12/31/2011	Transportation of radioactive waste into the State of Tennessee
Utah Department of Environmental Quality – Division of Radiation Control	Utah Radiation Control Rule R313-26	Generator Site Access Permit	0109000004	Issued: 07/16/2010 Expires: 07/16/2011	Grants access to a land disposal facility in the State of Utah

Note 1: Application submitted November 2009. There is an administrative extension of the existing permit until permit negotiations are complete and a final permit is issued. Negotiations are underway concerning permit conditions relative to present and planned future status of plants.

Sources: Progress Energy, 2010; Progress Energy, 2011

C.3. References

Progress Energy (Progress Energy Florida, Inc.). 2010. E-mail from Louise England Transmitting List of Expiration Dates for Permits Associated with Crystal River Unit 3, Agencywide Documents Access and Management System (ADAMS) Accession No. ML101390134.

Progress Energy (Progress Energy Florida, Inc.). 2011. E-mail from Mike Heath Transmitting List of Expiration Dates for Permits Associated with Crystal River Unit 3, ADAMS Accession No. ML110620143.

APPENDIX D.
CONSULTATION CORRESPONDENCE

D. CONSULTATION CORRESPONDENCE

The Endangered Species Act of 1973, as amended; the Magnuson-Stevens Fisheries Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 require that Federal agencies consult with applicable State and Federal agencies and groups prior to taking action that may affect threatened and endangered species, essential fish habitat, or historic and archaeological resources, respectively. This appendix contains the consultation documentation.

Table D-1. Consultation Correspondence. *This is a list of the consultation documents sent between the U.S. Nuclear Regulatory Commission (NRC) and other agencies and groups as required by the Acts mentioned above.*

Author	Recipient	Date of Letter/E-mail
U.S. Nuclear Regulatory Commission (D. Wrona)	State Historic Preservation Office (F. Gaske)	April 10, 2009 (ML090560140)
U.S. Nuclear Regulatory Commission (D. Wrona)	Seminole Indian Tribe (M. Cypress)	April 13, 2009 (ML090490749)
U.S. Nuclear Regulatory Commission (D. Wrona)	Seminole Nation of Oklahoma (E. Haney)	April 13, 2009 (ML090550244)
U.S. Nuclear Regulatory Commission (D. Wrona)	U.S. Fish and Wildlife Service, Southeast Regional Office (S. Hamilton)	April 13, 2009 (ML090400392)
U.S. Nuclear Regulatory Commission (D. Wrona)	Crystal River Refuge Manager (J. Kraus)	April 13, 2009 (ML090560584)
U.S. Nuclear Regulatory Commission (D. Wrona)	National Marine Fisheries Service, Southeast Region (R. Crabtree)	April 13, 2009 (ML090360156)
U.S. Nuclear Regulatory Commission (D. Wrona)	Miccosukee Tribe of Florida (B. Cypress)	April 13, 2009 (ML090570401)
National Marine Fisheries Service, Southeast Region (T. Mincey)	U.S. Nuclear Regulatory Commission (D. Wrona)	April 20, 2009 (ML091460262)
State Historic Preservation Office (F. Gaske)	U.S. Nuclear Regulatory Commission (D. Wrona)	May 4, 2009 (ML091460261)
National Marine Fisheries Service, Southeast Region (M. Croom)	U.S. Nuclear Regulatory Commission (D. Wrona)	May 4, 2009 (ML091460257)
U.S. Nuclear Regulatory Commission (D. Wrona)	Florida Department of Environmental Protection (D. Getzoff)	June 8, 2009 (ML091490526)
U.S. Nuclear Regulatory Commission (D. Wrona)	Florida Natural Areas Inventory (G. Knight)	June 8, 2009 (ML091540745)
U.S. Nuclear Regulatory Commission (D. Wrona)	Florida Fish and Wildlife Conservation Commission (R. Trindell)	June 8, 2009 (ML091540774)

Author	Recipient	Date of Letter/E-mail
U.S. Nuclear Regulatory Commission (D. Wrona)	Florida Fish and Wildlife Conservation Commission (K. Frohlich)	June 8, 2009 (ML091540774)
U.S. Nuclear Regulatory Commission (D. Wrona)	Advisory Council on Historic Preservation (R. Nelson)	June 10, 2009 (ML090420362)
Florida Fish and Wildlife Conservation Commission (M. Poole)	U.S. Nuclear Regulatory Commission (D. Wrona)	July 22, 2009 (ML092170380)

D.1. Consultation Correspondence

The following pages contain copies of the letters listed in Table D-1.

April 10, 2009

Mr. Frederick Gaske, SHPO & Division Director
State Historic Preservation Officer
Division of Historical Resources, Department of State
500 South Bronough Street
Room 305
Tallahassee, FL 32399-0250

SUBJECT: CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW (SHPO NO. LRP08-0040)

Dear Mr. Gaske:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating license for Crystal River Unit 3 Nuclear Generating Plant, which is located 35 miles southwest of Ocala, Florida. CR-3 is operated by Florida Power Company. The application for renewal was submitted by Florida Power Company in a letter dated December 16, 2008, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54).

The NRC has established that, as part of the staff's review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants", NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8(c), the SEIS will include analyses of potential impacts to historic and cultural resources.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for a license renewal action is the area at the power plant site and its immediate environs that may be impacted by post-license renewal land-disturbing operations or projected refurbishment activities associated with the proposed action. The APE may extend beyond the immediate environs in those instances where post-license renewal land-disturbing operations or projected refurbishment activities specifically related to license renewal may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

On April 16, 2009, the NRC will hold two public license renewal and environmental scoping meetings at The Plantation Inn, 9301 W Fort Island Trail, Crystal River, FL 34429. The first meeting will convene at 2:00 p.m. and will continue until 5:00 p.m., as necessary. The second meeting will convene at 7:00 p.m., with a repeat of the overview portions of the first meeting and continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session. Once the draft SEIS is completed, your office will receive a copy of the draft SEIS along with a request for comments.

F. Gaske - 2 -

If you have any questions or require additional information, please contact Elaine Keegan, Project Manager, by phone at 301-415-8517 or by email at elaine.keegan@nrc.gov.

Sincerely,

\RA Robert Kuntz for

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

cc: See next page

April 13, 2009

The Honorable Mitchell Cypress, Chairman
Seminole Indian Tribe
6300 Stirling Road
Hollywood, FL 33024

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Cypress:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Florida Power Corporation for the renewal of the operating license for the Crystal River Unit 3 Nuclear Generating Plant (CR-3), located 35 miles southwest of Ocala, Florida. CR-3 is in close proximity to lands that may be of interest to the Seminole Tribe of Florida. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(b) (10 CFR 51.28(b)), the NRC invites the Seminole Tribe of Florida to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966, through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years, if NRC requirements are met. The current operating license for CR-3 will expire on December 3, 2016. Florida Power Corporation submitted its application for renewal of the CR-3 operating license in a letter dated December 16, 2008.

The NRC is gathering information for a CR-3 site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the CR-3 site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action. Provided for your information is the Crystal River Site Layout (Enclosure 1) and Transmission Line Map (Enclosure 2).

Mr. Cypress - 2 -

To accommodate interested members of the public, the NRC will hold two public scoping meetings for the CR-3 license renewal supplement to the GEIS at the Plantation Inn, 9301 W Fort Island Trail, Crystal River, FL 34429, on April 16, 2009. There will be two sessions to accommodate interested parties. The first session will convene at 2:00 p.m. and will continue until 5:00 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The license renewal application (LRA) and the GEIS are publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agency wide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://adamswebsearch.nrc.gov/dologin.htm. The accession number for the LRA is, ML090080053. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr.resource@nrc.gov.

The CR-3 LRA is also available on the Internet at www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal-river.html. In addition, the Coastal Regional Library, located at 8619 W. Crystal St., Crystal River, FL 34428-4468, has agreed to make the LRA available for public inspection.

The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the Seminole Tribe of Florida may have to offer on the scope of the environmental review by June 6, 2009. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001. Electronic comments may be submitted to the NRC by e-mail at CrystalRiverEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

The NRC will publish a draft Supplement to the GEIS. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplement to the GEIS. A copy of the draft supplement to the GEIS will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS.

If you need additional information regarding the environmental review process, please contact Elaine Keegan, Project Manager, at 301-415-8517 or at elaine.keegan@nrc.gov.

Sincerely,

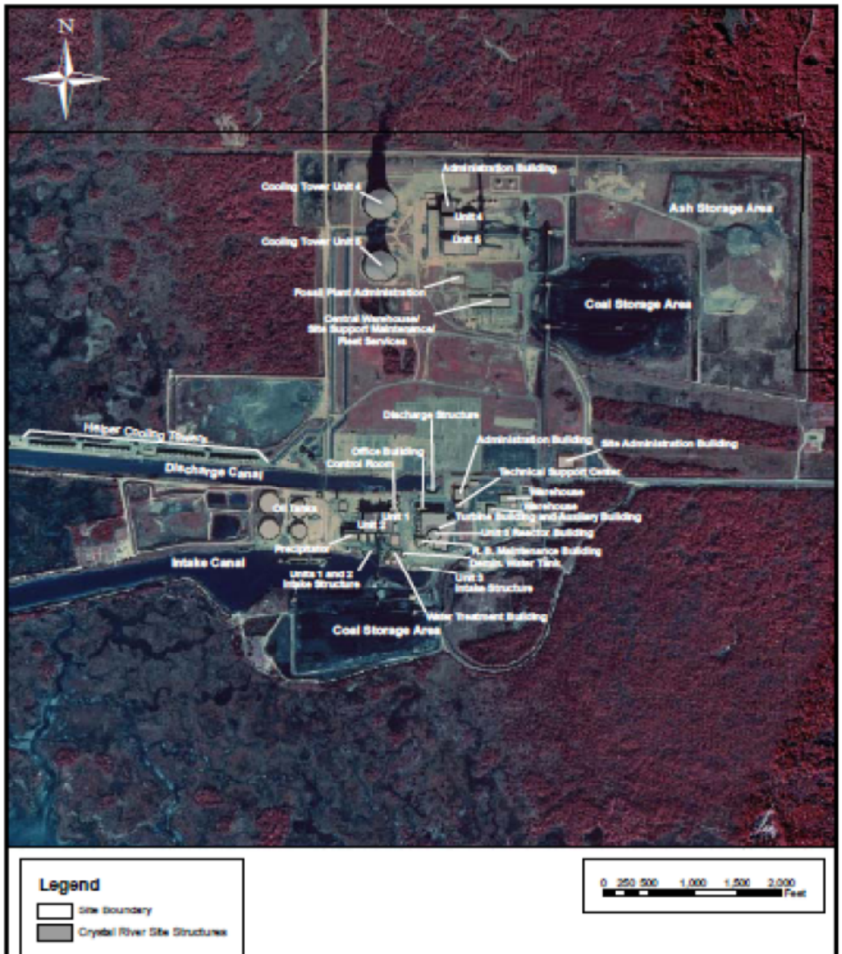
\RA Lisa Regner for

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Site Layout
2. Transmission Line Map

cc w/encls: See next page

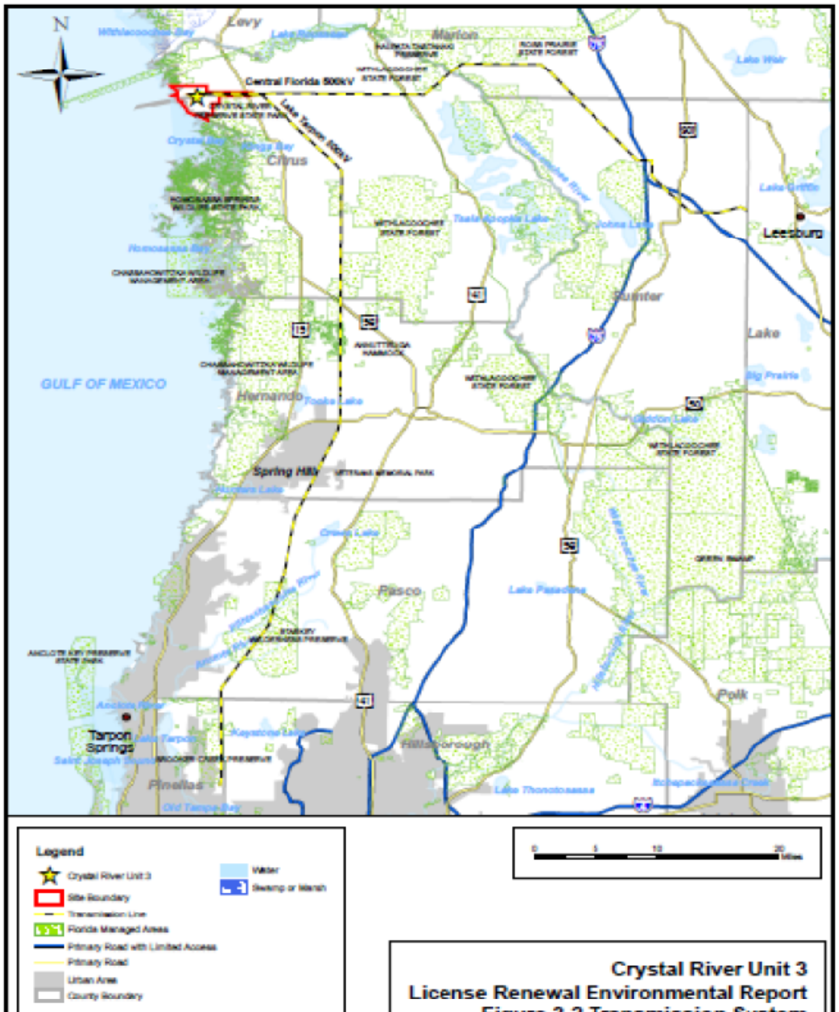


Crystal River Unit 3
License Renewal Environmental Report
Figure 3-1 Crystal River Site Layout

ENCLOSURE 1

1

Crystal River Unit 3
License Renewal Application | Environmental Report



Crystal River Unit 3
License Renewal Environmental Report
Figure 3-2 Transmission System

Proposed Action | Page 3-15

ENCLOSURE 2

April 13, 2009

Enoch Kelly Haney, Principal Chief
Seminole Nation of Oklahoma
P.O. Box 1498
Wewoka, OK 74884

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Haney:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Florida Power Corporation for the renewal of the operating license for the Crystal River Unit 3 Nuclear Generating Plant (CR-3), located 35 miles southwest of Ocala, Florida. CR-3 is in close proximity to lands that may be of interest to the Seminole Tribe of Florida. As described below, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(b) (10 CFR 51.28(b)), the NRC invites the Seminole Nation of Oklahoma to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966, through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years, if NRC requirements are met. The current operating license for CR-3 will expire on December 3, 2016. Florida Power Corporation submitted its application for renewal of the CR-3 operating license in a letter dated December 16, 2008.

The NRC is gathering information for a CR-3 site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the CR-3 site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action. Provided for your information is the Transmission Line Map (Enclosure 1) and Crystal River Site Layout (Enclosure 2).

E. Haney - 2 -

To accommodate interested members of the public, the NRC will hold two public scoping meetings for the CR-3 license renewal on April 16, 2009, at the Plantation Inn, 9301 W Fort Island Trail, Crystal River, FL 34429. There will be two sessions to accommodate interested parties. The first session will convene at 2:00 p.m. and will continue until 5:00 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The license renewal application (LRA) and the GEIS are publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, MD 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://adamswebsearch.nrc.gov/dologin.htm. The accession number for the LRA is ML090808053. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr.resource@nrc.gov.

The CR-3 LRA is also available on the Internet at www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal-river.html. In addition, the Coastal Regional Library, located at 8619 W. Crystal St., Crystal River, FL 34428-4468, has agreed to make the LRA available for public inspection.

The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the Seminole Tribe of Florida may have to offer on the scope of the environmental review by June 6, 2009. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at CrystalRiverEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

The NRC will publish a draft supplement to the GEIS. Once the draft supplement to the GEIS is completed, a copy will be sent to you for your review and comment. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplement to the GEIS. After consideration of public comments received on the draft, the NRC will prepare a final supplement to the GEIS, currently scheduled to be issued in October of 2010.

If you need additional information regarding the environmental review process, please contact Elaine Keegan, Project Manager, at 301-415-8517 or at elaine.keegan@nrc.gov.

Sincerely,

\RA Lisa Regner for

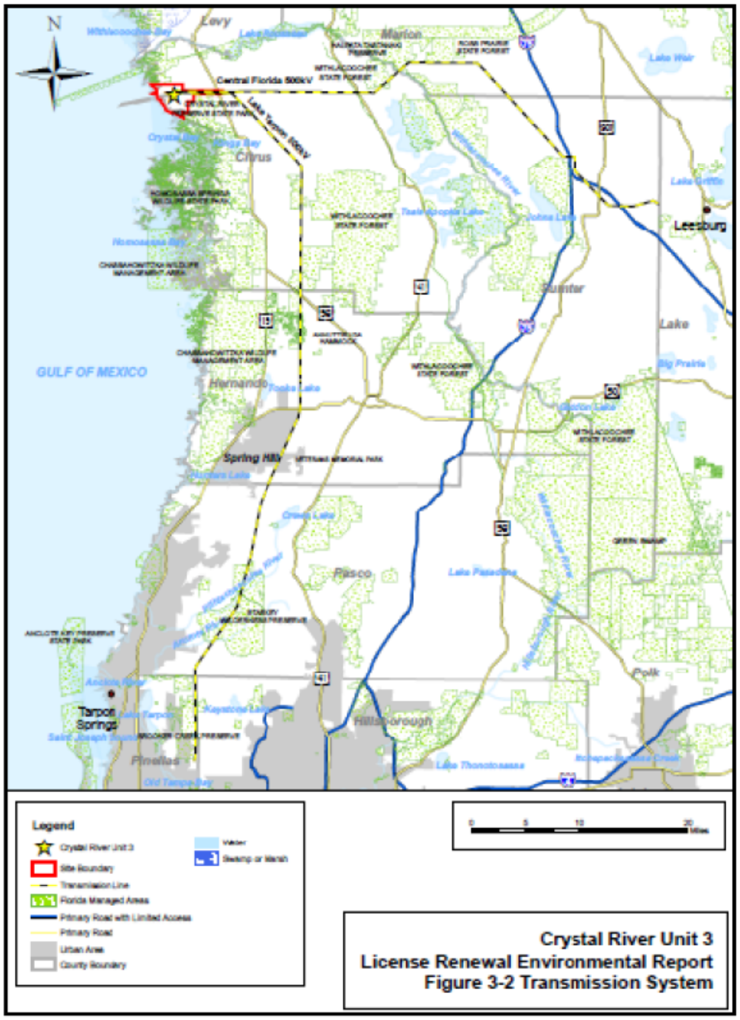
David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Site Layout
2. Transmission Line Map

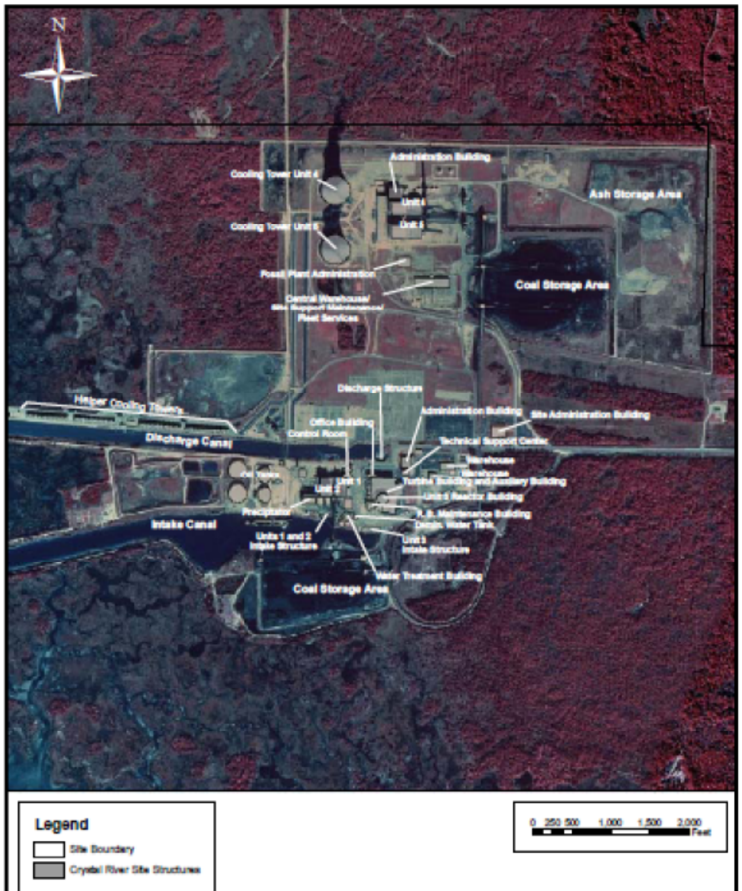
cc w/encls: See next page

Crystal River Unit 3
License Renewal Application
Environmental Report



Proposed Action
Page 3-15

ENCLOSURE 1



Crystal River Unit 3
License Renewal Environmental Report
Figure 3-1 Crystal River Site Layout

ENCLOSURE 2

1

April 13, 2009

Mr. Sam D. Hamilton, Regional Director
Southeast Regional Office
U.S. Fish and Wildlife Service
1875 Century Blvd. NE, Suite 400
Atlanta, GA 30345

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Hamilton:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by Florida Power Corporation for the renewal of the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3). CR-3 is located 35 miles southwest of Ocala, Florida. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action is to renew the facility operating licenses for CR-3 for an additional 20 years beyond the expiration of the current operating license. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The Crystal River site is on Crystal Bay, a shallow embayment of the Gulf of Mexico. The CR-3 site covers approximately 4,738 acres, of which approximately 1,062 acres is industrial. The area surrounding CR-3 is characterized by approximately 3,676 acres consisting of four natural habitat types: salt marsh, hardwood hammock forest, pineland, and freshwater swamp.

The cooling water intake structure for CR-3 is located approximately 400 feet east of the intake for Units 1 and 2 (Enclosure1), which are fossil fuel generating units. A chain link fence extends across the entire width of the intake canal downstream of the intakes for Units 1 and 2. It is intended to intercept floating and partially submerged debris and restrict access to the Unit 3 intake. The Unit 3 intake is 118 feet across and fitted with external trash racks with 4-inch openings between bars. There are four pump bays, each with conventional traveling screens with 3/8-inch mesh. The screens are rotated and washed every 8 hours. Material from the traveling screens is washed onto a trough and sluiced to a sump adjacent to the intake canal. CR-3 uses four circulating water pumps. The discharge from the once-through cooling systems of Units 1, 2, and 3 is used as cooling tower makeup for Units 4 and 5, which are fossil fuel generating units.

1

The Final Environmental Statement (Atomic Energy Commission, 1973) identifies two 500-kilovolt transmission lines that were built to connect CR-3 to the electric grid: (1) the Central Florida line terminating at the central Florida Substation and (2) the Lake Tarpon line terminating at the Lake Tarpon Substation. The lines are contained in a common corridor for the first 5.3 miles of corridor, then diverge, with the Central Florida line continuing east and the Lake Tarpon line angling southeast, continuing directly south, and turning southwest toward Tarpon Springs (Enclosure 2). The transmission corridors of interest are approximately 134 miles long and occupy approximately 2,440 acres. Both lines are owned and operated by Florida Power Corporation. The corridors pass through low population areas that are primarily forest and agricultural land (Environmental Protection Agency, 1994). The lines cross numerous state and U.S. highways and the Withlacoochee, Pithlachascotee, and Anclote rivers. Corridors that pass through agricultural land generally continue to be used as such. Florida Power Corporation plans to maintain these transmission lines, which are integral to the larger transmission system, indefinitely. These transmission lines will remain a permanent part of the transmission system after CR-3 is decommissioned.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on Federally-listed, proposed, and candidate species and critical habitat that may be in the vicinity of CR-3 and its associated transmission line rights-of-way. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

The NRC staff will hold two public license renewal and environmental scoping meetings on April 16, 2009, at the Plantation Inn, 9301 W Fort Island Trail, Crystal River, FL 34429. The first meeting will convene at 2:00 p.m. and will continue until 5:00 p.m., as necessary. The second meeting will convene at 7:00 p.m., with a repeat of the overview portions of the first meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session. You and your staff are invited to attend both the public meetings and the site audit. Once the draft SEIS is completed, your office will receive a copy along with a request for comments.

The CR-3 LRA is available on the internet at http://www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal/crystal-lra.pdf. If you have any questions concerning the NRC staff's review of this license renewal application, please contact Elaine Keegan, Project Manager, at 301-415-8517 or by e-mail at elaine.keegan@nrc.gov.

Sincerely,

\RA Lisa Regner for

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Transmission System
2. Crystal River Site Layout

cc w/encls.: See next page

Legend

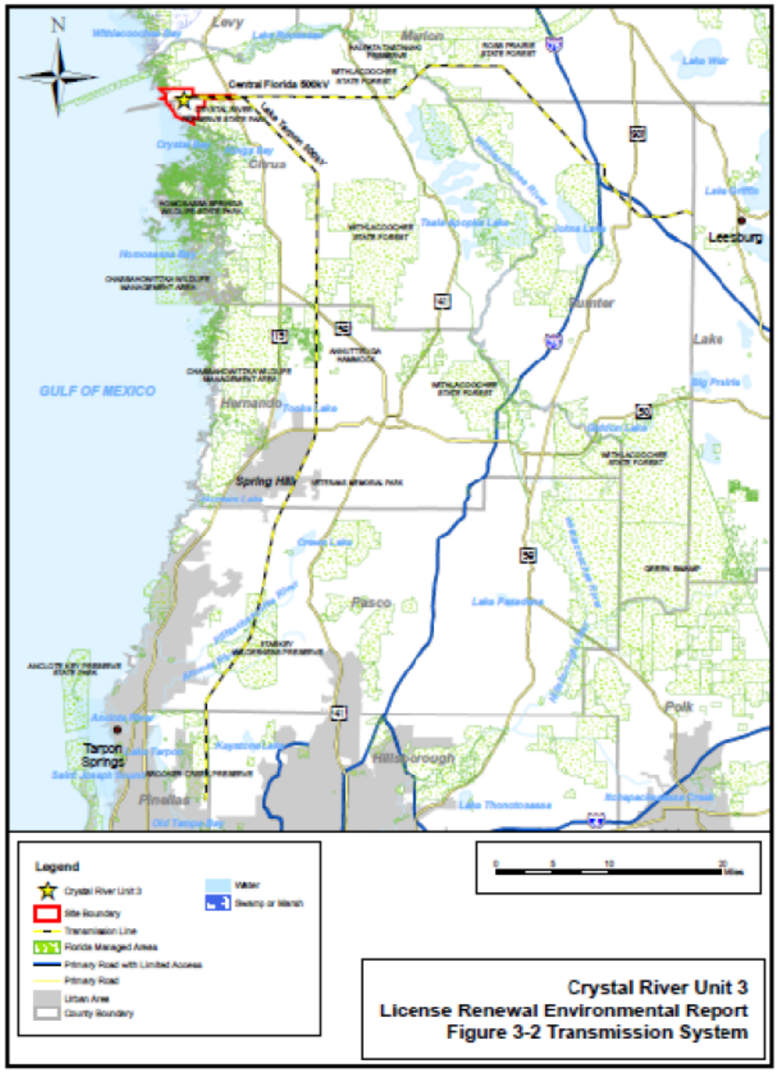
Site Boundary

Crystal River Site Structures

0 250 500 1,000 1,500 2,000 Feet

Crystal River Unit 3
License Renewal Environmental Report
Figure 3-1 Crystal River Site Layout

ENCLOSURE 1



Crystal River Unit 3
License Renewal Environmental Report
Figure 3-2 Transmission System

ENCLOSURE 2

1

April 13, 2009

Mr. James Kraus
Refuge Manager
502 S.E. Kings Bay Drive
Crystal River, FL 34429

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Kraus:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by Florida Power Corporation for the renewal of the operating license for Crystal River Unit 3 (CR-3). CR-3 is located 35 miles southwest of Ocala, Florida. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

The proposed action is to renew the facility operating licenses for CR-3 for an additional 20 years beyond the expiration of the current operating license. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The CR-3 site covers approximately 4,738 acres, of which approximately 1,062 acres is industrial. The area surrounding CR-3 is characterized by approximately 3,676 acres consisting of four natural habitat types: salt marsh, hardwood hammock forest, pineland, and freshwater swamp.

CR-3 is equipped with a once-through open-cycle cooling system that withdraws cooling water from and discharges back into the intake canal. The intake system includes four pump bays with conventional traveling screens. The screens are rotated and washed every 8 hours. Material from the traveling screens is washed onto a trough and sluiced to a sump adjacent to the intake canal. CR-3 uses four circulating water pumps. The discharge from the once-through cooling systems of Units 1, 2, and 3 is used as cooling tower makeup for Units 4 and 5. Units 1, 2, 4, and 5 are fossil fuel generating units.

The Final Environmental Statement (Atomic Energy Commission, 1973) identifies two 500-kilovolt transmission lines that were built to connect CR-3 to the electric grid: (1) the Central Florida line terminating at the central Florida Substation and (2) the Lake Tarpon line terminating at the Lake Tarpon Substation. The lines are contained in a common corridor for the first 5.3 miles of corridor, then diverge, with the Central Florida line continuing east and the Lake Tarpon line angling southeast, continuing directly south, and turning southwest toward Tarpon Springs (Enclosure 1). The transmission corridors of interest are approximately

134 miles long and occupy approximately 2,440 acres. Both lines are owned and operated by Progress Energy. The corridors pass through low population areas that are primarily forest and agricultural land (Environmental Protection Agency, 1994). The lines cross numerous state and U.S. highways and the Withlacoochee, Pithlachascotee, and Anclote rivers. Corridors that pass through agricultural land generally continue to be used as such. Progress Energy plans to maintain these transmission lines, which are integral to the larger transmission system, indefinitely. These transmission lines will remain a permanent part of the transmission system after CR-3 is decommissioned.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on Federally-listed, proposed, and candidate species and critical habitat that may be in the vicinity of CR-3 and its associated transmission line rights-of-way. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

The NRC staff will hold two public license renewal and environmental scoping meetings on April 16, 2009, at the Plantation Inn, 9301 W Fort Island Trail, Crystal River, FL 34429. The first meeting will convene at 2:00 p.m. and will continue until 5:00 p.m., as necessary. The second meeting will convene at 7:00 p.m., with a repeat of the overview portions of the first meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of the session. Once the draft SEIS is completed, your office will receive a copy of the draft SEIS along with a request for comments.

The CR-3 LRA is available on the internet at http://www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal/crystal-lra.pdf. If you have any questions concerning the NRC staff's review of this license renewal application, please contact Elaine Keegan, Project Manager, at 301-415-8517 or elaine.keegan@nrc.gov.

Sincerely,

***\RA Lisa Regner for ***

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

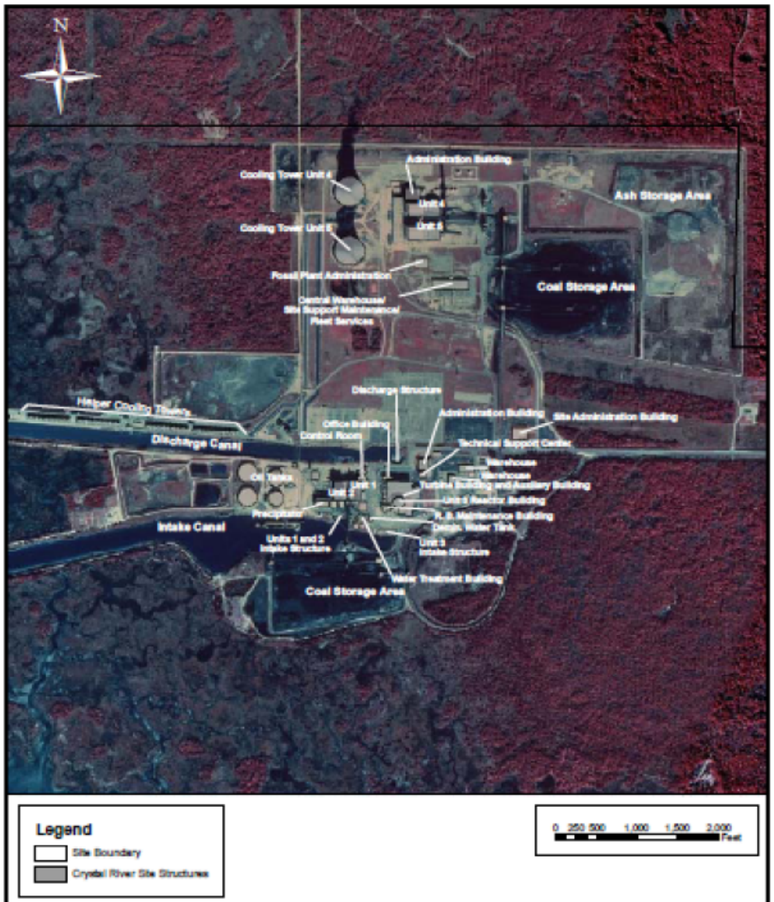
Docket No. 50-302

Enclosures:
1. Transmission System
2. Crystal River Site Layout

cc w/encls: See next page

Crystal River Unit 3
License Renewal Application

Environmental Report



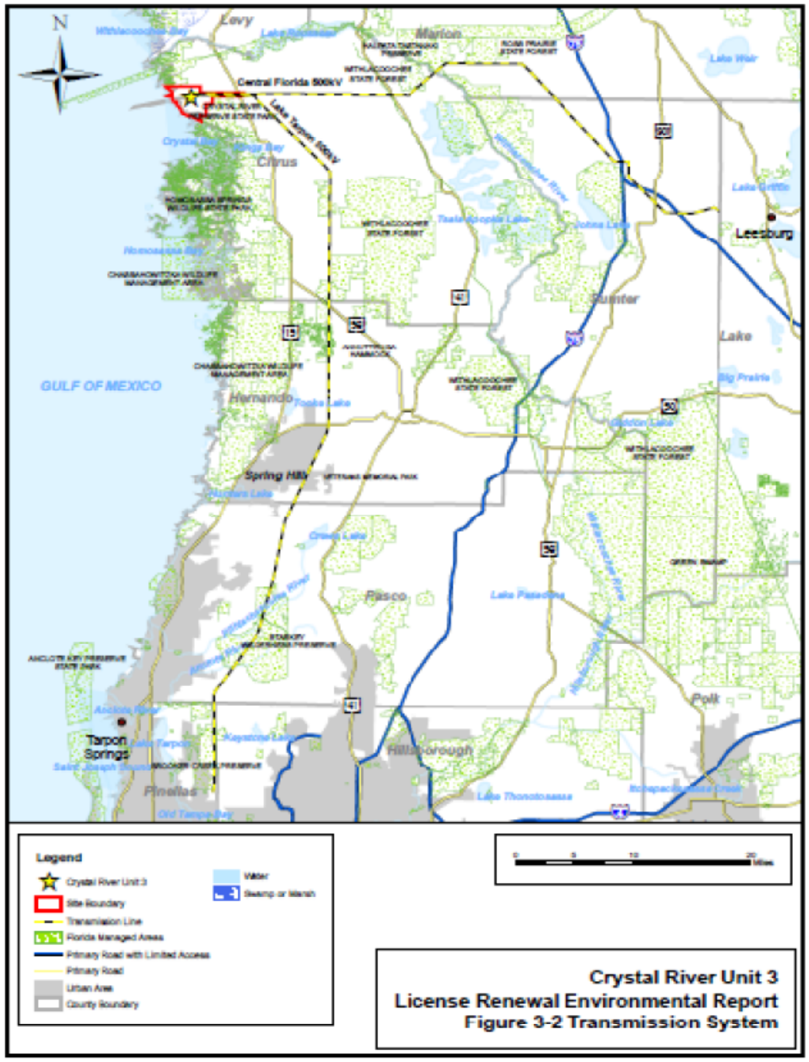
Crystal River Unit 3
License Renewal Environmental Report
Figure 3-1 Crystal River Site Layout

Proposed Action

Page 3-14

ENCLOSURE 1

1



Crystal River Unit 3
License Renewal Environmental Report
Figure 3-2 Transmission System

ENCLOSURE 2

April 13, 2009

Dr. Roy E. Crabtree
Regional Administrator
Southeast Region
National Marine Fisheries Service
263 13th Avenue, South
St. Petersburg, FL 33701

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES AND ESSENTIAL FISH HABITAT WITHIN THE AREA UNDER EVALUATION FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Dr. Crabtree:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by Florida Power Corporation for the renewal of the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3). CR-3 is located 35 miles southwest of Ocala, Florida. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to marine resources and habitat. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended, and the Sustainable Fisheries Act of 1996.

The proposed action is to renew the facility operating license for CR-3 for an additional 20 years beyond the expiration of the current operating license. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The Crystal River site covers approximately 4,738 acres, of which approximately 1,062 acres is industrial. The area surrounding the site is characterized by approximately 3,676 acres consisting of four natural habitat types: salt marsh, hardwood hammock forest, pineland, and freshwater swamp.

CR-3 is equipped with a once-through open-cycle cooling system that withdraws cooling water from and discharges back into the intake canal. The intake system includes four pump bays with conventional traveling screens. The screens are rotated and washed every 8 hours. Material from the screens is washed onto a trough and sluiced to a sump adjacent to the intake canal. CR-3 uses four circulating water pumps. The discharge from the once-through cooling systems of Units 1, 2, 3 is used as cooling tower makeup for Units 4 and 5. Units 1, 2, 4, and 5 are fossil fuel generating units.

The Final Environmental Statement (Atomic Energy Commission, 1973) identifies two 500-kilovolt transmission lines that were built to connect CR-3 to the electric grid: (1) the Central Florida line terminating at the central Florida Substation and (2) the Lake Tarpon line terminating at the Lake Tarpon Substation. The lines are contained in a common corridor for the first 5.3 miles of corridor, then diverge, with the Central Florida line continuing east and the Lake Tarpon line angling southeast, continuing directly south, and turning southwest toward Tarpon Springs. The transmission corridors of interest are approximately 134 miles long and occupy approximately 2,440 acres. Both lines are owned and operated by Progress Energy. The corridors pass through low population areas that are primarily forest and agricultural land (Environmental Protection Agency, 1994). The lines cross numerous state and U.S. highways and the Withlacoochee, Pithlachascotee, and Anclote rivers. Corridors that pass through agricultural land generally continue to be used as such. Florida Power Corporation plans to maintain these transmission lines, which are integral to the larger transmission system, indefinitely. These transmission lines will remain a permanent part of the transmission system after CR-3 is decommissioned.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on Federally-listed, proposed, and candidate species and critical habitat that may be in the vicinity of the Crystal River site. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. Also in support of the SEIS preparation and to ensure compliance with Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, the NRC requests a list of essential fish habitat that has been designated in the vicinity of the Crystal River site.

On April 16, 2009, the NRC staff will hold two public license renewal and environmental scoping meetings at the Plantation Inn, 9301 W Fort Island Trail, Crystal River, FL 34429. The first session will convene at 2:00 p.m. and will continue until 5:00 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of the session. Once the draft SEIS is completed, your office will receive a copy of the draft SEIS along with a request for comments.

R. Crabtree - 3 -

The CR-3 LRA is available on the internet at http://www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal/crystal-lra.pdf. If you have any questions concerning the NRC staff review of this LRA, please contact Elaine Keegan, Project Manager at 301-415-8517 or by e-mail at elaine.keegan@nrc.gov.

Sincerely,

***\RA Lisa Regner for ***

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Transmission System
2. Crystal River Site layout

cc w/encls: See next page

April 13, 2009

The Honorable Billy Cypress, Chairman
Miccosukee Tribe of Florida
P.O. Box 440021
Tamiami Station
Miami, FL 33144

SUBJECT: REQUEST FOR COMMENTS CONCERNING THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Cypress:

The U.S. Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of an application from Florida Power Corporation for the renewal of the operating license for the Crystal River Unit 3 Nuclear Generating Station (CR-3), located 35 miles southwest of Ocala, Florida. CR-3 is in close proximity to lands that may be of interest to the Miccosukee Tribe of Florida. As described, the NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(b) (10 CFR 51.28(b)), the NRC invites the Miccosukee Tribe of Florida to provide input to the scoping process relating to the NRC's environmental review of the application. In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966, through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years, if NRC requirements are met. The current operating license for CR-3 will expire on December 3, 2016. Florida Power Corporation submitted its application for renewal of the CR-3 operating license in a letter dated December 16, 2008.

The NRC is gathering information for a CR-3 site-specific supplement to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the CR-3 site related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action. Provided for your information is the Crystal River Site Layout (Enclosure 1) and Transmission Line Map (Enclosure 2)

To accommodate interested members of the public, the NRC will hold two public scoping meetings for the CR-3 license renewal supplement to the GEIS at the Plantation Inn, 9301 W Fort Island Trail, Crystal River, FL 34429 on April 16, 2009. There will be two sessions to accommodate interested parties. The first session will convene at 2:00 p.m. and will continue until 5:00 p.m., as necessary. The second session will convene at 7:00 p.m., with a repeat of the overview portions of the meeting, and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The license renewal application (LRA) and the GEIS are publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://adamswebsearch.nrc.gov/dologin.htm. The ADAMS accession number for the LRA is ML090080053. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr.resource@nrc.gov.

The CR-3 LRA is also available on the Internet at www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal-river.html. In addition, the Coastal Regional Library, located at 8619 W. Crystal St., Crystal River, FL 34428-4468, has agreed to make the LRA available for public inspection.

The GEIS, which documents the NRC's assessment of the scope and impact of environmental effects that would be associated with license renewal at any nuclear power plant site, can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that the Miccosukee Tribe of Florida may have to offer on the scope of the environmental review by June 6, 2009. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001. Electronic comments may be submitted to the NRC by e-mail at CrystalRiverEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplemental environmental impact statement (SEIS). Once the draft SEIS is complete, a copy will be sent to you for your review and comment. After consideration of public comments received on the draft, the NRC will prepare a final SEIS. The issuance of a final SEIS for CR-3 is planned for October 29, 2010.

If you need additional information regarding the environmental review process, please contact Elaine Keegan, Project Manager, at 301-415-8517 or at elaine.keegan@nrc.gov.

Sincerely,

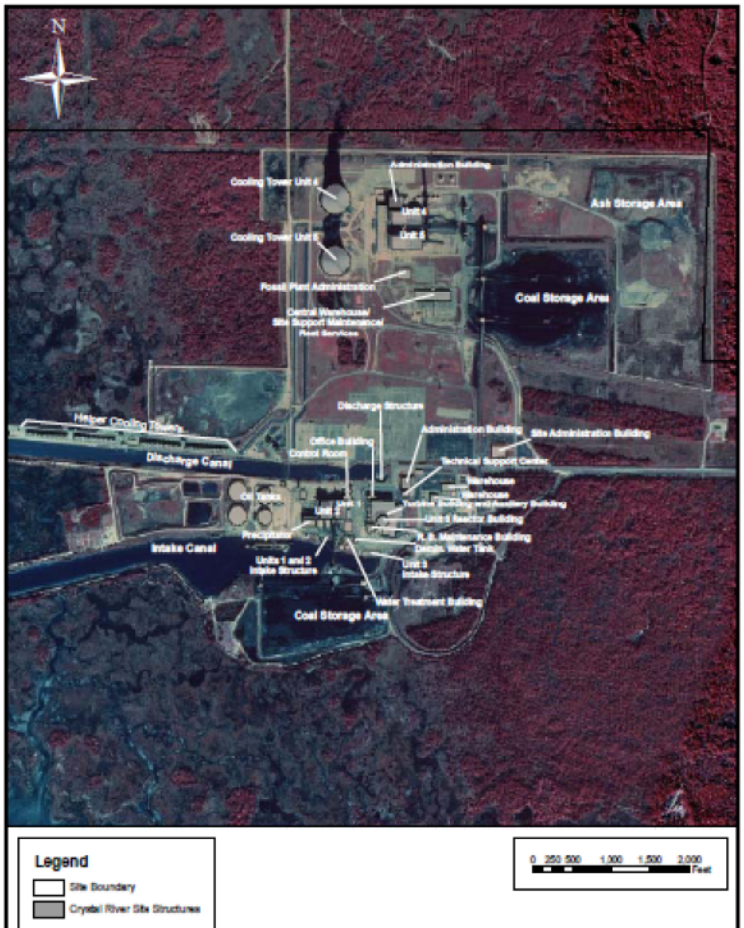
\RA Lisa Regner for

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Site Layout
2. Transmission Line Map

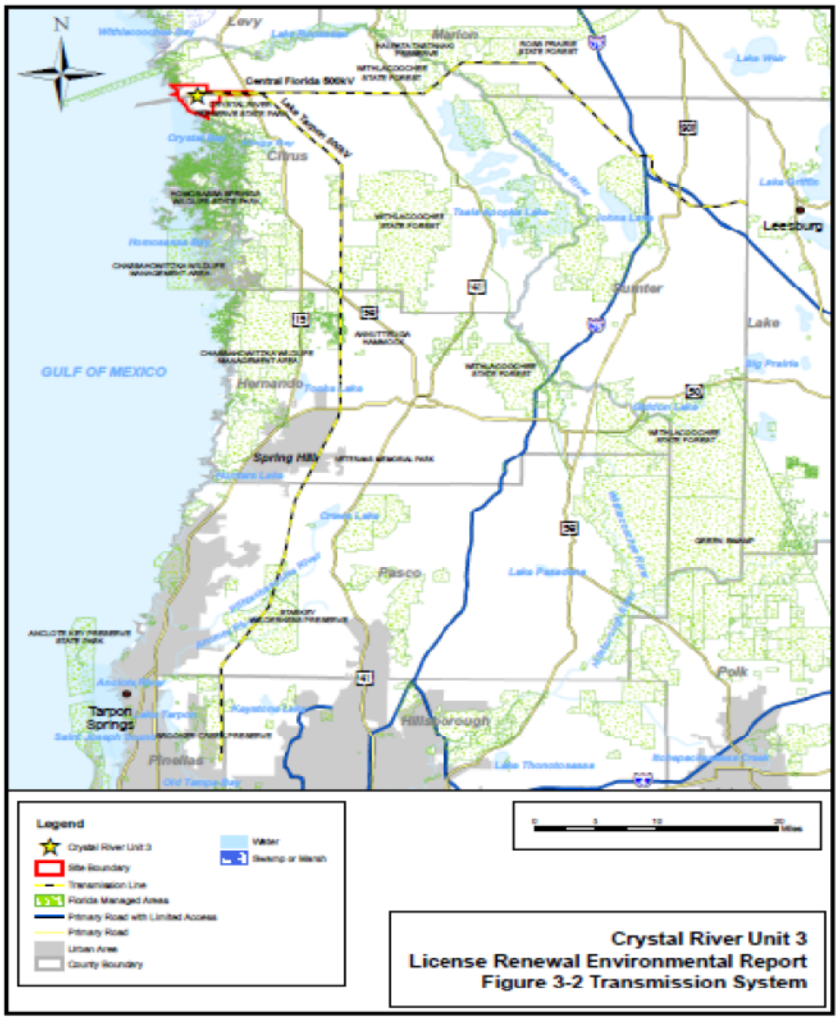
cc w/encls: See next page



Crystal River Unit 3
License Renewal Environmental Report
Figure 3-1 Crystal River Site Layout

ENCLOSURE 1

Crystal River Unit 3
License Renewal Application — Environmental Report



Crystal River Unit 3
License Renewal Environmental Report
Figure 3-2 Transmission System

Proposed Action — Page 3-15

ENCLOSURE 2

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701-5505
(727) 824-5312, FAX (727) 824-5309
http://sero.nmfs.noaa.gov

F/SER3:TM

APR 20 2009

Mr. David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Wrona:

This responds to the Nuclear Regulatory Commission's (NCR) letter dated April 13, 2009, regarding the proposed renewal of Florida Power Corporation's operating license for Crystal River Unit 3 Nuclear Power Plant located 35 miles southwest of Ocala, Florida.

As requested, enclosed is a list of species protected by the Endangered Species Act (ESA) and under the jurisdiction of the National Marine Fisheries Service for the state of Florida.

We look forward to continued cooperation with the NRC in conserving our endangered and threatened resources. If you have any questions regarding the ESA consultation process, please contact Mr. Eric Hawk, fishery biologist, at (727) 824-5312, or by e-mail at Eric.Hawk@noaa.gov.

Sincerely,

Teletha Mincey
Program Analyst
Protected Resources Division

Enclosure

File: 1514-22.M
Ref: T/SER/2009/01925

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Endangered and Threatened Species and Critical Habitats
under the Jurisdiction of the NOAA Fisheries Service

Florida-Gulf

Listed Species	Scientific Name	Status	Date Listed
Marine Mammals			
blue whale	*Balaenoptera musculus*	Endangered	12/02/70
finback whale	*Balaenoptera physalus*	Endangered	12/02/70
humpback whale	*Megaptera novaeangliae*	Endangered	12/02/70
sei whale	*Balaenoptera borealis*	Endangered	12/02/70
sperm whale	*Physeter macrocephalus*	Endangered	12/02/70
Turtles			
green sea turtle	*Chelonia mydas*	Threatened[1]	07/28/78
hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	06/02/70
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	12/02/70
leatherback sea turtle	*Dermochelys coriacea*	Endangered	06/02/70
loggerhead sea turtle	*Caretta caretta*	Threatened	07/28/78
Fish			
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	Threatened	09/30/91
smalltooth sawfish	*Pristis pectinata*	Endangered	04/01/03
Invertebrates			
elkhorn coral	*Acropora palmata*	Threatened	5/9/06
staghorn coral	*Acropora cervicornis*	Threatened	5/9/06

Designated Critical Habitat
Gulf Sturgeon: A final rule designating Gulf sturgeon critical habitat was published on March 19, 2003 (68 FR 13370) and 14 geographic areas (units) among the Gulf of Mexico Rivers and tributaries were identified. Maps and details regarding the final rule can be found at alabama.fws.gov/gs

Elkhorn and Staghorn Corals: All waters in the depths of 98 ft (30 m) and shallower to the mean low water line surrounding the Dry Tortugas, Florida. Within these specific areas, the essential feature consists of natural consolidated hard substrate or dead coral skeleton that are free from fleshy or turf macroalgae cover and sediment cover. Maps and details regarding coral critical habitat can be found at: http://sero.nmfs.noaa.gov/pr/esa/acropora.htm

[1] Green turtles are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific Coast of Mexico, which are listed as endangered.

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Florida-Gulf

Proposed Critical Habitat
Smalltooth Sawfish: A proposed rule to designate smalltooth sawfish critical habitat was published on November 20, 2008 (73 FR 70290). Proposed critical habitat consists of two coastal habitat units: the Charlotte Harbor Estuary Unit and the Ten Thousand Islands/Everglades Unit. Maps and details regarding the proposed critical habitat rule can be found at: http://sero.nmfs.noaa.gov/pr/SmalltoothSawfish.htm

Species Proposed for Listing
None

Candidate Species[2]	Scientific Name
None	

Species of Concern[3]	Scientific Name
Fish	
Alabama shad	*Alosa alabamae*
dusky shark	*Carcharhinus obscurus*
largetooth sawfish	*Pristis pristis*
night shark	*Carcharinus signatus*
saltmarsh topminnow	*Fundulus jenkinsi*
sand tiger shark	*Carcharias taurus*
speckled hind	*Epinephelus drummondhayi*
Warsaw grouper	*Epinephelus nigritus*
Invertebrates	
ivory bush coral	*Oculina varicosa*

[2] The Candidate Species List has been renamed the Species of Concern List. The term "candidate species" is limited to species that are the subject of a petition to list and for which NOAA Fisheries Service has determined that listing may be warranted (69 FR 19975).
[3] Species of Concern are not protected under the Endangered Species Act, but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

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FLORIDA DEPARTMENT OF STATE
Kurt S. Browning
Secretary of State
DIVISION OF HISTORICAL RESOURCES

Mr. David J. Wrona
Office of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, D.C. 20555-0001

May 4, 2009

RE: DHR Project File Number: 2009-2164
United States Nuclear Regulatory Commission
Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review
Levy County

Dear Mr. Wrona:

Our office reviewed the referenced project for possible impact to historic properties listed, or eligible for listing, in the National Register of Historic Places. The review was conducted in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended and 36 CFR Part 800: Protection of Historic Properties, the National Environmental Policy Act of 1969, as amended and the implementing state regulations.

Based on the information provided, it is the opinion of this office that the proposed undertaking will likely have no effect on historic properties.

However, in the event that prehistoric or historic artifacts, such as pottery or ceramics, stone tools or metal implements, or other physical remains that could be associated with Native American cultures or early colonial or American settlement, are encountered at any time within the project area, all activities involving subsurface disturbance in the immediate vicinity of such discoveries should cease and this office be notified.

If you have any questions concerning our comments, please contact Samantha Earnest, Historic Preservationist, by electronic mail at *swearnest@dos.state.fl.us*, or by telephone at 850-245-6333 or 800-847-7278.

Sincerely,

Frederick P. Gaske, Director, and
State Historic Preservation Officer

500 S. Bronough Street • Tallahassee, FL 32399-0250 • http://www.flheritage.com

☐ **Director's Office** (850) 245-6300 • FAX: 245-6436
☐ **Archaeological Research** (850) 245-6444 • FAX: 245-6452
☒ **Historic Preservation** (850) 245-6333 • FAX: 245-6437

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701
(727) 824-5317; FAX 824-5300
http://sero.nmfs.noaa.gov

May 4, 2009 F/SER46:MS/mt

Mr. David J. Wrona, Chief
U. S. Nuclear Regulatory Commission
Division of License Renewal, Projects Branch 2
Office of Nuclear Reactor Regulation
11555 Rockville Pike
Rockville, Maryland 20852-2738

Dear Mr. Wrona:

The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), Southeast Region, Habitat Conservation Division, has received your agency's letter dated April 13, 2009, regarding the preparation of an supplemental environmental impact statement (SEIS) for the proposed renewal of the operating license for the Crystal River Unit 3 Nuclear Generating Plant (CR-3). CR-3 is located on the Gulf of Mexico near the City of Crystal River, in Citrus County, Florida. The proposed action is to renew the facility's operating license for an additional 20 years beyond the expiration of the CR-3's current operating license.

Your letter indicates your agency seeks to consult with NMFS regarding the presence of protected species and essential fish habitat (EFH) in the project area potentially affected by the proposed action. To assist your agency in determining impacts associated with operation of the existing CR-3 facility, we are providing a list identifying fish/invertebrate species, life stages, and EFH categories of the project area (see enclosure).

To fully address EFH and associated fisheries in the project area, we recommend the SEIS include sections titled "Essential Fish Habitat" and "Marine Fishery Resources" that describe the potential project impacts on each category of EFH (e.g., marine non-vegetated water bottoms, continental shelf features, water column, and estuarine submerged aquatic vegetation, mangrove wetlands, estuarine water column) and marine and estuarine fishery species within the project area. These sections should analyze the potential impacts of the CR-3 on EFH and dependent federally managed species and life stages and should fully evaluate alternative measures to avoid, minimize, and offset adverse impacts. Section 600.810(a) of the EFH regulations defines an adverse effect to EFH as any impact that reduces the quality and/or quantity of EFH, including the loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. The SEIS should analyze impacts to benthic and prey species in the

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discussion of impacts to EFH. This descriptive and analytical information, coupled with a statement of your agency's conclusions regarding the effects of the action on EFH and marine fishery species, would provide the basic details necessary for an EFH assessment pursuant to the requirements of 50 CFR 600.920(e). The Gulf of Mexico Fishery Management Council should also be provided an opportunity for comment on EFH issues under provisions of the Magnuson-Stevens Fishery Conservation and Management Act.

Further, the project area is within the known distribution limits of a federally listed threatened species under purview of NMFS. In accordance with the Endangered Species Act of 1973, as amended, it is your responsibility to review this proposal and identify actions that may affect endangered or threatened species. Determinations involving listed species should be reported to our Protected Resources Division at the letterhead address. If it is determined that the activities may adversely affect any species listed as endangered or threatened under Protected Resources Division purview, formal consultation must be initiated.

Thank you for the opportunity to provide these comments on environmental issues concerning the proposed relicensing of the Crystal River Unit 3 Nuclear Generating Plant. If we may be of further assistance, please contact Mr. Mark Sramek at the letterhead address above, by telephone at (727) 824-5311, or e-mail at Mark.Sramek@noaa.gov.

Sincerely,

W. Mark Thompson

for Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

Enclosure

cc:
F/SER4
F/SER3
F/SER46
SER - Keys
GMFMC – Rester
FWC - Gregg, Smith
NRC – Masnik

EFH Requirements for Species Managed by the Gulf of Mexico Fishery Management Council: Ecoregion 2, Tarpon Springs to Pensacola Bay, FL.

Species	Life Stage	System[1]	EFH
Pink shrimp[2]	eggs	M	<50 m; sand/shell bottom
	larvae	M	<50 m; planktonic, sand/shell bottom, SAV
	juvenile	E	<64 m; sand/shell substrate, SAV
	adults	M	<64 m; sand/shell substrate
White shrimp[2]	eggs	M	9-34 m; sand/shell/soft bottoms
	larvae	E/M	<64 m; plankton, soft bottom, estuarine marsh
	juvenile	E	soft bottom, estuarine marsh
Stone crab	eggs	E/M	<62 m; sand/shell/hard bottoms, SAV, reefs
	larvae	E/M	<62 m; planktonic
	juvenile	E/M	<62 m; sand/shell/hard bottoms, SAV
Gulf stone crab	eggs	E/M	<18 m; sand/shell/soft bottom
	larvae/postlarvae	E/M	<18 m; planktonic, oyster reef, soft bottom
	juvenile	E	<18 m; sand/shell/soft bottom, oyster reef
Red drum	eggs	M	planktonic
	larvae/postlarvae	E	planktonic, SAV, sand/shell/soft bottom, emergent marsh
	juvenile	M/E	<5 m; SAV, sand/shell/soft/hard bottom, emergent marsh
	adults	M/E	1-46 m (9-18 m S of Crystal River); SAV, pelagic, sand/shell/soft/hard bottom, emergent marsh
Red grouper	eggs	M	20-100 m; planktonic
	larvae	M	20-100 m; planktonic
	juvenile	M/E	<50 m; hard bottoms, SAV, reefs
	adults	M	3-183 m; reefs, hard bottoms
Black grouper	eggs	M	18-28 m; planktonic
	larvae	M	10-150 m; planktonic
	juvenile	E/M	SAV, hard bottoms, reefs
	adults	M/E	10-150 m; hard bottoms, mangrove, reefs
Gag grouper	eggs	M	50-120 m; planktonic
	larvae	M	50-120 m; planktonic
	juvenile	M/E	<50 m; SAV, reefs, hard bottom
	adults	M	20-120 m; hard bottom, reefs
Nassau grouper	eggs	M	planktonic
	larvae	M	2-50 m; planktonic
	juvenile	M	SAV, reefs

[1] E=estuarine, M=marine
[2] Marine EFH S of Crystal River excludes 18-46 m. depth zone

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EFH Requirements Tarpon Springs to Pensacola Bay, FL -- Continued

Species	Life Stage	System	EFH
Warsaw grouper	eggs	M	40-183 m; planktonic
	larvae	M	40-183 m; planktonic
	juvenile	M	20-30 m; reefs
Yellowedge grouper	eggs	M	35-183 m; planktonic
	larvae	M	35-183 m; planktonic
	postlarvae/juvenile	M	35-183 m; hard bottom
	adults	M	35-183 m; reefs bottom
Red hind	eggs	M	18-110 m; planktonic
	larvae	M	18-110 m; planktonic
	juvenile	M	2-110 m; reefs
Rock hind	eggs	M	2-100 m; planktonic
	~~larvae~~	M	2-100 m; planktonic
	juvenile	M	2-110 m; reefs
Speckled hind	eggs	M	146-183 m; planktonic
	larvae	M	146-183 m; planktonic
Scamp	eggs	M	60-189 m; planktonic
	larvae	M	60-189 m; planktonic
	juvenile	M	12-33 m; hard bottoms, reefs, mangrove
Schoolmaster	eggs	M	<90 m; planktonic
	larvae	M	<90 m; planktonic
	juvenile	E/M	<90 m; SAV, mangrove, emergent marsh, reefs, hard bottom
Red snapper	eggs	M	18-37 m; planktonic
	larvae	M	18-37 m; planktonic
	juvenile	M	17-183 m; hard/soft/sand/shell bottom
	adults	M	7-146 m; reefs, hard/sand/shell bottoms
Vermilion snapper	eggs	M	>180 m; planktonic
	juvenile	M	1-25 m; reefs, hard bottom
	adult	M	>180 m; reefs, hard bottom
Gray snapper	eggs	M	<180 m; planktonic, reefs
	larvae	M/E	<180 m; planktonic, reefs
	postlarvae/juvenile	M/E	<180 m; SAV, mangrove, emergent marsh
	adults	E/M	<180 m; emergent marsh, reefs, sand/shell/soft/hard bottoms
Yellowtail snapper	eggs	M	1-183 m; planktonic
	juvenile	M/E	1-183 m; SAV, mangrove, soft bottom
	adults	M	1-183 m; reefs, hard bottom, shoals/banks
Lane snapper	eggs	M	4-132 m; planktonic
	larvae	E/M	4-132 m; reefs, SAV
	juvenile	E/M	<20 m; SAV, mangrove, reefs, sand/shell/soft bottom
Blackfin snapper	eggs	M	40-183 m; planktonic
	juvenile	M	12-40 m; hard bottom

EFH Requirements Tarpon Springs to Pensacola Bay, FL -- Continued

Species	Life Stage	System	EFH
Dog snapper	eggs	M	planktonic
	larvae	M	planktonic
	juvenile	E/M	SAV, mangrove, emergent marsh
Hogfish	juvenile	E/M	3-30 m; SAV
Dwarf sand perch	juvenile	M	hard bottom
Greater amberjack	eggs	M	1-183 m; planktonic
	larvae	M	1-183 m; pelagic
	juvenile	M	1-183 m; drift algae (Sargassum)
Lesser amberjack	eggs	M	planktonic
	larvae	M	pelagic
	juvenile	M	55-130 m; drift algae (Sargassum)
Almaco jack	eggs	M	15-160 m; planktonic
	juvenile	M	15-160 m; drift algae (Sargassum)
Banded rudderfish	larvae	M	10-130 m; planktonic
	juvenile	M	10-130 m; drift algae (Sargassum)
Blueline tilefish	eggs	M	60-183 m; planktonic
	larvae	M	60-183 m; planktonic
Goldface tilefish	eggs	M	60-183 m; planktonic
	larvae	M	60-183 m; planktonic
Golden tilefish	eggs	M	80-183 m; planktonic
	larvae	M	80-183 m; planktonic
	juvenile	M	80-183 m; hard/soft bottom, shelf edge/slope
Gray triggerfish	eggs	M	10-100 m; reefs
	larvae	M	drift algae (Sargassum)
	postlarvae/juvenile	M	10-100 m; drift algae (Sargassum), mangroves, reefs
Spanish mackerel	eggs	M	<50 m; plankton
	larvae	M	9-84 m; plankton
	juvenile	M	<50 m; pelagic
	adults	E/M	<75 m; pelagic
Coral	all stages	M	planktonic, FL Middle Grounds, reefs

June 8, 2009

Ms. Deborah Getzoff, Director
Southwest District
Florida Department of Environmental Protection
13051 N. Telecom Parkway
Temple Terrace, FL 33637

SUBJECT: CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Getzoff:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application, submitted by Florida Power Corporation, for the renewal of the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3). CR-3 is located in Citrus County about 35 miles southwest of Ocala, Florida. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969. The SEIS includes an analysis of environmental issues pertinent to CR-3. This letter is being sent to you to give you the opportunity to provide any information relating to CR-3's National Pollution Discharge Elimination System permit.

The CR-3 LRA is available on the internet at
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal/crystal-lra.pdf.

If you have any questions or require additional information, please contact Elaine Keegan, Project Manager, by phone at 301-415-8517 or by e-mail at Elaine.Keegan@nrc.gov.

Sincerely,

/RA/

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

cc: See next page

June 8, 2009

Mr. Gary Knight, Director
Florida Natural Areas Inventory
1018 Thomasville Road, Suite 200-C
Tallahassee, FL 32303

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Knight:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by Florida Power Corporation for the renewal of the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3). CR-3 is located in Citrus County about 35 miles southwest of Ocala, Florida. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered, threatened, and other species of special concern. This letter is being submitted to request from you information on such species that could occur in the project area.

The proposed action is to renew the facility operating license for CR-3 for an additional 20 years beyond the expiration of the current operating license. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The CR-3 site is on Crystal Bay, a shallow embayment of the Gulf of Mexico. The CR-3 site covers approximately 4,738 acres, of which approximately 1,062 acres are industrial facilities. The area surrounding the CR-3 facilities is characterized by approximately 3,676 acres consisting of four natural habitat types: salt marsh, hardwood hammock forest, pineland, and freshwater swamp.

The cooling water intake structure for CR-3 is located approximately 400 feet east of the intake for Units 1 and 2 (Enclosure 1), which are fossil fuel generating units. The discharge from the once-through cooling systems of Units 1, 2, and 3 is used as cooling tower makeup for Units 4 and 5, which are fossil fuel generating units.

The Final Environmental Statement (Atomic Energy Commission, 1973) identifies two 500-kilovolt transmission lines that were built to connect CR-3 to the electric grid. The Central Florida line is approximately 53 miles long, terminates at the central Florida Substation, and crosses Citrus, Marion, and Sumter Counties. The Lake Tarpon line is approximately 81 miles long, terminates at the Lake Tarpon Substation, and crosses Citrus, Hernando, Pasco, and Pinellas Counties. The lines are contained in a common corridor for the first 5.3 miles of corridor, then diverge, with the Central Florida line continuing east and the Lake Tarpon line angling southeast, continuing directly south, and turning southwest toward Tarpon Springs (Enclosure 2). These two transmission corridors occupy approximately 2,440 acres. Both lines are owned and operated by Florida Power Corporation. The corridors pass through low population areas that are primarily forest and agricultural land (Environmental Protection Agency, 1994). The lines cross numerous state and U.S. highways and the Withlacoochee, Pithlachascotee, and Anclote rivers. Corridors that pass through agricultural land generally continue to be used as such. Florida Power Corporation plans to maintain these transmission lines, which are integral to the larger transmission system, indefinitely. These transmission lines will remain a permanent part of the transmission system after CR-3 is decommissioned.

To support the SEIS preparation process, the NRC requests information on species tracked by the Florida Natural Areas Inventory as endangered, threatened, or species of special concern that may be in the vicinity of CR-3 and its associated transmission line rights-of-way.

The CR-3 LRA is available on the internet at http://www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal/crystal-lra.pdf.

If you have any questions concerning the NRC staff's review of this LRA, please contact Elaine Keegan, Project Manager, at 301-415-8517 or by e-mail at Elaine.Keegan@nrc.gov.

Sincerely,

/RA/

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Crystal River Site Layout
2. Transmission System

cc w/encls: See next page

June 8, 2009

Dr. Robbin Trindell, Biological Administrator
FWC-HSC-ISM
620 South Meridian Street MS-6A
Tallahassee, FL 32399-1600

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Dr. Trindell:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by Florida Power Corporation for the renewal of the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3). CR-3 is located in Citrus County about 35 miles southwest of Ocala, Florida. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered, threatened, and other species of special concern. This letter is being submitted to request from you information on such species that could occur in the project area.

The proposed action is to renew the facility operating license for CR-3 for an additional 20 years beyond the expiration of the current operating license. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The CR-3 site is on Crystal Bay, a shallow embayment of the Gulf of Mexico. The CR-3 site covers approximately 4,738 acres, of which approximately 1,062 acres are industrial facilities. The area surrounding the CR-3 facilities is characterized by approximately 3,676 acres consisting of four natural habitat types: salt marsh, hardwood hammock forest, pineland, and freshwater swamp.

The cooling water intake structure for CR-3 is located approximately 400 feet east of the intake for Units 1 and 2 (Enclosure 1), which are fossil fuel generating units. The discharge from the once-through cooling systems of Units 1, 2, and 3 is used as cooling tower makeup for Units 4 and 5, which are fossil fuel generating units.

The Final Environmental Statement (Atomic Energy Commission, 1973) identifies two 500-kilovolt transmission lines that were built to connect CR-3 to the electric grid. The Central Florida line is approximately 53 miles long, terminates at the central Florida Substation, and crosses Citrus, Marion, and Sumter Counties. The Lake Tarpon line is approximately 81 miles long, terminates at the Lake Tarpon Substation, and crosses Citrus, Hernando, Pasco, and Pinellas Counties. The lines are contained in a common corridor for the first 5.3 miles of corridor, then diverge, with the Central Florida line continuing east and the Lake Tarpon line angling southeast, continuing directly south, and turning southwest toward Tarpon Springs

(Enclosure 2). These two transmission corridors occupy approximately 2,440 acres. Both lines are owned and operated by Florida Power Corporation. The corridors pass through low population areas that are primarily forest and agricultural land (Environmental Protection Agency, 1994). The lines cross numerous state and U.S. highways and the Withlacoochee, Pithlachascotee, and Anclote rivers. Corridors that pass through agricultural land generally continue to be used as such. Florida Power Corporation plans to maintain these transmission lines, which are integral to the larger transmission system, indefinitely. These transmission lines will remain a permanent part of the transmission system after CR-3 is decommissioned.

To support the SEIS preparation process, the NRC requests information on species listed by the Florida Natural Areas Inventory as endangered, threatened, or species of special concern that may be in the vicinity of CR-3 and its associated transmission line rights-of-way.

The CR-3 LRA is available on the internet at
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal/crystal-lra.pdf.

If you have any questions concerning the NRC staff's review of this LRA, please contact Elaine Keegan, Project Manager, at 301-415-8517 or by e-mail at Elaine.Keegan@nrc.gov.

Sincerely,

/RA/

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Crystal River Site Layout
2. Transmission System

cc w/encls: See next page

June 8, 2009

Mr. Kipp Frohlich, Section Leader
Imperiled Species Management Section
Florida Fish and Wildlife Conservation
Commission
620 South Meridian Street MS-6A
Tallahassee, FL 32399-1600

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Frohlich:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by Florida Power Corporation for the renewal of the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3). CR-3 is located in Citrus County about 35 miles southwest of Ocala, Florida. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered, threatened, and other species of special concern. This letter is being submitted to request from you information on such species that could occur in the project area.

The proposed action is to renew the facility operating license for CR-3 for an additional 20 years beyond the expiration of the current operating license. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. The CR-3 site is on Crystal Bay, a shallow embayment of the Gulf of Mexico. The CR-3 site covers approximately 4,738 acres, of which approximately 1,062 acres are industrial facilities. The area surrounding the CR-3 facilities is characterized by approximately 3,676 acres consisting of four natural habitat types: salt marsh, hardwood hammock forest, pineland, and freshwater swamp.

The cooling water intake structure for CR-3 is located approximately 400 feet east of the intake for Units 1 and 2 (Enclosure 1), which are fossil fuel generating units. The discharge from the once-through cooling systems of Units 1, 2, and 3 is used as cooling tower makeup for Units 4 and 5, which are fossil fuel generating units.

The Final Environmental Statement (Atomic Energy Commission, 1973) identifies two 500-kilovolt transmission lines that were built to connect CR-3 to the electric grid. The Central Florida line is approximately 53 miles long, terminates at the central Florida Substation, and crosses Citrus, Marion, and Sumter Counties. The Lake Tarpon line is approximately 81 miles long, terminates at the Lake Tarpon Substation, and crosses Citrus, Hernando, Pasco, and Pinellas Counties. The lines are contained in a common corridor for the first 5.3 miles of corridor, then diverge, with the Central Florida line continuing east and the Lake Tarpon line angling southeast, continuing directly south, and turning southwest toward Tarpon Springs

(Enclosure 2). These two transmission corridors occupy approximately 2,440 acres. Both lines are owned and operated by Florida Power Corporation. The corridors pass through low population areas that are primarily forest and agricultural land (Environmental Protection Agency, 1994). The lines cross numerous state and U.S. highways and the Withlacoochee, Pithlachascotee, and Anclote rivers. Corridors that pass through agricultural land generally continue to be used as such. Florida Power Corporation plans to maintain these transmission lines, which are integral to the larger transmission system, indefinitely. These transmission lines will remain a permanent part of the transmission system after CR-3 is decommissioned.

To support the SEIS preparation process, the NRC requests information on species listed by the Florida Natural Areas Inventory as endangered, threatened, or species of special concern that may be in the vicinity of CR-3 and its associated transmission line rights-of-way.

The CR-3 LRA is available on the internet at
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/crystal/crystal-lra.pdf.

If you have any questions concerning the NRC staff's review of this LRA, please contact Elaine Keegan, Project Manager, at 301-415-8517 or by e-mail at Elaine.Keegan@nrc.gov.

Sincerely,

/RA/

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

Enclosures:
1. Crystal River Site Layout
2. Transmission System

cc w/encls: See next page

June 10, 2009

Mr. Reid J. Nelson, Director
Office of Federal Agency Programs
Advisory Council on Historic Preservation
Old Post Office Building
1100 Pennsylvania Avenue, NW, Suite 803
Washington, DC 20004

SUBJECT: CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT LICENSE RENEWAL REVIEW (TAC NO. ME0278)

Dear Mr. Nelson:

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing an application to renew the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3) which is located 35 miles southwest of Ocala, Florida. CR-3 is owned and operated by Florida Power Corporation (FPC). The application for renewal was submitted by FPC on December 16, 2008, pursuant to NRC requirements in Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) augmenting its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)," NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC regulation that implements the National Environmental Policy Act of 1969, as amended. In accordance with 36 CFR 800.8, the SEIS will include analyses of potential impacts to historic and archaeological resources.

If you have any questions or require additional information, please contact the NRC's Project Manager, Elaine Keegan, at 301-415-8517 or by e-mail at elaine.keegan@nrc.gov.

Sincerely,

/RA/

David J. Wrona, Chief
Projects Branch 2
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-302

cc: See next page

Florida Fish and Wildlife Conservation Commission

Office of Planning and Policy Coordination
Nancy Linehan
Director
(850) 487-3794
(850) 410-5265 FAX
(850) 410-5272
(850) 922-5679 FAX

Managing fish and wildlife resources for their long-term well-being and the benefit of people.

620 South Meridian Street
Tallahassee, Florida
32399-1600
Voice: (850) 488-4676
Hearing/speech impaired:
(800) 955-8771 (T)
(800) 955-8770 (V)
MyFWC.com

July 22, 2009

David J. Wrona, Chief Projects Branch 2
U.S. Nuclear Regulatory Commission
MS 011E1
Division of License Renewal
Office of Nuclear Reaction Regulation
Washington, DC 20555-0001

Re: Request for a list of protected species within the area under evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review, Citrus County

Dear Mr. Wrona:

The Division of Habitat and Species Conservation, Habitat Conservation Scientific Services Section, of the Florida Fish and Wildlife Conservation Commission (FWC) has coordinated our agency's review of the referenced License Renewal Application (LRA), and provides the following information. This response is being provided under the provisions of Title 10 of the *Code of Federal Regulations* Part 51, the Nuclear Regulatory Commission's (NRC) regulation that implements the National Environmental Policy Act of 1969.

Project Description

The NRC is reviewing an application submitted by Florida Power Corporation for the renewal of the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3). As part of the LRA review, the NRC is preparing a Supplemental Environmental Impact Statement (SEIS). The SEIS includes an analysis of pertinent environmental issues, including wildlife listed by the State as Endangered, Threatened, or Species of Special Concern.

CR-3 is located in Citrus County about 35 miles southwest of Ocala, Florida (Attachment 1). The CR-3 site is on the Crystal Bay, a shallow embayment of the Gulf of Mexico. The CR-3 site covers approximately 4,738 acres, of which approximately 1,062 acres are occupied by industrial facilities. The remaining acreage consists of salt marsh, hardwood hammock forest, pineland, and freshwater swamp.

The Atomic Energy Commission identifies two 500-kilovolt transmission lines that were built to connect CR-3 to the electric grid (Attachment 2). These two transmission corridors occupy approximately 2,440 acres. The Central Florida line is approximately 53 miles long, terminates at the Central Florida Substation; and crosses Citrus, Marion, and Sumter counties. The Lake Tarpon line is approximately 81 miles long, terminates at the Lake Tarpon Substation; and crosses Citrus, Hernando, Pasco, and Pinellas counties. Both lines are owned and operated by Florida Power Corporation and are included in the LRA review process.

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David J. Wrona
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July 22, 2009

Potentially Affected Resources

The NRC has requested information on species listed as Endangered, Threatened, or Species of Special Concern that may be in the vicinity of CR-3 and its associated transmission line rights-of-way.

Crystal River Unit 3 Nuclear Generating Plant
According to our Geographic Information System (GIS) analysis, the Crystal River Unit 3 Nuclear Generating Plant study area contains or falls within:

- Bear Range – Chassahowitzka Subpopulation-Secondary Zones;
- Priority wetlands for the American alligator, American oystercatcher, Homosassa shrew, Florida black bear, little blue heron, tricolored heron, Marian's marsh wren, Scott's seaside sparrow, brown pelican, gopher frog, and bald eagle;
- Strategic Habitat Conservation Areas for the bald eagle and Scott's seaside sparrow;
- U.S. Fish and Wildlife Service Consultation Area for the Florida scrub-jay and red-cockaded woodpecker;
- Florida Natural Areas Inventory (FNAI) – Manatee Aggregation Site;
- FNAI Conservation Lands – Waccasassa Bay Preserve State Park, Crystal River Archeological State Park, Crystal River Preserve State Park, Felburn Park; Yankeetown Conservation Area, and Marjorie Harris Carr Conservation Area; and
- FNAI Conservation Needs – Under-Represented Natural Communities: Pine flatwoods and sandhill.

These habitats support a diverse array of wildlife species including 31 that are protected by state or federal law.

Potentially Occurring Listed Fish and Wildlife Species

Common Name	*Scientific Name*	Status*	1-Mile Radius	5-Mile Radius
Smalltooth sawfish	*Pristis pectinata*	FE	X	X
American alligator	*Alligator mississippiensis*	SSC; FT	X	
Gopher frog	*Rana capito*	SSC		X
Gopher tortoise	*Gopherus polyphemus*	ST	X	X
Hawksbill sea turtle	*Eretmochelys imbricate*	SE; FE		X
Eastern indigo snake	*Drymarchon corais couperi*	ST; FT	X	X
Florida pine snake	*Pituophis melanoleucus mugitus*	SSC		X
Short-tailed snake	*Stilosoma extenuatum*	ST		X
Suwannee cooter	*Pseudemys concinna suwanniensis*	SSC		X
Piping plover	*Charadrius melodus*	ST; FT	X	X
Least tern	*Sterna antillarum*	ST		X
Bald eagle	*Haliaeetus leucocephalus*	Not Listed**	X	X
Osprey	*Pandion haliaetus*	SSC	X	X

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Peregrine falcon	*Falco peregrinus*	SE		X
Southeastern American kestrel	*Falco sparverius paulus*	ST	X	X
American oystercatcher	*Haematopus palliates*	SSC		X
Brown pelican	*Pelecanus occidentalis*	SSC	X	X
Black skimmer	*Rynchops niger*	SSC		X
Little blue heron	*Egretta caerulea*	SSC	X	X
Snowy egret	*Egretta thula*	SSC		X
Tricolored heron	*Egretta tricolor*	SSC		X
White ibis	*Eudocimus albus*	SSC		X
Florida scrub-jay	*Aphelocoma coerulescens*	ST; FT		X
Marian's marsh wren	*Cistothorus palustris marianae*	SSC	X	X
Scott's seaside sparrow	*Ammodramus maritimus peninsulae*	SSC	X	X
Wood stork	*Mycteria americana*	SE; FE		X
Florida black bear	*Ursus americanus floridanus*	ST	X	X
Florida manatee	*Trichechus manatus latirostris*	SE;FE	X	X
Florida mouse	*Podomys floridanus*	SSC	X	X
Homosassa shrew	*Sorex longirostris eionis*	SSC	X	X
Sherman's fox squirrel	*Sciurus niger shermani*	SSC	X	X

* SSC - Species of Special Concern; ST - State Threatened; SE - State Endangered; FT - Federally Threatened; FE - Federally Endangered
** Covered by the federal Bald Eagle and Golden Eagle Protection Act and the State's Bald Eagle Rule (see http://myfwc.com/docs/WildlifeHabitats/Eagle_Plan_April_2008.pdf#page=35)

Central Florida Transmission Line

Our Geographic Information System (GIS) analysis incorporated a half-mile buffer study area around the Central Florida line, and we found that this area contains or falls within:

- Bear Range – Chassahowitzka and Ocala subpopulations-Secondary Zones;
- Priority wetlands for the American alligator, limpkin, Homosassa shrew, Florida black bear, little blue heron, tricolored heron, snowy egret, gopher frog, and bald eagle;
- Strategic Habitat Conservation Areas for the bald eagle, limpkin, sandhill communities, and rare plant species;
- U.S. Fish and Wildlife Service Consultation Area for the Florida scrub-jay, snail kite, red-cockaded woodpecker, and Lake Wales Ridge plants;
- FNAI Conservation Lands – Ventura Ranch, Gum Slough Springs, Ross Prairie State Forest, Halpata Tastanaki Preserve, Withlacoochee State Forest, Potts Preserve, Lake Panasoffkee, and Crystal River Preserve State Park; and
- FNAI Conservation Needs – Under-Represented Natural Communities: Pine flatwoods, sandhill, and upland hardwood forest.

These habitats support a diverse array of wildlife species including 20 that are protected by state or federal law.

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Potentially Occurring Listed Wildlife Species

Common Name	***Scientific Name***	**Status***
American alligator	*Alligator mississippiensis*	SSC; FT
Gopher frog	*Rana capito*	SSC
Gopher tortoise	*Gopherus polyphemus*	ST
Eastern indigo snake	*Drymarchon corais couperi*	ST; FT
Florida pine snake	*Pituophis melanoleucus mugitus*	SSC
Short-tailed snake	*Stilosoma extenuatum*	ST
Bald eagle	*Haliaeetus leucocephalus*	Not Listed**
Osprey	*Pandion haliaetus*	SSC
Southeastern American kestrel	*Falco sparverius paulus*	ST
Red-cockaded woodpecker	*Picoides borealis*	SSC, FE
Limpkin	*Aramus guarauna*	SSC
Florida sandhill crane	*Grus canadensis pratensis*	ST
Little blue heron	*Egretta caerulea*	SSC
Snowy egret	*Egretta thula*	SSC
Tricolored heron	*Egretta tricolor*	SSC
Florida scrub-jay	*Aphelocoma coerulescens*	ST; FT
Florida black bear	*Ursus americanus floridanus*	ST
Florida mouse	*Podomys floridanus*	SSC
Homosassa shrew	*Sorex longirostris eionis*	SSC
Sherman's fox squirrel	*Sciurus niger shermani*	SSC

* SSC - Species of Special Concern; ST - State Threatened; SE - State Endangered; FT - Federally Threatened; FE - Federally Endangered

** Covered by the federal Bald Eagle and Golden Eagle Protection Act and the State's Bald Eagle Rule (see http://myfwc.com/docs/WildlifeHabitats/Eagle_Plan_April_2008.pdf#page=35)

Lake Tarpon Transmission Line

Our Geographic Information System (GIS) analysis incorporated a half-mile buffer study area around the Lake Tarpon line, and we found that this area contains or falls within:

- Bear Range – Chassahowitzka Subpopulation-Secondary Zones;
- Priority wetlands for the American alligator, limpkin, Homosassa shrew, Florida black bear, little blue heron, tricolored heron, wood stork, Florida sandhill crane, white ibis, gopher frog, and reddish egret;
- Strategic Habitat Conservation Areas for wading birds and scrub communities;
- U.S. Fish and Wildlife Service Consultation Area for the Florida scrub-jay and red-cockaded woodpecker;
- FNAI Conservation Lands – Starkey Wilderness Park, Brooker Creek Preserve, Withlacoochee State Forest, Annutteliga Hammock, Chassahowitzka Wildlife Management Area, and Lake Dan Preserve; and
- FNAI Conservation Needs – Under-Represented Natural Communities: Pine flatwoods, sandhill, and scrub.

1

These habitats support a diverse array of wildlife species including 24 that are protected by state or federal law.

Potentially Occurring Listed Wildlife Species

Common Name	***Scientific Name***	**Status***
American alligator	*Alligator mississippiensis*	SSC; FT
Gopher frog	*Rana capito*	SSC
Gopher tortoise	*Gopherus polyphemus*	ST
Red rat snake	*Elaphe guttata*	SSC
Eastern indigo snake	*Drymarchon corais couperi*	ST; FT
Florida pine snake	*Pituophis melanoleucus mugitus*	SSC
Short-tailed snake	*Stilosoma extenuatum*	ST
Bald eagle	*Haliaeetus leucocephalus*	Not Listed**
Osprey	*Pandion haliaetus*	SSC
Southeastern American kestrel	*Falco sparverius paulus*	ST
Red-cockaded woodpecker	*Picoides borealis*	SSC, FE
Limpkin	*Aramus guarauna*	SSC
Florida sandhill crane	*Grus canadensis pratensis*	ST
Little blue heron	*Egretta caerulea*	SSC
Snowy egret	*Egretta thula*	SSC
Tricolored heron	*Egretta tricolor*	SSC
White ibis	*Eudocimus albus*	SSC
Florida scrub-jay	*Aphelocoma coerulescens*	ST; FT
Florida burrowing owl	*Athene cunicularia floridana*	SSC
Wood stork	*Mycteria americana*	SE; FE
Florida black bear	*Ursus americanus floridanus*	ST
Florida mouse	*Podomys floridanus*	SSC
Homosassa shrew	*Sorex longirostris eionis*	SSC
Sherman's fox squirrel	*Sciurus niger shermani*	SSC

* SSC - Species of Special Concern; ST - State Threatened; SE - State Endangered; FT - Federally Threatened; FE - Federally Endangered
** Covered by the federal Bald Eagle and Golden Eagle Protection Act and the State's Bald Eagle Rule (see http://myfwc.com/docs/WildlifeHabitats/Eagle_Plan_April_2008.pdf#page=35)

Thank you for the opportunity to assist in the review of this LRA renewal process. If you or your staff would like to coordinate further on the information provided in this letter, please contact me at 850-410-5272 or by email at MaryAnn.Poole@myfwc.com and I will be glad to make the necessary arrangements. If you have any specific questions

1

David J. Wrona
Page 6
July 22, 2009

regarding our analysis, please contact Luis F. Gonzalez by phone at 863-581-6914 or by email at Luis.Gonzalez@myfwc.com.

Sincerely,

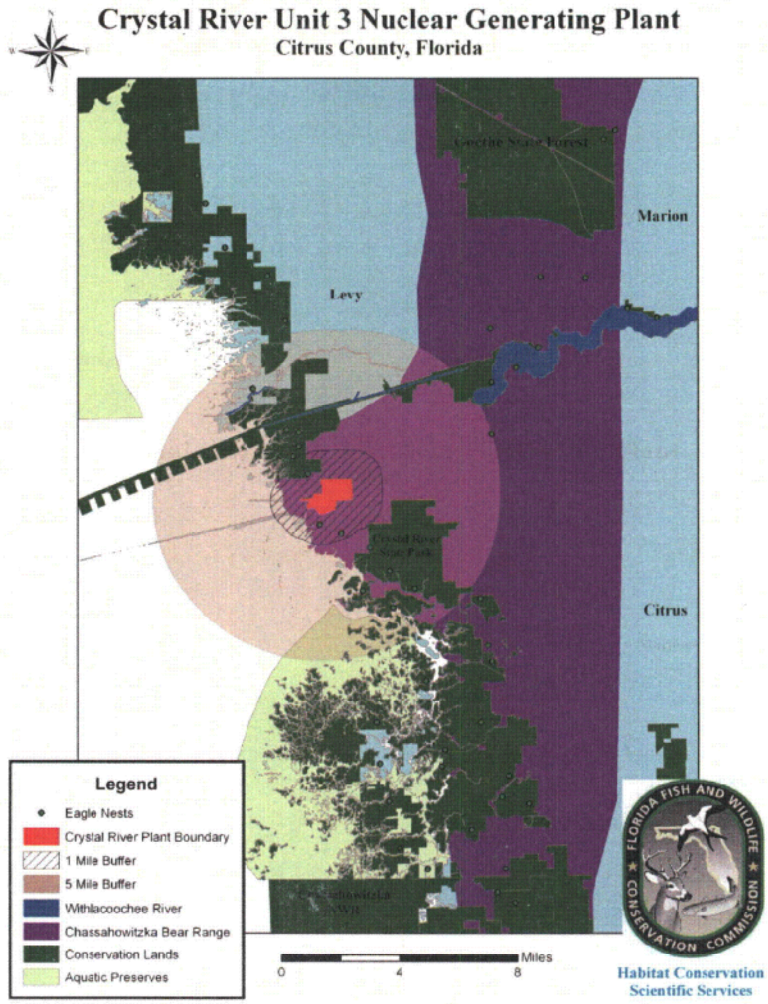
Mary Ann Poole
Commenting Program Coordinator

map/lg
Crystal River Nuclear Plant Unit 3_2251_07-20-09
ENV 1-3-2
cc: Elaine Keegan, NRC (Elaine.Keegan@nrc.gov)

1

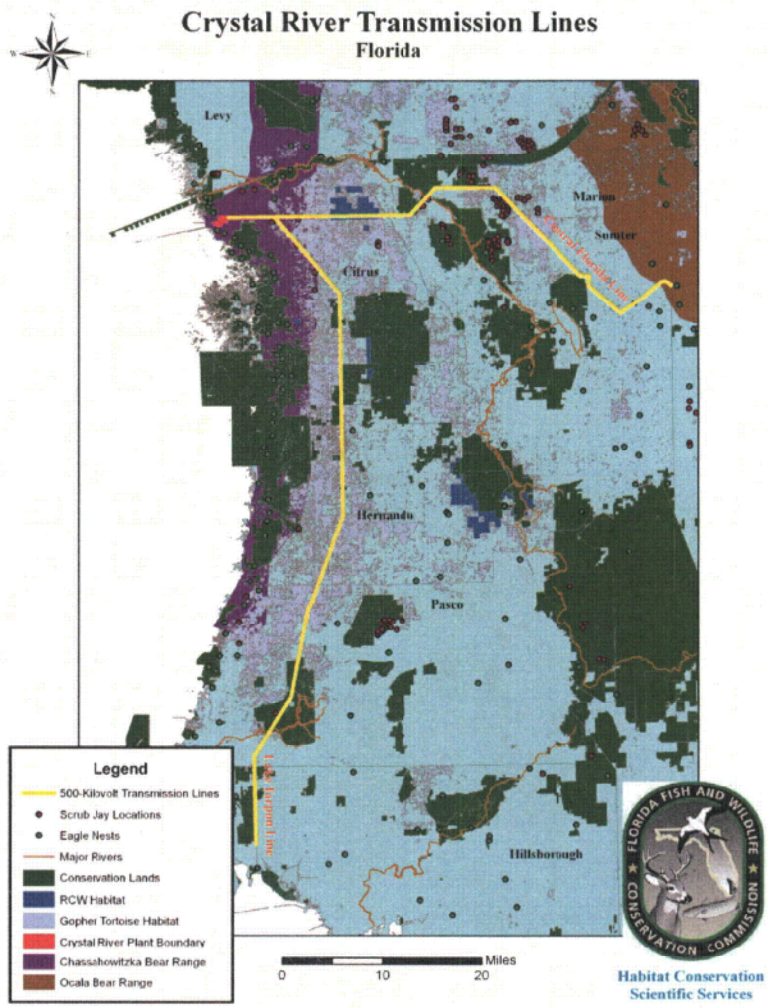
David J. Wrona
Page 7
July 22, 2009

Attachment 1.



David J. Wrona
Page 8
July 22, 2009

Attachment 2.



APPENDIX D.1.
ESSENTIAL FISH HABITAT ASSESSMENT FOR THE PROPOSED RENEWAL OF THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT OPERATING LICENSE

Essential Fish Habitat Assessment

Crystal River Unit 3 Nuclear Generating Plant

License Renewal

May 2011

Docket No. 50-302

U.S. Nuclear Regulatory Commission

Rockville, Maryland

TABLE OF CONTENTS

FIGURES

TABLES

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

°C	degrees Celsius
°F	degrees Fahrenheit
<	less than
>	greater than
≥	greater than or equal to
ac	acre(s)
AEC	Atomic Energy Commission
Btu/hr	British thermal units per hour
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
cm	centimeter(s)
CR-1	Crystal River Unit 1
CR-2	Crystal River Unit 2
CR-3	Crystal River Unit 3 Nuclear Generating Plant
CR-4	Crystal River Unit 4
CR-5	Crystal River Unit 5
CPUE	catch per unit effort
CREC	Crystal River Energy Complex
CWA	Clean Water Act
EFH	essential fish habitat
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
FMP	fishery management plan

ft	foot(feet)
ft^2	square foot(feet)
ft/s	feet per second
FWC	Florida Fish and Wildlife Conservation Commission
FWS	U.S. Fish and Wildlife Service
gpm	gallons per minute
GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437
GMFMC	Gulf of Mexico Fisheries Management Council
ha	hectare(s)
kg	kilogram(s)
km	kilometer(s)
lb	pound(s)
LNP	Levy Nuclear Plant
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
m/s	meters per second
m^3/s	cubic meters per second
mgpd	million gallons per day
mg/L	milligrams per liter
mi	mile(s)
MSFCMA	Magnuson-Stevens Fishery and Conservation Management Act
MW	megawatt(s)
NEPA	National Environmental Policy Act of 1969
NMFS	National Marine Fisheries Service

NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
POD	point of discharge
ppt	parts per thousand
Progress Energy	Progress Energy Florida, Inc.
s	second(s)
SAV	submerged aquatic vegetation
SEIS	supplemental environmental impact statement
STAC	Seagrass Technical Advisory Committee
yr	year(s)

D. 1. ESSENTIAL FISH HABITAT ASSESSMENT FOR THE PROPOSED RENEWAL OF THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT OPERATING LICENSE

1.0 INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. § 1801 et seq.), which was reauthorized and amended by the Sustainable Fisheries Act of 1996 (Public Law 104-297), sets forth the essential fish habitat (EFH) provisions designed to protect important habitats of Federally-managed marine and anadromous species. The definition of EFH is the waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. Identifying EFH is an essential component in the development of fishery management plans (FMPs) to evaluate the effects of habitat loss or degradation on fishery stocks and take actions to mitigate such damage. The National Marine Fisheries Service (NMFS) expanded this responsibility to ensure additional habitat protection (NMFS, 1999). The consultation requirements of Section 305(b) of the MSFCMA provide that Federal agencies consult with the Secretary of Commerce on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. The consultation document must include the following information:

- a description of the proposed action
- an analysis of the potential adverse effects of the action on EFH and the Federally-managed species
- the Federal agency's conclusions regarding the effects of the action on EFH
- proposed mitigation, if applicable

Florida Power Corporation applied to the Atomic Energy Commission (AEC) for licenses to build and operate a nuclear power plant at the Crystal River site in 1967. (The nuclear power plant is Unit 3 of the Crystal River Energy Complex [CREC], which consists of four fossil fuel units and one nuclear unit. Throughout this EFH assessment, CR-3 is the designation for the nuclear unit while CR-1 and CR-2 are the designations for the two fossil units that withdraw water from and discharge water to the same intake and discharge canals as CR-3.) The AEC issued a construction permit on September 25, 1968, and an operating license on December 3, 1976. Commercial operation began on March 13, 1977. The operating license for CR-3 will expire December 3, 2016. Florida Power Corporation (FPC), doing business as Progress Energy Florida, Inc., (Progress Energy) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) on December 16, 2008, to renew the CR-3 operating license. The renewed operating license, if granted, would allow an additional 20 years of plant operation until December 3, 2036.

On April 6, 2009, the NRC staff (Staff) published a Notice of Intent to prepare a plant-specific supplement to NUREG-1437, Volumes 1 and 2, *Generic Environmental Impact Statement for*

License Renewal of Nuclear Plants (GEIS)[1] (NRC, 1996), (NRC, 1999). During the development of the supplemental environmental impact statement (SEIS) and this EFH assessment, the Staff visited the site, met and corresponded with members of Federal and State regulatory agencies, and reviewed a variety of technical reports, journal articles, and other relevant information to determine whether renewal would result in adverse environmental impacts to managed species, their EFH, or their forage species. This EFH assessment fulfills the NRC requirements under the MSFCMA for the CR-3 license renewal review.

2.0 DESCRIPTION OF THE PROPOSED ACTION

The proposed Federal action is renewal of the operating license for CR-3, one of five power plant units at the CREC (Figure 1). Crystal Bay, located within the Gulf of Mexico, is the source for cooling water for the main condensers at CR-3 and the other units at the CREC.

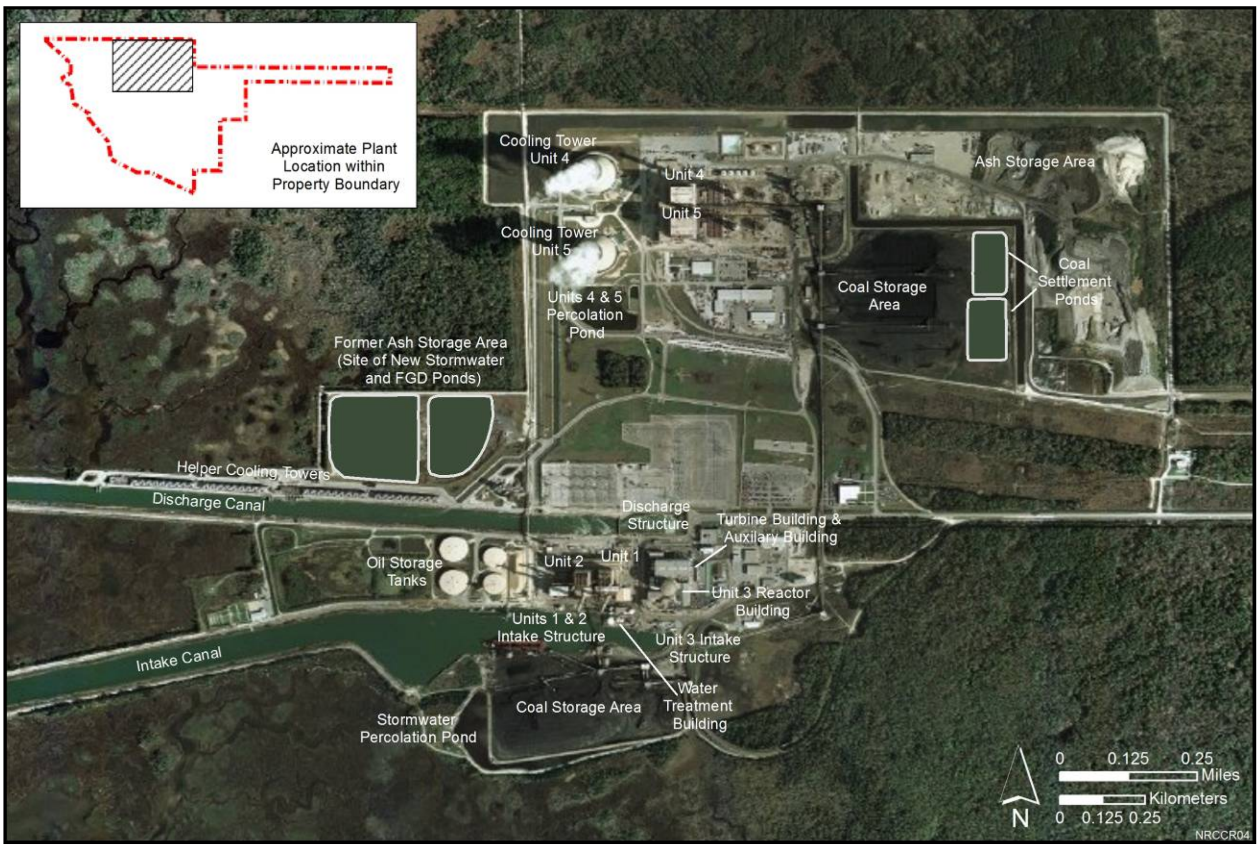


Figure 1. Location of Crystal River Unit 3 Nuclear Generating Plant at the Crystal River Energy Complex

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

2.1 Site Location and Description

The CREC is located in western Florida adjacent to Crystal Bay, a shallow embayment of the Gulf of Mexico. It is located 4.5 miles (mi) (7.2 kilometers [km]) south of the Withlacoochee River and 2.5 mi (4 km) north of the Crystal River. CR-3 is located within the 4,738 acre (ac) (1,513-hectare [ha]) CREC (Figure 1). A substantial part of the CREC site is undeveloped, providing a buffer zone containing 3,676 ac (1,488 ha) of hardwood hammock forest and pineland, salt marches, small tidal creeks, and freshwater swamps, protected against encroachment from any other coastal development (AEC, 1973). The west-central coast of Florida is an area of low relief, ranging in elevation from mean sea level to about 5 feet (ft) (1.5 meters [m]). It is a low-wave energy coast dominated by salt marshes and swamps dissected by branching tidal channels. These features occur in a 1-mi (1.6-km) wide band along the coast near the CREC, separating the uplands to the east from the Gulf of Mexico. Nearshore areas off the coast are shallow (with an average depth of less than 20 ft [6.1 m]), broad, and gently sloping (Progress Energy, 2008).

There are no natural surface water bodies on or immediately adjacent to CR-3. Crystal Bay is a shallow estuarine embayment of the Gulf of Mexico largely located between the Cross Florida Barge Canal (Marjorie Harris Carr Cross Florida Greenway) and Crystal River, and extends offshore for about 10 mi (16 km) (SWEC, 1985). It has an estimated surface area of over 100,000 ac (40,470 ha). Figure 2 shows the surface waters in the vicinity of the CREC. Crystal Bay is shallow with depths less than 10 ft (3 m) out to 3 mi (5 km) from shore. It has relatively low-wave energy with many rocky reef areas, oyster reefs, and seagrass beds. Salt marshes are extensive in undeveloped areas of the coast (SWEC, 1985). Most oyster reefs are underwater at high tide with portions exposed at low tide (SWEC, 1985). Numerous small basins created by the oyster reefs run in a north-south orientation in the area of the CREC intake and discharge canals (Progress Energy, 2008). During the tidal cycle, water levels fluctuate from 2 to 4 ft (0.6 to 1.2 m) (ReMetrix, 2007). Because of high rainfall and large volumes of freshwater that discharge from rivers and springs along the coast, nearshore waters in the Gulf of Mexico are generally low in salinity. Salinities tend to be higher offshore and near the CREC point of discharge (POD), while areas near the rivers and the Cross Florida Barge Canal have reduced salinities (SWEC, 1985). Nearshore waters of Crystal Bay have a salinity of 22 to 29 parts per thousand (ppt) (AEC, 1973); while salinities about 8 to 10 mi (13 to 16 km) offshore are about 35 ppt, a value typical of open ocean waters (National Ocean Service, 2008). Shallow estuaries are less able to store heat compared to deeper waters, and water temperatures fluctuate from 39 °F to 90 °F (4 °C to 32 °C) annually (EPA, 1999). Annual water temperatures near the CREC intake average 71.2 °F (21.8 °C), ranging from 43 °F (6.1 °C) to 94.6 °F (34.8 °C) (Golder Associates, 2007a).

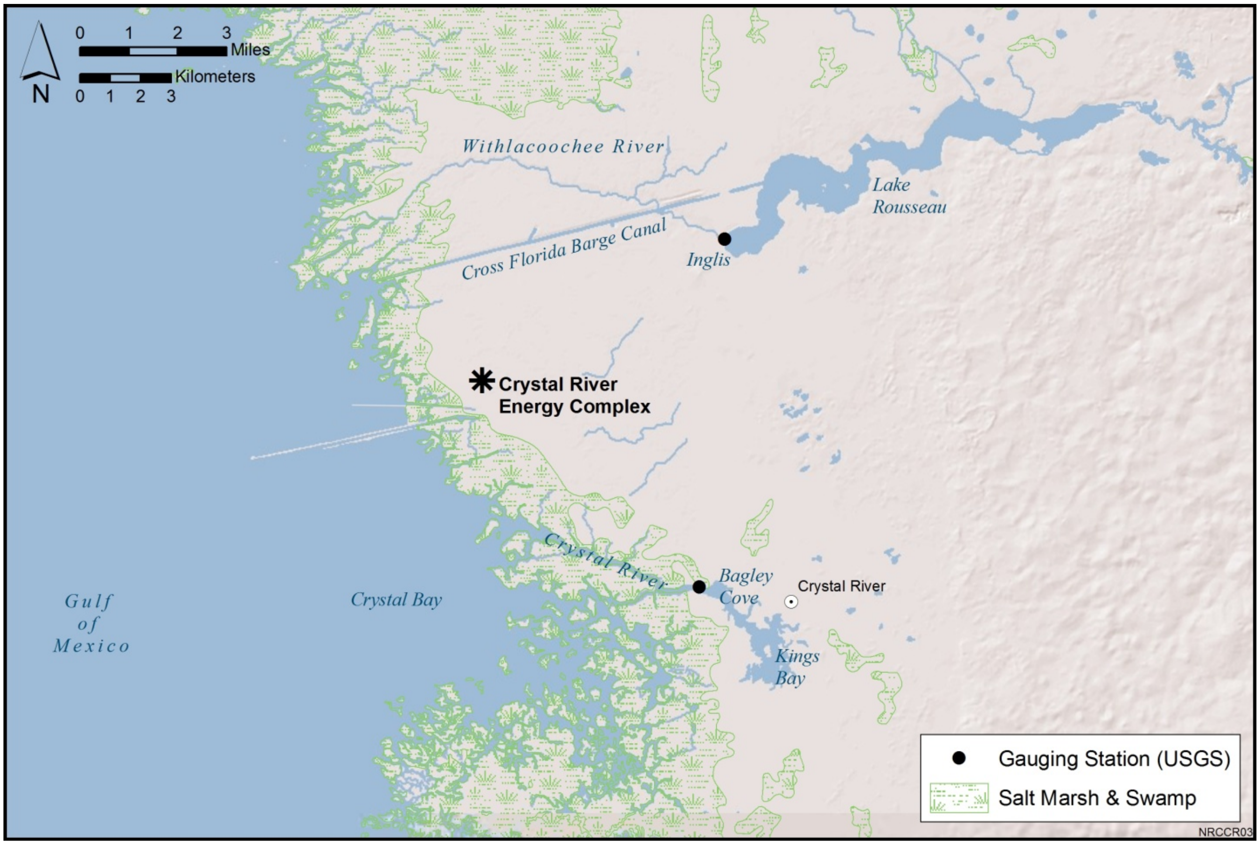

Figure 2. Surface Waters in the Vicinity of the Crystal River Energy Complex

Crystal Bay is located within Florida's Big Bend, which includes the coastlines between Franklin County and Pinellas County (i.e., the coastlines of Wakulla, Jefferson, Taylor, Dixie, Levy, Citrus, Hernando, and Pasco Counties). The estuary areas of Big Bend total over 250,000 ac (101,000 ha) (Kilgen and Dugas, 1989). Very gentle slopes characterize the Big Bend bathymetry, increasing about 3 ft (1 m) in depth per 3-mi (5-km) distance from shore (Hale et al., 2004). Overall, the shallow waters of Florida's Big Bend have exceptional water quality and clarity (Handley et al., 2007). Nevertheless, land use practices such as agriculture, urbanization, and industrial development affect water quality; resulting in hydrologic alterations to watersheds that flow into Big Bend and result in nutrient enrichment of the estuarine and coastal waters (GMP, 2004), (Handley et al., 2007). Water quality within the estuarine areas of Citrus County are affected by increased urban stormwater runoff, seepage from onsite sanitary sewage disposal, sewage treatment plant effluent, residential use of pesticides, herbicide and fertilizers, and activities associated with commercial and leisure boating (CCBCC, 2009).

A variety of habitats, discussed below, support an abundance of aquatic resources in Crystal Bay. Open water habitats include saltwater, tidally influenced water of variable salinities, and tidal freshwater areas. The bottom of Crystal Bay provides a number of different benthic habitats, with their characteristics dictated by salinity, tides, and substrate type. Unless cited otherwise, the habitat descriptions are from the Florida Fish and Wildlife Conservation Commission (FWC) (2005).

2.1.1 Artificial Structures

Artificial structures include artificial reefs and hardened shorelines. The construction of artificial reefs can enhance recreational fishing and diving opportunities; while hardened shorelines (e.g., rip-rap, other types of coastal armoring, breakwaters, piers, and docks) enhance coastal development. While hardened shorelines provide some habitat for bivalves, shellfish, and some fishes, they alter natural marine and estuarine shoreline processes and alter or replace naturally-occurring coastal habitats. The dikes that parallel the CREC intake and discharge canals are artificial structures. Other artificial structures in the area are the spoils islands located along the South Florida Barge Canal. These structures and the oyster reefs (discussed later in this section) affect tidal flux and current patterns in the area of the CREC (Steidinger and Van Breedveld, 1971).

2.1.2 Coastal Tidal Rivers and Streams

Coastal tidal rivers and streams are the segments of rivers and streams that experience a tidal influence that affects water levels, flow rates, and salinity concentrations. Water flow in tidal rivers and streams is bidirectional, and salinity can range from freshwater to brackish. Many tidal rivers and streams occur within the Big Bend region of Florida. Tidal rivers and streams near the CREC include the Withlacoochee River, Cross Florida Barge Canal, Crystal River, Cutoff Creek, and Salt Creek.

2.1.3 Oyster Reefs

Dense concentrations of Eastern oysters (*Crassostrea virginica*) attach to hard substrates and to each other to create oyster reefs. The Eastern oyster occurs within estuarine areas with salinities of 15 to 30 ppt. Oyster reefs generally consist of an upper layer of live oysters over a core of buried shell and mud. The reefs can range from small mounds or patches to long ridges extending several miles. Large reefs have a significant role in the energy flow dynamics of estuaries by dividing bays, changing circulation patterns (GMFMC, 2004), and causing flow restrictions during portions of the tidal cycle (Galya and McDougall, 1985). Oyster reefs also absorb wave energy, which helps to minimize shore erosion, and help to maintain water quality through live oyster filtering capacities (GMFMC, 2004). Oyster reef habitats provide nursery grounds, refugia, and foraging areas for over 300 species of macroinvertebrates and fishes (Stanley and Sellers, 1986). Peterson et al. (2003) determined that 108 square feet (ft^2) (10 square meters [m^2]) of restored oyster reef can yield an additional 5.5 pounds per year (lb/yr) (2.5 kilograms per year [kg/yr]) of production of fish and large mobile crustaceans. A number of oyster reefs parallel the shoreline near the CREC (Progress Energy, 2008).

The Eastern oyster tolerates widely fluctuating temperatures, salinities, and suspended solids concentrations (Stanley and Sellers, 1986). Optimal temperatures for growth, reproduction, and survival are 68 °F to 86 °F (20 °C to 30 °C) (Stanley and Sellers, 1986); while optimal salinities are 12 to 25 ppt (GMFMC, 2004). Exposure of Eastern oysters to 95 °F (35 °C) rarely caused death, but did inhibit effective reproduction by causing premature spawning, spawning out of season, and deterioration of oyster condition (Quick, 1971). Mortality can occur from extended exposure to salinities less than 2 ppt (GMFMC, 2004).

Most commercial landings of Eastern oyster in Florida occur along the panhandle and Big Bend area. The FWC (2011) reported 2010 annual commercial landings of oysters to be 1,694,664 lb (768,687 kg) for the west coast of Florida with no commercial landings reported for Citrus County. In Citrus County, the Florida Department of Agriculture and Consumer Services (2011) allows oyster harvesting south of the Crystal River intake (normally opened to harvesting, but may be temporarily closed during periods of red tide, hurricanes, and sewage spills) during spring and fall months; and conditionally approved (periodically closed to shellfish harvesting during predictable pollution events) during winter months.

2.1.4 Salt Marshes

Salt marshes occur where wave energies are low and mangroves are absent. About 442,600 ac (179,100 ha) of salt marshes occur in Florida. Tidal rivers and streams often dissect larger stretches of salt marsh. The herbaceous plants of salt marshes include grasses, sedges, and rushes. Salt marshes provide nursery areas for many larval and juvenile invertebrate and fish species; provide a major source of organic matter to sustain estuarine detrital food webs; and reduce erosion, buffer inland areas from storm damage, recycle inorganic nutrients, and remove contaminants (GMFMC, 2004). The salinity of salt marsh waters ranges from 0.5 to 34 ppt (Ward, 1999). Soil salinity and tidal frequency affect primary production in salt marshes. When the density, growth, and survival of juvenile fishes and decapod crustaceans are considered, the relative nursery value of salt marsh habitats for nekton appear higher than open water habitats but lower than seagrass habitats (Minello et al., 2003).

A 0.5- to 1-mi (0.8- to 1.6-km) band of salt marshes drained by numerous small creeks occurs in the CREC area (SWEC, 1985). The salt marshes near the CREC are typical of northwest Gulf shoreline areas. Sediments in the salt marsh area are primarily muds with small areas of exposed limestone and oyster shell banks. Rushes and cordgrass (e.g., *Juncus roemerianus* and *Spartina patens*, respectively) and other salt-tolerant plants border shallow creeks and bayous. Smaller areas of mangroves and glasswort (*Salicornia* spp.) are scattered throughout the salt marshes. *Spartina*-dominated areas also occur along the intake and discharge spoil banks for the CREC (Progress Energy, 2008).

2.1.5 Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) habitats include any combination of seagrasses, attached macroalgae, and drift algae that cover 10 to 100 percent of the substrate (GMP, 2004). Seagrasses are marine flowering plants adapted for underwater growth and reproduction. Seagrass beds occur in areas of low-wave energy and often occur next to tidal flat, salt marsh, and mangrove communities. Salt marshes and adjacent seagrass beds share a diverse fauna (Dawes et al., 2004). Seagrasses help maintain water clarity, stabilize substrates, provide habitat for fish and shellfish, provide food for some marine animals, and provide nursery areas for recreationally and commercially important fish and shellfish (Sargent et al., 1995), (FDEP, 2008a), (Handley et al., 2007). Nearly all of the commercially and recreationally valuable estuarine and marine animals depend on seagrass beds as refuge or habitat for parts or all of their lifecycles (Dawes et al. 2004).

Over 2.4 million ac (1 million ha) of seagrass beds occur in Florida (FWC, 2005). The Big Bend area of Florida has the highest acreage of seagrass along the northern Gulf of Mexico. Over 3,486,500 ac (1,415,000 ha) of potential seagrass habitat occurs in Big Bend out to a depth of 60 ft (18 m). This includes deepwater *Halophila* beds (Handley et al., 2007).

Handley et al. (2007) reported the following known areal coverage of seagrasses in Big Bend over a 20-year period:

- In 1984 – 197,880 ac (80,891 ha) of continuous seagrass and 619,648 ac (250,768 ha) of patchy seagrass
- In 1992 – 67,110 ac (27,159 ha) of continuous seagrass and 200,529 ac (81,153 ha) of patchy seagrass
- In 2003 – 70,443 ac (28,508 ha) of continuous seagrass and 541,372 ac (219,090 ha) of patchy seagrass

Seagrass habitats occur within the shallows of Crystal Bay and extend westward about 7 to 12 mi (11 to 19 km) into the Gulf (CCBCC, 2009).

Seven seagrass species occur in Florida (FDEP, 2008a). The four most widespread species are shoal grass (*Halodule beaudettei*, formerly known as *Halodule wrightii*), ditch grass or widgeon grass (*Ruppia maritima*), turtle grass (*Thalassia testudinum*), and manatee grass (*Syringodium filiforme*). The other three species are star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and Johnson's seagrass (*Halophila johnsonii*) (FDEP, 2008a). Turtle grass, manatee grass, and shoal grass are the major species of seagrass present in the Big Bend area (GMP, 2004). Shoal grass, widgeon grass, star grass, and attached macrolagae are pioneer species that rapidly colonize bare areas. Manatee grass then occurs, usually intermixed with shoal grass in early stages of seagrass bed development and turtle grass in later stages. Turtle grass is the climax species in seagrass succession (GMFMC, 2004).

Shoal grass, ditch grass, turtle grass, manatee grass, and star grass occur near the CREC (AEC, 1973), (SWEC, 1985), (Progress Energy, 2008). However, during the 316 Demonstration, only shoal grass occurred at sampling stations most affected by the CREC's heated discharge; whereas the biomass of shoal grass, ditch grass, and turtle grass were lower in areas less affected by thermal discharges compared to areas unaffected by thermal discharges (SWEC, 1985). Section 5.3 provides further information on the effect of CREC thermal discharges on seagrasses.

SAV habitats, including those dominated by seagrasses, can also contain rooted green algae, particularly *Caulerpa and Sargassum* spp., and epiphytic algae. Algae can contribute over 50 percent of primary production in seagrass habitats (GMFMC, 2004). Epiphytic algae growth may affect seagrass photosynthesis by intercepting incident light (Hale et al., 2004). Some macroalgae found in SAV habitats include attached macroalgae that broke loose from other locations as occurs as drift algae, which can comprise an important component of SAV habitat (Dawes et al., 2004), (GMFMC, 2004). Crabs, isopods, and sea urchins are direct grazers on seagrasses; while other invertebrates may feed on the epiphytes that occur on the seagrasses (Dawes et al., 2004). Total fish density in Tampa Bay was similar at sites dominated by either drift algae or seagrasses but was significantly reduced at sites with little cover by either vegetation type. Thus, both drift algae and seagrasses are essential habitats for juvenile and small adult fishes (Rydene and Matheson, 2003). Drift algae functions as both a dispersal mechanism and an alternative habitat for seagrass-associated fish and macroinvertebrates (Rydene and Matheson, 2003).

Both natural perturbations (e.g., storms, floods, droughts, hurricanes, and overgrazing by manatees and sea turtles) and anthropogenic perturbations (e.g., nutrient loading) can affect SAV (Dawes et al., 2004), (GMP, 2004), (Handley et al., 2007). Since the 1950s, over 2 million ac (800,000 ha) of seagrasses were eliminated in Florida due to nutrient loading, salinity changes caused by water control projects, boat propeller and trawl net damage, dredging, and other human-related causes (Sargent et al., 1995). Eutrophication from nutrient loading is the major cause of seagrass habitat degradation (GMP, 2004), (Hale et al., 2004). Increased nutrient loading in the Big Bend region has increased phytoplankton abundance and possibly periphyton abundance on seagrass blades. This has altered the light regime available to seagrasses, reducing the maximum depth of occurrence since the late 1970s (Hale et al., 2004). Similar effects on seagrasses can occur when nutrients increase macroalgae growth (Dawes et al., 2004).

2.1.6 Subtidal Unconsolidated Marine/Estuary Sediments

Subtidal unconsolidated marine/estuary sediment habitats consist of open areas of mineral substrates within tidal zones (i.e., less than 10 percent of the habitat is comprised of SAV or corals). Substrates consisting of unconsolidated sediments (e.g., mud, mud/sand, sand, or shell) occur throughout the coastal areas of Florida. These habitats can support large populations of infaunal organisms such as tube worms, sand dollars, mollusks, isopods, amphipods, burrowing shrimp, and crabs and are important feeding grounds for bottom-feeding fish and invertebrate species. Microscopic photosynthetic eukaryotic algae and cyanobacteria, anaerobic photosynthetic bacteria, and chemosynthetic bacteria occur in unconsolidated sediments (MacIntyre et al., 1996).

2.2 Cooling Water Description and Operation

CR-3 has a once-through heat dissipation system that withdraws water from, and discharges it to, Crystal Bay in the Gulf of Mexico. Cooling water circulates through CR-3 in one of two modes of operation: open cycle (once-through cooling, with no cooling towers in operation) and helper cycle (once-through cooling, with mechanical draft cooling towers in operation). The applicant selects the mode of operation so that thermal discharges at the POD to Crystal Bay are in compliance with the thermal limits of the National Pollutant Discharge Elimination System (NPDES) Permit No. FL0000159 (FDEP, 2005). Unless otherwise cited, the applicant's environmental report (Progress Energy, 2008) is the source of the following information on the CR-3 cooling and auxiliary water systems.

The CR-3 cooling water system consists of the intake canal, intake structure and pumps, circulating water intake piping, condensers, circulating water discharge piping, outfall structure, discharge canal, and cooling towers. The intake canal, discharge canal, and cooling towers are shared systems with CR-1 and CR-2. Crystal River Unit 4 (CR-4) and Crystal River Unit 5 (CR-5) withdraw makeup water from, and discharge cooling tower blowdown to, the discharge canal. The cooling towers, described later in this section, were not a component of the cooling water system as described in the original environmental impact statement (EIS) for CR-3 (AEC, 1973).

The intake canal, which extends into the Gulf, is 14 mi (22.5 km) long. It has a minimum depth of 20 ft (6 m) to accommodate barge traffic used to deliver coal for the fossil fuel units. A southern and northern dike parallel the intake canal for about 3.4 mi (5.4 km) offshore. The southern dike terminates at this point, while the northern dike extends an additional 5.3 mi (8.5 km) into the Gulf. Starting at Fisherman's Pass, irregularly-spaced openings occur in the northern dike to allow boat traffic to pass in a north-south direction without having to completely circumnavigate the dike. The dikes are about 50- to 100-ft (15- to 30-m) wide on top and are elevated about 10 ft (3 m) above the water surface at mean low tide (FPC, 2002). The dikes are comprised of intake canal construction spoils (SWEC, 1985). Starting at the east end, the intake canal is 150-ft (45.6-m) wide for 2.8 mi (4.5 km); 225-ft (69.5-m) wide for the next 6.3 mi (10 km); and 300-ft (91-m) wide for the last 4.9 mi (7.8 km) (FPC, 2002). Current velocities at the mouth of the intake canal range from 0.6 to 2.6 feet per second (ft/s) (0.2 to 0.8 meters per second [m/s]) (SWEC, 1985). Dredging occurs in the intake canal every 5 to 7 years.

The cooling water intake structure for CR-3 is located near the eastern end of the intake canal and about 400 ft (122 m) east of the intake structures for CR-1 and CR-2. The intake structures for all three units are located on the north side of the intake canal. A security boom, to intercept floating and partially submerged debris and restrict access to CR-3, extends across the intake canal downstream of the intake structures for CR-1 and CR-2 and about 200 ft (61 m) from the face of the CR-3 intake structure. The CR-3 intake structure is 118-ft (36-m) wide. It is fitted with eight external trash racks with 0.38- by 4-inch (1- by 10- centimeter [cm]) steel bars on 4-inch (10-cm) centers, resulting in a 3.63-inch (9.2-cm) distance between adjacent bars. The bars extend from above the water line to the concrete slab on the bottom of the intake structure. The bar racks are aligned 10° from vertical with the bottoms of the bar racks extending about 5 ft (1.5 m) into the intake canal (FPC, 2002). Seven of the bar racks are in front of the traveling screens for the circulating water condenser system. They are each 33 ft (10 m) high and 15.6 ft (4.75 m) wide. The eighth bar rack is in front of the traveling screen that serves the nuclear services and decay heat water system. It is 33-ft (10-m) high and 9.3-ft (2.8-m) wide (FPC, 2002). A catwalk extends across the front of the bar racks in order to allow the racks to be inspected for debris. An overhead rail mounted trash rake removes collected debris. About four times per year, removal of the bar racks occur so that they can be pressure washed to remove barnacles or other marine growth and are then coated with a biofouling material (FPC, 2002). Under normal water elevation and full-flow conditions, the velocity approaching the bar racks is 0.9 ft/s (0.27 m/s) and increases to 1 ft/s (0.30 m/s) at the traveling screens.

The CR-3 intake structure has four pump bays and eight traveling screens. The seven traveling screens for the circulating water system are 10 ft (3 m) wide by 35 ft (11 m) high with 0.38-inch (1-cm) mesh. The eighth traveling screen, used for the nuclear services and decay heat cooling water system, is of similar design, but is only 6 ft (2 m) wide (Golder Associates, Inc., 2007a). Rotation and washing of the intake screens occurs every 8 hours or when there is a greater than or equal to 6-inch (15-cm) pressure differential across the screens. Debris washed from the screens goes into a common trough and then into to a sump adjacent to the intake structure. Solid material (including impinged organisms) in the screen wash is collected in a screened basket. The solid material collected from the bar racks and intake screens are placed into the trash for ultimate disposal in the Citrus County landfill. The screen wash water, which is seawater pumped from the intake canal, is discharged back into the intake canal (Golder Associates, Inc., 2007b). Refurbishment of the traveling screens occurs every 7 years.

CR-3 has two circulating water pumps rated at 167,000 gallons per minute (gpm) (372 cubic feet per second [cfs] or 10.5 cubic meters per second [m^3/s]) and two rated at 179,000 gpm (399 cfs or 11.3 m^3/s). The design intake volume for CR-3 is 680,000 gpm (1,515 cfs or 42.9 m^3/s). The combined condenser flow limit for the three units is 1,897.9 million gallons per day (gpd) (2,936 cfs or 83.2 m^3/s) from May 1 through October 31 and 1,120,000 gpm (2,495 cfs or 70.7 m^3/s) from November 1 through April 30 (FDEP, 2005). Throttling back on CR-1 and CR-2 accomplishes the flow reduction from November 1 through April 30 (Progress Energy, 2010a).

The four circulating water pumps send water through four 90-inch (229-cm) internal diameter reinforced concrete pipes to four 6.5- by 7.5-ft (2- by 2.3-m) rectangular reinforced concrete flumes that are connected to the four condenser tube banks. A separate flow path exists for the nuclear services and decay heat cooling water heat exchangers. Each condenser tube bank discharges separately into a 6.5- by 7.5-ft (2- by 2.3-m) reinforced concrete flume connected to a 90-inch (229-cm) diameter reinforced concrete pipe. The four concrete pipes terminate in a common outfall structure provided with a weir. Water flows over the weir and into the discharge canal (Wahanik, 1969). At operating design capacity, the rises in discharge temperature from condenser passage from CR-1 through CR-3 are 14.9 °F (8.3 °C), 16.9 °F (9.4 °C), and 17.5 °F (9.7 °C), respectively (Mattson et al., 1988). The corresponding condenser cooling system heat rejection rates for each unit are approximately 2.28, 2.74, and 5.88 billion British thermal units per hour (Btu/hr), respectively. For all three units, the total heat rejection rate is 10.91 billion Btu/hr (Golder Associates, Inc., 2007a).

The nuclear services and decay heat cooling water system for CR-3 withdraws 10,000 gpm (22.3 cfs or 0.6 m^3/s) under normal conditions and up to 20,000 gpm (44.6 cfs or 1.3 m^3/s) under emergency conditions in order to provide sufficient capacity to remove heat generated by system operations. The nuclear services water system uses most of this flow. The decay heat cooling water system only operates for short time periods during unit shutdown, which occurs predominately during refueling outages once every 2 years (Progress Energy, 2010a).

Periodic addition of chlorine prevents the growth of biofouling organisms. The maximum total residual oxidant (as chlorine) concentration at the unit outfall cannot exceed 0.01 milligrams per liter (mg/L) (FDEP, 2005). Cleaning balls, recirculated through the condensers, provides mechanical cleaning of the CR-3 condenser tubes (Golder Associates, Inc., 2007a). The applicant periodically injects the biocide Spectrus CT1300 into the nuclear services and decay heat cooling water system (Golder Associates, Inc., 2007a). The NPDES permit limits the rate of CT1300 application to no more than 4.5 mg/L for a period not to exceed 18 hours and at an interval of at least 21 days between applications (written approval is required to extend the length of applications or decrease the interval between applications) (FDEP, 2005).

CR-3 cooling water discharges into a 125-ft (38-m) wide discharge canal just north of the unit. Cooling water from CR-1 and CR-2 also discharge into the canal. The discharge canal extends west about 1.6 mi (2.6 km) to the POD to Crystal Bay. The discharge canal, and an associated south dike, extends an additional 1.2 mi (1.9 km) from the POD. The dike is comprised of discharge canal construction spoils (SWEC, 1985). The discharge canal is the source of cooling system makeup for CR-4 and CR-5. The intake pumps for those units are located on the north side of the discharge canal and over 900 ft (274 m) west of the discharge for CR-1. The combined blowdown canal for CR-4 and CR-5 is also on the north side of the discharge canal and is located over 1,400 ft (427 m) east of the two units' intake pumps. The blowdown canal is located about 1,700 ft (518 m) upstream of the bank of helper cooling towers used for CR-1, CR-2, and CR-3. The bank of helper cooling towers consists of 4 permanent cooling towers installed in 1993 and 67 modular cooling towers installed in 2006. When CR-1, CR-2, and CR-3 are operating at maximum pumping capacity, the velocity in the discharge canal is about 2.4 ft/s (0.7 m/s) at low tide (Golder Associates, Inc., 2007a). Dredging maintains the discharge canal at a depth of about 10 ft (3 m).

Through NPDES Permit No. FL0000159, the Florida Department of Environmental Protection (FDEP) (2005) regulates the thermal limits of the combined discharge of CR-1 through CR-3 at the POD to Crystal Bay. The discharge temperature at the POD cannot exceed 96.5 °F (35.8 °C) as a 3-hour rolling average. The helper cooling towers usually allow CR-1, CR-2, and

CR-3 to meet this requirement without the need to reduce power generation for CR-1 and CR-2. The modular cooling towers are normally used after all of the permanent cooling towers have been placed in service and when the POD temperature limits may otherwise be exceeded without load reduction on the CREC generating units. The modular cooling towers are also the first turned off. Generally, the permanent and modular cooling towers operate between May 1 through October 31 (Progress Energy, 2007).

The applicant plans to add 180 megawatts (MW) of electrical generation to CR-3 (Golder Associates, Inc., 2007a). Two phases are required for the extended power uprate (EPU). Phase I, which is completed, added 40 MW of power and included a retrofit of the low pressure turbines and electrical generator, replacement of the main steam reheaters, and replacement of the steam generator (FDEP, 2008b). Phase II, which will add the remaining 140 MW, will occur before the current CR-3 operating license expires (December 3, 2016). This phase will retrofit the high-pressure turbine and turbine/generator coolers and replace the circulating water pumps, condensate and feedwater booster pumps, and motors (FDEP, 2008b). This will include alterations that will elevate temperatures within the reactor and the use of enriched uranium fuel. The four new circulating water pumps will each deliver as much as 207,778 gpm (463 cfs or 13.1 m^3/s) each. As a result, through-screen velocity will increase from 1.45 ft/s (0.44 m/s) (maximum at mean low water level) to as high as 2.02 ft/s (0.62 m/s) (maximum at mean low water level) (Golder Associates, Inc., 2007a).

The net increase in heat rejection for the CR-3 EPU would be 0.768 billion Btu/hr, which is about a 13.1 percent increase over CR-3's current heat rejection (Golder Associates, Inc., 2007a). Unless mitigated in some manner, the increased heat rejection will result in an elevated thermal discharge temperature at the POD. Thus, plans for Phase II of the EPU called for the installation of a new south cooling tower. The south cooling tower would assist in offsetting the increased circulating water rejected heat, avoid potential increase in flow into the intake canal from Crystal Bay, and allow removal of the existing 67 modular cooling towers. One option for the operation of the south cooling tower is to recirculate some of the flow from the cooling tower discharge back into the intake canal, thus avoiding any increase in flow into the intake canal from Crystal Bay (FDEP, 2008b). Under this option, flow through the south cooling tower would be as high as 534,000 gpm (1,190 cfs or 33.7 m^3/s), which would include a maximum discharge of 320,000 gpm (713 cfs or 20.2 m^3/s) to the discharge canal and 214,000 gpm (477 cfs or 13.5 m^3/s) to the intake canal (Progress Energy, 2010a). This option will most likely occur if the intake for CR-3 increases from the current 680,000 gpm (1,515 cfs or 42.9 m^3/s) to 830,000 gpm (1,849 cfs or 52.4 m^3/s) (Golder Associates, Inc., 2007a), (Golder Associates, Inc., 2007b).

The more likely option is no change in the existing CR-3 flow of 680,000 gpm (1,515 cfs or 42.9 m^3/s) as a result of the EPU, but rather an increase in thermal load (increased temperature) to the discharge canal (Progress Energy, 2009a). Under this option, the south cooling tower will only discharge a maximum of 320,000 gpm (713 cfs or 20.2 m^3/s) to the discharge canal. The total heat rejection to Crystal Bay due to the EPU for either option will not exceed the currently permitted maximum rate of 10.91 billion Btu/hr (FDEP, 2008b).

The applicant planned to complete Phase II of the EPU in 2011. Due to the containment issues at CR-3, Phase II of the EPU is delayed and so will not be part of the renewed NPDES permit (i.e., aspects of the NPDES application related to the south cooling tower will be withdrawn). A renewed NPDES permit, expected in July 2011, will essentially involve the renewal of existing operating permit limits. Should Phase II of the EPU occur before the end of the next NPDES permit period, the applicant will be required to conduct a Clean Water Act (CWA) Section 316(a)

Demonstration study, likely involving a 2-year study period initiated after completion of EPU Phase II. The need for the study is to demonstrate compliance with CWA Section 316(a) in order to renew any applicable Section 316(a) variance (i.e., a variance from applicable thermal limitations to surface waters is allowed if the permittee demonstrates that the balanced indigenous community of aquatic organisms is protected and maintained).

Expediting Phase II of the EPU will occur by issuing an FDEP Administrative Order with the new NPDES permit. The Administrative Order would require the applicant to demonstrate reasonable assurance that it could meet the current POD thermal limit by derating the fossil fuel units in place of building the south cooling tower. Tentatively, issuance of both the new NPDES permit and the Administrative Order will occur by midsummer of 2011 (NRC, 2011). Should the applicant decide to add the south cooling tower at a later date, an NPDES permit modification pertaining to the cooling tower will be required.

3.0 ESSENTIAL FISH HABITAT NEAR THE SITE

The Gulf of Mexico provides EFH for a number of marine and estuarine fish species, several shellfish species, and corals that are Federally-managed by the Gulf of Mexico Fisheries Management Council (GMFMC) under seven fishery management plans. EFH in the Gulf of Mexico typically includes some palustrine wetlands; estuarine wetlands; SAV; and marine, estuarine, and tidally-influenced water columns and sediment. EFH that occurs within estuarine areas includes estuarine emergent wetlands; mangrove wetlands; SAV; algal flats; mud, sand, shell, and rock substrates; and estuarine water column (GMFMC, 2004), (GMFMC, 2005). Continued operations of CR-3 could potentially affect Federally-managed species, their EFH, and their forage species. The following is a description of the EFH for those species listed in the Gulf of Mexico fishery management plans that encompass the area within which the CREC is located:

- Red Drum – All Gulf of Mexico estuaries, waters, and substrates extending from Vermilion Bay, Louisiana, to the eastern edge of Mobile Bay, Alabama, out to depths of 25 fathoms (45.8 m); waters and substrates extending from Crystal River, Florida, to Naples, Florida, between depths of 5 to 10 fathoms (9.1 to 18.3 m); waters and substrates extending from Cape Sable, Florida, to the boundary between areas covered by the GMFMC and the South Atlantic Fishery Management Council between depths of 5 to 10 fathoms (9.1 to 18.3 m)

- Reef Fish – Gulf of Mexico waters and substrates extending from the U.S.-Mexico border to the boundary between the area covered by the GMFMC and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms (182.9 m)

- Coastal Migratory Pelagics – Gulf of Mexico waters and substrates extending from the U.S.-Mexico border to the boundary between the area covered by the GMFMC and the South Atlantic Fishery Management Council from estuarine waters out to depths of 100 fathoms (182.9 m)

- Shrimp – Gulf of Mexico waters and substrates extending from the U.S.-Mexico border to Fort Walton Beach, Florida, from estuarine waters out to depths of 100 fathoms; waters and substrates extending from Grand Isle, Louisiana, to Pensacola Bay, Florida, between depths of 100 to 325 fathoms (182.9 to 594.4 m); waters and substrates extending from Pensacola Bay, Florida, to the boundary between the area covered by the GMFMC and the South Atlantic Fishery Management Council out to depths of 35 fathoms (64 m), with the exception of waters extending from Crystal River, Florida, to Naples, Florida, between depths of 10 to 25 fathoms (18.3 to 33.5 m) and in Florida bay between depths of 5 to 10 fathoms (9.1 to 18.3 m)

- Stone Crab – Gulf of Mexico waters and substrates extending from the U.S.-Mexico border to Sanibel, Florida, from estuarine waters out to depths of 10 fathoms (18.3 m); waters and substrates extending from Sanibel, Florida, to the boundary between the areas covered by the GMFMC and the South Atlantic Fishery Management Council from estuarine waters out to depths of 15 fathoms (27.4 m) (GMFMC, 2004), (GMFMC, 2005)

EFH for species listed in the Gulf of Mexico fishery spiny lobster and coral and coral reef fishery management plans do not encompass the area affected by CREC operations.

The NMFS (2009) provided a list of species managed by the GMFMC for Ecoregion 2 (Table 1). The Staff eliminated some of these species or their life stages from further consideration based on its review of habitat and life history information that suggests that the presence of some species or life stage is unlikely to occur near areas affected by CREC operations. Table 2 is an amended list of species and life history stages excluded and included in this EFH assessment.

Table 1. Ecoregion 2 Species Managed by the Gulf of Mexico Fishery Management Council

Common Name (Scientific Name)	Life Stage	System[(a)]	Essential Fish Habitat[(b)]
Red drum			
Red drum (*Sciaenops ocellatus*)	Eggs	M	Planktonic
	Larvae/ post-larvae	E	Planktonic, SAV, sand/shell/soft bottoms, emergent marshes
	Juveniles	M/E	<5 m; SAV, sand/shell/soft/hard bottoms, emergent marshes
	Adults	M/E	1–46 m; SAV, pelagic, sand/shell/soft/hard bottoms, emergent marshes
Reef fish – triggerfishes (Balistidae)			
Gray triggerfish (*Balistes capriscus*)	Eggs	M	10–100 m; reefs
	Larvae	M	Drift algae (Sargassum)
	Post-larvae/ juveniles	M	10–100 m; drift algae (Sargassum), mangroves, reefs
Reef fish – jacks (Carangidae)			
Greater amberjack (*Seriola dumerili*)	Eggs	M	1–183 m; planktonic
	Larvae	M	1–183 m; pelagic
	Juveniles	M	1–183 m; drift algae (Sargassum)
Lesser amberjack (*Seriola fasciata*)	Eggs	M	Planktonic
	Larvae	M	Pelagic
	Juveniles	M	55–130 m; drift algae (Sargassum)
Almaco jack (*Seriola rivoliana*)	Eggs	M	15–160 m; planktonic
	Juveniles	M	15–160 m; drift algae (Sargassum)
Banded rudderfish (*Seriola zonata*)	Larvae	M	10–130 m; planktonic
	Juveniles	M	10–130 m; drift algae (Sargassum)
Reef fishes – wrasses (Labridae)			
Hogfish (*Lachnolaimus maximus*)	Juveniles	E/M	3–30 m; SAV
Reef fish – snappers (Lutjanidae)			
Schoolmaster (*Lutjanus apodus*)	Eggs	M	<90 m; planktonic
	Larvae	M	<90 m; planktonic
	Juveniles	E/M	<90 m; SAV, mangroves, emergent marshes, reefs, hard substrates
Blackfin snapper (*Lutjanus buccanella*)	Eggs	M	40–183 m; planktonic
	Juveniles	M	12–40 m; hard bottoms

Common Name (Scientific Name)	Life Stage	System[(a)]	Essential Fish Habitat[(b)]
Red snapper (*Lutjanus campechanus*)	Eggs	M	18–37 m; planktonic
	Larvae	M	18–37 m; planktonic
	Juveniles	M	17–183 m; hard/soft/sand/shell bottoms
	Adults	M	7–146 m; reefs, hard/sand/shell bottoms
Gray snapper (*Lutjanus griseus*)	Eggs	M	<180 m; planktonic reefs
	Larvae	M/E	<180 m; planktonic, reefs
	Post-larvae/ juveniles	M/E	<180 m; SAV, mangroves, emergent marshes
	Adults	E/M	<180 m; emergent marshes, reefs, sand/shell/soft/hard bottoms
Dog snapper (*Lutjanus jocu*)	Eggs	M	Planktonic
	Larvae	M	Planktonic
	Juveniles	E/M	SAV, mangroves, emergent marshes
Lane snapper (*Lutjanus synagris*)	Eggs	M	4–132 m; planktonic
	Larvae	E/M	4–132 m; reefs, SAV
	Juveniles	E/M	<20 m; SAV, mangroves, reefs, sand/shell/soft bottoms
Yellowtail snapper (*Ocyurus chrysurus*)	Eggs	M	1–183 m; planktonic
	Juveniles	M/E	1–183 m; SAV, mangroves, soft bottoms
	Adults	M	1–183 m; reefs, hard bottoms, shoals/banks
Vermilion snapper (*Rhomboplites aurorubens*)	Eggs	M	>180 m; planktonic
	Juveniles	M	1–25 m; reefs, hard bottoms
	Adults	M	>180 m; reefs, hard bottoms
Reef fish – tilefishes (Malacanthidae)			
Goldface tilefish (*Caulolatilus chrysops*)	Eggs	M	60–183 m; planktonic
	Larvae	M	60–183 m; planktonic
Blueline tilefish (*Caulolatilus microps*)	Eggs	M	60–183 m; planktonic
	Larvae	M	60–183 m; planktonic
Golden tilefish (*Lopholatilus chamaeleonticeps*)	Eggs	M	80–183 m; planktonic
	Larvae	M	80–183 m; planktonic
	Juveniles	M	80–183 m; hard/soft bottoms, shelf edge/slope
Reef fish – groupers (Serranidae)			
Dwarf sand perch (*Diplectrum bivittatum*)	Juveniles	M	Hard bottoms
Rock hind (*Epinephelus adscensionis*)	Eggs	M	2–100 m; planktonic
	Larvae	M	2–100 m; planktonic
	Juveniles	M	2–100 m; reefs

Common Name (Scientific Name)	Life Stage	System[(a)]	Essential Fish Habitat[(b)]
Speckled hind (*Epinephelus drummondhayi*)	Eggs	M	146–183 m; planktonic
	Larvae	M	146–183 m; planktonic
Yellowedge grouper (*Epinephelus flavolimbatus*)	Eggs	M	35–183 m; planktonic
	Larvae	M	35–183 m; planktonic
	Post-larvae/ juveniles	M	35–183 m; hard bottoms
	Adults	M	35–183 m; reefs, hard bottoms
Red hind (*Epinephelus guttatus*)	Eggs	M	18–110 m; planktonic
	Larvae	M	18–110 m; planktonic
	Juveniles	M	2–110 m; reefs
Red grouper (*Epinephelus morio*)	Eggs	M	20–100 m; planktonic
	Larvae	M	20–100 m; planktonic
	Juveniles	M/E	<50 m; hard bottoms, SAV, reefs
	Adults	M	3–183 m; reefs, hard bottoms
Warsaw grouper (*Epinephelus nigritus*)	Eggs	M	40–183 m; planktonic
	Larvae	M	40–183 m; planktonic
	Juveniles	M	20–30 m; reefs
Nassau grouper (*Epinephelus striatus*)	Eggs	M	Planktonic
	Larvae	M	2–50 m; planktonic
	Juveniles	M	SAV, reefs
	Adults	M	0–100 m; reefs and crevice caves
Black grouper (*Mycteroperca bonaci*)	Eggs	M	18–28 m; planktonic
	Larvae	M	10–150 m; planktonic
	Juveniles	M/E	SAV, hard bottoms, reefs
	Adults	M	10–150 m; hard bottoms, mangroves, reefs
Gag (*Mycteroperca microlepis*)	Eggs	M	50–120 m; planktonic
	Larvae	M	50–120 m; planktonic
	Juveniles	M/E	<50 m; SAV, reefs, hard bottoms
	Adults	M	20–120 m; hard bottoms, reefs
Scamp (*Mycteroperca phenax*)	Eggs	M	60–189 m; planktonic
	Larvae	M	6–189 m; planktonic
	Juveniles	M	12–33 m; hard bottoms, reefs, mangroves
Coastal migratory pelagics			
Spanish mackerel (*Scomberomorus maculatus*)	Eggs	M	<50 m; planktonic
	Larvae	M	9–84 m; planktonic
	Juveniles	M	<50 m; pelagic
	Adults	E/M	<75 m; pelagic

Common Name (Scientific Name)	Life Stage	System[a]	Essential Fish Habitat[b]
		Shrimp	
White shrimp (*Litopenaeus setiferus*)	Eggs	M	9–34 m; sand/shell/soft bottoms
	Larvae	E/M	<64 m; plankton, soft bottoms, estuarine marshes
	Juveniles	E	Soft bottoms, estuarine marshes
Pink shrimp (*Farfantepenaeus duorarum*)	Eggs	M	<50 m; sand/shell bottoms
	Larvae	M	<50 m; planktonic, sand/shell bottoms, SAV
	Juveniles	E	<64 m; sand/shell bottoms, SAV
	Adults	M	<64 m; sand/shell bottoms
		Stone crabs	
Florida stone crab (*Menippe mercenaria*)	Eggs	E/M	<62 m; sand/shell/ hard bottoms, SAV, reefs
	Larvae	E/M	<62 m; planktonic
	Juveniles	E/M	<62 m; sand/shell/hard bottoms, SAV
Gulf stone crab (*Menippe adina*)	Eggs	E/M	<18 m; sand/shell/soft bottoms
	Larvae/ post-larvae	E/M	<18 m; planktonic, oyster reefs, soft bottoms
	Juveniles	E	<18 m; sand/shell/soft bottoms, oyster reefs
		Corals	
Coral	All stages	M	planktonic, Florida middle grounds, reefs

(a) M = marine; E = estuarine

(b) SAV = submerged aquatic vegetation. To convert meters to feet, multiply by 3.28.

Source: NMFS, 2009

Table 2. Species or Life Stages Excluded from and Retained for the Essential Fish Habitat Assessment

Common Name (Scientific Name)	Life Stages Excluded[a] (Rationale for Exclusion)	Life Stages Retained[a]
	Red drum	
Red drum (*Sciaenops ocellatus*)	None	Eggs, larvae/post-larvae, juveniles, adults
	Reef fish – triggerfishes (Balistidae)	
Gray triggerfish (*Balistes capriscus*)	All life stages (Depth requirements and drift algae not present in the affected area.)[b]	None
	Reef fish – jacks (Carangidae)	
Greater amberjack (*Seriola dumerili*)	None	Eggs, larvae, juveniles
Lesser amberjack (*Seriola fasciata*)	All life stages (Depth requirements not present in the affected area.)	None
Almaco jack (*Seriola rivoliana*)	All life stages (Depth requirements not present in the affected area.)	None
Banded rudderfish (*Seriola zonata*)	All life stages (Depth requirements not present in the affected area.)	None
	Reef fish – wrasses (Labridae)	
Hogfish (*Lachnolaimus maximus*)	None	Juveniles
	Reef fish – snappers (Lutjanidae)	
Schoolmaster (*Lutjanus apodus*)	None	Eggs, larvae, juveniles
Blackfin snapper (*Lutjanus buccanella*)	All life stages (Depth requirements not present in the affected area.)	None
Red snapper (*Lutjanus campechanus*)	All life stages (Depth requirements not present in the affected area.)	None
Gray snapper (*Lutjanus griseus*)	None	Eggs, larvae, post-larvae/juveniles, adults
Dog snapper (*Lutjanus jocu*)	None	Eggs, larvae, juveniles

Common Name (Scientific Name)	**Life Stages Excluded[a] (Rationale for Exclusion)**	**Life Stages Retained[a]**
Lane snapper (*Lutjanus synagris*)	Eggs (Depth requirements not present in the affected area.)	Larvae, juveniles
Yellowtail snapper (*Ocyurus chrysurus*)	Eggs (Depth requirements not present in the affected area.)	Juveniles, adults
Vermilion snapper (*Rhomboplites aurorubens*)	Eggs, adults (Depth and substrate requirements not present in the affected area.)	Juveniles
	Reef fish – tilefishes (Malacanthidae)	
Goldface tilefish (*Caulolatilus chrysops*)	All life stages (Depth requirements not present in the affected area.)	None
Blueline tilefish (*Caulolatilus microps*)	All life stages (Depth requirements not present in the affected area.)	None
Golden tilefish (*Lopholatilus chamaeleonticeps*)	All life stages (Depth requirements not present in the affected area.)	None
	Reef fish – groupers (Serranidae)	
Dwarf sand perch (*Diplectrum bivittatum*)	None	Juveniles
Rock hind (*Epinephelus adscensionis*)	Eggs, larvae (Depth requirements not present in the affected area.)	Juveniles
Speckled hind (*Epinephelus drummondhayi*)	All life stages (Depth requirements not present in the affected area.)	None
Yellowedge grouper (*Epinephelus flavolimbatus*)	All life stages (Depth and substrate requirements not present in the affected area.)	None
Red hind (*Epinephelus guttatus*)	All life stages (Depth requirements not present in the affected area.)	None
Red grouper (*Epinephelus morio*)	Eggs, larvae, adults (Depth requirements not present in the affected area.)	Juveniles
Warsaw grouper (*Epinephelus nigritus*)	All life stages (Depth and substrate requirements not present in the affected area.)	None

Common Name (Scientific Name)	Life Stages Excluded[(a)] (Rationale for Exclusion)	Life Stages Retained[(a)]
Nassau grouper (*Epinephelus striatus*)	None	Eggs, larvae, juveniles, adults
Black grouper (*Mycteroperca bonaci*)	Eggs, larvae, adults (Depth requirements not present in the affected area.)	Juveniles
Gag (*Mycteroperca microlepis*)	Eggs, larvae, adults (Depth requirements not present in the affected area.)	Juveniles
Scamp (*Mycteroperca phenax*)	All life stages (Depth and substrate requirements not present in the affected area.)	None
	Coastal migratory pelagics	
Spanish mackerel (*Scomberomorus maculatus*)	Eggs, larvae (Depth requirements not present in the affected area.)	Juveniles, adults
	Shrimp	
White shrimp (*Litopenaeus setiferus*)	Eggs (Depth requirements not present in the affected area.)	Larvae, juveniles
Pink shrimp (*Farfantepenaeus duorarum*)	Eggs (Depth requirements not present in the affected area.)	Larvae, juveniles, adults
	Stone crabs	
Florida stone crab (*Menippe mercenaria*)	Eggs (Remain attached to the female until hatching, and EFH for adult life stage not identified as of concern in Ecoregion 2)	Larvae, juveniles
Gulf stone crab (*Menippe adina*)	All life stages (Species not present in geographical area.)	None
	Corals	
Coral	All life stages (Depth and substrate requirements not present in the affected area.)	None

(a) Only life stages listed in NMFS, 2009 considered.

(b) The affected area is that portion of Crystal Bay area bordered on the north by the Withlacoochee River and on the south by the Crystal River.

4.0 EFH SPECIES CONSIDERED FOR IN-DEPTH ANALYSIS

This section discusses the retained species and life stages listed in Table 2. Species descriptions include information on species depth distributions, relevant migratory and spawning habits, tolerance and preference ranges for temperature and salinity, habitat needs, and information on food preferences.

4.1 Red Drum (*Sciaenops Ocellatus*): Eggs, Larvae, Juveniles, and Adults

The red drum (*Sciaenops ocellatus*), a member of the drum family (Sciaenidae), occurs from the Gulf of Maine to Tuxpan, Mexico (Reagan, 1985). Schools of red drum are common at depths less than 230 ft (70 m) (GMFMC, 2004). In the Gulf of Mexico, red drum can live up to 40 years; males mature when 1 to 3 years old and females when 3 to 6 years old (FWC, 2009). Spawning occurs in inlets, estuaries, or nearshore shelf waters (FWC, 2009). Most spawning in the Gulf of Mexico occurs from mid-August to December, with spawning along the west coast of Florida beginning in September and peaking in October (Reagan, 1985). A female red drum can produce 20,000 to 2 million eggs per spawn (Reagan, 1985). Levin and Stunz (2005) reported the following number of eggs produced per female: 10.9 for sub-adults (1 to 2 years old); 3,422,000 for adults 3 to 9 years old; and 15,207,000 for adults 10+ years old.

Eggs. Spawning occurs at depths of 131 to 230 ft (40 to 70 m). The pelagic eggs drift into estuaries on tides and currents. Spawning occurs at a temperature range of 68 °F to 86 °F (20 °C to 30 °C) with an optimal temperature of 77 °F (25 °C) and at salinities of 24 to 34 ppt (GMFMC, 2004). Eggs hatch in 24 to 30 hours at water temperatures of 70 °F to 74 °F (21.1 °C to 23.3 °C) (Davis, 1990).

Larvae. Newly hatched larvae spend about 20 days in the water column before becoming demersal (FWC, 2009). The planktonic larvae passively drift into estuaries (GMFMC, 2004). Demersal larvae occur in vegetated or unvegetated soft substrates in estuaries, tidal flats, and open bays from mid-August through late November. Preference is for vegetated muddy bottoms if available; otherwise the larvae inhabit soft or hard bottom unvegetated areas with little or no current. Juveniles occur at a temperature range of 64.9 °F to 87.8 °F (18.3 °C to 31 °C) with an optimal temperature of 77 °F (25 °C) and at salinities of 16 to 36 ppt with an optimal salinity of 30 ppt. Copepods are the primary prey of larval red drum (GMFMC, 2004).

Juveniles. Within estuaries, small juveniles inhabit rivers, bays, canals, tidal creeks, boat basins, and passes. Sub-adults also occur in these habitats. Additionally, large aggregations of sub-adults occur on seagrass beds, oyster reefs, mud flats, and sand bottoms. Early juveniles are most abundant during early winter in backwater protected areas, tidal flats, and open waters of bays at depths up to 9.8 ft (3 m). Late juveniles occur in depths up to 16.4 ft (5 m). Habitat preference is for grassy clumps or muddy bottoms, avoiding currents or shallow unvegetated bays. Juvenile red drums occur at temperatures of 54.5 °F to 90 °F (12.5 °C to 32.2 °C) and salinities of 0 to 45 ppt (with 20 to 40 ppt preferred). Juveniles feed on copepods, mysids, and amphipods (FWC, 2009). Larger juveniles feed on fish and shellfish, with crabs becoming more important in the diet as they grow (GMFMC, 2004).

Adults. Adult red drum inhabit continental shelf and inshore waters. Adults regularly occur at depths of 131 to 230 ft (40 to 70 m), but also inhabit littoral and shallow nearshore waters including bayous, bays near barrier islands, and inshore marsh habitats. Red drum adults occur at a temperature range of 35.6 °F to 95 °F (2 °C to 35 °C), moving into deeper waters when extreme temperatures occur. Salinity range is 0 to 45 ppt with a preference of 20 to 40 ppt. Adult red drums prey on crabs, shrimp, and fishes (GMFMC, 2004).

4.2 Greater Amberjack (*Seriola dumerili*): Eggs, Larvae, and Juveniles

The greater amberjack (*Seriola dumerili*), a member of the jack family (Carangidae), occurs throughout the Gulf of Mexico primarily in offshore habitats to depths of 1,300 ft (400 m). Spawning occurs in offshore areas. The pelagic eggs and larvae are associated with offshore areas; while juveniles are associated with drift algae in both offshore and nearshore areas. However, eggs, larvae, and juveniles may drift into shallower marine habitats (GMFMC, 2004).

<u>Eggs</u>. Eggs occur in the open Gulf at salinities of 30 to 35 ppt. Hatching occurs in 2 days (GMFMC, 2004).

<u>Larvae</u>. Larvae are present year-round in offshore open waters at salinities of 30 to 35 ppt (GMFMC, 2004).

<u>Juveniles</u>. Juveniles are often associated with rip lines and floating Sargassum. They are present year-round in offshore open waters at salinities of 30 to 35 ppt. They prey on invertebrates (GMFMC, 2004).

4.3 Hogfish (*Lachnolaimus maximus*): Juveniles

Hogfish (*Lachnolaimus maximus*), a member of the wrasse family (Labridae), range from North Carolina, through the Caribbean Sea and Gulf of Mexico, to the northern coast of South America (FWC, 2009). The species is primarily associated with hard sand and rock bottoms near shallow patch reefs near main reef structures at depths of 10 to 100 ft (3 to 30 m) (Bester, 2010a). Spawning occurs from September to April, peaking in February and March (Ault et al., 2003).

<u>Juveniles</u>. Juvenile hogfish occur in shallow estuarine and marine areas near SAV habitats; where they forage on benthic crustaceans, mollusks, and echinoderms (FWC, 2009), (GMFMC, 2004).

4.4 Gray Snapper (*Lutjanus griseus*): Eggs, Larvae, Juveniles, and Adults

The gray snapper (*Lutjanus griseus*), a member of the snapper family (Lutjanidae), ranges from Massachusetts to Brazil, being especially abundant along the coastline of Florida (Bester, 2010b). It is typically found at depths of 98 to 590 ft (30 to 180 m), but can occur at depths up to 585 ft (180 m) (Bester, 2010b), (Hill, 2005a). The gray snapper often aggregates at coral reefs, rocky areas, estuaries, and mangrove habitats (Bester, 2010b), (Benson, 1982). Spawning occurs offshore in aggregations over rock or sand substrates from April to November, peaking in summer months. Spawning may occur multiple times during the season. The gray snapper is a broadcast spawner of demersal eggs (Bester, 2010b), (Benson, 1982). Fecundity can be as high as 5.9 million eggs (Bortone and Williams, 1986).

<u>Eggs</u>. Gray snappers spawn in offshore reefs and nearshore reefs and shoals from June to August. The eggs are present from June through September in offshore shelf waters and offshore and nearshore reefs (GMFMC, 1998).

Larvae. Larvae are present in offshore shelf waters and near coral reefs from April through November with abundance peaking in June through August (GMFMC, 2004). Larvae are planktonic at lengths under 0.4 inch (1 cm) (Bester, 2010b). Larvae occur at a temperature range of 61 °F to 81 °F (16 °C to 27 °C) (Benson, 1982). Post-larvae move into estuarine habitats, especially over dense seagrass beds and within mangroves (Bester, 2010b), (GMFMC, 2004). Larvae prey on zooplankton and amphipods (GMFMC, 2004).

Juveniles. Juveniles occur in marine, estuarine, and riverine areas in seagrass beds, marl bottom, mangrove, and emergent marsh habitats (GMFMC, 2004). Juveniles use estuarine bays as nursery grounds from May through September, migrating to deeper offshore waters in fall (Benson, 1982). Juveniles occur at a temperature range of 55 °F to 96.8 °F (12.8 °C to 36 °C) and salinities of 0 to nearly 67 ppt. Juveniles prey on amphipods, shrimp, crabs, mollusks, polychaetes, and fish (GMFMC, 2004).

Adults. Adult gray snappers occur in marine, estuarine, and riverine areas (GMFMC, 1998). Within estuaries, adults feed in soft bottom, sand/shell, and SAV habitats; while in nearshore and offshore areas, adults feed in soft bottom, sand/shell, hard bottom, and reef habitats (GMFMC, 2004). Adult gray snappers occur at a temperature range of 51.8 °F to 90.5 °F (11 °C to 32.5 °C) and salinities of 0 to nearly 48 ppt (Benson, 1982), (GMFMC, 2004). Spawning occurs in offshore waters around reefs and shoals (GMFMC, 2004). Adults prey upon small fishes, shrimp, crabs, gastropods, and cephalopods (Bester, 2010b).

4.5 Lane Snapper (*Lutjanus synagris*): Larvae and Juveniles

The lane snapper (*Lutjanus synagris*), a member of the snapper family (Lutjanidae), ranges from North Carolina to southern Brazil; being most abundant in the Antilles, off Panama, and the northern coast of South America (Murray and Bester, 2010). Adults regularly inhabit high salinity offshore habitats at depths of 13 to 433 ft (4 to 132 m) (Benson, 1982) but occur to depths of 1,300 ft (400 m) (Murray and Bester, 2010). Group spawning occurs offshore. Fecundity can be nearly 1 million eggs per female (Bortone and Williams, 1986). Eggs are pelagic and hatch after about 23 hours (Hill, 2005b). Lane snappers occur at a temperature range of 59 °F to 81.5 °F (15 °C to 27.5 °C) (Bortone and Williams, 1986). The lane snapper preys on fish and invertebrates (Hill, 2005b).

Larvae. Larvae are planktonic at lengths under 0.4 inch (1 cm) (Murray and Bester, 2010). Post-larvae occur in nearshore areas in reef and SAV habitats and in estuarine areas in SAV habitats (GMFMC, 2004).

Juveniles. Juveniles are present in late summer to early fall in nearshore and estuarine areas at depths up to 66 ft (20 m). Habitats selected include SAV, mangroves, sand/shell, soft bottoms, and reefs. Juveniles normally occur at salinities ranging from 19.1 to 35 ppt, varying with the tidal cycle (Hill, 2005b), but often occur at salinities less than 15 ppt (GMFMC, 2004). Juveniles migrate to offshore waters in the winter (Benson, 1982). Prey items include copepods, amphipods, decapods, and fishes (FWC, 2009).

4.6 Schoolmaster (*Lutjanus apodus*): Eggs, Larvae, and Juveniles

The schoolmaster (*Lutjanus apodus*), a member of the snapper family (Lutjanidae), occurs throughout the Gulf of Mexico where it is most common along western Florida. Spawning occurs in offshore areas. The planktonic eggs and larvae occur in offshore and nearshore areas. Early juveniles inhabit SAV and mangroves in nearshore and estuarine areas. Late juveniles occur in reefs and hard bottom habitats in offshore areas; reefs, hard bottom, SAV, and mangrove habitats in nearshore areas; and SAV and mangroves in estuarine areas (GMFMC, 2004).

Eggs. Schoolmaster eggs are planktonic (GMFMC, 2004) and are associated with water depths up to 295 ft (90 m) (NMFS, 2009).

Larvae. Schoolmaster juveniles are planktonic (GMFMC, 2004) and are associated with water depths up to 295 ft (90 m) (NMFS, 2009).

Juveniles. Early juvenile schoolmasters occur in shallow habitats such as seagrass beds and mangrove habitats and around jetties. As juveniles grow, they tend to move to deeper waters such as offshore rocky and coral reefs. Early juveniles prey on crustaceans. Late juveniles also prey on crustaceans but primarily feed on fishes (GMFMC, 2004).

4.7 Dog Snapper (*Lutjanus jocu*): Eggs, Larvae, and Juveniles

The dog snapper (*Lutjanus jocu*), a member of the snapper family (Lutjanidae), ranges from Massachusetts to Brazil, but is rare north of Florida. Spawning typically occurs near Jamaica and the northeastern Caribbean although a lesser degree of spawning does occur throughout the range of the species (Murray, 2010). Juveniles and adults are commonly found around coral reefs and rocky bottoms at depths of 16 to 100 ft (5 to 30 m), although young occur in estuaries and will swim into rivers (Murray, 2010). The dog snapper preys on smaller fish and invertebrates (e.g., shrimp, crabs, gastropods, and squid) (Murray, 2010). Adult dog snappers occur throughout coastal waters ranging from estuarine and nearshore SAV habitats to nearshore and offshore reefs. Spawning occurs on nearshore reefs at depths of 49 to 98 ft (15 to 30 m). Adults mostly prey on fishes as well as on crustaceans and other invertebrates (GMFMC, 2004).

Eggs. Dog snapper eggs are pelagic, occurring in nearshore areas (GMFMC, 2004).

Larvae. Dog snapper larvae are pelagic, occurring in nearshore areas (GMFMC, 2004).

Juveniles. Dog snapper juveniles occur in nearshore and estuarine areas and early juveniles may enter rivers. Nursery habitats include SAV, emergent marshes, and mangrove roots. Juveniles may also forage in sand, shell, or soft bottom estuarine habitats. Late juveniles move to deeper waters as they grow (GMFMC, 2004).

4.8 Yellowtail Snapper (*Lutjanus chrysurus*): Juveniles and Adults

The yellowtail snapper (*Lutjanus chrysurus*), a member of the snapper family (Lutjanidae), ranges from Massachusetts to southeastern Brazil; being most common in the Bahamas, off south Florida, and in the Caribbean Sea (Bester, 2010c). Adults generally occur over sandy areas or hard bottom habitats at depths of 32 to 230 ft (10 to 70 m) (Bester, 2010c). Spawning occurs year-long in offshore aggregations although spawning activity declines in winter months (Bester, 2010c). Fecundity can be as high as 1.5 million eggs per female (Hill, 2005c). Eggs are planktonic and primarily occur in offshore marine waters (GMFMC, 2004). Larvae are also planktonic at lengths less than 0.4 inch (10 cm) (Bester, 2010c), (Hill, 2005c). The yellowtail snapper may live 6 to 14 years (Bester, 2010c). The preferred upper temperature range for the yellowtail snapper is 75 °F to 86 °F (24 °C to 30 °C) (Bortone and Williams, 1986); while the upper lethal temperature is 92.3 °F to 93.2 °F (33.5 °C to 34 °C) (Hill, 2005c).

Juveniles. Early juvenile yellowtails occur in nearshore and estuarine areas in SAV, mangrove roots, and soft bottom habitats. Late juveniles inhabit reefs in nearshore areas. Juveniles primarily prey on zooplankton, benthic invertebrates, and detritus (FWC, 2009), (GMFMC, 2004).

Adults. Adult yellowtail snappers occur from very shallow waters to depths of almost 600 ft (183 m). Adults primarily occur in nearshore and offshore areas in reef, hard bottom, and shoal/bank habitats. Being semi-pelagic, yellowtail adults prefer deeper reefs. Adults mostly feed on crabs, jellyfish, mollusks, and fishes (FWC, 2009), (GMFMC, 2004).

4.9 Vermilion Snapper (*Rhomboplites aurorubens*): Juveniles

The vermilion snapper (*Rhomboplites aurorubens*), a member of the snapper family (Lutjanidae), ranges from North Carolina, throughout the Gulf of Mexico, to Brazil. Adults occur at depths of 66 to 656 ft (20 to 200 m) over reefs and rocky bottoms (GMFMC, 1998). Offshore spawning occurs from April to September. An individual may spawn several times during this period (GMFMC, 1998).

Juveniles. Juvenile vermillion snappers are typically found over shelf areas of the Gulf of Mexico and occupy hard structure bottom substrates, such as reefs in marine waters (GMFMC, 2004).

4.10 Dwarf Sand Perch (*Diplectrum bivittatum*): Juveniles

The dwarf sand perch (*Diplectrum bivittatum*), a member of the grouper family (Serranidae), occurs in the Gulf of Mexico, the Atlantic coast of Florida, the Caribbean Sea, and Brazil (FishBase, 2010a).

Juveniles. Juveniles inhabit nearshore hard bottom marine areas and move to offshore areas during winter (GMFMC, 2004).

4.11 Red Grouper (*Epinephelus morio*): Juveniles

The red grouper (*Epinephelus morio*), a member of the grouper family (Serranidae), primarily ranges from Massachusetts to Brazil (FWC, 2009). Adults occur in reefs at depths of 16 to 984 ft (5 to 300 m) (Hill, 2005d), preferring depths of 98 to 394 ft (30 to 120 m) (GMFMC, 1998). Spawning occurs at depths of 82 to 295 ft (25 to 90 m) (GMFMC, 1998). Eggs and larvae are pelagic. After about 1 month, the planktonic larvae metamorphose to benthic juveniles after they attain a standard length of 0.8 to 1 inch (2 to 2.5 cm) (Hill, 2005d).

Juveniles. Early juveniles occur in inshore waters at depths ranging from very shallow to 49 ft (15 m). Favored nursery areas are seagrass beds, rock formations, and shallow reefs. Late juveniles move into deeper waters to about 164 ft (50 m) and inhabit hard bottom areas with crevices and other types of hiding places. Juveniles occur at a temperature range of 61 °F to 88.2 °F (16.1 °C to 31.2 °C) and a salinity range of 20.7 to 35.5 ppt. Early juveniles prey on demersal crustaceans, while late juveniles will also consume fish (GMFMC, 2004).

4.12 Nassau Grouper (*Epinephelus striatus*): Eggs, Larvae, and Juveniles

The Nassau grouper (*Epinephelus striatus*), a member of the grouper family (Serranidae), ranges from New England to southeastern Brazil, throughout the Bahamas, Caribbean, and Gulf of Mexico (Dineen, 2004). It is common on offshore rocky habitats and coral reefs throughout the Caribbean (Bester, 2010d). Adult Nassau groupers normally occur in rocky reefs at depths up to 328 ft (100 m) (Dineen, 2004). Spawning aggregations of up to 100,000 individuals form at depths of 59 to 130 ft (18 to 40 m) (Bester, 2010d), (GMFMC, 2004). A female can produce over 785,000 planktonic eggs. The fertilized eggs can hatch in less than 29 hours (Dineen, 2004). The planktonic larvae start their transformation to juveniles about 42 days following hatching and complete the process by 46 to 70 days following hatching (Dineen, 2004).

Eggs. Spawning occurs at depths of 59 to 131 ft (18 to 40 m). Eggs occur in December and January with hatching occurring 23 to 40 hours after fertilization (GMFMC, 2004).

Larvae. Larvae are present from January through February with post-larvae extending into March. Larvae occur at depths of 6.6 to 164 ft (2 to 50 m) (GMFMC, 2004). Larvae drift with the currents for about a month before becoming juveniles (Bester, 2010d). They feed on copepods and decapod larvae (GMFMC, 2004).

Juveniles. Early juveniles occur from February through August in shallow waters where they inhabit seagrass beds, macroalgal mats, tilefish mounds, and small coral clumps. Late juveniles occur in August and move to offshore reefs. Juveniles occur at a temperature range of 71.6 °F to 91.4 °F (22 °C to 33 °C) and at salinities of 34 to 40 ppt. Early juveniles consume dinoflagellates, fish larvae, and small crustaceans. Late juveniles are piscivorous (GMFMC, 2004).

4.13 Black Grouper (*Mycteroperca bonaci*): Juveniles

The black grouper (*Mycteroperca bonaci*), a member of the grouper family (Serranidae), ranges from Massachusetts to southern Brazil. It is abundant in south Florida, the Florida Keys, Cuba, and the Bahamas but less common in the eastern Gulf of Mexico (Hill, 2005e). The black grouper mainly occurs at depths of 19 to 108 ft (6 to 33 m) on rocky bottoms and coral reefs (Ford, 2010).

Juveniles. Juveniles occasionally enter estuaries (GMFMC, 1998). Early juveniles occur in SAV habitats, moving to deeper waters as they grow. Late juveniles inhabit shallow water reefs and rocky bottoms, patch reefs, and muddy bottoms of mangrove lagoons. Juveniles mainly consume crustaceans (GMFMC, 2004).

4.14 Gag (*Mycteroperca microlepis*): Juveniles

The gag (*Mycteroperca microlepis*), a member of the grouper family (Serranidae), normally ranges from North Carolina to the Yucatan Peninsula in Mexico; although juveniles have been reported as far north as Massachusetts and adults off the coasts of Bermuda, Cuba, and Brazil (Bester, 2010e). Adults occur at depths of 33 to 328 ft (10 to 100 m) in hard bottoms, reefs and wrecks, coral, and live bottoms. Spawning occurs from December through April in spawning aggregations at depths of 164 to 328 ft (50 to 100 m). Pelagic larvae are present mostly in early spring (GMFMC, 1998).

Juveniles. Early juveniles are present from late spring to early fall, spending 3 to 5 months in nearshore and estuarine areas inhabiting seagrass beds, grass flats, mangroves, rock piles, and oyster beds. In the fall, late juveniles move to deeper hard bottom habitats (e.g., offshore reefs) (GMFMC, 2004), (Hill, 2004). Juveniles occur from very shallow waters to depths of 39 ft (12 m) but are most common at depths less than 16 ft (5 m). Juveniles have been collected at a temperature range of 71.6 °F to 89.6 °F (22 °C to 32 °C) and at salinities of 25.9 to 37.6 ppt. Juveniles less than 8 inches (20 cm) in length feed mostly on crustaceans (Bester, 2010e). Larger juveniles also feed on fishes (including being cannibalistic on other gags) (GMFMC, 2004).

4.15 Rock Hind (*Epinephelus adscensionis*): Eggs, Larvae, and Juveniles

The rock hind (*Epinephelus adscensionis*), a member of the grouper family (Serranidae), occurs from North Carolina to Brazil (FishBase, 2010b). Adults occur at depths of 6.6 to 328 ft (2 to 100 m) with large adults usually captured at depths greater than 98 ft (30 m). Habitats include shallow rocky reefs, rock piles, and oil well rigs.

Eggs. The planktonic rock hind eggs occur in waters 6.6 to 328 ft (2 to 100 m) deep (NMFS, 2009).

Larvae. The planktonic rock hind larvae occur in waters 6.6 to 328 ft (2 to 100 m) deep (NMFS, 2009).

Juveniles. Early juveniles inhabit reefs in nearshore waters 6.6 to 328 ft (2 to 100 m) deep (GMFMC, 2004), (NMFS, 2009).

4.16 Spanish Mackerel (*Scomberomorus maculatus*): Juveniles and Adults

The Spanish mackerel (*Scomberomorus maculatus*), a member of the mackerel family (Scombridae), ranges from Nova Scotia to the Yucatan Peninsula in Mexico. Large schools commonly occur in south Florida (Godcharles and Murphy, 1986). From spring through fall, the Spanish mackerel is most abundant in the northern Gulf or Mexico and along the east coast of the United States as far north as Virginia; in winter it primarily occurs off south Florida and the east coast of Mexico (Godcharles and Murphy, 1986). The Spanish mackerel normally resides at depths ranging from 33 to 115 ft (10 to 35 m), occurring in large schools near the surface. Adults frequent barrier islands and their passes, but during migration they cover long distances close to shore. Larvae primarily occur offshore while juveniles occur both offshore and inshore (Press, 2010). In Florida, spawning occurs from August through September (Press, 2010). A female may produce between 194,000 to 1.5 million eggs (Hill, 2005f). Spanish mackerel larvae usually occur in inner continental shelf areas with salinities of 28 to 37 ppt and at depths greater than 164 ft (50 m) (Hill, 2005f). The Spanish mackerel normally occurs in waters with temperatures ranging from 70 °F to 88 °F (21 °C to 31 °C) and salinities of 32 to 36 ppt (Hill, 2005f).

Juveniles. Spanish mackerel juveniles are pelagic in estuarine and nearshore waters (GMFMC, 2004). Juveniles use seagrasses as nursery areas (Hill, 2005f); but most juveniles stay nearshore in open beach waters (Godcharles and Murphy, 1986). Preferred substrate is clean sand (GMFMC, 1998). Most juveniles occur at temperatures greater than 77 °F (25 °C) and tolerate a wide range of salinities greater than 10 ppt. Juveniles prey mostly on fish and also on crustaceans, gastropods, and squid (GMFMC, 2004).

Adults. Spanish mackerel adults occur in the northern portion of the Gulf, from spring through fall, in estuarine and nearshore waters at depths up to 246 ft (75 m) (GMFMC, 2004). Adults typically occur at depths of 33 to 115 ft (10 to 35 m) (Hill, 2005f). While not estuarine dependent (Benson, 1982), adults may enter estuaries in pursuit of prey. Adults occur at temperatures greater than 68 °F (20 °C) and are usually collected at a temperature range of 69.8 °F to 80.6 °F (21 °C to 27 °C). Spawning occurs on the inner continental shelf. Adults prey on fishes such as clupeids, engraulids, and carangids; as well as on crustaceans and squid (GMFMC, 2004).

4.17 Pink Shrimp (*Farfantepenaeus duorarum*): Larvae, Juveniles, and Adults

The pink shrimp (*Farfantepenaeus duorarum*), a member of the penaeid shrimp family (Penaeidae), occurs from the lower Chesapeake Bay to south Florida, into the Gulf of Mexico, and to Isla Mujeres, Mexico (Bielsa et al., 1983). It inhabits coastal waters and estuaries (Hill, 2002a). Most pink shrimp occur in waters less than 164 ft (50 m) deep (GMFMC, 2004). Pink shrimp may live a year or more (Hill, 2002a). Large males reach a total length of 6.7 inches (17 cm) and obtain sexual maturity at 2.9 inches (7.4 cm); while large females are 8.3 inches (21 cm) long and reach sexual maturity at 3.3 inches (8.5 cm) (Bielsa et al., 1983).

The pink shrimp spawns offshore at depths usually between 13 to 171 ft (4 to 52 m) (Benson, 1982). It can spawn multiple times, with peak spawning occurring from April through July. Spawning occurs at temperatures between 66 °F and 86 °F (19 °C and 30 °C) (Hill, 2002a). Fecundity ranges from 44,000 to 534,000 eggs (Hill, 2002a). Hatching takes only 2 to 3 minutes. There are five naupliar, three protozoeal, three mysid, and several post-larval stages (Hill, 2002a). Post-larvae migrate into estuaries and become benthic once reaching their nursery grounds. Pink shrimp then metamorphose to the juvenile stage (GMFMC, 2004). Post-larval and juvenile pink shrimp commonly occur in seagrass habitats. Sub-adults and adults burrow into the substrate during the day and feed at night (Hill, 2002a). Preferred substrates are calcareous-type sediments and sand/shell/mud mixtures (GMFMC, 2004).

Larvae. Pink shrimp larvae and presettlement post-larvae occur year-round in west Florida and are most abundant in spring and summer. They occur from inshore to 25 mi (40 km) offshore at depths of 3 to 164 ft (1 to 50 m), although larvae are most abundant at depths less than 92 ft (28 m). Pink shrimp larvae are pelagic in nearshore areas (GMFMC, 2004). The larval stage lasts about 2 weeks (Benson, 1982). Tidal currents carry post-larvae through deep passes into the estuarine nursery grounds (Benson, 1982). Post-larvae occur in nearshore waters occurring in SAV and sand/shell habitats. Pink shrimp larvae generally occur at a temperature range of 59 °F to 95 °F (15 °C to 35°C) and a salinity range of 0 to 43 ppt (optimal is 10 to 22 ppt) (GMFMC, 2004). Larvae can occur at temperatures as high as 99 °F (37 °C) (Benson, 1982). Pink shrimp larvae prey on phytoplankton and zooplankton (GMFMC, 2004).

Juveniles. Juvenile pink shrimp occur year-long in west Florida and are most abundant from summer through fall. They occur in nearshore waters at depths less than 3.3 to 9.8 ft (1 to 3 m) and are most abundant at depths less than 6.6 ft (2 m). Juveniles occur in SAV and sand/shell habitats (GMFMC, 2004). After several months in estuaries, mature juveniles migrate offshore from April through September near the surface during ebb tides (Benson, 1982). Pink shrimp juveniles occur at a temperature range of 39 °F to 100 °F (4 °C to 38 °C) (optimum is greater than 82 °F [28 °C]) and a salinity range of 0 to 70 ppt (optimum is greater than 30 ppt) (Benson, 1982), (GMFMC, 2004). Juvenile pink shrimp are opportunistic feeders on detritus, small invertebrates and fishes, and plants (FWC, 2009).

Adults. Non-spawning pink shrimp adults are present year-long and are most abundant from fall through spring. They occur in nearshore sand/shell substrates at depths of 3 to 361 ft (1 to 110 m) and are most abundant at depths of 42 to 164 ft (16 to 50 m). Spawning occurs over shelf waters at depths of 13 to 171 ft (4 to 52 m) (Benson, 1982), (GMFMC, 2004). Adult pink shrimp occur at a temperature range of 50 °F to 97 °F (10 °C to 36 °C) and are most abundant above 77 °F (25 °C) (Benson, 1982), (GMFMC, 2004). They occur at a salinity range of 0 to 70 ppt (Benson, 1982). Adult pink shrimp are opportunistic feeders on detritus, small invertebrates and fishes, and plants (FWC, 2009).

4.18 White shrimp (*Litopenaeus setiferus*): Larvae and Juveniles

The white shrimp (*Litopenaeus setiferus*), a member of the penaeid shrimp family (Penaeidae), ranges along the Atlantic coast from New York to Florida and along the Gulf of Mexico from the Florida Peninsula to Campeche, Mexico. The Crystal Bay area is not one of the centers of abundance for the species (Hill, 2002b), (Muncy, 1984). Most white shrimp do not live as long as a year but some live 2 to 4 years (Hill, 2002b). The white shrimp normally inhabits estuaries and the inner littoral zone along the coast to depths of about 98 ft (30 m). In the Gulf of Mexico, the white shrimp can occur as deep as 262 ft (80 m) but is most abundant in brackish wetlands with connections to shallow, coastal areas (Hill, 2002b). Non-spawning adults are most abundant in late summer and fall in nearshore waters less than 89 ft (27 m) deep. An increase in offshore bottom temperatures initiates spawning behavior (Hill, 2002b). Spawning, which peaks in June or July, generally occurs at depths of 26 to 112 ft (8 to 34 m) and a salinity of at least 27 ppt (Benson, 1982), (Muncy, 1984). A female may release 500,000 to 1 million eggs per spawn and may spawn up to four times during its life (Hill, 2002b), (Muncy, 1984). Eggs sink to the bottom of the water column and hatch after 10 to 12 hours into planktonic nauplii larvae (Hill, 2002b). The larval period lasts 10 or more days that include five naupliar stages, three protozoeal stages, three mysis stages, and two post-larval stages. Two to three weeks after hatching, the planktonic post-larval white shrimp travel to estuaries and tidally-influenced wetlands that serve as nursery areas (GMFMC, 2004), (Hill, 2002b). Preferred nursery areas contain muddy substrates in waters with low to moderate salinity (Hill, 2002b). Estuarine marshes and seagrass beds provide both food and protection (Turner and Brody, 1983).

Larvae. White shrimp larvae occur at all levels of the water column (Benson, 1982). Larvae primarily occur over nearshore shelf waters and in passes to estuaries. From May through November (with peak in June and September), presettlement post-larvae migrate through passes in the upper 6.6 ft (2 m) of the water column at night and at mid-depths during the day into estuaries. Post-larvae occur in emergent marshes and soft bottom habitats in estuaries. Post-larval white shrimp occur at temperatures ranging from 54 °F to 90 °F (12 °C to 32 °C) and salinities of 0.4 to 37 ppt (Benson, 1982), (GMFMC, 2004). They feed on phytoplankton and zooplankton (GMFMC, 2004).

Juveniles. Late post-larvae and juveniles are present from late spring through fall, being most abundant in late summer and early fall. They generally occur in shallow waters less than 3.3 ft (1 m) deep. Juvenile densities are highest in marsh edges and SAV, followed by marsh ponds and channels, inner marsh, subtidal, and oyster reefs on non-vegetated substrates with high organic content (GMFMC, 2004). After several months in shallow nursery areas, mature larvae move to deeper waters (Benson, 1982). Juveniles occur at a temperature range of 48.2 °F to 96.8 °F (9 °C to 36 °C) and a salinity range of less than 1 to greater than 40 ppt (being most abundant at salinities less than 10 ppt) (Benson, 1982), (GMFMC, 2004). Juvenile pink shrimp prey on polychaetes, crustaceans, and diatoms (GMFMC, 2004).

4.19 Florida Stone Crab (*Menippe mercenaria*): Larvae and Juveniles

Stone crabs, members of the mud crab family (Xanthidae), range from North Carolina to the Yucatan Peninsula and Belize and throughout the Bahamas and Greater Antilles (FWC, 2009). Two species of stone crabs occur along the Gulf coast of Florida: the Florida stone crab (*Menippe mercenaria*) and the Gulf stone crab (*M. adina*). The Gulf stone crab generally replaces the Florida stone crab in the northern and western portions of the Gulf of Mexico. Some hybridization between the species occurs between Cedar Key, Levy County, Florida, and Cape San Blas, Gulf County, Florida (GMFMC, 2004). Most stone crabs in the Crystal Bay area are the Florida stone crab.

Generally, the Florida stone crab occurs in subtidal areas but can occur to depths of 197 ft (60 m) (Puglisi, 2008). Adult Florida stone crabs, which are present year-round, inhabit burrows under rock ledges, coral heads, dead shells, and seagrass patches; they also occur on oyster bars, rock jetties, and artificial reefs that have adequate refugia (GMFMC, 2004). Females generally spawn when they reach 2 years of age (Puglisi, 2008). The lower limit for spawning is 68 °F to 71.6°F (20 °C to 22 °C) with optimal ovarian development at 82.4 °F (28 °C). Spawning occurs year-round, but most often from April through September (GMFMC, 2004); an individual female may produce 4 to 6 egg masses during a single mating season, with each egg mass containing 160,000 to 1 million eggs (Lindberg and Marshall, 1984). The female carries the fertilized eggs under her abdomen until they hatch (Puglisi, 2008). Females with eggs occur at salinities of 28 to 36 ppt (GMFMC, 2004). The Florida stone crab has five zoeal stages and one megalopal stage (Puglisi, 2008). Adult stone crabs occur at temperatures ranging from 46.4 °F to 89.6 °F (8 °C to 32 °C) (Lindberg and Marshall, 1984).

<u>Larvae</u>. Pelagic Florida stone crab larvae occur from spring through fall in nearshore marine environments. The most rapid larval growth occurs in warm water of about 86 °F (30 °C) and salinities of 30 to 35 ppt; with larval survival and growth declining rapidly below temperatures of 77 °F (25 °C) and a salinity of 25 ppt (GMFMC, 2004). At temperatures of 68 °F (20 °C) or less, larval crabs do not survive past the megalopal stage; while temperatures of 41 °F to 59 °F (5 °C to 15 °C) inhibit molting of post-settlement juveniles (Puglisi, 2008). The upper temperature limit for survival is between 95 °F and 104 °F (35 °C and 40 °C) (Brown and Bert, 1993). Larvae consume zooplankton and phytoplankton (GMFMC, 2004).

<u>Juveniles</u>. Juvenile Florida stone crabs are present year-round. They occur in nearshore and estuarine areas in SAV, hard bottom, emergent live rock, sponges, oyster beds, and sand/shell habitats (GMFMC, 1998), (GMFMC, 2004). The temperature tolerance range is from 46.4 °F to 100.4 °F (8 °C to 38 °C); while the salinity tolerance range is from 5 to 40 ppt. Juveniles are opportunistic carnivores although some herbivory is noted (GMFMC, 2004).

5.0 POTENTIAL ADVERSE EFFECTS TO ESSENTIAL FISH HABITAT

The provisions of the MSFCMA define an "adverse effect" to EFH as the following (50 CFR 600.810):

Adverse Effect to EFH

An adverse impact is any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810(a)).

For purposes of conducting National Environmental Policy Act of 1969 (NEPA) reviews, the Staff published the GEIS (NRC, 1996), which identifies 13 impacts to aquatic resources as either Category 1 or Category 2. Category 1 issues are generic in that they are similar at all nuclear plants and have one impact level (SMALL, MODERATE, or LARGE) for all nuclear plants, and mitigation measures for Category 1 issues are not likely to be sufficiently beneficial to warrant implementation. Category 2 issues vary from site to site and require a site-specific evaluation. Table 3 lists the resource issues as identified in the GEIS.

Table 3. Aquatic Resource Issues Identified in the GEIS

Issues	Category	Impact Level
For All Plants[(a)]		
Accumulation of contaminants in sediments or biota	1	SMALL
Entrainment of phytoplankton and zooplankton	1	SMALL
Cold shock	1	SMALL
Thermal plume barrier to migrating fish	1	SMALL
Distribution of aquatic organisms	1	SMALL
Premature emergence of aquatic insects	1	SMALL
Gas supersaturation (gas bubble disease)	1	SMALL
Low dissolved oxygen in the discharge	1	SMALL
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	1	SMALL
Stimulation of nuisance organisms	1	SMALL
For Plants with Cooling-Tower-Based Heat Dissipation Systems[(b)]		
Entrainment of fish and shellfish in early life stages	1	SMALL
Impingement of fish and shellfish	1	SMALL
Heat shock	1	SMALL
For Plants with Once-Through and Cooling Pond Heat Dissipation Systems[(a)]		
Entrainment of fish and shellfish in early life stages	2	SMALL, MODERATE, or LARGE
Impingement of fish and shellfish	2	SMALL, MODERATE, or LARGE
Heat shock	2	SMALL, MODERATE, or LARGE

(a) Applicable to CR-3

(b) Not applicable to CR-3 because CR-3 only has helper cooling towers as part of an open-cycle system

Source: NRC, 1996

The GEIS classifies all impact levels for aquatic resources as “SMALL” except impingement, entrainment, and heat shock, which are classified as “SMALL,” “MODERATE,” or “LARGE.” “SMALL” is defined as, “environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource”; “MODERATE” is defined as, “environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource”; and “LARGE” is defined as, “environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource” (10 CFR Part 51, Appendix B, Table B-1). The Staff believes that impacts concluded to be “SMALL” will also be small for EFH. Therefore, this EFH assessment will focus on the potential adverse effects of impingement, entrainment, and heat shock on EFH. Impingement occurs when aquatic organisms are pinned against intake screens or other parts of the cooling water system intake structure. Entrainment occurs when aquatic organisms (usually eggs, larvae, and other small organisms) enter the cooling water system and experience thermal, physical, and chemical stress. Heat shock is acute thermal stress caused by exposure to a sudden elevation of water temperature that adversely affects the metabolism and behavior of fish and other aquatic organisms. In addition to heat shock, increased water temperatures in the thermal plume can cause chronic thermal effects by reducing the available habitat for aquatic organisms (e.g., causing loss of SAV) if thermal plume temperatures are higher than the environmental preferences of a particular species (e.g., resulting in displacement of managed species or their forage species).

In addition to impingement, entrainment, and heat shock to Federally-managed species, the Staff assessed the impacts to EFH species' food (forage species) in the form of displacement or loss of forage species and loss of forage species habitat, as well as cumulative impacts to EFH species or their habitat resulting from the past, present, and reasonably foreseeable future projects in the vicinity of CR-3.

In summary, the Staff has identified the following potential adverse effects to managed species, their EFH, and their forage species as a result of the proposed license renewal of CR-3:

- impingement
- entrainment
- thermal effects (heat shock and loss of habitat)

The following sections provide a generalized overview of impingement, entrainment, and thermal effects from continued operation of CR-3, followed by specific analyses of the managed species and their life stages identified in Section 4.0.

5.1 Impingement

Three impingement studies have occurred at the CREC since CR-3 became operational (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). The following focuses on those species identified in the Gulf of Mexico fishery management plans for Ecoregion 2 (NMFS, 2009) and collected in impingement samples at the CREC. There is no fish return system at the CREC so all organisms impinged on the intake screens are considered losses from the Crystal Bay ecosystem.

To meet the requirements of NRC Environmental Technical Specifications, NUS Corporation (1978) collected impingement samples during one 24-hour period each week for 51 weeks, between March 13, 1977, and March 13, 1978. Estimated yearly impingement totaled 2,642,402 fishes and 271,672 invertebrates for CR-1 through CR-3. Estimated annual numbers impinged at each unit were as follows:

- CR-1 – 245,535 (9.3 percent of fish) and 46,952 invertebrates (17.4 percent of invertebrates)
- CR-2 – 323,471 fish (12.2 percent of fish) and 92,005 invertebrates (33.9 percent of invertebrates)
- CR-3 – 2,073,396 fish (78.5 percent of fish) and 132,715 invertebrates (48.9 percent of invertebrates)

The only EFH fish species impinged were the gray snapper and Spanish mackerel (NUS Corporation, 1978). Impingement of gray snappers occurred in January, February, July, October, November, and December; while the Spanish mackerel occurred only in October. As neither species was among the dominant fish species impinged, numbers and biomass of these species were not reported (NUS Corporation, 1978). Pink shrimp and stone crabs occurred in all months; while the white shrimp occurred in January, October, November, and December (NUS Corporation, 1978). The pink shrimp was the numerically dominant invertebrate impinged with about 287,700 individuals impinged over the study period (39.9 percent of invertebrates impinged). As neither the white shrimp nor stone crabs were among the most numerically dominant invertebrates impinged, numbers of these species impinged were not reported (NUS Corporation, 1978). Based on estimated biomass of invertebrates impinged (18,168.7 lb [8,241.2 kg]), the pink shrimp ranked second (23.9 percent - 4,342.2 lb [1,969.6 kg]), the stone crab fifth (1.2 percent - 210.8 lb [95.6 kg]), and the white shrimp tenth (0.2 percent - 38.1 lb [17.3 kg]). Impingement of pink shrimp represented only 1 percent of the total commercial catch for the Citrus-Pasco County area (NUS Corporation, 1978).

Impingement studies were included as part of the 316 Demonstration study for assessing impacts as required under NPDES Permit No. FL0000159 for the CREC (SWEC, 1985). Impingement sampling occurred over a 24-hour period once every week for a 1-year period between June 1983 and June 1984. Estimated yearly impingement totaled 647,435 fish and 1,319,341 invertebrates for CR-1 through CR-3. Estimated annual numbers impinged at each unit were as follows:

- CR-1 – 64,987 (10 percent of fish) and 196,985 invertebrates (14.9 percent of invertebrates)
- CR-2 – 280,012 fish (43.2 percent of fish) and 282,302 invertebrates (21.4 percent of invertebrates)
- CR-3 – 302,436 fish (46.7 percent of fish) and 840,054 invertebrates (63.7 percent of invertebrates)

The estimated number of EFH species impinged for all CREC units were: dwarf sand perch - 628, gray snapper - 96, Spanish mackerel - 21, gag - 11, red drum - 11, pink shrimp - 640,887, white shrimp - 8, and Florida stone crab - 1,535. Impingement at the CREC during the 316 Demonstration study represented 0.6 percent of the annual pink shrimp, 0.03 percent of the annual red drum, and 0.01 percent of the annual stone crab commercial catch for Citrus County in 1982 (SWEC, 1985).

The Ager et al. (2008) study provided a baseline assessment of fish and invertebrate impingement upon which to compare impingement following the EPU of CR-3. Bi-weekly 24-hour impingement sampling occurred from December 2006 through November 2007 (Ager et al., 2008). Ager et al. (2008) estimated annual impingement numbers totaled 945,631 fish and 341,780 invertebrates. Estimated annual impingement numbers at each unit were as follows:

- CR-1 – 40,930 fish (4.3 percent of fish) and 35,165 invertebrates (10.3 percent of invertebrates)
- CR-2 – 83,566 fish (8.8 percent of fish) and 50,178 invertebrates (14.7 percent of invertebrates)

- CR-3 – 821,423 fish (86.9 percent of fish) and 256,468 invertebrates (75 percent of invertebrates)

The only EFH species impinged were the gray snapper (February, March, and October), lane snapper (November through May), vermilion snapper (January), Spanish mackerel (March and May), pink shrimp (all months), and Florida stone crab (all months) (Ager et al., 2008). Table 4 presents the number and percentage of EFH species impinged at CR-3 and for CR-1, CR-2, and CR-3 combined.

Table 4. Ecoregion 2 Species Listed in the Gulf of Mexico Fishery Management Plans Impinged at the Crystal River Energy Complex, December 2006 through November 2007

Species		CR-3		All Units[(a)]	
Scientific Name	**Common Name**	**Number (Percent)**	**Biomass[(b)] (Percent)**	**Number (Percent)**	**Biomass (Percent)**
Fishes					
Lutjanus griseus	Gray snapper	292 (0.04)	3.719 (0.02)	331 (0.03)	3.921 (0.02)
Lutjanus synagris	Lane snapper	1,300 (0.16)	10.702 (0.07)	1,715 (0.18)	12.941 (0.07)
Rhomboplites aurorubens	Vermilion snapper	155 (0.02)	1.380 (0.01)	155 (0.02)	1.380 (0.01)
Scomberomorus maculatus	Spanish mackerel	62 (0.01)	39.705 (0.27)	166 (0.02)	51.070 (0.27)
Invertebrates					
Farfantepenaeus duorarum	Pink shrimp	114,442 (44.61)	922.646 (35.04)	149,710 (43.80)	1145.711 (29.95)
Menippe mercenaria[(c)]	Florida stone crab	4,950 (1.93)	44.966 (1.70)	7,950 (3.33)	88.237 (2.31)

(a) Includes CR-1, CR-2, and CR-3.
(b) Biomass in kg (to convert to lb, multiply by 2.2).
(c) Includes individuals only identified as “stone crabs.”
Source: Ager et al., 2008

The NPDES permit contains no requirements for the applicant to conduct impingement monitoring at CR-3 (FDEP, 2005). As discussed in Section 2.2, Phase II of the planned CR-3 EPU should not alter the volume of water withdrawn at the entrance of the intake canal. Therefore, an increase in the number of organisms impinged at CR-3 due to the EPU is not expected. Studies conducted near the CREC since the late 1960s indicate that Crystal Bay near the CREC has maintained a diverse assemblage of fish and shellfish species. Impingement losses will continue at CR-3 during the license renewal term with numbers of fish and shellfish impinged expected to be in the annual range of the 1.1 to 1.2 million organisms reported by NUS Corporation (1978), SWEC (1985), and Ager et al. (2008). CR-3 has an intake flow rate greater than that recommended by the U.S. Environmental Protection Agency (EPA), and its annual impingement numbers are much higher than the 250,000 estimated by the AEC (1973). Based on the preceding information, the Staff has determined that the potential impacts of impingement of fish and shellfish by CR-3 on the Crystal Bay aquatic community during the 20-year renewal period would be SMALL to MODERATE for the purposes of NEPA.

Under the provisions of the CWA 316(b), the FDEP may impose further restrictions or require modifications to the cooling system to reduce the impact of impingement under the NPDES permitting process. The Site Certification Application for Levy Nuclear Plant (LNP) was approved by the Governor's Siting Board on August 11, 2009, and includes a requirement that the applicant shut down CR-1 and CR-2 by the end of 2020 (or by the end of the year when LNP begins operation) (Progress Energy, 2009b). This will lessen impingement impacts to Crystal Bay due to CREC operations

5.2 Entrainment

Only one entrainment study, conducted as part of the 316 Demonstration for the CREC (SWEC, 1985), has occurred since CR-3 became operational. Plankton sampling occurred in the vicinity of the CREC every 2 weeks for 15 months between 1983 and 1984. SWEC (1985) used the highest densities of plankton among three sampling sites near the CREC intakes or near the CREC discharge to estimate entrainment at the CREC. SWEC (1985) observed the highest densities of fish eggs in April and May and the highest invertebrate meroplankton densities in July and August. The following discusses those species identified in the Gulf of Mexico fishery management plans for Ecoregion 2 (NMFS, 2009) that occurred in the entrainment samples at the CREC.

Estimated annual entrainment totaled 300,000 red drum post-larvae at the CREC. This loss represented an equivalent of 18 adults (SWEC, 1985). Annual entrainment of shrimp totaled 220,000 mysis, 18.83 million post-larvae, and 1.023 million juveniles. Assuming these to all be pink shrimp resulted in an equivalent loss of 29,802 adult pink shrimp, about 0.02 percent of the pink shrimp commercially caught in Citrus-Pasco and Levy Counties in 1982 (SWEC, 1985). Florida stone crab zoeal through megalop stage entrainment represented the equivalent loss of 3,652 adults (SWEC, 1985). Over 950,000 lb (430,900 kg) of claws were harvested in Citrus-Pasco and Levy Counties in 1982 and, assuming that claws make up half the crab's weight (Lindberg and Marshall, 1984), entrainment of Florida stone crabs was less than 0.01 percent of the commercial harvest. The 316 Demonstration study provided no information on entrainment of other Federally-managed species (SWEC, 1985).

Adults and other stages of small planktonic invertebrates (e.g., copepods) and phytoplankton (e.g., diatoms), which provide potential forage for Federally-managed species, are generally not sampled in entrainment studies due to their small size and the assumption that their large population sizes and rapid growth and reproduction make ecologically important impacts (e.g., population loss or alteration of community structure) unlikely (York et al., 2005). Nevertheless, prior to CR-3 becoming operational, Fox and Moyer (1973) and Alden (1976) determined entrainment survival of phytoplankton and zooplankton at the CREC.

Fox and Moyer (1973) observed that phytoplankton were either killed or at least hindered in their ability to assimilate carbon due to passage through the CREC; whereas bacteria survive the passage and even increased in numbers due to prolonged exposure to increased heat. Primary production decreased 13.8 to 48.1 percent from passage through the CREC when the intake temperature was 80.6 °F (27 °C) or higher. In summary, if the intake temperature is 80.6 °F (27 °C) or more, there is a loss of primary production by a temperature increase of (9 °F) (5 °C). Fox and Moyer (1973) concluded that as long as the temperature remains above 89.6 °F (32 °C), primary production will continue to drop. However, Fox and Moyer (1973) noted that phytoplankton recovery was rapid; primary production values reached or exceeded those recorded at the intake water within 1 mile from the plant discharge (i.e., recovery would occur within the discharge canal).

Alden (1976) analyzed the growth, reproduction, and survival of copepods subject to entrainment at the CREC and the associated thermal stress on copepods of the Crystal River estuary. Mortality was generally low for temperatures below 86 °F (30 °C), moderate at 87.8 °F to 95 °F (31 °C to 35 °C), and increased exponentially between 95 °F and 98.6 °F (35 °C and 37 °C). Alden (1976) noted that entrained juvenile copepods and juveniles collected from the discharge canal showed depressed growth and reproduction rates compared to copepods collected from the intake canal. Alden (1976) concluded that mechanical damage from condenser passage accounted for only a small percentage of the mortality, but may be the major lethal factor during colder months. Alden (1976) observed that the long-term survival of copepods that did survive entrainment was not significantly different from control populations.

SWEC (1985) concluded that entrainment only had a localized effect on fish and invertebrates of Crystal Bay, with populations concentrated offshore and in the northwest section of the Crystal Bay study area less affected by entrainment. An EPA fact sheet on the CREC NPDES permit prepared in 1993 (as cited in Golder Associates, Inc., 2006) stated that the results of the 316 Demonstration study (SWEC, 1985) showed that entrainment at the CREC has an adverse impact to the aquatic resources of Crystal Bay. The applicant and the EPA determined that a combination of seasonal flow reduction and stock enhancement through rearing and stocking of commercially and recreationally important species would be the most prudent methods to mitigate entrainment losses (Progress Energy, 2008). Flow reductions at the CREC began in 1992; the NPDES permit for the CREC (CR-1 through CR-3) stipulated that cooling water withdrawals would be limited to 1,318,000 gpm (2,937 cfs or 83.2 m^3/s) over the period May 1 through October 31 and 1,132,792 gpm (2,524 cfs or 71.5 m^3/s) from November 1 through April 30 (Progress Energy, 2008). The 15 percent withdrawal reduction from November 1 through April 30 minimizes impacts to fall, winter, and early spring spawners including pinfish (*Lagodon rhomboides*), Atlantic croaker (*Micropogonias undulates*), Gulf flounder (*Paralichthys albigutta*), Gulf menhaden (*Brevoortia patronus*), striped mullet (*Mugil cephalus*), and spot (*Leiostomus xanthurus*) (Golder Associates, Inc., 2007a).

Golder Associates, Inc. (2006) determined that the hydraulic zone of influence (that portion of Crystal Bay hydraulically influenced by the intake within which very weakly motile or planktonic organisms are possibly influenced by the induced flow and, therefore, most likely to be entrained) is up to 197 ac (79.7 ha) from May 1 through October 31 and up to 142 ac (57.5 ha) from November 1 through April 30 (Golder Associates, Inc., 2006). The acreages assume an ambient mean velocity in the bay of 0.1 ft/s (0.03 m/s); as ambient velocities increase, the hydraulic zone of influence would decrease (Golder Associates, Inc., 2006).

The logic behind fish stocking is that releasing a large number of larvae, juvenile, or adult fish or shellfish into a water body may directly compensate for the mortality associated with impingement and entrainment (EPRI, 2003). As part of the negotiated settlement with the EPA to mitigate impacts of the CREC once-through cooling system, Florida Power Corporation opened the Crystal River Mariculture Center in 1991 (FWC, undated). Initial cultures included red drum, spotted seatrout (*Cynoscion nebulosus*), striped mullet, and pink shrimp. Subsequent species cultured at the Mariculture Center included pigfish (*Orthopristis chrysoptera*), silver perch (*Bairdiella chrysoura*), blue crab (*Callinectes sapidus*), and Florida stone crab. To date, Mariculture Center releases of pigfish to

Mariculture

Mariculture is the farming and husbandry of marine plants and animals to replenish natural populations of marine biota depleted by natural or man-made effects (FWC, 2010).

Crystal Bay have not occurred. Total releases made from 1992 through 2009 for the other seven species are as follows (Progress Energy, 2010b):

- Red drum – 947,394 fingerlings and 1,375,500 larvae
- Silver perch – 39,942 first feeding larvae
- Spotted seatrout - 1,131,813 fingerlings and 715,000 larvae
- Striped mullet – 525,000 first feeding larvae
- Blue crab – 93,746,281 zoeal stage I
- Pink shrimp – 415,102 (life stage not provided)
- Stone crab – 32,347,962 zoeal stage I

Releases of fish and shellfish produced at the Mariculture Center occur in areas of the Gulf for which they are best suited, based on time of year and water quality conditions (Progress Energy, 2008).

As discussed in Section 2.2, Phase II of the planned CR-3 EPU should not alter the volume of water withdrawn at the entrance of the intake canal. Therefore, an increase in the number of organisms entrained at CR-3 due to the EPU is not expected. Annual entrainment losses will continue at CR-3 during the license renewal term; with numbers of fish and shellfish entrained expected to be in the billions of organisms with equivalent adult losses in the millions, as observed by SWEC (1985). Nevertheless, studies conducted near the CREC since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009) indicate that Crystal Bay near the CREC has maintained a diverse assemblage of fish and shellfish species.

Based on the review of the information presented above, coupled with the paucity of entrainment studies at the CREC, the Staff has determined that the potential impacts of entrainment of fish and shellfish by CR-3 on the Crystal Bay aquatic community during the 20-year renewal period would be SMALL to MODERATE. Under the provisions of the CWA 316(b), the FDEP may impose further restrictions or require modifications to the cooling system to reduce the impact of entrainment under the NPDES permitting process. The Site Certification Application for the LNP was approved by the Governor’s Siting Board on August 11, 2009, and includes a requirement that the applicant shut down CR-1 and CR-2 by the end of 2020 (or by the end of the year when LNP begins operation) (Progress Energy, 2009a). This will lessen entrainment impacts to Crystal Bay due to CREC operations.

5.3 Thermal Effects

The discharge of heated water from the CREC creates elevated temperatures in Crystal Bay and produces a thermal plume that varies in extent and magnitude based on operational characteristics of the facility, ambient air and water temperatures, and hydrodynamic characteristics of Crystal Bay (e.g., tidal cycle and wave action). The discharge of heated water into Crystal Bay can cause lethal or sublethal effects on resident fish and shellfish, influence food web characteristics and structure, and create barriers to nearshore/offshore or along shore movements of fish and shellfish. However, there are no reports of fish mortality incidents due to heat shock at the CREC. The maximum permitted discharge temperature at the POD for the CREC is 96.5 °F (35.8 °C) as a 3-hour rolling average (FDEP, 2005).

At the CREC, CR-1, CR-2, and CR-3 have once-through cooling systems that withdraw water from and discharge water to the Gulf of Mexico; while CR-4 and CR-5 have closed-cycle systems that withdraw water from the CREC discharge canal and discharge their blowdown back to the discharge canal (Section 2.1.6). At operating design capacity, the rises in discharge temperature from condenser passage from CR-1 through CR-3 are 14.9 °F (8.3 °C), 16.9 °F (9.4 °C), and 17.5 °F (9.7 °C), respectively (Mattson et al., 1988). Combined blowdown temperature from CR-4 and CR-5 is less than their combined intake flow. For example, at a combined intake temperature of 107.3 °F (41.8 °C), the combined blowdown temperature is 94.7 °F (34.8 °C) (Progress Energy, 2009a). Average intake temperature at the CREC is 85.6 °F (29.8 °C) in summer and 63.5 °F (17.5 °C) in winter; while the average discharge temperature at the POD is 93.4 °F (34.1 °C) in summer and 78.1 °F (25.6 °C) in winter (Progress Energy, 2010c). Through NPDES Permit No. FL0000159, the FDEP (2005) regulates the thermal limits of the combined discharge of CR-1 through CR-3 at the POD to Crystal Bay. The discharge temperature at the POD cannot exceed 96.5 °F (35.8 °C) as a 3-hour rolling average.

Prior to CR-3 operations, the thermal discharge from CR-1 and CR-2 had a localized effect on Crystal Bay fishes—attracting them during late fall and early winter and repulsing them during summer (Grimes and Mountain, 1971). Grimes and Mountain (1971) found no statistically significant differences in the occurrence of the four most abundant fish species near the CREC (none of these were Federally-managed species) in thermally affected versus non-affected areas.

When operating at design capacity, thermal discharge from CR-3 is 17.1 °F (9.5 °C) above inlet temperature. The combined discharge for CR-1, CR-2, and CR-3 is 14.5 °F (8.1 °C) (AEC, 1973). The north spoil bank of the intake prevents recycling of heated effluent into the intake canal (AEC, 1973). Tide-induced flow and water influx from the Withlacoochee River-Cross Florida Barge Canal area govern water flow patterns within the thermal mixing zone for the CREC (AEC, 1973). Table 5 tabulates the predicted area of the thermal plume due to the addition of CR-3.

Table 5. Predicted Acreage of the Crystal River Energy Complex Thermal Plume

Temperature Increase above Ambient	Acres[a]		
	Flood Tide	Ebb Tide	Complete Tidal Cycle[b]
1 °F (0.6 °C)	2,860 (1,230)	3,770 (1,620)	4,600 (2,350)
2 °F (1.1 °C)	2,100 (870)	2,760 (1,140)	3,500 (1,700)
4 °F (2.2 °C)	1,350 (420)	1,750 (650)	2,300 (1,050)
6 °F (3.3 °C)	730 (200)	1,130 360)	1,500 (510)
8 °F (4.4 °C)	400 (90)	740 (160)	950 (220)
10 °F (5.5 °C)	220 (-)(c)	430 (-)	500 (-)

(a) To convert to hectares, multiply by 0.4047.
(b) Numbers in parentheses are thermal sizes for CR-1 and CR-2 only.
(c) - = not provided.
Source: AEC, 1973

The AEC (1973) concluded that a localized impact could occur for sessile marine invertebrates, attached algae and plants, some planktonic organisms, and possibly some fishes in the discharge area due to increase of temperature in the discharge effluent from 11.5 °F (6.4 °C) to about 14.5 °F (8.1 °C) and more notably to a more than doubling in the size of the thermal mixing zone. Most ecological impacts would occur when temperatures exceed 95 °F (35 °C), a condition that would occur about 53 percent of the time annually. Most biological and ecological effects would be within the 6 °F (3.3 °C) isotherm, an area that would cover about 1,500 ac (607 ha) over a complete tidal cycle with all three units operating (AEC, 1973).

During the 316 Demonstration study (SWEC, 1985), the mean weekly POD temperatures ranged from 63.2 °F (17.3 °C) (for the period January 1, 1984, through January 7, 1984) to 100.1 °F (37.8 °C) (for the period August 21, 1983, through August 27, 1983). For 9 weeks during the summers of 1983 and 1984, weekly temperatures at the POD ranged between 96.9 °F and 100.1 °F (36.1 °C and 37.8 °C) (SWEC, 1985). These summer discharge temperatures are above the temperature preference, and in some cases tolerance, of a number of aquatic organisms that occur in the area. The lowest densities of fish and invertebrates occurred in the sample transects most affected by thermal discharges (SWEC, 1985). While no clear patterns in benthic infauna density related to thermal areas were evident; a number of mollusk and crustacean species tended to be lower in the thermal areas (SWEC, 1985). Mattson et al. (1988) found that the standing crop, productivity, and growth rates of seagrasses were lower in the thermally-impacted area near the POD at the CREC. Adverse effects also occurred to macroalgal communities.

SWEC (1985) concluded that the thermal discharges from the CREC had an adverse impact on the benthic infaunal community within an area less than 400 ac (162 ha) and minimal benthic infaunal community alterations within an area less than 2,400 ac (971 ha). In general, the thermal effects were limited to an area within about 2.2 mi (3.5 km) from the POD, which encompasses less than 2,400 ac (971 ha) (SWEC, 1985).

Following completion of the 316 Demonstration (SWEC, 1985), the EPA and FDEP issued a public notice of determination that substantial damage had occurred to about 1,100 ac (445 ha) of Crystal Bay, primarily due to thermal discharges (FPC, 2010). Operational constraints placed on CREC operations required a 15 percent flow reduction from November 1 through April 30 and a limitation on plant operations to maintain a 3-hour average temperature not to exceed

96.5 °F (35.8 °C) at the POD. Additional requirements included a seagrass monitoring and planting program, the construction and operation of a mariculture center, and the construction and operation of helper cooling towers. The mariculture center became operational in 1991, seasonal flow reductions started in 1992, and cooling towers became operational in 1993. The cooling tower requirement was primarily to mitigate thermal impacts to water quality and macrophytes (particularly seagrasses) (FPC, 2010).

From May 1 through October 31, a portion of the heated discharge from the CREC flows through the helper cooling towers to meet the NPDES permitted 3-hour rolling average of 96.5 °F (35.8 °C) (FDEP, 2005). During hot summers, the applicant occasionally reduces power at the coal-fired units (CR-1 and CR-2) to stay within NPDES permit thermal limits. In April 2006, the applicant received approval from the FDEP to install additional modular cooling towers. The 67 modular cooling towers allow CR-1 and CR-2 to operate most of the time during the warmest periods of the year without reducing power (Progress Energy, 2008).

The Mote Marine Laboratory surveyed SAV from 1993 through 1995 to determine the potential beneficial effect of the CREC helper cooling towers on the distribution of SAV in the thermal discharge area (FPC, 2010). Results indicated that several new SAV beds occurred in areas that were completely barren of vegetation in 1993, although recruitment of seagrasses into barren areas was not extensive. Additionally, 8 of 15 surveyed seagrass beds showed some expansion beyond their original boundaries, but the percent coverage of SAV declined at 10 of 15 sites surveyed (FPC, 2010), (Marshall, 2002).

In 2001, the Coastal Seas Consortium, Inc. resurveyed the same area surveyed by the Mote Marine Laboratory to determine what changes in SAV beds occurred since 1995 (Marshall, 2002). Seagrass beds first began at a point 245 ft (74.6 m) from the POD, and shoal grass had spread throughout the area most affected by thermal discharges. The occurrence of shoal grass seemed to be only constrained by rocky bars, shelly substrates inappropriate for seagrass growth, and water depths too shallow or too deep for seagrass (Marshall, 2002). Marshall (2002) concluded that the helper cooling towers have altered the thermal regime to the degree that suitable conditions for seagrass survival, bed expansion, and reproduction exist. However, seagrass recolonization has not been dramatic since the helper cooling towers have become operational. The Seagrass Technical Advisory Committee (STAC) suggested that light intensity, salinity variation, and suspended solids load could be more influential than temperature in affecting seagrass colonization; had temperature been the primary factor, a more dramatic recolonization of seagrass should have occurred after the cooling towers became operational (FPC, 2010).

Marshall (2002) reported that the helper cooling towers have apparently altered the thermal regime to achieve suitable conditions for seagrass survival, bed expansion, and reproduction. However, seagrass recolonization has not been dramatic since the helper cooling towers have become operational. The STAC suggested that light intensity, salinity variation, and suspended load could be more critical than temperature regarding seagrass colonization (FPC, 2010).

As discussed in Section 2.2, the scheduled completion of the CR-3 EPU has changed from 2011 to, supposedly, prior to the expiration of the next NPDES permit period. The EPU will increase heat rejection to the CREC discharge canal from CR-3, but will not change existing CR-3 intake flow of about 680,000 gpm (1,515 cfs or 42.9 m^3/s) (Progress Energy, 2009a). To mitigate the increased thermal load, a new south cooling tower will be constructed and operated as part of the EPU project. The use of the south cooling tower will ensure that the heat rejection rate from the three units will be limited so as not to exceed the present maximum rate of 10.91

billion Btu/hr at the POD. Therefore, the CR-3 EPU will not change the shape and extent of the thermal plume (Golder Associates, Inc., 2007b). Table 6 lists the projected summer operational discharges and temperatures for the CREC based on the CR-3 EPU.

Table 6. Projected Post-Uprate Summer Operational Discharges and Temperatures for the Crystal River Energy Complex

CREC Unit	Discharge Flow (gpm)	Intake Temperature (°F)[a]	Discharge Temperature (°F)[a]
CR-1	310,001	91.0	101.7
CR-2	328,001	91.0	105.1
CR-3 (uprated)	680,001	91.0	110.9
CR-4 and CR-5 (combined)[b]	7,000	107.3	94.7
Harmon Cooling Towers (existing)	673,944	107.2	92.0
South Cooling Tower (new)	314,018	107.2	91.0
Point of Discharge	1,291,212	NA[c]	95.4

(a) High summer design values in August. To convert to °C: (°F-32) x 0.556.

(b) Net internal discharge to the CREC discharge canal from CR-4 and CR-5 cooling towers.

(c) NA = not applicable.

Source: Progress Energy, 2009a

Flows and temperatures at the POD will not noticeably change as a result of the CR-3 EPU. The POD temperature during summer will be 95.4 °F (35.2 °C). Therefore, the EPU will have no effect on the effluent plume (Progress Energy, 2009a). Under average monthly conditions, the POD temperature will be less after the EPU than that which currently exists (Golder Associates, Inc., 2007b).

As discussed in Section 2.2, the CR-3 EPU may be completed without, or prior to, the south cooling tower. In this case, derating of CR-1 and CR-2 may be required to meet the NPDES permit temperature requirement at the POD. Should the EPU occur before the end of the next NPDES permit period, the applicant will be required to conduct a CWA Section 316(a) Demonstration study, likely involving a 2-year study period initiated after completion of the EPU. The need for the study is to demonstrate compliance with CWA Section 316(a) in order to renew any applicable Section 316(a) variance (i.e., a variance from applicable thermal limitations to surface waters is allowed if the permittee demonstrates that the balanced indigenous community of aquatic organisms is protected and maintained). The applicant has proposed a plan of study (not yet approved by the FDEP) to assess the potential impacts of the thermal plume from current operation of the CREC on seagrasses, benthic macroinvertebrates, and other aquatic species, as appropriate (Progress Energy, 2007).

The Staff has determined that the potential for acute heat shock during the license renewal term is unlikely because of the design, location, and operation of CR-3 (and the other units at the CREC). The plant discharges via a discharge canal to the Gulf of Mexico, a large body of water. In high-temperature plumes, mobile organisms are generally able to detect the limits to their survival and escape dangerous situations. For this reason, direct kills from heat shock are rare (Hall et al., 1978). Chronic thermal effects occur within less than 2,400 ac (971 ha) affected by the thermal discharges from the CREC. Most notable are impacts to seagrasses, although light intensity, salinity variation, and suspended solids load also influence seagrass habitats in the area of the thermal plume. The Staff concludes that thermal impacts could range from SMALL to MODERATE depending on the extent and magnitude of the thermal plume, the sensitivity of various aquatic species and the life stages likely to encounter the thermal plume, and the probability of an encounter occurring that could result in lethal or sublethal effects. The range of the impact level expresses the uncertainty resulting from the current lack of studies and data. Additional thermal studies or modeling and verification of the applicant's past thermal studies might generate data to refine or modify this impact level.

For the purpose of the SEIS, the Staff's conclusion that the thermal impact level could range from SMALL to MODERATE satisfies the NRC's NEPA obligations and does not prejudice any determinations the FDEP may reach in response to new studies and information submitted to it by the applicant. The Site Certification Application for LNP was approved by the Governor's Siting Board on August 11, 2009, and includes a requirement that the applicant shut down CR-1 and CR-2 by the end of 2020 (or by the end of the year when LNP begins operation) (Progress Energy, 2009a). This will lessen thermal impacts to Crystal Bay due to CREC operations.

5.4 Potential Impacts on Identified Federally-Managed Species

The following sections address potential adverse effects to the Federally-managed species identified for in-depth analysis in Section 4.0. For each species and life stage, evaluations were made to determine whether continued operation of CR-3 will result in: (1) no adverse impact, (2) minimal adverse impact, or (3) substantial adverse impact on the species, its EFH, or its forage species. Reviews of scientific journal articles, NMFS publications, CREC data, technical reports, and other relevant information formed the basis for the impact determinations. Section 6.0 addresses cumulative impacts.

5.4.1 Red Drum (*Sciaenops ocellatus*): Eggs, Larvae, Juveniles, and Adults

As discussed in Section 4.1, EFH for red drum eggs, larvae, juveniles, and adults occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 near the CREC (prior to operation of CR-3), three red drum were collected in trawl samples within the discharge plume area and four specimens were collected in screen wash (impingement) samples from CR-1 and CR-2 (Mountain, 1972). No red drum occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). In the aquatic samples collected for the proposed LNP[2], red drum comprised 0.4 and 0.7 percent of the fish catch per unit effort (CPUE) in the CREC thermal plume area in gill nets and cast nets, respectively; and 0.1 and 0.2 percent of the fish CPUE in the area of the Cross Florida Barge Canal in seine nets and cast nets, respectively. Trawls or minnow traps collected no red drums at the CREC; trawls, gill nets, or minnow traps collected no red drum at the Cross Florida Barge Canal (CH2M Hill, 2009).

Annual impingement at the CREC during the 316 Demonstration study totaled about 11 red drum (SWEC, 1985). An estimated 300,000 post-larval red drum were entrained which equated

[2] CH2M Hill (2009) conducted an aquatic sampling program to describe the physical, chemical, and biological characteristics of waters potentially influenced by the proposed LNP. The study area included the nearshore Gulf of Mexico waters near the CREC discharge canal with biological samples collected from April 2008 to November 2008.

to a loss of 18 adult red drum (SWEC, 1985). As spawning occurs at depths of 131 to 230 ft (40 to 70 m) (GMFMC, 2004), the potential entrainment of the pelagic eggs at the CREC is negligible. Although impingement and entrainment of red drum prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for larval, juvenile, and adult red drum. Continued operation of CR-3 would likely have no adverse effect on red drum eggs and minimal adverse effect on larval, juvenile, and adult red drum and their EFH.

5.4.2 Greater Amberjack (*Seriola dumerili*): Eggs, Larvae, and Juveniles

As discussed in Section 4.2, EFH for greater amberjack eggs, larvae, and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), trawl samples collected no greater amberjacks within the area of the CREC and no specimens were collected in screen wash (impingement) samples for CR-1 and CR-2 (Mountain, 1972). No greater amberjacks occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no greater amberjacks (CH2M Hill, 2009).

The greater amberjack was not a component of impingement samples collected at the CREC (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). The 316 Demonstration study provided no information on entrainment of greater amberjacks (SWEC, 1985). As eggs and larvae are primarily associated with offshore open waters, their potential entrainment at the CREC would be negligible. Although impingement and entrainment of greater amberjack prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for eggs, larval, and juvenile greater amberjacks. However, these life stages are more likely to occur in offshore areas (GMFMC, 2004). Continued operation of CR-3 would likely have no adverse effect on eggs, larvae, and juvenile greater amberjacks and their EFH.

5.4.3 Hogfish (*Lachnolaimus maximus*): Juveniles

As discussed in Section 4.3, EFH for hogfish juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), 18 hogfish were collected in trawl samples throughout the CREC area (Mountain, 1972). No hogfish occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no hogfish (CH2M Hill, 2009).

The hogfish was not a component of impingement samples collected at the CREC (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). Although impingement and entrainment of hogfish prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile hogfish. Continued operation of CR-3 would likely have a minimal adverse effect on juvenile hogfish and their EFH.

5.4.4 Gray Snapper (*Lutjanus griseus*): Eggs, Larvae, Juveniles, and Adults

As discussed in Section 4.4, EFH for gray snapper eggs, larvae, juveniles, and adults occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 at the CREC (prior to operation of CR-3), 11 gray snappers were collected in screen wash (impingement) samples for CR-1 and CR-2 and one by hook and line near the screen wash sluiceway (Mountain, 1972). Only one gray snapper occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). In the aquatic samples collected for the proposed LNP, gray snappers comprised 0.4 and 3.6 percent of the fish CPUE in the CREC thermal plume area in trawls and cast nets, respectively. In the area of the Cross Florida Barge Canal, CPUE of gray snappers were 0.6 percent of seine net, 0.2 percent of trawl, 0.3 percent of gill net, and 2.7 percent of cast net collections. No gray snappers were collected in minnow traps at either the CREC or the Cross Florida Barge Canal (CH2M Hill, 2009).

All three impingement studies at the CREC reported gray snappers (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). NUS Corporation (1978) did not provide the number of gray snappers impinged; however, impingement occurred in January, February, July, October, November, and December. In the 316 Demonstration study (SWEC, 1985), annual impingement totaled about 100 gray snappers (SWEC, 1985). Ager et al. (1978) reported a yearly impingement total of 292 gray snappers for CR-3 (0.04 percent of all fish impinged) and 331 for CR-1, CR-2, and CR-3 (0.03 percent of all fish impinged). The weight of gray snappers impinged totaled 8.2 lb (3.7 kg) for CR-3 and 8.6 lb (3.9 kg) for all three units (Ager et al., 2008). The 2007 annual commercial landings of gray snapper totaled 1,010 lb (458 kg) for Citrus County and 183,581 lb (83,271 kg) for the west coast of Florida (FWC, 2011).

There was no entrainment information provided on the gray snapper in the 316 Demonstration study (SWEC, 1985). However, as the demersal eggs and planktonic larvae are primarily associated with offshore open waters, their potential entrainment at the CREC would be negligible. Although impingement and entrainment of gray snapper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile gray snapper. Continued operation of CR-3 would likely have no adverse effect on gray snapper eggs and minimal adverse effects on larvae, juvenile, and adult gray snappers and their EFH.

5.4.5 Lane Snapper (*Lutjanus synagris*): Larvae and Juveniles

As discussed in Section 4.5, EFH for lane snapper larvae and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no lane snappers were collected in trawl samples within the CREC area and no specimens were collected in screen wash (impingement) samples for CR-1 and CR-2 (Mountain, 1972). Only 12 lane snappers occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). In the aquatic samples collected for the proposed LNP, lane snappers comprised 1 percent of the fish CPUE in the CREC thermal plume area in trawls and 0.03 percent of the fish CPUE in the area of the Cross Florida Barge Canal in trawls. No lane snappers were collected in seines, gill nets, cast nets, or minnow traps at either the CREC or Cross Florida Barge Canal (CH2M Hill, 2009).

Neither NUS Corporation (1978) nor SWEC (1985) collected lane snappers in impingement samples. Ager et al., (2008) estimated that 1,300 lane snappers were impinged over the sampling year at CR-3 (0.16 percent of all fish impinged) and that 1,725 lane snappers were impinged at CR-1, CR-2, and CR-3 (0.18 percent of all fish impinged). The weight of lane snappers impinged totaled 23.6 lb (10.7 kg) for CR-3 and 27.3 lb (12.4 kg) for all three units (Ager et al., 2008). The 2007 annual commercial landings of lane snapper totaled 131 lb (59.4 kg) for Citrus County and 14,608 lb (6,626 kg) for the west coast of Florida (FWC, 2011).

There was no entrainment information provided on the lane snapper in the 316 Demonstration study (SWEC, 1985). As larvae are primarily associated with water depths of 13 to 433 ft (4 to 132 m) (NMFS, 2009), their potential entrainment at the CREC would be negligible. Although impingement and entrainment of lane snapper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect a small portion of the Crystal Bay SAV that provides EFH for larvae and juvenile lane snapper. However, defined EFH for lane snapper larvae includes a depth range of 13 to 433 ft (4 to 132 m) (NMFS, 2009), which does not occur in the discharge plume region. The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for larval and juvenile lane snappers. Continued operation of CR-3 would likely have a minimal adverse effect on larval and juvenile lane snappers and their EFH.

5.4.6 Schoolmaster (*Lutjanus apodus*): Eggs, Larvae, and Juveniles

As discussed in Section 4.6, EFH for schoolmaster eggs, larvae, and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no schoolmasters were collected in trawl samples within the area of the CREC and no specimens were collected in screen wash (impingement) samples for CR-1 and CR-2 (Mountain, 1972). No schoolmasters occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no schoolmasters (CH2M Hill, 2009).

Impingement samples at the CREC contained no schoolmasters (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). There was no entrainment information provided on the schoolmaster in the 316 Demonstration study (SWEC, 1985). As spawning occurs offshore, and eggs and larvae are associated with water depths up to 295 ft (90 m) (NMFS, 2009), their potential entrainment at the CREC would be negligible. Although impingement and entrainment of schoolmaster prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for eggs, larval, and juvenile schoolmasters. Continued operation of CR-3 would likely have no adverse effect on schoolmaster eggs or larvae and a minimal adverse effect on juveniles and their EFH.

5.4.7 Dog Snapper (*Lutjanus jocu*): Eggs, Larvae, and Juveniles

As discussed in Section 4.7, EFH for dog snapper eggs, larvae, and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no dog snappers were collected in trawl samples in the area of the CREC and no specimens were collected in screen wash (impingement) samples for CR-1 and CR-2 (Mountain, 1972). No dog snappers occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no dog snappers (CH2M Hill, 2009).

Impingement samples at the CREC contained no dog snappers (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). There was no entrainment information provided on the dog snapper in the 316 Demonstration study (SWEC, 1985). As spawning occurs over reefs at depths of 49 to 98 ft (15 to 30 m), the expected amount of eggs and larvae entrained at the CREC would be negligible. Although impingement and entrainment of dog snapper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for eggs, larval, and juvenile dog snappers. Continued operation of CR-3 would likely have a minimal adverse effect on eggs, larvae, and juvenile dog snappers and their EFH.

5.4.8 Yellowtail Snapper (*Lutjanus chrysurus*): Juveniles and Adults

As discussed in Section 4.8, EFH for yellowtail snapper juveniles and adults occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no yellowtail snappers were collected in trawl samples in the area of the CREC and no specimens were collected in screen wash (impingement) samples for CR-1 and CR-2 (Mountain, 1972). No yellowtail snappers occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no yellowtail snappers (CH2M Hill, 2009).

No yellowtail snapper occurred in impingement samples at the CREC (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). Preferred habitat for juvenile and adult yellowtail snapper does not occur within the intake canal at the CREC; therefore, impingement of juveniles and adults would not routinely occur. Although impingement and entrainment of yellowtail snapper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile and adult yellowtail snappers. Continued operation of CR-3 would likely have a minimal adverse effect on juvenile and adult yellowtail snappers and their EFH.

5.4.9 Vermilion Snapper (*Rhomboplites aurorubens*): Juveniles

As discussed in Section 4.9, EFH for vermilion snapper juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no vermilion snappers were collected in trawl samples in the area of the CREC and no specimens were collected in screen wash (impingement) samples for CR-1 and CR-2 (Mountain, 1972). No vermilion snappers occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no vermilion snappers (CH2M Hill, 2009).

Impinged vermilion snapper were only collected in the Ager et al. (2008) impingement study. Yearly impingement totaled 155 vermilion snappers at CR-3 (about 0.02 percent of all fish impinged) (Ager et al., 2008). The weight of vermilion snappers impinged totaled 3.1 lb (1.4 kg) (Ager et al., 2008). The 2007 annual commercial landings of vermilion snapper totaled 196 lb (89 kg) for Citrus County and 1,066,201 lb (483,621 kg) for the west coast of Florida (FWC, 2011). Although impingement and entrainment of vermilion snapper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile vermilion snappers. Because preferred habitats do not occur near the CREC area, continued operations of CR-3 would likely have a minimal adverse effect on juvenile vermilion snappers and their EFH.

5.4.10 Dwarf Sand Perch (*Diplectrum bivittatum*): Juveniles

As discussed in Section 4.10, EFH for dwarf sand perch juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no dwarf sand perch were collected in trawl samples within the area of the CREC and no specimens were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No dwarf sand perch occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no dwarf sand perch (CH2M Hill, 2009).

Annual dwarf sand perch impingement was about 630 individuals during the 316 Demonstration study (SWEC, 1985). No dwarf sand perches were reported from impingement samples collected by NUS Corporation (1978) or Ager et al. (2008); although both studies reported impingement of the sand perch (*Diplectrum formosum*) which is not a Federally-managed species for Ecoregion 2 (NMFS, 2009). Although impingement and entrainment of dwarf sand perch prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile dwarf sand perch. Continued operation of CR-3 would likely have a minimal adverse effect on juvenile dwarf sand perch and their EFH.

5.4.11 Red Grouper (*Epinephelus morio*): Juveniles

As discussed in Section 4.11, EFH for red grouper juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no red groupers occurred in trawl samples in the area of the CREC and no specimens were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No red groupers occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no red groupers (CH2M Hill, 2009).

No red groupers occurred in impingement samples at the CREC (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). As preferred habitat for juvenile red grouper does not occur within the intake canal, impingement of juveniles would not routinely occur at the CREC. Although impingement and entrainment of red grouper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile red groupers. Continued operation of CR-3 would likely have a minimal adverse effect on juvenile red grouper and their EFH.

5.4.12 Nassau Grouper (*Epinephelus striatus*): Eggs, Larvae, and Juveniles

As discussed in Section 4.12, EFH for Nassau grouper eggs, larvae, and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no Nassau groupers were collected in trawl samples within the area of the CREC and no specimens were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No Nassau groupers occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no Nassau groupers (CH2M Hill, 2009).

No Nassau grouper occurred in impingement samples at the CREC (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). There was no entrainment information provided on the Nassau grouper in the 316 Demonstration study (SWEC, 1985). Spawning occurs in waters

59 to 131 ft (18 to 40 m) deep and eggs hatch within 40 hours; therefore, entrainment of Nassau grouper eggs at the CREC is unlikely. Larvae generally occur at depths of 6.6 to 164 ft (2 to 50 m); therefore, the potential entrainment of larvae at the CREC would be negligible. Preferred habitat for juvenile Nassau grouper does not occur within the intake canal at the CREC; therefore, potential impingement of juveniles at the CREC would be negligible. Although impingement and entrainment of Nassau grouper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for eggs, larval, and juvenile Nassau groupers. Continued operation of CR-3 would likely have no adverse effects on Nassau grouper eggs and larvae and a minimal adverse effect on juvenile Nassau grouper and their EFH.

5.4.13 Black Grouper (*Mycteroperca bonaci*): Juveniles

As discussed in Section 4.13, EFH for black grouper juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no black groupers occurred in trawl samples in the area of the CREC and no specimens were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No black groupers occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no black groupers (CH2M Hill, 2009).

Impingement samples at the CREC contained no black groupers (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). Preferred habitat for juvenile black grouper does not occur within the intake canal at the CREC; therefore, potential impingement of juveniles at the CREC would be negligible. Although impingement and entrainment of black grouper prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH juvenile black groupers. Continued operation of CR-3 would likely have a minimal adverse effect on juvenile black grouper and their EFH.

5.4.14 Gag (*Mycteroperca microlepis*): Juveniles

As discussed in Section 4.14, EFH for gag juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 at the CREC (prior to operation of CR-3), four gags were collected in trawl samples near the intake canal area and one specimen was collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No gags occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no gags (CH2M Hill, 2009).

Annual impingement totaled about 11 gags in the 316 Demonstration study (SWEC, 1985). No gags occurred in impingement samples collected by NUS Corporation (1978) or Ager et al. (2008). Although impingement and entrainment of gag prey items occur at the CREC, there is no indication that prey populations are measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile gags. Continued operation of CR-3 would likely have a minimal adverse effect on juvenile gags and their EFH.

5.4.15 Rock Hind (*Epinephelus adscensionis*): Eggs, Larvae, and Juveniles

As discussed in Section 4.15, EFH for rock hind eggs, larvae, and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no rock hinds were collected in trawl samples in the area of the CREC and no specimens were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No rock hinds occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Fish collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP contained no rock hinds (CH2M Hill, 2009).

Impingement samples at the CREC contained no red hinds (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). There was no entrainment information provided on the rock hind in the 316 Demonstration study (SWEC, 1985). As rock hind eggs, larvae, and juveniles occur in waters from 6.6 to 328 ft (2 to 100 m) deep (NMFS, 2009), potential impingement and entrainment at the CREC would be negligible. Although impingement and entrainment of rock hind prey items occur at the CREC, there is no indication that prey populations are measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay. However, this area contains minimal EFH for eggs, larvae, and juvenile rock hinds. Continued operation of CR-3 would likely have no adverse effect on rock hind eggs, larvae, and juveniles and their EFH.

5.4.16 Spanish Mackerel (*Scomberomorus maculatus*): Juveniles and Adults

As discussed in Section 4.16, EFH for Spanish mackerel juveniles and adults occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no Spanish mackerels occurred in trawl collections near the CREC and five Spanish mackerel were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No Spanish mackerel occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). In the aquatic samples collected for the proposed LNP, Spanish mackerel comprised 3.7 and 1.2 percent of the fish CPUE in the CREC thermal plume area in gill nets and cast nets, respectively; and 0.03 and 2.5 percent of the fish CPUE in the area of the Cross Florida Barge Canal in trawls and gill nets, respectively. No Spanish mackerel were collected in trawls or minnow traps at the CREC; while none were collected in seines, cast nets, or minnow traps at the Cross Florida Barge Canal (CH2M Hill, 2009).

Spanish mackerel occurred in all three impingement studies conducted at the CREC (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). NUS Corporation (1978) did not report the number of Spanish mackerel impinged; however, it occurred only in October samples. In the 316 Demonstration study (SWEC, 1985), annual impingement at the CREC totaled about 20 Spanish mackerels (SWEC, 1985). In the Ager et al. (2008) study, yearly impingement totaled 62 Spanish mackerels at CR-3 (0.01 percent of all fish impinged at the unit) and 166 for CR-1, CR-2, and CR-3 (0.02 percent of all fish impinged at the CREC). The weight of Spanish mackerels impinged totaled 87.5 lb (39.7 kg) for CR-3 and 112.7 lb (51.1 kg) for all three units (Ager et al., 2008). The 2007 annual commercial landings of Spanish mackerel totaled 429 lb (195 kg) for Citrus County and 369,274 lb (167,500 kg) for the west coast of Florida (FWC, 2011).

Although impingement and entrainment of Spanish mackerel prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for juvenile and adult Spanish mackerels. Continued operation of CR-3 would likely have a minimal adverse effect on juvenile and adult Spanish mackerels and their EFH.

5.4.17 Pink Shrimp (*Farfantepenaeus duorarum*): Larvae, Juveniles, and Adults

As discussed in Section 4.17, EFH for pink shrimp larvae, juveniles, and adults occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), pink shrimp were collected in seine and trawl samples throughout the CREC area and were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). Ninety-five pink shrimp occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). In the aquatic samples collected for the LNP, pink shrimp comprised 14.9 percent of the invertebrate CPUE in the CREC thermal plume area and 16.7 percent of the invertebrate CPUE in the area of the Cross Florida Barge Canal (CH2M Hill, 2009).

Impinged pink shrimp occurred in all three impingement studies at the CREC (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). In the NUS Corporation (1978) study, pink shrimp occurred in impingement samples every month with the yearly impingement totaling 132,716 pink shrimp weighing about 11,230 lb (5,094 kg). In the 316 Demonstration study (SWEC, 1985), annual impingement totaled over 590,000 pink shrimp. In the Ager et al. (2008) study, yearly impingement totaled about 114,440 pink shrimp for CR-3 (44.6 percent of all invertebrates impinged at the unit) and about 149,710 for CR-1, CR-2, and CR-3 (43.8 percent of all invertebrates impinged at the CREC) (Ager et al., 2008). The weight of pink shrimp impinged totaled 2,034 lb (922.6 kg) for CR-3 and 2,776 lb (1,259 kg) for all three units (Ager et al., 2008). The 2007 annual commercial landings of pink shrimp totaled 1,361 lb (617 kg) for Citrus County and 4,981,837 lb (2,259,723 kg) for the west coast of Florida (FWC, 2011).

Yearly estimated entrainment of pink shrimp totaled 220,000 mysis, 18,830,000 post-larvae, and 1,023,000 juveniles (SWEC, 1985). The entrainment losses equated to the loss of over 29,000 adult pink shrimp (SWEC, 1985). Although impingement and, more likely, entrainment of pink shrimp prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS

Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for larval, juvenile, and adult pink shrimp. Continued operation of CR-3 would likely have a minimal adverse effect on larvae, juvenile, and adult pink shrimp and their EFH.

5.4.18 White Shrimp (*Litopenaeus setiferus*): Larvae and Juveniles

As discussed in Section 4.18, EFH for white shrimp larvae and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), no white shrimp were collected in seine and trawl samples within the area of the CREC and no specimens were collected in screen wash (impingement) samples at CR-1 and CR-2 (Mountain, 1972). No white shrimp occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). Invertebrate collections in the areas of the CREC thermal plume and the Cross Florida Barge Canal conducted during the recent studies for the proposed LNP also contained no white shrimp (CH2M Hill, 2009).

Impinged white shrimp were identified in the NUS Corporation (1978) and SWEC (1985) impingement studies. NUS Corporation (1978) did not report numbers of impinged white shrimp; however, impingement of white shrimp occurred in October through January and totaled about 90 lb (41 kg). In the 316 Demonstration study (SWEC, 1985), annual impingement totaled only about eight white shrimp (SWEC, 1985). SWEC (1985) assumed that all entrained immature shrimp were pink shrimp; although a small percentage was probably white shrimp. Although entrainment of white shrimp prey items occurs at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for larval and juvenile white shrimp. Continued operation of CR-3 would likely have a minimal adverse effect on larvae and juvenile white shrimp and their EFH.

5.4.19 Florida Stone Crab (*Menippe mercenaria*): Larvae and Juveniles

As discussed in Section 4.19, EFH for Florida stone crab larvae and juveniles occurs within the vicinity of the CREC. In ecological surveys conducted from 1969 through 1971 (prior to operation of CR-3), several Florida stone crabs were collected in trawl samples within offshore areas near the CREC (Mountain, 1972). One Florida stone crab occurred in monthly trawl collections made at three locations near the offshore areas of the intake canal from December 2006 through November 2007 (Ager et al., 2008). In the aquatic samples collected for the LNP, Florida stone crabs comprised 14.9 percent of the motile invertebrate CPUE in the CREC thermal plume area. No Florida stone crabs were collected in the area of the Cross Florida Barge Canal (CH2M Hill, 2009).

Samples from all three impingement studies contained Florida stone crabs (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008). In the NUS Corporation (1978) study, Florida stone crabs occurred every month. Annual impingement totaled 545 lb (247 kg). In the 316 Demonstration study (SWEC, 1985), annual impingement totaled about 1,535 Florida stone crabs (SWEC, 1985). In the Ager et al. (2008) study, yearly impingement totaled about 4,950 Florida stone crabs for CR-3 (about 1.9 percent of all invertebrates impinged) and about 7,950 for CR-1, CR-2, and CR-3 (about 2.3 percent of all invertebrates impinged). The weight of Florida stone crabs impinged totaled 99.2 lb (45 kg) for CR-3 and 194.4 lb (88.2 kg) for all three units (Ager et al., 2008). The 2007 annual commercial landings of stone crabs totaled 350,646 lb (159,050 kg) for Citrus County and 2,921,931 lb (2,259,723 kg) for the west coast of Florida (FWC, 2011).[3]

Yearly estimated entrainment of stone crabs totaled: (1) over 3 billion zoeal stage 1, (2) over 254 million zoeal stage 2, (3) over 52 million zoeal stage 3, (4) over 14.8 million zoeal stage 4, (5) 380,000 zoeal stage 5, and (6) 2.35 million megalops. SWEC (1985) equated the entrainment losses to the loss of 3,642 adult stone crabs, although a very high degree of uncertainty accompanies such estimates. Although entrainment of Florida stone crab prey items occur at the CREC, there is no indication that prey populations have been measurably affected based on the high diversity and similarity of species in Crystal Bay reported since the late 1960s (Grimes and Mountain, 1971), (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). The thermal plume from the CREC may affect up to 2,400 ac (971 ha) of Crystal Bay which contains EFH for larval and juvenile Florida stone crabs. Continued operation of CR-3 would likely have a minimal adverse effect on larvae and juvenile Florida stone crabs and their EFH.

6.0 ESSENTIAL FISH HABITAT CUMULATIVE EFFECTS ANALYSIS

This section addresses the direct and indirect effects of CR-3 license renewal on Federally-managed species and their EFH when added to the aggregate effects of past, present, and reasonably foreseeable future actions. The primary effects on Federally-managed species and their EFH and forage species from an additional 20 years of CR-3 operation will primarily occur from impingement, entrainment, and thermal effects.

When considering power plant operations, three suites of cumulative impacts are identifiable: (1) those from the power plant (e.g., interaction of entrainment, impingement, and thermal discharges); (2) those due to effects of closely located power plants; and (3) those due to multiple activities in the area (York et al., 2005). The CREC is the only electrical generating facility in Citrus County (CCBCC, 2009); however, it is comprised of five generating units. Two generating units will be located at the proposed LNP in Levy County. Operation of the LNP will begin in 2020 or later (Progress Energy, 2009a).

The geographic boundaries for assessing cumulative aquatic impacts are somewhat variable and depend on the specific aquatic resource. The estuary area of Crystal Bay between Withlacoochee River and Crystal River and the offshore areas of the Gulf of Mexico within the Citrus and Levy Counties generally bound the potentially affected area. However, for some resources and stressors, a much larger area is considered. This area may include much of the Gulf of Mexico (e.g., due to the recent Deepwater Horizon oil spill) to North America and beyond (in the case of global warming). In large part, stressors outside the area influenced by operation of the CREC affect Federally-managed species that migrate throughout the Gulf of Mexico and the Atlantic Ocean (NMFS, 2002). Additionally, the EFH for those species listed in the Gulf of Mexico fishery management plans that encompass the area within which the CREC is located occurs throughout the Gulf States (Section 3.0).

[3] The commercial catch includes only the claws. Some of the commercial catch, particularly along the entire west coast of Florida, would include the Gulf stone crab in addition to the Florida stone crab.

The FWC (2005) detailed 32 stressors that could affect habitats and biota in Florida (Table 7). The majority of these could adversely affect Federally-managed species and their EFH and forage species within Crystal Bay.

Table 7. Stressors to Habitats and Biota in Florida

Channel modification/shipping lanes	Incompatible industrial operations
Chemicals and toxins	Incompatible recreational activities
Climate variability	Incompatible resource extraction
Conversion to agriculture	Incompatible wildlife and fisheries management strategies
Conversion to housing and urban development	Industrial spills
Coastal development	Invasive animals
Conversion to recreation areas	Invasive plants
Dam operations	Key predator/prey loss
Disruption of longshore transport of sediments	Management of nature (e.g., beaches)
Fishing gear impacts	Nutrient loads - agriculture
Groundwater withdrawal	Nutrient loads - urban
Harmful algal blooms	Roads, bridges, and causeways
Inadequate stormwater management	Shoreline hardening
Incompatible fire	Surface water diversion
Incompatible fishing pressure	Surface and groundwater withdrawal
Incompatible forestry practices	Vessel impacts

Source: FWC, 2005

The main stressors that can cause cumulative impacts on Federally-managed species and their EFH and forage species within Crystal Bay include:

- the continued operation of the CREC, as modified by the CR-3 EPU, discharge of LNP blowdown into the CREC discharge canal, and potential decommissioning of CR-1 and CR-2
- preconstruction, construction, and operation of LNP
- continued withdrawal of water for various human uses
- residential, commercial, and industrial development
- fishing (commercial and recreational) and boating
- water quality degradation
- invasive species
- disease
- climate change

Each of these may influence the structure and function of Crystal Bay in a way that could result in observable changes to Federally-managed species and their EFH and forage species. The following is a brief discussion of how the stressors listed above could contribute to cumulative impacts on Federally-managed species and their EFH and forage species in Crystal Bay.

6.1 Continued Operation of Crystal River Unit 3 Nuclear Generating Plant and Other Crystal River Energy Complex Units

Changes in the operation of the CREC since the late 1980s have had a potential influence on aquatic resources in Crystal Bay. The first is the alteration in discharge temperatures to meet the NPDES permit limit of 96.5 °F (35.8 °C) (as a 3-hour rolling limit) at the POD from the CREC. This has lessened the maximum discharge temperature at the POD during a portion of the summer and, thus, the potential size of the thermal plume. For example, the POD temperature averaged 100.1 °F (37.8 °C) the week of August 21, 1983; while most other weeks of August 1983 and 1984, and the week of September 4, 1983, averaged above 96.5 °F (35.8 °C) (SWEC, 1985). The second operational change has been in water withdrawals for operation of the CREC. The NPDES permit limits the combined flow through CR-1 through CR-3 to 1,318,000 gpm (2,836.5 cfs or 83.2 m^3/s) from May 1 through October 31 and 1,132,792 gpm (2,524 cfs or 71.5 m^3/s) from November 1 through April 30 (FDEP, 2005). The FDEP established these limitations to decrease entrainment and, to a lesser extent, impingement at the CREC.

The CR-3 EPU, scheduled for completion by December 2011, will increase the thermal and electrical output of the plant (Progress Energy, 2008). The EPU could require an increase in circulating water flow of up to 150,000 gpm (334.2 cfs or 9.46 m^3/s) (Golder Associates, Inc., 2007a). However, the new south cooling tower, a component of the EPU, may discharge an equivalent amount of water flow back into the intake canal resulting in no net increase in water withdrawn from the intake canal. Alternatively, there may be no increase above the current circulating water flow, but there will be an increase in the thermal load (Progress Energy, 2009a). Under either operating scenario, the Staff does not expect increases in entrainment and impingement due to the EPU. The applicant reported that, following the EPU, the maximum summer temperature at the CREC POD to Crystal Bay would be 95.4 °F (35.2 °C) at an ambient Crystal Bay temperature of 91 °F (32.8 °C) (Progress Energy, 2009a). This would be within the 3-hour rolling limit of 96.5 °F (35.8 °C) allowed in the NPDES permit (FDEP, 2005).

Impacts to aquatic resources from the operation of the other units at the CREC should be similar to those over the past several decades. The Governor’s Siting Board approved the Site Certification Application for LNP on August 11, 2009. It includes a requirement that CR-1 and CR-2 cease operation by the end of 2020 (assuming timely licensing and construction of the LNP) (Progress Energy, 2009b). When CR-1 and CR-2 cease operations, they would no longer contribute to entrainment, impingement, or thermal impacts that affect Federally-managed species and their EFH habitats and forage species.

The Staff concludes that CREC operation will continue to be a contributor to cumulative impacts on Federally-managed species and their EFH and forage species.

6.2 Preconstruction, Construction, and Operation of Levy Nuclear Plant

Preconstruction and construction of LNP and its associated transmission lines and other offsite facilities would result in the permanent and temporary loss of about 773 ac (313 ha) of wetlands. Some of these wetlands would provide spawning, nursery, and feeding habitats for some Federally-managed species and their forage species within Crystal Bay. The applicant has committed to mitigate the loss or impairment of functions in all wetlands affected by the LNP project.

Operational impacts from LNP would include impingement and entrainment of aquatic organisms. LNP will have closed-cycle cooling, requiring a net intake of 85,278 gpm (190 cfs or 5.38 m^3/s). Discernable impacts on aquatic organisms from entrainment and impingement will be minor (NRC, 2010). Combined blowdown from the LNP units will increase the discharge to the CREC discharge canal by about 61,000 gpm (135.9 cfs or 3.85 m^3/s). With the addition of the LNP blowdown, the maximum summer temperature at the POD will be 95.6 °F (35.3 °C) (Progress Energy, 2009a). This will be within the 3-hour rolling limit of 96.5 °F (35.8 °C) allowed in the NPDES permit (FDEP, 2005).

Chemical contaminants in the LNP blowdown will mix with those from the CREC discharges (Progress Energy, 2010a). The combined discharges to Crystal Bay from the CREC and LNP will be subject to review and approval of the FDEP and would have to meet NPDES requirements (Progress Energy, 2010a).

The Staff concluded that both the NRC-authorized construction activities and the impacts of operation of LNP on aquatic resources would be SMALL (NRC, 2010). Nevertheless, construction and operation of LNP would contribute to cumulative impacts on Federally-managed species and their EFH and forage species.

6.3 Continued Water Withdrawals

Surface and groundwater withdrawals can have a greater impact on individual springs, streams, rivers, and wetlands associated with Crystal Bay than to the bay itself. Water withdrawals can reduce stream flow, increase salinity, alter temperature regimes, and reduce wetted areas. These changes can have adverse impacts to areas used for spawning or nursery habitats by aquatic organisms. Groundwater withdrawals for human use threaten natural springs that provide warm water refuges for Florida manatees (Laist and Reynolds, 2005). Total projected average daily water use for Citrus County in 2020 is 47.5 million gallons per day (mgpd) (180,000 m^3/day); a 6.1-mgpd (23,100-m^3/day) increase over that projected for 2010. This use includes public supply (21.2 mgpd [80,250 m^3/day]), rural (11.4 mgpd [43,200 m^3/day]), agriculture (4.2 mgpd [15,900 m^3/day]), industrial (chemical manufacturing, food processing, power generation, and miscellaneous) (2.6 mgpd [9,800 m^3/day]), mining (2 mgpd [7,600 m^3/day]), and recreation (mostly golf course and large-scale landscaped areas) (6.1 mgpd [2,300 m^3/day]) (CCBCC, 2009). Water withdrawals to support human needs will continue and will likely increase during the license renewal term.

The Staff concludes that water withdrawals will continue to be a contributor to cumulative impacts on Federally-managed species and their EFH and forage species.

6.4 Residential, Commercial, and Industrial Development

In addition to the CREC and LNP, other existing or proposed residential, commercial, or industrial developments could impact the aquatic resources of Crystal Bay. The NRC (2010b) identified a number of existing and proposed projects in the Citrus-Levy County area including the proposed Inglis Lock bypass channel spillway hydropower project, existing limestone mines, and the proposed Tarmac King Road Limestone Mine, commercial forestry operations, and future urbanization. The proposed Port District is a planned waterfront development that could include residential, commercial, and industrial uses. Stressors to aquatic biota that can occur from these projects and actions include habitat loss and alteration, erosion and sedimentation, shoreline hardening, chemical contamination, and incompatible recreational activities.

The Staff concludes that residential, commercial, and industrial development will continue to be a contributor to cumulative impacts on aquatic resources.

6.5 Fishing and Boating

Many fish and shellfish species in Crystal Bay, including Federally-managed species, are subject to the effects of fishing pressure. In many cases, Federal or State agencies regulate commercial or recreational catches, but losses of some species (including Federally-managed species) continue to occur as the result of bycatch or illegal capture. Also, overharvesting of prey species may degrade the habitat value of EFH for higher trophic level fish by depleting the food resources. The extent and magnitude of fishing pressure and its relationship to overall cumulative impacts to Federally-managed species is difficult to determine. Normal use of fishing gear and discarded or lost fishing gear poses a threat to Federally-managed species (FWC, 2005).

The 2010 commercial finfish and shellfish landings for Citrus and Levy Counties were 491,471 lb (222,928 kg) of finfish; 1,113,817 lb (505,219 kg) of invertebrates (excluding shrimp); and 431,641 lb (195,789 kg) of shrimp (FWC, 2011). Table 8 presents the 1986, 2007, and 2010 commercial landings for Citrus County and the west coast of Florida for those Federally-managed species addressed in Section 5.

1 **Table 8. Commercial Landings of Federally-Managed Species for Citrus County and the**
2 **West Coast of Florida for 1986, 2007, and 2010**

Common Name (Scientific Name)	Commercial Landings (lb)[a]		
	1986[b] Citrus County (West Coast Florida)	2007[c] Citrus County (West Coast Florida)	2010[d] Citrus County (West Coast Florida)
Red drum			
Red drum (*Sciaenops ocellatus*)	14,062 (882,863)	--[e] (--)	--[e] (--)
Reef fish – jacks (Carangidae)			
Amberjacks[f]	2,147 (889,691)	103 (640,470)	171 (701,372)
Reef fish – wrasses (Labridae)			
Hogfish (*Lachnolaimus maximus*)	162 (38,093)	60 (26,202)	2646 (38,444)
Reef fish – snappers (Lutjanidae)			
Gray snapper (*Lutjanus griseus*)	17,189 (625,620)	1,010 (183,581)	1,746 (203,864)
Lane snapper (*Lutjanus synagris*)	5,445 (67,741)	131 (14,608)	51 (15,230)
Yellowtail snapper (*Ocyurus chrysurus*)	21 (1,026,904)	1 (881,060)	0 (1,322,854)
Vermillion snapper (*Rhomboplites aurorubens*)	329 (876,396)	196 (1,066,201)	326 (1,110,931)
Other snappers[g]	1,440 (144,963)	95 (40,516)	0 (19,041)
Reef fish – groupers (Serranidae)			
Red grouper (*Epinephelus morio*)	28,923 (7,474,704)	69,295 (4,351,846)	99,908 (2,863,450)
Nassau grouper (*Epinephelus striatus*)	0 (5,801)	NL[h]	NL[h]
Black grouper (*Mycteroperca bonaci*)	14,651 (1,327,450)	252 (220,161)	0 (48,197)
Gag grouper (*Mycteroperca microlepis*)	15,394 (842,988)	9,983 (1,333,990)	14,237 (482,264)
Other groupers[i]	503 (127,602)	30 (93,899)	5 (19,028)

Common Name (Scientific Name)	Commercial Landings (lb)[a]		
	1986[b] Citrus County (West Coast Florida)	2007[c] Citrus County (West Coast Florida)	2010[d] Citrus County (West Coast Florida)
Coastal migratory pelagic			
Spanish mackerel (*Scomberomorus maculatus*)	135 (3,071,862)	429 (369,274)	103 (444,660)
Shrimp			
White shrimp (*Litopenaeus setiferus*)	22,539 (1,153,687)	0 (87,097)	0 (299,068)
Pink shrimp (*Farfantepenaeus duorarum*)	11,599 (14,000,890)	1,361 (4,981,837)	1,180 (6,839,868)
Stone Crab			
Stone crabs[j]	332,372 (1,942,995)	350,646 (2,921,931)	188,443 (1,806,341)

(a) To convert to kilograms, multiply by 0.4536.

(b) 1986 is the first year of commercial landing information available and also coincides to the period when the CREC did not have cooling towers along the discharge canal for CR-1 through CR-3.

(c) 2007 corresponds to the most recent impingement study at the CREC.

(d) 2009 is the most recent finalized landings list.

(e) No commercial catch of red drum occurs.

(f) Includes the greater amberjack (*Seriola dumerili*), which is retained as a Federally-managed species of concern, and the lesser amberjack (*S. fasciata*), which is not retained as a Federally-managed species of concern (see Section 4.0).

(g) The "other snappers" may include schoolmasters (*Lutjanus apodus*) and dog snappers (*L. synagris*), which are retained as Federally-managed species of concern.

(h) NL = not listed. The Nassau grouper may be included among the "other groupers" category.

(i) The "other groupers" may include the dwarf sand perch (*Diplectrum bivittatum*), rock hind (*Epinephelus adscensionis*), and Nassau grouper.

(j) Stone crabs include the Florida stone crab (*Menippe mercenaria*), which is retained as a Federally-managed species of concern, and the Gulf stone crab (*M. adina*), which is not maintained as a Federally-managed species of concern (see Section 4.0). The commercial landings only include stone crab claws.

Source: FWC, 2011

Boating has adversely affected aquatic resources along the Gulf coast, including Crystal Bay. Impacts from boating include wave and surge effects that adversely affect wetland habitats and increase water turbidity. Vessel propellers or their wash can scar seagrass bed and disturb sediments (Hanson et al., 2004). Marina and docking facilities can introduce petroleum products, human waste, and hull anti-fouling paints to the water column and sediments that can be detrimental to aquatic resources (CCBCC, 2009). Barge traffic within the CREC intake canal can result in short-term increases in impingement (NUS Corporation, 1978), (SWEC, 1985). Dredging navigable waters (including infrequent dredging of the CREC intake and discharge canals) can adversely affect EFH species, their prey, and their habitats by direct removal or burial of organisms, turbidity and sedimentation effects, contaminant release and uptake, release of oxygen consuming substances, entrainment, and alteration to hydrodynamic regimes and physical habitat (Hanson et al., 2004). After LNP becomes operational, CR-1 and CR-2 will cease operations and the number of barge shipments to the CREC will decrease.

Because fishing and boating remain a concern, the Staff concludes that these stressors will continue to be an important contributor to cumulative impacts on Federally-managed species and their EFH and forage species within the Crystal Bay area.

6.6 Water Quality Degradation

Point-source chemical and thermal discharges can adversely affect EFH by reducing habitat functions, modifying community structure, causing bioaccumulation, and modifying habitat (Hanson et al., 2004). The Staff considered the potential cumulative impacts from thermal and chemical releases, including increases in total dissolved solids in the combined CREC and LNP discharge. Thermal and chemical releases from the CREC comply with NPDES permit requirements (FDEP, 2005). The FDEP will take cumulative thermal and chemical releases from the CREC and the proposed LNP, as well as from other industrial sites discharging to the Crystal Bay, into consideration before approving an NPDES permit for LNP. The FDEP periodically reviews and renews NPDES permits, thus regulating the flow of industrial effluents to Crystal Bay and its associated streams and rivers in a manner that preserves water quality and protects aquatic resources through implementation of best technologies available and other mitigation measures. Given the lack of other discharges into the immediate area of the CREC discharge, it is likely that the cumulative impacts from the combined discharge would be minimal. Thus, thermal and chemical releases from these facilities would only have a localized, minimal adverse impact on some Federally-managed species and their EFH and forage species.

Cumulative effects of non-point sources (e.g., urban and stormwater runoff, boating activities, sewage disposal facilities, and agricultural runoff) may be the largest detriment to estuaries and spring-fed river systems in Citrus County (CCBCC, 2009). Pesticides used to control aquatic plants and mosquitoes may be contributing directly or indirectly to degrading water quality (FWC, 2005), (CCBCC, 2009). Fertilizers, wastewater, nutrient loads, and road and parking lot pollutants have affected aquifers and springs in the county (CCBCC, 2009). These sources of non-point pollution can adversely affect a number of aquatic habitats such as coastal tidal rivers or streams, springs, tidal marshes, bivalve reefs, subtidal unconsolidated marine and estuarine sediment, and SAV (FWC, 2005) that provide EFH for Federally-managed species.

Industrial spills can cause habitat disturbance, altered water quality, altered species composition, and sediment contamination (FWC, 2005). Some industrial spills may have little residual effects and the affected resource may recover quickly. However, some spills, particularly petroleum hydrocarbon spills, can have disastrous, widespread effects that can last decades (FWC, 2005). Petroleum spills have proven to be disastrous to marine organisms either due to direct toxicity or indirectly through habitat destruction and contamination (e.g., seagrass beds). The review team is aware of recent events in the Gulf of Mexico associated with the Deepwater Horizon oil spill. To date, information associated with Federally-managed species and their EFH are preliminary and inconclusive. Although not included in this EFH, the review team will consider information associated with the oil spill as it becomes available.

The Staff concludes that water quality degradation in Crystal Bay and its wetlands and tributaries will continue in the future and will be a potential contributor to cumulative impacts on Federally-managed species and their EFH and forage species.

6.7 Invasive Species

The introduction of invasive species is often a source of critical stress to endemic species or their habitats. Estuaries and sheltered coastal areas are among the most susceptible to invasive species, especially those that have suffered prior disturbance by navigation, industrial development, and urbanization (Ray, 2005). Most invasive species in estuarine and marine systems result from shipping. These include species capable of attaching to hard surfaces (e.g., ship hulls) or those found in ballast water. Species introduced from the aquarium trade are also a concern (Ray, 2005). Ray (2005) reported that 74 non-indigenous estuarine and marine species occur in the Gulf of Mexico.

A number of species may pose serious threats to marine and freshwater habitats in Florida. Some of these are parasites and/or pathogens of native species (FWC, 2005). Ray (2005) considered the Australian spotted jellyfish (*Phylloriza punctata*), green mussel (*Perna viridis*), green porcelain crab (*Petrolisthes armatus*), and lionfish (*Pterios volitan*) to be the invasive species of most concern in the eastern Gulf of Mexico. The green mussel can clog intake pipes, interfere with shellfish culture, displace local fauna, and possibly harbor algal species that cause toxic shellfish poisoning (Ray, 2005). The University of Florida (2007) expects the green mussel to spread throughout Florida. The green porcelain crab has the potential to directly and indirectly affect oyster beds (Ray, 2005), (Masterson, 2007b). The Australian spotted jellyfish is a threat to fisheries and fisheries restoration operations as it feeds on zooplankton and fish larvae and can foul fishing nets (Ray, 2005), (Masterson, 2007a). The lionfish can negatively affect coral reef fishes through consuming or competing with various species. If lionfish decrease population densities of important herbivorous species such as parrotfish, seaweeds and macroalgae could overgrow corals. Currently, observations of lionfish from the Gulf of Mexico are limited (Schofield et al., 2010).

The Staff concludes that invasive and nuisance species will continue to be a concern and a potential contributor to cumulative impacts on Federally-managed species and their EFH and forage species.

6.8 Disease

Aquatic biota are subjected to a number of diseases. Among the most prevalent is red tide. Red tide, the common name for the harmful bloom of the marine algae *Karenia brevis*, produces a brevetoxin that can cause mortality to hundreds of fish species (including Federally-managed species) (FWS and NMFS, 2009). The trigger for red tide could include excess nutrients and other pollutants (FWC, 2005).

The Staff concludes that disease will continue to be a concern and a potential contributor to cumulative impacts on Federally-managed species and their forage species.

6.9 Climate Change

The potential cumulative effects of climate change on Crystal Bay, whether from natural cycles or related anthropogenic activities, could result in a variety of changes that would affect aquatic resources. The environmental factors of significance that could affect estuary systems include sea level rise, temperature increases, salinity changes, wind and water circulation changes, and ocean acidification (Kennedy, 1990), (Doney et al., 2009), (Raven et al., 2005). Changes in sea level could result in effects to nearshore communities, including the reduction or redistribution of SAV, changes in marsh communities, and influences to other wetland areas adjacent to nearshore systems. Water temperature changes could affect spawning patterns or success, or influence the distribution of important species (e.g., cold water species may move northward while the ranges of warm water species expand) (Kennedy, 1990). Changes in salinity could influence the spawning and distribution of important species and the range of invasive species. Fundamental changes in precipitation could 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. Some fisheries and aquaculture enterprises might benefit from climate change, while others might suffer (Kennedy, 1990). However, climate change could increase the frequency of red tide blooms, with adverse impacts to many fish species (FWS and NMFS, 2009).

Increasing atmospheric carbon dioxide concentrations can reduce ocean pH and carbonate ion concentrations. This will cause organisms such as corals, benthic mollusks, echinoderms, and some plankton difficulty in maintaining their external calcium carbonate skeletons (Doney et al., 2009). Other influences caused by ocean acidification could include decreased reproductive potential, slower growth, and increased susceptibility to disease. The cascading effects through food webs caused by ocean acidification could be adverse effects to ecosystem structure and elemental cycling (Raven et al., 2005).

The Florida Oceans and Coastal Council (2009) concluded that the predicted effects of climate change would not benefit oceanic and estuarine aquatic resources. Climate change effects to aquatic resources could include:

- adverse impacts to corals, clams, shrimp, and other organisms with calcium carbonate shells or skeletons due to increased acidity
- more frequent die-offs of sponges, seagrasses, and other organisms could occur as sea surface temperatures increase
- increased exceedance of thermal tolerance and increases in the rate of disease in corals
- geographic range of marine species will shift northward and may drastically alter marine and estuarine community composition
- Florida coastal waters may become more favorable for invasive species
- increase in the incidence of harmful algal blooms

- increased stormwater runoff and transport of nutrients could contribute to hypoxia (low oxygen)
- sea level rises could alter the integrity of natural communities in estuaries, tidal wetlands, and tidal rivers

The Staff concludes that climate change impacts to Federally-managed species and their EFH could be an important contributor to cumulative impacts in Crystal Bay.

6.10 Total Cumulative Impacts on Federally-Managed Species and Their EFH

Based on the Staff's review, multiple stressors affect the aquatic resources of Crystal Bay. Management actions may address the impacts of some of the stressors (e.g., cooling system operations, fishing pressure, and water quality). Although the impacts associated with cumulative impacts cannot be quantified, cumulative impacts on aquatic resources have had or potentially will have destabilizing and adverse effects on at least some aquatic resources, including Federally-managed species and their EFH and forage species.

7.0 ESSENTIAL FISH HABITAT CONSERVATION MEASURES AND CONCLUSIONS

7.1 Conservation Measures

Three categories of impacts related to CR-3 operation could influence Federally-managed species, their EFH, or their prey species: (1) impingement, (2) entrainment, and (3) thermal discharges. The applicant's NPDES permit (FDEP, 2005) contains operational and temperature and chemical discharge limits to protect water quality and minimize impacts to aquatic biota. These limits and operating conditions would continue during the license renewal period for CR-3.

Based on the results of the 316 Demonstration study (SWEC, 1985), the EPA and FDEP issued a public notice of determination that the thermal discharges from the CREC had substantially damaged 1,100 ac (445 ha) of Crystal Bay. After several years of testimony, engineering studies, and negotiations, the CREC operations required:

- a 15 percent reduction in flow through the plant from November 1 through April 30 to reduce entrainment and, to some extent, impingement
- construction and operation of a multi-species mariculture center to mitigate intake impacts on fish and shellfish
- a maximum discharge temperature limitation of 96.5 °F (35.8 °C) as a 3-hour rolling average at the POD and construction and operation of helper cooling towers to mitigate thermal impacts to water quality and SAV (FPC, 2010)

The addition of the cooling towers to meet the NPDES permit limit of 96.5 °F (35.8 °C) (as a 3-hour rolling limit) at the POD lessened the size of the thermal plume and the maximum discharge temperature. However, during hot summers, the applicant occasionally chooses to reduce power at the coal-fired units (CR-1 and CR-2) to stay within NPDES permit thermal limits. In April 2006, the applicant received approval from the State of Florida to install additional modular cooling towers to allow CR-1 and CR-2 to operate during the warmest times of the year without reducing power (Progress Energy, 2008).

Once the helper cooling towers began operation in 1993, seagrass monitoring occurred for 3 years to quantify seagrass presence and recovery within a 2-mi (3.2-km) radius from the POD. Operation of the cooling towers did not have a dramatic impact on seagrass re-colonization. Changes in the area of the thermal plume only reflected changes also observed in the unaffected portions of Crystal Bay (FPC, 2010). Thus, thermal impacts do not have a substantial adverse impact on seagrass, which provides EFH for several of the Federally-managed species that occur within the nearshore areas of Crystal Bay. This is evident by the fact that sprig and seagrass plantings and seagrass monitoring are no longer requirements in the NPDES permit. The STAC reviewed the results and made recommendations regarding future activities at the CREC. The STAC suggested that light intensity, turbidity, salinity variation, and suspended solids have a significant influence on seagrass colonization and could be more critical than temperature (FPC, 2010). This may account for the lack of dramatic re-colonization in the discharge area since the operation of the helper cooling towers at the CREC (FPC, 2010).

Federally-managed species cultured and released from the Crystal River Mariculture Center include red drum, pink shrimp, and stone crab. From 1992 through 2009, releases of Federally-managed species have included the following: (1) red drums – 947,394 fingerlings and 1,375,500 larvae; (2) pink shrimp – 415,102 (life stage not provided), and (3) stone crabs – 32,347,962 zoea stage 1 (Progress Energy, 2010b).

7.2 Conclusions

The potential impacts of the continued operation of CR-3 on Federally-managed species and their EFH near the site have been evaluated. The known distributions and records of the Federally-managed species and the potential ecological impacts of operation on them, their habitat, and their prey base have been considered in this EFH assessment[4]. The continued operation of CR-3 was evaluated to determine whether it resulted in: (1) no adverse effect, (2) minimal adverse effect, or (3) substantial adverse effect on Federally-managed species and their EFH. The expected impacts of continued operation of CR-3 on the Federally-managed species and their EFH are summarized in Table 9. Few of the Federally-managed species for Ecoregion 2 have been collected in Crystal Bay near the CREC, and even fewer Federally-managed species have been collected in impingement or entrainment samples at CREC (Mountain, 1972), (NUS Corporation, 1978), (SWEC, 1985), (Ager et al., 2008), (CH2M Hill, 2009). When coupled with the current mitigation measures in place at the CREC, potential adverse effects on the various life stages of the Federally-managed species and their EFHs are reduced. The Staff concludes that license renewal of CR-3 for an additional 20 years of operation would result in no to minimal adverse effects on Federally-managed species and their EFH in Ecoregion 2 of the Gulf of Mexico.

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[4] Impingement and/or entrainment of Federally-managed species prey items would occur, but substantial adverse effects on prey populations would not occur.

Table 9. Impacts of Continued Operation of Crystal River Unit 3 Nuclear Generating Plant on Ecoregion 2 Species and Their Essential Fish Habitat

Common Name (Scientific Name)	Life Stage	EFH Description[(a)]	Expected Effect of Continued operation of CR-3 on EFH
		Red drum	
Red drum (*Sciaenops ocellatus*)	Eggs	M, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Larvae	E, planktonic, SAV, sand/shell/soft bottom	Minimal Adverse Effect. Thermal plume may affect small portion of Crystal Bay SAV.
	Juveniles	M/E, less than 5 m, SAV, sand/shell/soft/hard bottom	Minimal Adverse Effect. Not commonly impinged. Thermal plume may affect small portion of Crystal Bay SAV.
	Adults	M/E, between 1–46 m, SAV, pelagic, sand/shell/soft/hard bottom	Minimal Adverse Effect. Not commonly impinged. Thermal plume may affect small portion of Crystal Bay SAV.
		Reef fish – jacks (Carangidae)	
Greater amberjack (*Seriola dumerili*)	Eggs	M, 1–183 m, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Larvae	M, 1–183 m, pelagic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Juveniles	M, 1–183 m, drift algae	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples.
		Reef fish – wrasses (Labridae)	
Hogfish (*Lachnolaimus maximus*)	Juveniles	E/M, between 3–30 m, SAV	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples. Thermal plume may affect small portion of Crystal Bay SAV.

Common Name (Scientific Name)	Life Stage	EFH Description[(a)]	Expected Effect of Continued operation of CR-3 on EFH
Reef fish – snappers (Lutjanidae)			
Schoolmaster (*Lutjanus apodus*)	Eggs	M, less than 90 m, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Larvae	M, less than 90 m, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Juveniles	E/M, less than 90 m, hard bottoms, SAV, and mangroves	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples. Thermal plume may affect small portion of Crystal Bay SAV.
Gray snapper (*Lutjanus griseus*)	Eggs	M, less than 180 m, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Larvae	M/E, less than 180 m, planktonic	Minimal Adverse Effect. Operation of intake may entrain small percentage of population.
	Juveniles	M/E, less than 180 m, SAV	Minimal Adverse Effect. Operation of intake may impinge small percentage of population. Thermal plume may affect small portion of Crystal Bay SAV.
	Adults	E/M, less than 180 m, sand/shell/soft/hard bottom	Minimal Adverse Effect. Operation of intake may impinge small percentage of population.
Dog snapper (*Lutjanus jocu*)	Eggs	M, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Larvae	M, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.

Common Name (Scientific Name)	**Life Stage**	**EFH Description[(a)]**	**Expected Effect of Continued operation of CR-3 on EFH**
	Juveniles	E/M, SAV	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples. Thermal plume may affect small portion of Crystal Bay SAV.
Lane snapper (*Lutjanus synagris*)	Larvae	E/M, between 4–132 m, SAV	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples. Thermal plume may affect small portion of Crystal Bay SAV.
	Juveniles	E/M, less than 20 m, SAV, sand/shell/soft bottom	Minimal Adverse Effect. Not commonly impinged. Thermal plume may affect small portion of Crystal Bay SAV.
Yellowtail snapper (*Ocyurus chrysurus*)	Juveniles	M/E, between 1–183 m, SAV, soft bottom	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples. Thermal plume may affect small portion of Crystal Bay SAV.
	Adults	M, between 1–183 m, hard bottom, shoals/banks	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples.
Vermillion snapper (*Rhomboplites aurorubens*)	Juveniles	M, between 1–25 m, hard bottom	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Operation of intake may impinge small percentage of population.
		Reef fish – groupers (Serranidae)	
Dwarf sand perch (*Diplectrum bivittatum*)	Juveniles	M, hard bottom	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not commonly impinged.

Common Name (Scientific Name)	Life Stage	EFH Description[a]	Expected Effect of Continued operation of CR-3 on EFH
Rock hind (*Epinephelus adscensionis*)	Eggs	M, 2–100 m, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Larvae	M, 2–100 m, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Juveniles	M, 2–110 m, reefs	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples.
Red grouper (*Epinephelus morio*)	Juveniles	M/E, less than 50 m, hard bottom, SAV	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples. Thermal plume may affect small portion of Crystal Bay SAV.
Nassau grouper (*Epinephelus striatus*)	Eggs	M, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Larvae	M, between 2–50 m, planktonic	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from entrainment samples.
	Juveniles	M, SAV	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples. Thermal plume may affect small portion of Crystal Bay SAV.

Common Name (Scientific Name)	Life Stage	EFH Description[(a)]	Expected Effect of Continued operation of CR-3 on EFH
Black grouper (*Mycteroperca bonaci*)	Juveniles	E/M, SAV, hard bottom	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples. Thermal plume may affect small portion of Crystal Bay SAV.
	Adults	M/E, hard bottom	No Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not reported from impingement samples.
Gag grouper (*Mycteroperca microlepis*)	Juveniles	M/E, less than 50 m, SAV, hard bottom	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Not commonly impinged. Thermal plume may affect small portion of Crystal Bay SAV.
Coastal migratory pelagic			
Spanish mackerel (*Scomberomorus maculatus*)	Juveniles	M, less than 50 m, pelagic	Minimal Adverse Effect. Operation of intake may impinge small percentage of population.
	Adults	E/M, less than 75 m, pelagic	Minimal Adverse Effect. Operation of intake may impinge small percentage of population.
Shrimp			
White shrimp (*Litopenaeus setiferus*)	Larvae	E/M, less than 64 m, plankton, soft bottom	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Operation of intake may entrain small percentage of population.
	Juveniles	E, soft bottom	Minimal Adverse Effect. Not common or limited distribution in Crystal Bay near the CREC. Operation of intake may impinge small percentage of population.

Common Name (Scientific Name)	Life Stage	EFH Description[a]	Expected Effect of Continued operation of CR-3 on EFH
Pink shrimp (*Farfantepenaeus duorarum*)	Eggs	M, less than 50 m, sand/shell bottom	Minimal Adverse Effect. Operation of intake may entrain small percentage of population.
	Larvae	M, less than 50 m, planktonic, sand/shell bottom	Minimal Adverse Effect. Operation of intake may entrain small percentage of population.
	Juveniles	E, less than 64 m, sand/shell bottom, SAV	Minimal Adverse Effect. Operation of intake may impinge small percentage of population.
	Adults	M, less than 64 m, sand/shell bottom	Minimal Adverse Effect. Operation of intake may impinge small percentage of population.
Stone Crab			
Florida stone crab (*Menippe mercenaria*)	Larvae	E/M, less than 62 m, planktonic	Minimal Adverse Effect. Operation of intake may entrain small percentage of population.
	Juveniles	E/M, less than 62 m, sand/shell/hard bottom, SAV	Minimal Adverse Effect. Operation of intake may impinge small percentage of population. Thermal plume may affect small portion of Crystal Bay SAV.

(a) M = marine; E = estuarine; SAV = submerged aquatic vegetation

Source of EFH descriptions: NMFS, 2009

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APPENDIX E.
CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

E. CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of its environmental review for Crystal River Unit 3 Nuclear Generating Plant (CR-3). All documents, with the exception of those containing proprietary information, are available electronically from the NRC's Public Electronic Reading Room found on the Internet at the following Web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Documents Access and Management System (ADAMS), which provides text and image files of NRC's public documents in ADAMS. The ADAMS accession number for each document is included in the following list.

E.1. Environmental Review Correspondence

December 16, 2008	Letter from Florida Power Corporation (FPC) forwarding the application for renewal of the operating license for CR-3 to request an extension of the operating license for an additional 20 years (ADAMS Accession No. ML090080053)
January 16, 2009	NRC press release announcing the availability of license renewal application for CR-3 (ADAMS Accession No. ML090160331)
January 29, 2009	Letter to FPC, "Receipt and Availability of the License Renewal Application for the Crystal River Unit 3 Nuclear Generating Plant" (ADAMS Accession No. ML083470614)
February 4, 2009	*Federal Register* Notice of Receipt and Availability of Application for Renewal of Crystal River Unit 3 Nuclear Generating Plant Facility Operating License No. DPR-72 for an Additional 20-Year Period (74 FR 6060) (ADAMS Accession No. ML090290253)
February 27, 2009	Letter to FPC, "Determination of Acceptability and Sufficiency for Docketing and Opportunity for a Hearing Regarding the Application From Florida Power Corporation for Renewal of the Operating License for the Crystal River Unit 3 Nuclear Generating Plant" (ADAMS Accession No. ML090090233)
March 9, 2009	NRC press release announcing opportunity for hearing on license renewal application for CR-3 (ADAMS Accession No. ML090680492)
March 9, 2009	*Federal Register* Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. DPR-72 for an Additional 20-Year Period; Florida Power Corporation; Crystal River Unit 3 Nuclear Generating Plant (74 FR 10099) (ADAMS Accession No. ML090210171)
March 31, 2009	Letter to FPC transmitting notice of intent to prepare an environmental impact statement and conduct the scoping process for license renewal for CR-3 (ADAMS Accession No. ML090350657)

April 2, 2009	Memo to David Wrona, NRC, "Forthcoming Meeting to Discuss the License Renewal Process and Environmental Scoping for Crystal River Unit 3 Nuclear Generating Plant, License Renewal Application Review" (ADAMS Accession No. ML090860401)
April 6, 2009	*Federal Register* Notice of Intent to Prepare an Environmental Impact Statement and Conduct the Scoping Process for CR-3 (74 FR 15523) (ADAMS Accession No. ML090780840)
April 7, 2009	NRC press release announcing the CR-3 license renewal environmental scoping meeting (ADAMS Accession No. ML090970844)
April 10, 2009	Letter to Mr. Frederick Gaske, State Historic Preservation Officer, Division of Historical Resources, Florida Department of State, "Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review (SHPO No. LRP08-0040)" (ADAMS Accession No. ML090560140)
April 13, 2009	Letter to Mr. Mitchell Cypress, Chairman, Seminole Indian Tribe, "Request for Comments Concerning the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review" (ADAMS Accession No. ML090490749)
April 13, 2009	Letter to Mr. Enoch Kelly Haney, Principal Chief, Seminole Nation of Oklahoma, "Request for Comments Concerning the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review" (ADAMS Accession No. ML090550244)
April 13, 2009	Letter to Mr. Sam Hamilton, Regional Director, Southeast Regional Office, U.S. Fish and Wildlife Service, "Request for List of Protected Species within the Area under Evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review" (ADAMS Accession No. ML090400392)
April 13, 2009	Letter to Mr. James Kraus, Manager, Crystal River National Wildlife Refuge, "Request for List of Protected Species within the Area under Evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review" (ADAMS Accession No. ML090560584)
April 13, 2009	Letter to Mr. Roy Crabtree, Regional Administrator, Southeast Region, National Marine Fisheries Service, "Request for List of Protected Species and Essential Fish Habitat within the Area under Evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review" (ADAMS Accession No. ML090360156)
April 13, 2009	Letter to Mr. Billy Cypress, Chairman, Miccosukee Tribe of Florida, "Request for Comments Concerning the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review" (ADAMS Accession No. ML090570401)
April 16, 2009	Transcript of the CR-3 license renewal public meeting—afternoon session, April 16, 2009 (ADAMS Accession No. ML091460259)
April 16, 2009	Transcript of the CR-3 license renewal public meeting—evening session, April 16, 2009 (ADAMS Accession No. ML091460260)

April 20, 2009	Letter from Ms. Teletha Mincey, Program Analyst, Protected Resources Division, National Marine Fisheries Service, providing a list of species (ADAMS Accession No. ML091460262)
May 4, 2009	Letter from Mr. Frederick Gaske, State Historic Preservation Officer, regarding the license renewal of CR-3 (ADAMS Accession No. ML091460261)
May 4, 2009	Letter from Mr. Miles Croom, Assistant Regional Administrator, Habitat Conservation Division, National Marine Fisheries Service, addressing essential fish habitat (ADAMS Accession No. ML091460257)
May 11, 2009	E-mail from Mr. Paul Roberts, “Crystal River 3 Plant Life Extension” (ADAMS Accession No. ML101390392)
May 13, 2009	E-mail from Mr. Kent Wood to Mr. Paul Roberts, “Kopp Letter from 1998” (ADAMS Accession No. ML101390391)
May 22, 2009	Letter to FPC, “Proposed Review Schedule Regarding the Application from Florida Power Corporation for Renewal of the Operating License for Crystal River Unit 3 Nuclear Generating Plant (TAC Nos. ME0274 and ME0278)” (ADAMS Accession No. ML091200415)
June 8, 2009	Letter to Ms. Deborah Getzoff, Director, Southwest District, Florida Department of Environmental Protection, “Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review” (ADAMS Accession No. ML091490526)
June 8, 2009	Letter to Mr. Gary Knight, Director, Florida Natural Areas Inventory, “Request for List of Protected Species Within the Area Under Evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review” (ADAMS Accession No. ML091540745)
June 8, 2009	Letter to Dr. Robbin Trindell, Biological Administrator, Florida Fish and Wildlife Conservation Commission, “Request for List of Protected Species Within the Area Under Evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review” (ADAMS Accession No. ML091540774)
June 8, 2009	Letter to Mr. Kipp Frohlich, Section Leader, Imperiled Species Management Section, Florida Fish and Wildlife Conservation Commission, “Request for List of Protected Species Within the Area Under Evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review” (ADAMS Accession No. ML091540774)
June 10, 2009	Letter to Mr. Reid Nelson, Director, Office of Federal Agency Programs, Advisory Council on Historic Preservation, “Crystal River Unit 3 Nuclear Generating Plant License Renewal Review (TAC No. ME0278)” (ADAMS Accession No. ML090420362)

July 22, 2009	Letter from Ms. Mary Ann Poole, Florida Fish and Wildlife Conservation Commission, response to a request for a list of protected species within the area under evaluation for the Crystal River Unit 3 Nuclear Generating Plant License Renewal Application Review (ADAMS Accession No. ML092170380)
August 10, 2009	Letter to FPC, “Request for Additional Information Regarding Severe Accident Mitigation Alternatives for Crystal River Unit 3 Nuclear Generating Plant License Renewal Application (TAC No. ME0278)” (ADAMS Accession No. ML091970068)
October 6, 2009	Letter to FPC, “Request for Additional Information Regarding the Review of the License Renewal Application for the Crystal River Unit 3 Nuclear Generating Plant (TAC No. ME0278)” (ADAMS Accession No. ML092670523)
October 9, 2009	Letter from FPC, “Crystal River Unit 3 – Response to Request for Additional Information Regarding Severe Accident Mitigation Alternatives for Crystal River Unit 3 Nuclear Generating Plant License Renewal Application (TAC No. ME0278)” (ADAMS Accession No. ML092860615)
November 5, 2009	Letter from FPC, “Crystal River Unit 3 – Response to Request for Additional Information Regarding the Review of the License Renewal Application for the Crystal River Unit 3 Nuclear Generating Plant (TAC No. ME0278) – Revised Environmental Site Audit Needs List” (ADAMS Accession No. ML100980588)
December 18, 2009	Letter from FPC, “Crystal River Unit 3 – Response to Follow-up to Progress Energy RAI Responses on CR-3 SAMA [Severe Accident Mitigation Alternative] Evaluation (TAC No. ME0278)” (ADAMS Accession No. ML093580090)
January 25, 2010	Schedule revision for the review of the CR-3 license renewal application (ADAMS Accession No. ML100050166)
February 8, 2010	Letter from FPC, “Crystal River Unit 3 – Revised Environmental Site Audit Needs List (TAC No. ME0278) – Supplemental Documents” (ADAMS Accession No. ML100480234)
March 5, 2010	Letter to FPC, “Request for Additional Information for the Review of the Crystal River Unit 3 Nuclear Generating Plant, License Renewal Application (TAC No. ME0278)” (ADAMS Accession No. ML100570208)
April 1, 2010	Letter from FPC, “Crystal River Unit 3 – Response to Request for Additional Information for the Review of the Crystal River Unit 3 Nuclear Generating Plant, License Renewal Application (TAC No. ME0278) – Environmental Document Request” (ADAMS Accession No. ML101320427)
April 1, 2010	Letter from FPC, “Crystal River Unit 3 – Response to Request for Additional Information for the Review of the Crystal River Unit 3 Nuclear Generating Plant, License Renewal Application (TAC No. ME0278) – Environmental Review” (ADAMS Accession No. ML100970076)

May 11, 2010	E-mail from FPC, “Table Clarification” (ADAMS Accession No. ML101340277)
May 17, 2010	E-mail from FPC, “Permits with expiration dates.doc” (ADAMS Accession No. ML101390134)
June 3, 2010	Letter to FPC, “Request for Additional Information for the Review of the Crystal River Unit 3 Nuclear Generating Plant, License Renewal Application (TAC No. ME0278)” (ADAMS Accession No. ML101380408)
August 12, 2010	Schedule revision for the review of the CR-3 license renewal application (ADAMS Accession No. ML101460577)
November 5, 2010	Schedule revision for the review of the CR-3 license renewal application (ADAMS Accession No. ML103070380)
February 15, 2011	E-mail from FPC, “CR-3 License Renewal NPDES and South Cooling Tower Update” (ADAMS Accession No. ML110460629)
February 17, 2011	Schedule revision for the review of the CR-3 license renewal application (ADAMS Accession No. ML110320090)
March 2, 2011	E-mail from FPC, “Regulatory/environmental authorizations for current CR-3 operations” (ADAMS Accession No. ML110620143)
March 21, 2011	Letter to FPC, “Issuance of Environmental Scoping Summary Report associated with the Staff’s Review of the Application by Florida Power Corporation for Renewal of the Operating License for Crystal River Unit 3 Nuclear Generating Plant (TAC No. ME0278)” (ADAMS Accession No. ML110490462)
March 23, 2011	E-mail from Mr. Daniel Doyle to Mr. Bo Pham, “CR-3 Scoping Summary Report Distribution” (ADAMS Accession No. ML110820185)
March 24, 2011	Letter from FPC, “Crystal River Unit 3 – Review of the Crystal River Unit 3 Nuclear Generating Plant, License Renewal Application (TAC No. ME0278) – Request for Florida Department Protection Document” (ADAMS Accession No. ML110880294)

APPENDIX F.
U.S. NUCLEAR REGULATORY COMMISSION STAFF EVALUATION OF SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT IN SUPPORT OF LICENSE RENEWAL APPLICATION REVIEW

F. SEVERE ACCIDENT MITIGATION ALTERNATIVE ANALYSIS

F.1. Introduction

Florida Power Corporation (FPC), doing business as Progress Energy Florida, Inc., submitted an assessment of severe accident mitigation alternatives (SAMAs) for the Crystal River Unit 3 Nuclear Generating Plant (CR-3) as part of the environmental report (ER) (Progress Energy, 2008). This assessment was based on the most recent CR-3 probabilistic safety assessment (PSA) available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer code (NRC, 1998a), and insights from the CR-3 individual plant examination (IPE) (FPC, 1993) and individual plant examination of external events (IPEEE) (FPC, 1997). In identifying and evaluating potential SAMAs, FPC considered SAMA candidates that addressed the major contributors to core damage frequency (CDF) and large early release frequency (LERF) at CR-3, as well as SAMA candidates for other operating plants which have submitted license renewal applications. FPC identified 25 potential SAMA candidates. This list was reduced to 15 SAMA candidates by eliminating SAMAs that are not applicable at CR-3 due to design differences or were judged to have a low benefit relative to the cost of implementation. FPC assessed the costs and benefits associated with each of these 15 potential SAMAs, and concluded in the ER that several of the candidate SAMAs evaluated are potentially cost-beneficial.

Based on a review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) staff (Staff) issued a request for additional information (RAI) to FPC by letter dated August 10, 2009, (NRC, 2009). Key questions concerned: (1) additional details regarding the plant-specific PSA model and changes to CDF and LERF since the IPE, (2) the process used to map Level 1 PSA results into the Level 2 analysis and group containment event tree (CET) end states into release categories, (3) justification for the multiplier used for external events, (4) the impact on the SAMA analysis of the planned extended power uprate (EPU), (5) the rationale for not identifying SAMAs for many basic events included in the risk importance list and for certain fire compartments, and (6) further information on the cost-benefit analysis of several specific candidate SAMAs and low cost alternatives. FPC submitted additional information to the Staff by letters dated October 9, 2009 (Progress Energy, 2009a), and December 18, 2009 (Progress Energy, 2009b). In response to the RAIs, FPC provided: (1) the CDF and LERF values for, and major changes to, each version of the CR-3 PSA model; (2) a description of the process for mapping Level 1 results into the Level 2 analysis, and for assigning CET sequences to release categories; (3) a revised SAMA analysis reflecting a higher external events multiplier; (4) an assessment of the impact on the SAMA analysis of the planned EPU; (5) additional rationale for not identifying SAMAs for many of the basic events on the risk importance list; (6) an assessment of plant improvements for certain fire areas; and (7) additional information regarding several specific SAMAs. FPC's responses addressed the Staff's concerns and resulted in the identification of additional, potentially cost-beneficial SAMAs.

An assessment of SAMAs for CR-3 is presented below.

F.2. Estimate of Risk for Crystal River Unit 3 Nuclear Generating Plant

FPC's estimates of offsite risk at the CR-3 are summarized in Section F.2.1. The summary is followed by the Staff's review of FPC's risk estimates in Section F.2.2.

F.2.1 Florida Power Corporation's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the CR-3 Level 1 and Level 2 PSA model, which is an updated version of the IPE (FPC, 1993); and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PSA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent CR-3 Level 1 and Level 2 PSA model available at the time of the ER, referred to as the 2006 Model of Record (MOR). The scope of this CR-3 PSA does not include external events.

The CR-3 CDF is approximately 4.99×10^{-6} per year using a truncation value of 1×10^{-12} per year, and 4.95×10^{-6} per year using a truncation value of 1×10^{-11} per year. The latter value was used as the baseline CDF in the SAMA evaluations. The CDF is based on the risk assessment for internally-initiated events, which includes internal flooding. FPC did not include the contribution from external events in the CR-3 PSA risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 2. For fire-related SAMAs, FPC separately estimated the risk reduction benefits using the fire risk model. This is discussed further in Sections F.2.2 and F.6.2.

Table F-1. Crystal River Unit 3 Nuclear Generating Plant Core Damage Frequency for Internal Events[(a)]

Initiating Event	CDF (per year)	Percent Contribution to CDF
Small Break loss-of-coolant accident (LOCA)	1.5×10^{-6}	30
Transients	9.9×10^{-7}	20
Reactor vessel rupture	5.0×10^{-7}	10
Internal flooding	4.0×10^{-7}	8
Steam generator tube rupture (SGTR)	3.5×10^{-7}	7
Loss of alternating current (AC) buses	3.3×10^{-7}	7
Loss of offsite power (LOOP)	3.0×10^{-7}	6
Large break LOCA	1.7×10^{-7}	3
Loss of direct current (DC) power	1.5×10^{-7}	3
Loss of main feedwater	1.2×10^{-7}	2
Medium break LOCA	1.1×10^{-7}	2
Interfacing system LOCA (ISLOCA)	5.1×10^{-8}	1
Total CDF (internal events)[(b)]	**4.99×10^{-6}**	**100**

(a) Based on model quantification using 1×10^{-12} per year truncation

(b) Column totals may be different due to round off

The breakdown of CDF by initiating event is provided in Table F-1. This information was summarized from that provided in response to a Staff RAI (Progress Energy, 2009a). As shown in this table, small LOCAs and transients (reactor trips, loss of intake, and loss of makeup) are the dominant contributors to the CDF.

In response to a Staff RAI, FPC stated that the Level 2 PSA model that forms the basis for the SAMA evaluation represents a complete revision of the original IPE Level 2 model (Progress Energy, 2009a). The current Level 2 model uses a single CET containing both phenomenological and systemic events. The Level 1 core damage sequences are binned into one of 26 plant damage state (PDS) bins which provide the interface between the Level 1 analysis and Level 2 CET analysis (Progress Energy, 2009b). The CET probabilistically evaluates the progression of the damaged core with respect to release to the environment. CET nodes are evaluated using supporting fault trees and logic rules. The CET end states are then examined for considerations of timing and magnitude of release, and assigned to release categories.

The result of the Level 2 PSA is a set of 11 release categories, also referred to as source term categories, with their respective frequency and release characteristics. The results of this analysis for CR-3 are provided in Table E.3-6 of Appendix E to the ER (Progress Energy, 2008). The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints assigned to each release category. Source terms were developed for each of the 11 release categories using the results of modular accident analysis program (MAAP) computer code calculations. In response to a Staff RAI, FPC stated that MAAP Version 4.0.6 was used in the CR-3 analysis (Progress Energy, 2009a).

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for these analyses include: (1) plant-specific and site-specific input values for core radionuclide inventory, (2) source term and release characteristics, (3) site meteorological data, (4) projected population distribution within a 50-mile (mi) (80-kilometer [km]) radius for the year 2036, (5) emergency response evacuation planning, and (6) economic parameters. The core radionuclide inventory corresponds to the end-of-cycle values for CR-3 operating at 2,568 megawatts-thermal (MWt) (the currently approved power level). The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC, 1997a).

In the ER, FPC estimated the dose to the population within 50 mi (80 km) of the CR-3 site to be approximately 0.040 person-Sievert (Sv) (4 person-roentgen equivalent man (rem)) per year[1]. The breakdown of the total population dose by containment release mode is summarized in Table F-2. Containment bypass events (such as SGTR-initiated accidents or ISLOCA accidents) and small early containment failures dominate the population dose risk at CR-3.

[1] The CR-3 total population dose is approximately 3.98 person-rem/year using a truncation value of $1x10^{-12}$ per year and 3.79 person-rem/year using a truncation value of $1x10^{-11}$ per year. The latter value was used as the baseline population dose in the SAMA evaluations.

Table F-2. Breakdown of Population Dose by Containment Release Mode[a]

Containment Release Mode	Population Dose (Person-Rem[b] Per Year)	Percent Contribution
Containment intact	0.04	1
Late containment failure	0.04	1
Large early containment failure	0.02	<1
Small early containment failure	0.37	9
Containment bypass accident, small leakage rate	2.68	67
Containment bypass accident, large leakage rate	0.83	21
Total[c]	**3.98**	**100**

(a) Based on model quantification using 1x10^{-12} per year truncation
(b) One person-rem = 0.01 person-Sv
(c) Column totals may be different due to round off

F.2.2 Review of Florida Power Corporation's Risk Estimates

FPC's determination of offsite risk at CR-3 is based on the following three major elements of analysis:

- the Level 1 and 2 risk models that form the bases for the 1993 IPE submittal (FPC, 1993) and the external event analyses of the 1997 IPEEE submittal (FPC, 1997)
- the major modifications to the IPE model that have been incorporated in the CR-3 PSA, including a complete revision of the Level 2 risk model
- the MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PSA model into offsite consequence measures

Each of these analyses was reviewed to determine the acceptability of the CR-3 risk estimates for the SAMA analysis, as summarized below.

The Staff's review of the CR-3 IPE is described in NRC reports dated April 28, 1997 (NRC, 1997b) and June 30, 1998 (NRC, 1998b). Based on a review of the original IPE submittal, responses to RAIs, and supplemental responses to the NRC's April 28, 1997, report, the Staff concluded that the IPE submittal met the intent of Generic Letter (GL) 88-20 (NRC, 1988); that is, the licensee's IPE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities. Although no vulnerabilities were identified in the IPE, improvements to the plant or procedures were identified and implemented. These improvements are discussed in Section F.3.2.

There have been seven revisions to the IPE model between the 1993 IPE submittal and the model used for the SAMA analysis. A listing of the major changes in each revision of the PSA was provided by FPC in Section E.2-1 of the ER (Progress Energy, 2008) and in response to a Staff RAI (Progress Energy, 2009a), and is summarized in Table F-3. A comparison of the internal events CDF between the 1993 IPE and the MOR 2006 PSA model used for the SAMA evaluation indicates a decrease of approximately 67 percent (from 1.4×10^{-5} per year to 5.0×10^{-6} per year).

Table F-3. Crystal River Unit 3 Nuclear Generating Plant Probabilistic Safety Assessment Historical Summary

PSA Version	Summary of Changes from Prior Model	CDF (per year)
1993	IPE Submittal	1.4×10^{-5}
2000	- Added backup engineered safeguards transformer (BEST) - Added feedwater pump 7 (FWP-7) powered by alternate emergency diesel generator (EDG), MTDG-1 - Added installed Appendix R chiller - Added installed alternate AC diesel generator - Added installed backup water supply for raw water pump flushing water	3.4×10^{-6}
2001	- Updated timing for post initiator events and dependencies - Updated internal plant flooding model - Updated component reliability database - Updated common cause data - Revised human reliability analysis (HRA) to include more detailed dependency	5.1×10^{-6}
2002	- Added pipe rupture event on elevation 95 of the auxiliary building based upon internal flooding analysis revision - Updated post-initiator events and dependency analysis in the HRA - Revised the SGTR binning per revised event tree and updated the sequences for the Level 2 analysis	6.8×10^{-6}
2003	- Added new initiating event fault trees for loss of service water and loss of makeup - Updated mutually exclusive combinations of several events	7.5×10^{-6}
2003a	- Revised Level 2 model core damage binning and LERF split fractions	7.5×10^{-6}
2003b	- Updated fault tree to reflect power-operated relief valve (PORV) block valve alignment - Added two HRA events to address high-pressure injection (HPI) flow control issues	5.4×10^{-6}
2006	- Updated fault tree to reflect installation of a third diesel generator, removal of the FWP-7 alternate EDG, and ability to align unit buses from the auxiliary transformer	5.0×10^{-6}

The CDF value from the 1993 CR-3 IPE (1.4×10^{-5} per year) is near the lower end of the range of the CDF values reported in the IPEs for Babcock & Wilcox plants. Figure 11.6 of NUREG-1560 shows that the IPE-based internal events CDF for these plants range from about 1×10^{-5} per year to 7×10^{-5} per year, with an average CDF for the group of 3×10^{-5} per year (NRC, 1997c). It is recognized that other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. The internal events CDF result for CR-3 used for the SAMA analysis (4.95×10^{-6} per year, including internal flooding) is comparable to that for other plants of similar vintage and characteristics.

The Staff considered the peer reviews performed for the CR-3 PSA and the potential impact of the review findings on the SAMA evaluation. In the ER (Progress Energy, 2008), FPC described the peer review and PSA certification by the Nuclear Energy Institute (NEI) conducted on the MOR 2000 PSA model. The peer review identified 11 Level A and 27 Level B facts and observations (F&Os). FPC stated in the ER that all Level A and Level B F&Os have been subsequently addressed and are considered closed, with all final disposition of comments incorporated in the MOR 2003 PSA model. FPC further stated that all Level C and Level D F&Os have also been addressed and closed. In light of the amount of time that has passed since the NEI peer review, the Staff asked FPC if any other internal or external reviews have been conducted on the CR-3 internal events PSA (NRC, 2009). In response to the RAI, FPC identified that a full scope PSA self assessment was performed in 2007 to the guidance in NRC Regulatory Guide (RG) 1.200 (NRC, 2007), and that a limited scope peer review was performed in 2009 covering the following technical elements: initiating events (IE) analysis, quantification (QU) – partial, and LERF analysis (Progress Energy, 2009a). In response to a followup RAI, FPC provided additional information on three F&Os from the 2007 self assessment that resulted in a change to the PSA model or results and provided an assessment of the impact of the F&Os on the SAMA analysis (Progress Energy, 2009b). The three F&Os are as follows:

- F&O AS-B6 pertains to the installation of a nonsafety EDG since the MOR 2006 PSA model used in the SAMA evaluation. The CR-3 PSA model has been updated to credit the nonsafety EDG. FPC concluded that the impact of this F&O on the SAMA evaluation is insignificant since the result is a decrease in CDF due to credit being taken for the enhanced capability to recover from loss of offsite power events.

- F&O HR-G4-2 pertains to suspect human error probabilities and accident progression timing due to out-of-date or inadequate documentation. Human reliability analysis timelines have been updated in the CR-3 draft 2009 PSA model reflecting the latest MAAP analysis. Based on this update, FPC concluded that the impact of this F&O on the SAMA evaluation is insignificant since operator actions account for a large portion of the overall CDF in both the MOR 2006 model and the updated draft 2009 model. The Staff notes that FPC identified and evaluated potential SAMA candidates for numerous operator actions as a result of FPC’s importance analyses.

- F&O DA-C1 pertains to the lack of justification for the LOOP frequency. The LOOP methodology and data have been updated in the CR-3 PSA model to use NUREG/CR-6890 data that has been Bayesian updated against experience at CR-3. FPC concluded that the impact of this F&O on the SAMA evaluation is insignificant since the result is a decrease in the contribution to CDF from LOOP events.

In response to the same followup RAI, FPC noted that there were no F&Os from the 2009 limited scope peer review that required changes to the PSA model or its results. FPC further concluded that resolution of the above described F&Os would not have significantly changed the basic event importance listing used in the SAMA evaluation, as discussed in Section F.3.2, and that the uncertainty analysis discussed in Section F.6.2 adequately accounts for any uncertainty in the overall PSA model results due to resolution of the F&Os. Based on FPC’s rationale for concluding that resolution of the F&Os will not significantly impact the results of the SAMA evaluation, and considering that the internal events CDF has significantly decreased subsequent to the MOR 2006 model used in the SAMA evaluation (see discussion below), the

Staff finds that resolution of the review findings is not likely to impact the results of the SAMA analysis.

In response to a Staff RAI (NRC, 2009), FPC described the quality control process in use at CR-3 as applied to development of the PSA (Progress Energy, 2009a). An administrative procedure prescribes the quality control process for updates to the CR-3 PSA and ensures that the PSA model is maintained current with the changes to the plant. The procedure covers model update administration, implementation, and tracking of error and improvement opportunities. The Staff considers FPC's quality control process to be reasonable.

The Staff asked FPC to identify any changes to the plant, including physical and procedural modifications, since the MOR 2006 PSA model, which could have a significant impact on the results of the SAMA analysis (NRC, 2009). In response to the RAI, FPC stated that there have been no major plant changes, since the MOR 2006 PSA model, which would have a significant impact on the SAMA analysis. FPC further stated that the major changes to the PSA model, since the MOR 2006 PSA model, are to bring the model into compliance with the guidance in NRC RG 1.200 (NRC, 2007), and to include the addition of potential multiple spurious operation (MSO) events; none of these changes are expected to have a significant impact on the results of the SAMA evaluation. In response to a followup RAI, FPC further clarified that the CDF has decreased to 3.4×10^{-6} per year in the CR-3 2009a draft PSA model, which is a decrease from the CDF of 4.95×10^{-6} per year used in the SAMA analysis. In response to this same RAI, FPC noted that the CDF is expected to increase to about 3.6×10^{-6} per year after plant changes are made to implement an EPU of approximately 20 percent (Progress Energy, 2009b). Given that the CDF is expected to decrease by about 27 percent compared to the MOR 2006 PSA model used for the SAMA analysis, after accounting for plant changes that are expected to be made to implement the EPU and model updates, the Staff concurs with FPC's conclusion that changes to the CR-3 PSA model, since the MOR 2006 PSA model, are not likely to impact the results of the SAMA analysis.

Given that the CR-3 internal events PSA model has been peer-reviewed and the peer review findings were all addressed, and that FPC has satisfactorily addressed Staff questions regarding the PSA, the Staff concludes that the internal events Level 1 PSA model is of sufficient quality to support the SAMA evaluation.

As indicated above, the current CR-3 PSA does not include external events. In the absence of such an analysis, CR-3 used the CR-3 IPEEE to identify the highest risk accident sequences and the potential means of reducing the risk posed by those sequences, as discussed below and in Section F.3.2.

FPC submitted revision 0 of the CR-3 IPEEE in June 1996 (FPC, 1996) and revision 1 in March 1997 (FPC, 1997) in response to Supplement 4 of GL 88-20 (NRC, 1991). These submittals included an internal fire PSA and an evaluation of high winds, external flooding, and other hazards. In response to Staff RAIs on the IPEEE, FPC submitted a report titled "IPEEE Seismic Summary Report" in June 1998 (FPC, 1998), which included a seismic margins analysis. While no fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events were identified, a number of opportunities for risk reduction were identified as discussed below. In a letter dated January 11, 2001, the Staff concluded that the submittal met the intent of Supplement 4 to GL 88-20, and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC, 2001).

The seismic portion of the IPEEE consisted of a reduced-scope seismic evaluation using the Electric Power Research Institute (EPRI) methodology for Seismic Margins Assessment (SMA), and the Seismic Qualification User's Group (SQUG) Generic Implementation Procedure (SQUG, 1992). This method is qualitative and does not provide numerical estimates of the CDF contributions from seismic initiators (EPRI, 1991). For this assessment, the review level earthquake (RLE) value for CR-3 was one-tenth the acceleration of gravity (0.1g), plant walkdowns were performed in which components and structures were screened for the RLE based on the EPRI guidelines, and specific high confidence in low probability of failure (HCLPF) capacities were calculated for six components to demonstrate the rugged design of the plant. The CR-3 IPEEE seismic evaluation identified no additional outliers other than the unresolved outliers remaining from implementation of the Unresolved Safety Issue (USI) A-46 program. The USI A-46 safety evaluation report (SER) for CR-3 identified three unresolved issues (NRC, 2000). In response to a Staff RAI, FPC clarified that all unresolved USI A-46 outliers have been resolved (Progress Energy, 2009a).

To provide additional insight into the appropriate seismic CDF to use for the SAMA evaluation, the Staff developed an independent estimate of the seismic CDF for CR-3 using the simplified-hybrid approximation method described in a paper by Robert P. Kennedy, entitled "Overview of Methods for Seismic PRA and Margin Analysis Including Recent Innovations" (Kennedy, 1999) and using updated 2008 seismic hazard curve data from the U.S. Geologic Survey (USGS, 2008). The Staff's independent calculations indicate the seismic CDF for CR-3 to be approximately 1.2×10^{-5} per year depending on the seismic hazard curve and plant fragility assumptions. Since FPC did not provide a seismic CDF contribution in the ER, the Staff used this result to assess the appropriateness of the external event multiplier used in the SAMA evaluation.

The CR-3 IPEEE fire analysis employed a combination of PSA with the EPRI's fire-induced vulnerability evaluation (FIVE) methodology (EPRI, 1993). Quantitative screening of fire zones was performed using fire frequencies based on the FIVE methodology and the conservative assumption that all equipment in a fire zone would fail if there was a fire. Fire sequences were then quantified using the internal events PSA model. If the CDF was greater than 1×10^{-6} per year, the compartment was subjected to more detailed analysis. In this analysis, the FIVE fire screening methodology was used in the fire modeling with the exception that the generic EPRI fire frequencies were modified by applying a fire severity factor to certain types of ignition sources. The Staff asked FPC to provide the fire CDF by fire zone (NRC, 2009). In response to the RAI, FPC provided the requested information for all fire zones having a fire CDF greater than 1×10^{-6} per year and for the control room and cable spreading room (Progress Energy, 2009a). FPC further stated that the fire PSA has not been updated since the IPEEE. The fire zone CDFs are, therefore, the same as provided in the IPEEE, and are listed in Table F-4. The total fire CDF, found by summing the values for all zones in Table F-4, is 4.2×10^{-5} per year.

Table F-4. Crystal River Unit 3 Nuclear Generating Plant Fire Zones and Their Contribution to Fire Core Damage Frequency

Fire Zone	Fire Zone Description	CDF (per year)
CC-108-106	Battery Charger Room 3A	1.5×10^{-5}
CC-108-108	4160V ES Switchgear Bus Room 3A	7.3×10^{-6}
CC-108-107	4160V ES Switchgear Bus Room 3B	6.8×10^{-6}
CC-124-117	480V ES Switchgear Bus Room 3A	3.8×10^{-6}
CC-108-105	Battery Charger Room 3B	2.7×10^{-6}
CC-108-102	Hallway and Remote Shutdown Room	2.7×10^{-6}
CC-124-111	Control Rod Drive (CRD) & Communication Equipment Room	1.6×10^{-6}
CC-108-109	Inverter Room 3B	1.5×10^{-6}
CC-145-118B	Control Room	5.7×10^{-7}
CC-134-118A	Cable Spreading Room	9.9×10^{-8}
Total Fire CDF (all fire zones)		**4.2×10^{-5}**

The Staff inquired about additional measures that FPC had already taken to reduce fire risk since the IPEEE (NRC, 2009). FPC provided a description of the specific fire protection related modifications that have been implemented since the Staff review of the IPEEE, which includes installation of emergency lighting, improved separation of electrical cables, improved administrative control of transient combustibles, fire detector upgrades, suppression system upgrades, and upgrades of programmatic controls for penetration seals. In response to a followup RAI, FPC provided a table that identified the specific fire protection related modifications that have been implemented for each of the dominant fires zones identified in Table F-4 (Progress Energy, 2009b). Fire protection modifications that have been implemented include some electrical cable re-routing, upgraded fire detectors in every dominant fire zone, and enhanced emergency lighting in most dominant fire zones.

Considering the above discussion, and the actions taken by FPC to reduce fire risk since the IPEEE, the Staff concludes that the fire CDF of 4.2×10^{-5} per year is reasonable for the SAMA analysis.

The CR-3 IPEEE analysis of high winds, tornadoes, external floods, and other external events followed the screening and evaluation approaches specified in Supplement 4 to GL 88-20 (NRC, 1991) and did not identify any sequences or vulnerabilities that exceeded the 1.0×10^{-6} per year criterion (FPC, 1997). Based on this result, the licensee concluded that these other external hazards would be negligible contributors to overall core damage and did not consider any plant-specific SAMAs for these events.

Based on the aforementioned results, including the Staff assessment of the CR-3 seismic CDF, the external events CDF is approximately 11 times the internal events CDF (based on a seismic CDF of 1.2×10^{-5} per year, a fire CDF of 4.2×10^{-5} per year, and an internal events CDF of 4.95×10^{-6} per year). The Staff requested FPC provide additional justification for increasing the internal events benefits by only a factor of 2 to account for external events in light of this result (NRC, 2009). In response to the RAI, FPC chose to provide a revised SAMA evaluation using a multiplier of 12 [(4.2×10^{-5} + 1.2×10^{-5}) / (4.95×10^{-6}) + 1)] to account for external events (Progress Energy, 2009a). This is discussed further in Section F.6.2.

The Staff reviewed the general process used by FPC to translate the results of the Level 1 PSA into containment releases, as well as the results of the Level 2 analysis, as described in the ER and in response to Staff RAIs (Progress Energy, 2008), (Progress Energy, 2009a). The Level 2 model is completely revised from the model used in the IPE and reflects the CR-3 plant as designed and operated as of April 2006. Major revisions and updates to the Level 2 model include use of updated thermal hydraulics and containment analysis tools and methods, a single top fault tree solution, revised SGTR and core damage binning and LERF split fractions, updated sequences, and updated fault exposure time for steam generator instrumentation. The Level 1 core damage sequences are binned into one of 26 PDS bins which provide the interface between the Level 1 and Level 2 analyses. The PDS bins, which are described in the response to a Staff follow-up RAI, are defined by a set of core damage states and containment system status parameters (Progress Energy, 2009b).

Each PDS is analyzed through the Level 2 CET to evaluate the phenomenological progression of the sequence. The current Level 2 model uses a single CET, containing both phenomenological and systemic events. In response to a Staff RAI, FPC clarified that the CET end states are then assigned to one of 11 release categories based on characteristics that determine the timing and magnitude of the release, whether or not the containment remains intact, and isotopic composition of the release material (Progress Energy, 2009a). The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints binned into the release category.

Source term release fractions were developed for each of the 11 release categories based on the results of plant-specific calculations using the MAAP Version 4.0.6 (Progress Energy, 2009a). In response to a Staff RAI, FPC clarified that a single MAAP calculation was performed for each of the 11 release categories (i.e., 11 MAAP calculations) and that no weighting of multiple MAAP cases was required (Progress Energy, 2009a). The release categories, their frequencies, and release characteristics are presented in Tables E.2-3 and E.3-5 of Appendix E to the ER (Progress Energy, 2008).

The Staff's review of the Level 2 IPE concluded that it addressed the most important severe accident phenomena normally associated with large, dry containments, and identified no significant problems or errors (NRC, 1998b). The revisions to the Level 2 model, since the IPE to update the methodology and to address peer review recommendations, are described in Section E.2.1 of the ER. The Level 2 PSA model was included in the NEI peer review mentioned previously. All peer review findings have been addressed and are considered closed. In response to a Staff RAI, FPC identified that the Level 2 PSA model was included in the 2007 full scope PSA self assessment and the LERF analysis was included in the 2009 limited scope peer review (Progress Energy, 2009a). In response to a follow-up RAI, FPC identified no significant F&Os, defined as a change to the PSA model or results, from these reviews related to the Level 2 PSA model (Progress Energy, 2009b).

Based on its review of the Level 2 methodology, the Staff determined that: (1) FPC has adequately addressed the Staff RAIs, (2) the Level 2 PSA model was reviewed in more detail as part of the NEI peer review and the peer review findings have been addressed in the model used for the SAMA analysis, and (3) the Level 2 PSA model was reviewed as part of the more recent full scope PSA self assessment and limited scope peer review of the LERF analysis.

Therefore, the Staff concludes that the Level 2 PSA provides an acceptable basis for evaluating the benefits associated with various SAMAs.

As indicated in the ER, the reactor core radionuclide inventory used in the consequence analysis corresponds to the end-of-cycle values for CR-3 operating at 2,568 MWt. The core radionuclide inventory is provided in Table E.3-3 of Appendix E of the ER (Progress Energy, 2008). The ER noted that this did not account for an NRC-approved thermal power uprate of 1.6 percent to 2,609 MWt in 2007 as a result of feedwater flow measurement uncertainty recapture. FPC performed a sensitivity analysis and determined that results of the SAMA evaluation are not impacted by the measurement uncertainty power uprate. The ER also stated that FPC plans to increase the licensed power level of CR-3 by approximately 20 percent in an EPU to be implemented before the renewal period. The Staff noted that operation at this higher power level could impact the results of the SAMA evaluation due to the higher fission product inventory and replacement power costs associated with the EPU, and requested that FPC provide an analysis of the impacts of the EPU on the SAMA analysis (NRC, 2009). FPC responded by providing a sensitivity analysis of the SAMA results assuming population dose and economic consequences increased by 20 percent, as the result of the 20 percent increase in power level (Progress Energy, 2009b). This resulted in an increase in the population dose risk from 3.98 person-rem per year, reported in Table F-2, to 4.77 person-rem per year. The analysis showed that the EPU would not impact the results (i.e., no additional candidate SAMAs would become cost beneficial). Considering that the SAMA evaluation results are not impacted by the higher fission product inventory corresponding to the EPU, the Staff concludes that the reactor core radionuclide inventory assumptions for estimating consequences are reasonable and acceptable for purposes of the SAMA evaluation.

The Staff reviewed the process used by FPC to extend the containment performance (Level 2) portion of the PSA to an assessment of offsite consequences (Level 3). This included consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses. Version 2 of the MACCS2 code was used to estimate offsite consequences. Plant-specific input to the code includes the source terms for each release category and the reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within a 50-mi (80-km) radius for the year 2036, emergency evacuation planning, and economic parameters including agricultural production. This information is provided in Section 3.0 of Attachment E to the ER (Progress Energy, 2008).

Releases were modeled as occurring at ground level, except that the SGTR event was modeled as a release from the 39.5-foot high building vents. The results of a sensitivity study, assuming releases occurred at the top of the containment building, indicated a negligible impact (1 percent increase) on both population dose and offsite economic cost risk. The thermal content of each of the releases was assumed to be the same as ambient (that is a non-buoyant plume). Wake effects for the 53-meter high and 44-meter diameter containment building were included in the model. Sensitivity studies were performed on these assumptions and indicated a maximum of 2 percent increase in population dose risk and a high of 4 percent increase in offsite economic cost risk. Based on the information provided, the Staff concludes that the release parameters used are acceptable for the purposes of the SAMA evaluation.

FPC used site-specific meteorological data for the year 2004 as input to the MACCS2 code. The development of the meteorological data is discussed in Section E.3.6 of the ER (Progress Energy, 2008). Data from 2003 through 2006 were also considered, but the 2004 data was chosen because it was the most complete data set and because results of an MACCS2 sensitivity case indicated that the 2004 data produced more conservative results (i.e., the 2004 data set was found to result in the largest offsite economic cost risk and was within 0.3 percent of the maximum population dose risk) (Progress Energy, 2008). Less than 2 percent of the data were missing for the years 2003 through 2006. Missing data were estimated using data substitution methods. These methods include substitution of missing data with corresponding data from another level on the meteorological tower, interpolation between data from the same level, or data from the same hour and a nearby day of a previous year. Hourly stability was classified according to the system used by the NRC (NRC, 1983), and atmospheric mixing heights were specified for AM and PM hours for each season of the year using data from the Environmental Protection Agency (EPA, 1992). The baseline analysis assumes perpetual rainfall in the 40- to 50-mi segment surrounding the site. Another sensitivity study was also performed assuming measured rainfall rather than perpetual rainfall in the 40- to 50-mi spatial segment. This resulted in a decrease in population dose risk of 41 percent and a decrease in offsite economic cost of 50 percent. The Staff concludes that the use of the 2004 meteorological data in the SAMA analysis is reasonable.

The population distribution that the licensee used as input to the MACCS2 analysis was estimated for the year 2036, using year 2000 census data as accessed by SECPOP2000 (NRC, 2003). The baseline population was determined for each of 160 sectors, consisting of the 16 directions for each of 10 concentric distance rings with outer radii at 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 mi surrounding the site. County population growth estimates were applied to year 2000 census data to develop year 2036 population distribution. The distribution of the population is given for the 10-mi (16-km) radius from CR-3 and for the 50-mi (80-km) radius from CR-3 in the ER (Progress Energy, 2008). The Staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 10 mi (16 km) from the plant. FPC assumed that 95 percent of the population would evacuate. This assumption is conservative relative to the NUREG-1150 study (NRC, 1990), which assumed evacuation of 99.5 percent of the population within the emergency planning zone (EPZ). The evacuated population was assumed to move at an average speed of approximately 1.1 miles per hour (0.48 meters per second) with a delayed start time of 30 minutes after declaration of a general emergency. The evacuation speed was derived from the projected time to evacuate the entire EPZ under adverse weather conditions for 1990 (Progress Energy, 2006), and then adjusted by the ratio of the year 1990 EPZ population to the projected year 2036 EPZ population. FPC performed a sensitivity study in which the evacuation speed was decreased by 50 percent. This resulted in a 2 percent increase in the total offsite population dose risk and no change in the offsite economic cost risk. In response to the Staff’s inquiry concerning the transient population (NRC, 2009), FPC provided the results of a sensitivity study in which the EPZ population was increased to account for the transient population (Progress Energy, 2009a). The most conservative scenario in this study assumed the residential population within the EPZ for the year 2036 was increased by 10 percent and the evacuation speed was decreased by 19.4 percent. This resulted in a 2 percent increase in population dose risk and a 0.7 percent increase in offsite economic cost risk. A second scenario assumed the increase in EPZ population and corresponding decrease in evacuation speed were adjusted to only reflect the maximum documented monthly park visitations between July 2007 and June 2009. Using the maximum visitation month during those years, and adjusting the number of visitors to an equivalent year 2036, using the same growth rate as the residential population near the parks, resulted in a 1.1 percent increase in population dose risk and a 0.1 percent increase in offsite economic cost risk. The Staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

Site-specific agriculture and economic data were provided from 2002 National Census of Agriculture (USDA, 2002) data for each of the 10 counties surrounding CR-3 to a distance of 50 mi (80 km). This included the fraction of land devoted to farming, annual farm sales, the fraction of farm sales resulting from dairy production, and the value of non-farm land. Non-farm land property values were taken from 2005 property valuations (FDR, 2006).

Area wide farm wealth was determined from 2002 National Census of Agriculture (USDA, 2002) county statistics for farmland, buildings, and machinery, with only the fraction of each county within 50 mi (80 km) of CR-3 considered. Non-farm wealth was derived from 2005 property tax valuations (FDR, 2006). In addition, generic economic data that applied to the region as a whole were revised from the MACCS2 sample problem input in order to account for cost escalation since 1986 (the year the input was first specified). This included parameters describing cost of evacuating and relocating people, land decontamination, and property condemnation. An escalation factor of 1.85 was applied to these parameters to account for cost escalation from 1986 to February 2007 (USDL, 2007).

The Staff requested FPC provide an explanation of the reasons for the difference in the total population dose risk reported in Table 3-7 of the ER (3.98 person-rem per year) and Section E.4.6 of the ER (3.79 person-rem per year) used in the SAMA evaluations. FPC responded that the MOR 2006 CDF of 4.99×10^{-6} per year, corresponding to 3.98 person-rem per year, was derived using a truncation of 1×10^{-12} per year. The model quantification used for the SAMA evaluations was derived with a higher truncation limit of 1×10^{-11} per year to support a more efficient re-quantification of the PSA model. This resulted in a CDF of 4.95×10^{-6} per year and a population dose of 3.79 person-rem per year (Progress Energy, 2009a). FPC also stated that the two CDFs were quantified from the MOR 2006 PSA model using different methods or software, each of which is considered a valid methodology. FPC noted that all of the SAMA calculations used the same method of quantification. Since the SAMA benefits are based on the difference between severe accident costs with and without the SAMA implemented, and because the same method of quantification (and truncation level) is used in all SAMA calculations, the truncation level has no real impact on estimated benefits. The Staff notes that the difference in CDF and total population dose values using the two truncation values is small, and considers the approach, as clarified, to be reasonable and acceptable for purposes of the SAMA evaluation.

The Staff concludes that the methodology used by FPC to estimate the offsite consequences for CR-3, provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the Staff based its assessment of offsite risk on the CDF and offsite doses reported by FPC.

F.3. Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by FPC are discussed in this section.

F.3.1 Process for Identifying Potential Plant Improvements

FPC's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of the most significant basic events from the current, plant-specific PSA and insights from the CR-3 PRA Group
- review of potential plant improvements identified in the CR-3 IPE and IPEEE
- review of SAMA candidates identified for license renewal applications for selected nuclear power plants
- review of other industry documentation discussing potential plant improvements

Based on this process, an initial set of 25 candidate SAMAs, referred to as Phase I SAMAs, was identified. In Phase I of the evaluation, FPC performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- The SAMA modified features not applicable to CR-3 due to design differences.
- The SAMA was qualitatively judged to have a low benefit relative to the cost of implementation.

Based on this screening, 10 SAMAs were eliminated, leaving 15 for further evaluation. The remaining SAMAs, referred to as Phase II SAMAs, are listed in Table E.6-1 of the ER (Progress Energy, 2008). In Phase II, a detailed evaluation was performed for each of the 15 remaining SAMA candidates, as discussed in Sections F.4 and F.6 below. To account for the potential impact of external events, the estimated benefits based on internal events were multiplied by a factor of 2, as previously discussed.

In response to a Staff RAI, FPC reevaluated the 10 SAMAs screened in Phase I, using a multiplier of 12 to account for the impact of external events (Progress Energy, 2009a). Based on this reevaluation, all 10 of the original SAMAs screened in Phase I were retained for a detailed Phase II evaluation. These additional SAMAs are included in Table F-5.

F.3.2 Review of Florida Power Corporation's Process

FPC's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events, but also included explicit consideration of potential SAMAs for fire events. The initial list of SAMAs generally addressed the accident sequences considered to be important to CDF from functional, initiating event, and risk reduction worth (RRW) perspectives at CR-3, and included selected SAMAs from prior SAMA analyses for other plants.

FPC provided a tabular listing of the Level 1 PSA basic events sorted according to their RRW (Progress Energy, 2008). SAMAs impacting these basic events would have the greatest potential for reducing risk. FPC used an RRW cutoff of 1.02, which corresponds to about a 2 percent change in CDF, given 100-percent reliability of the SAMA. This equates to a benefit of approximately $13,000 (after the benefits have been multiplied by a factor of 2 to account for external events). All 70 basic events in the listing were reviewed to identify potential SAMAs. Based on this review, 22 SAMAs were identified and included in the Phase I list of Table E.5-3 of the ER, which were shown to specifically impact about 40 of the basic events. The remaining basic events were found to be events that had no physical meaning (such as tag or flag events and split fractions) or were initiating events described as being addressed by one or more of the 22 SAMAs already identified to mitigate associated basic events. For a few basic events, no feasible SAMAs were identified. One additional SAMA was identified based on a review of PSA insights from the CR-3 PRA Group, which addressed one basic event on the Level 1 basic events importance list.

The Staff requested that FPC identify the basic events related to certain of the initiating events described as being addressed by SAMAs already identified to mitigate associated basic events (NRC, 2009). In response to the RAI, FPC provided a table that presented the requested information, using the RRW cutoff of 1.02 (Progress Energy, 2009a). For each initiating event, the associated basic events identified were already included in Table E.5-1 of the ER. As a result, FPC identified no new SAMAs from this review.

The Staff noted that no SAMA was identified to address basic event HHUMPSBY, “operators fail to start standby makeup pump,” even though it has an exceptionally high failure probability (1.0) for an operator action. The Staff questioned FPC as to why a SAMA to improve procedures and training, or provide a hardware modification, is not applicable for this basic event (NRC, 2009). In response to the RAI, FPC clarified that the failure probability of 1.0 was assigned after its dependency with other operator actions was evaluated and that the actual failure probability is 0.5 for non-transient scenarios and 8.6×10^{-3} for transient scenarios (Progress Energy, 2009a). In addressing the relatively high failure probability for non-transient scenario, FPC further clarified that the 0.5 failure probability for non-transient scenarios is based on the limited time to perform the pump start action. Thus, enhancing existing training and procedures is unlikely to improve the failure probability.

FPC also provided and reviewed the LERF-based RRW events down to an RRW of 1.02 (Progress Energy, 2008). FPC correlated these basic events with the SAMAs already identified from the Level 1 basic event review and did not identify any additional SAMAs. In addition, FPC reviewed the basic events, down to an RRW of 1.02, associated with Release Categories 3B and 4C, the dominant non-LERF related contributors to population dose. Any events not identified in the list of Level 1 basic events was added to that list and included in the Level 1 basic event review. This resulted in the identification of one additional SAMA. The Staff noted that by not counting basic events that are flags, split fractions, and initiating events, only five LERF-based basic events are identified. The Staff requested that FPC clarify why there are so few basic events having an RRW greater than 1.02 for LERF sequences, including explaining why there are no LOOP related events, and to provide the RRW for each basic event (NRC, 2009). The Staff also requested, in a separate RAI, that FPC provide a list of the basic events considered in the Release Categories 3B and 4C review. In response to the RAIs, FPC clarified that the LERF-based basic events identified were only those events unique to both LERF and to Release Categories 3B and 4C, and provided a table identifying all basic events associated with LERF and Release Categories 3B and 4C down to an RRW of 1.02 (Progress Energy, 2009a). FPC correlated these basic events with the SAMAs already identified from the Level 1 basic event review and did not identify any additional SAMAs. FPC also clarified that LERF for CR-3 is mainly dominated by SGTR and ISLOCA events, and that LOOP events are not significant contributors to either LERF or Release Categories 3B and 4C.

In response to a Staff RAI on the impact of the planned 20 percent EPU on the results of the SAMA evaluation, FPC provided a sensitivity analysis of the SAMA results, assuming population dose and economic consequences increased by 20 percent (as discussed in Section F.2.2). While FPC did not provide an updated assessment of basic events having an RRW greater than 1.02 for the draft CR-3 PSA model incorporating the EPU-necessitated changes, the Staff concludes that, based on the significant decrease in CDF (discussed above) since the MOR 2006 PSA model used for the SAMA evaluation, it is unlikely that additional cost-beneficial SAMAs would be found in a revised assessment.

The Staff also requested clarification on the screening process used for the Phase I SAMAs because: (1) the ER description of this process was unclear and appeared to include quantitative, not just qualitative, screening; and (2) the results of the Phase I screening process were not described consistently in the ER, which reported both 9 and 10 SAMAs as being screened (NRC, 2009). FPC responded that the process for screening Phase I SAMAs involved the use of engineering judgment to compare estimated implementation costs to the perceived risk reduction benefit, and that those that were not deemed to be cost-beneficial were screened from further analysis (Progress Energy, 2009a). FPC also clarified that 10 SAMAs had, in fact, been screened during the Phase I screening process, and that the 9 SAMAs reported elsewhere in the ER were not correct, and the error was likely due to failure to update the information from an earlier version of the report.

The ER did not identify the selected nuclear power plants that FPC reviewed to identify potential plant improvements. The Staff requested that FPC identify these plants and the Phase I SAMAs that resulted from this review (NRC, 2009). In its response, FPC clarified that the SAMA analyses in the license renewal applications for three nuclear power plants were reviewed to determine if any insights might be gained from what these analyses had concluded to be potentially cost-beneficial SAMAs. The three plants were identified as Calvert Cliffs Nuclear Power Plant; H.B. Robinson Steam Electric Plant, Unit No. 2; and Brunswick Steam Electric Plant. FPC further clarified that no Phase I SAMAs resulted from this review since the CR-3 plant-specific importance lists provided greater insight with regards to identifying SAMAs that might potentially be cost-beneficial for CR-3.

For a number of the Phase II SAMAs listed in the ER, the information provided did not sufficiently describe the proposed modification. Therefore, the Staff asked the applicant to provide more detailed descriptions of the modifications for several of the Phase II SAMA candidates (NRC, 2009). In response to the RAI, FPC provided the requested information on the modifications for SAMAs 4, 5, 15, 35, and 49 (Progress Energy, 2009a).

FPC considered the potential plant improvements described in the IPE and IPEEE in the identification of plant-specific candidate SAMAs for internal and external events. Although the IPE did not identify any vulnerabilities, a loss of flush water supply to the raw water pumps (RWPs) was found during the evaluation to potentially result in the loss of all five RWPs. As a result, the flush water supply system was modified prior to completion of the IPE to include a flush water supply for each pump, thereby significantly reducing the likelihood of a loss of all flush water supply. Other improvements prompted by the IPE included several additions to the emergency operating procedures (EOPs) regarding recovery actions (e.g., the addition of a recovery action to the STGR procedure to refill the borated water storage tank (BWST) if HPI is active). All of the EOP improvements were implemented prior to the completion of the IPE.

The Staff questioned FPC about lower cost alternatives to some of the SAMAs evaluated (NRC, 2009), including:

- enhancing procedures and training in lieu of SAMA 18, “add another EDG”
- enhancing local manual swap-over procedures and training in lieu of SAMA 15, “provide control room ability to realign power to MUP-1B,” where MUP refers to the makeup and purification (MUP) system

In response to the RAIs, FPC addressed the suggested lower cost alternatives, and indicated that neither would provide a measureable benefit (Progress Energy, 2009a). This is discussed further in Section F.6.2.

Based on this information, the Staff concludes that the set of SAMAs evaluated in the ER, together with those identified in response to Staff RAIs, addresses the major contributors to internal event CDF.

FPC did not identify CR-3-specific candidate SAMAs for seismic events. The CR-3 IPEEE seismic evaluation identified no additional outliers, other than the unresolved outliers remaining from implementation of the USI A-46 program. The USI A-46 SER for CR-3 identified three unresolved issues (NRC, 2000). In response to a Staff RAI, FPC clarified that all unresolved USI A-46 outliers have been resolved (Progress Energy, 2009a). The Staff concludes that the opportunity for seismic-related SAMAs has been adequately explored, and that it is unlikely that there are any cost-beneficial, seismic-related SAMA candidates.

The IPEEE did not identify opportunities for improvements related to fire events (FPC, 1997). Nevertheless, FPC further reviewed the top contributors to fire risk in order to identify areas for potential plant improvement, and identified one opportunity for additional reduction of the fire risk, specifically, SAMA 49, “upgrade fire compartment barriers,” in battery charger room 3A. In response to a Staff RAI, FPC additionally identified upgrades to the fire compartment barriers in the 4.16 kilovolt (kV) switchgear bus rooms 3A and 3B, as potential plant improvements for further evaluation. The Staff concludes that the opportunity for fire-related SAMAs has been adequately explored and that it is unlikely there are additional potentially cost-beneficial, fire-related SAMA candidates.

As stated earlier, the CR-3 IPEEE analysis of other external hazards (high winds, tornadoes, external floods, and other external events) did not identify opportunities for improvement for these events. Based on this result, the licensee concluded that these other external hazards would be negligible contributors to overall core damage and did not consider any plant-specific SAMAs for these events.

The Staff noted that the 25 Phase I SAMA numbers were not consecutive from 1 to 25, but rather were intermittently numbered between 1 and 52 and requested clarification on the process used to develop the Phase I SAMA list (NRC, 2009). In response to the RAI, FPC clarified that a consecutive numbering scheme had been the intent when the SAMA identification process was initiated and that this numbering scheme was related to the basic event importance lists (Progress Energy, 2009a). However, as a result of the review of the importance lists, some SAMAs were subsumed into other identified SAMAs, and it was determined that a SAMA was not necessary for some basic events, such as flag events. FPC further clarified that the resulting set of Phase I SAMAs was not renumbered to be consecutive, so as to avoid configuration management errors that could occur when working with personnel from different organizations.

The Staff notes that the set of SAMAs submitted is not all-inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the Staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated, and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The Staff concludes that FPC used a systematic and comprehensive process for identifying potential plant improvements for CR-3, and that the set of SAMAs evaluated in the ER, together with those evaluated in response to Staff inquiries, is reasonably comprehensive and, therefore, acceptable. This search included reviewing insights from the plant-specific risk studies, and reviewing plant improvements considered in previous SAMA analyses. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for fire risks and the absence of external event vulnerabilities reasonably justifies examining, primarily, the internal events risk results for this purpose.

F.4. Risk Reduction Potential of Plant Improvements

FPC evaluated the risk-reduction potential of the 15 SAMAs retained for the Phase II evaluation in the ER. In response to a Staff RAI, FPC also evaluated the risk-reduction potential of the 10 SAMAs eliminated in the Phase I screening (Progress Energy, 2009a). The SAMA evaluations were performed using realistic assumptions with some conservatism. On balance, such calculations overestimate the benefit and are conservative.

FPC used model re-quantification to determine the potential benefits. The CDF, population dose, and offsite economic cost reductions were estimated using the CR-3 MOR 2006 model with a truncation level of 1×10^{-11} per year. The changes made to the model to quantify the impact of SAMAs are detailed in Section E.6 of Attachment E to the ER (Progress Energy, 2008). Table F-5 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The estimated benefits reported in Table F-5 reflect the combined benefit in both internal and external events. The determination of the benefits for the various SAMAs is further discussed in Section F.6.

It is noted in Table F-5 that implementation of SAMA 52, “install a parallel flow path for the decay heat removal drop line,” results in an increase, rather than a decrease, in population dose from the baseline evaluation. In response to a Staff RAI, FPC clarified that this increase is due to the introduction of an additional high/low pressure interface that provides for an additional pathway for release of radioactivity outside of containment, during SGTR or ISLOCA events (Progress Energy, 2009a).

The Staff questioned the assumptions used in evaluating the benefits or risk reduction estimates of certain SAMAs provided in the ER (NRC, 2009). For example, SAMA 5, “improve FPW-7 availability," is identified as a mitigation strategy for basic event QHUFWP7Y, "operators fail to start FWP-7," in ER Table E.5-1 which is inconsistent with the modeling assumption for SAMA 5 in ER Section E.6.8. Furthermore, SAMA 4, "automate FWP-7 start," is also identified as the mitigation strategy for basic event QHUFWP7Y in ER Table E.5-2 which is also inconsistent with the modeling assumption for SAMA 4 in ER Section E.6.12. The Staff requested clarification on which of SAMAs 4 and 5 is considered to address basic event QHUFWP7Y, and on the corresponding modeling assumption used in the SAMA evaluation (NRC, 2009). In response to the RAIs, FPC clarified that SAMA 4 is the appropriate SAMA for addressing basic event QHUFWP7Y (Progress Energy, 2009a). FPC further clarified that the modeling assumption for SAMA 4, which reduced the failure probability from 1.0 to 1.0 x 10^{-5} for basic event QHUFW7EY, "operators fail to start FWP-7 before PORV lifts," bounds the risk reduction from basic event QHUFWP7Y, since the RRW for QHUFW7EY is 1.115 while that for QHUFWP7Y is 1.063. The Staff considers the assumptions, as clarified, to be reasonable and acceptable for purposes of the SAMA evaluation.

For the SAMA that specifically addressed fire events (i.e., SAMA 49, "upgrade fire compartment barriers"), the reduction in fire CDF and population dose was not directly calculated (in Table F-5, this is noted as "Not Estimated"). For this SAMA, a realistic estimate of the impact was made based on general assumptions regarding: (1) the approximate contribution to total risk from external events relative to that from internal events, (2) the fraction of the external event risk attributable to fire events, (3) the fraction of the fire risk affected by the SAMA (based on information from the IPEEE), and (4) the assumption that this SAMA would reduce the contribution to fire CDF from fires in the dominant fire zone, "Battery Charger Room 3B," by a factor of 10. Specifically, it is assumed that the contribution to risk from external events is approximately equal to that from internal events, and that internal fires contribute 82 percent of this external events risk. The benefit or averted cost risk from reducing the risk in the dominant fire zone is then calculated, by multiplying the ratio of 90 percent of the fire zone CDF to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at CR-3. This SAMA was assumed to have no additional benefits in internal events.

As indicated in Table F-4, the fire CDF for fire zone CC-108-106, "Battery Charger Room 3B," is 1.5 x 10^{-5} per year, which is a factor of 3 greater than the internal events CDF. Based on this information, the Staff asked FPC to justify the assumptions used to estimate the benefit of SAMA 49 (NRC, 2009). FPC responded with a revised bounding evaluation of SAMA 49 that assumed that the fire CDF for this zone was a factor of 3 greater than the internal events CDF, and that all of the fire risk for fire zone CC-108-106 was eliminated (Progress Energy, 2009a). The benefit, or averted cost risk from reducing the risk in fire zone CC-108-106, is then calculated by multiplying the ratio of the fire zone CDF to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at CR-3. The Staff considers the assumptions, as revised, to be conservative and acceptable for purposes of the evaluation of this SAMA.

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

Table F-5. Severe Accident Mitigation Alternatives Cost/Benefit Screening Analysis for Crystal River Unit 3 Nuclear Generating Plant [a]

SAMA	Modeling Assumptions	% Risk Reduction		Total Benefit ($)[c]		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty	
1[b] – Automate Emergency Feedwater Initiation and Control (EFIC)/Inverter Backup Cooling	Reduce the probability of failure of operators to use the dedicated chilled water system from 1.0 to 1.0×10^{-4}.	12	6	340K	740K	1.0M
3 – Automate Switchover to Reactor Building Sump Recirculation	Reduce the probability of failure to transfer suction of the decay heat (DH) system pumps from the BWST to the reactor building (RB) sump by a factor of 100.	9	<1	140K	310K	350K
4 – Automate Start of Auxiliary Feedwater (AFW) Pump (FWP-7) When Required	**Reduce failure of operator action to manually start FWP-7 from 2.6×10^{-2} to 1.0×10^{-5}.**	**9**	**2**	**180K**	**390K**	**250K**
5 – Improve Availability of AFW Pump FWP-7	**Reduce the maintenance unavailability for AFW pump FWP-7 to 0.0.**	**11**	**3**	**230K**	**510K**	**500K**
6 – Provide Ability to Rapidly Identify and Isolate Seawater Floods in Auxiliary Building	Eliminate all risk from internal flooding due to a pipe rupture on elevation 95 of the auxiliary building.	8	<1	120K	260K	400K
7[b] – Install a Separate and independent AFW Suction Source and Pump	Modify fault tree to include a new event, having a failure probability of 1.0×10^{-3}, representing the unavailability of the independent AFW backup system.	38	11	870K	1.9M	5.0M
8[b] – Provide a Temporary Pump to Replace RWP	**Modify fault tree to include new human-error probability (HEP) and system basic events to model the backup RWP pump as described in response to RAI 3.d (Progress Energy, 2009a).**	**22**	**1**	**360K**	**780K**	**500K**
9 – Proceduralize Additional Responses to Decay Heat Removal (DHR) System Valves (DHV) DHV-11 and DHV-12 Failures	**Modify fault tree to include a new HEP event, having a failure probability of 2.5×10^{-2}, to manually open valves DHV-11 and DHV-12 in the event remote operation fails.**	**6**	**<1**	**97K**	**210K**	**50K**

SAMA	Modeling Assumptions	% Risk Reduction		Total Benefit ($)[c]		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty	
10 – Proceduralize Additional Responses to Makeup Valve (MUV) MUV-23, MUV-24, MUV-25, and MUV-26 Failures	**Modify fault tree to include a new HEP event, having a failure probability of 1.1 x 10^{-2}, to manually open valves MUV-23, MUV-24, MUV-25, and MUV-26 in the event remote operation fails.**	**2**	**5**	**180K**	**390K**	**50K**
11 – Provide an Automated Crosstie/Makeup Supply for Emergency Feedwater (EFW)	Reduce the probability of failure to cross-tie the three EFW pumps to a viable suction source by a factor of 100.	2	1	53K	120K	250K
13[b] – Add Additional Train of DH Removal of Diverse Design	Modify fault tree to include a new basic event, having a failure probability of 1.0 x 10^{-3}, representing the unavailability of the backup DH removal train.	32	5	600K	1.3M	10M
14[b] – Automate Steam Generator (SG) Level Control Requirements for Small LOCA	Reduce the probability of failure of operator action to raise the water level of the once-through steam generators (OSTGs) from 2.7 x 10^{-3} to 2.7 x 10^{-6}.	3	<1	55K	120K	900K
15 – Provide Control Room Capability to Realign Power to Makeup Pump 1B	**Reduce failure of operator action to manually realign power to makeup pump 1B from 0.28 to 1.0 x 10^{-3}.**	**3**	**4**	**150K**	**320K**	**300K**
16[b] - Enhance Procedures and Make Design Changes as Required to Facilitate Crosstying Trains of DH and Decay Heat Closed Cooling (DHCC) Systems.	Modify fault tree to combine existing DH and DHCC events under new logical AND gates.	16	1	260K	570K	5.0M
17 – Improve SG Level Control	Modify fault tree to include a new basic event, having a failure probability of 1.0 x 10^{-4}, representing the unavailability of an independent and redundant backup level control system for both OTSGs.	5	4	160K	360K	500K
18[b] – Add Another EDG	Modify fault tree to include a new basic event, having a failure probability of 1.0 x 10^{-3}, representing the unavailability of an independent and redundant backup EDG.	7	5	230K	490K	8.0M

SAMA	Modeling Assumptions	% Risk Reduction		Total Benefit ($)[c]		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty	
26[b] – Install Separate and Independent EFIC Cooling System	Modify fault tree to include two new basic events, having a failure probability of 1.0 x 10^{-2}, representing the unavailability of each backup heating, ventilation, and air-conditioning (HVAC) system.	25	7	560K	1.2M	2.0M
33 – Proceduralize Manual Operation of DHR System Valves DHV-42 and DHV-43	**Modify fault tree to include a new HEP event, having a failure probability of 2.5 x 10^{-2}, to manually operate valves DHV-42 and DHV-43 in the event remote operation fails.**	**6**	**<1**	**92K**	**200K**	**50K**
34 – Improve Procedures for Manual Operation of EFW Valves	**Reduce failure of operator action to manually control OTSG water level using the EFW discharge valves from 0.3 to 1.7 x 10^{-2}.**	**25**	**8**	**570K**	**1.2M**	**50K**
35 – Update PORV Controls to Open Automatically When Operator Action Was Previously Required	**Reduce failure of operator action to manually open the PORV from 0.5 to 1.0 x 10^{-5}.**	**8**	**54**	**1.6M**	**3.4M**	**700K**
37(b) – DH Heat Exchanger (HX) Strainers	Reduce the probability off failure of the DH system strainers due to common cause plugging from 2.39 x 10^{-4} to 2.39 x 10^{-6}.	3	0	54K	120K	600K
38 – Additional Condensate Storage Tank (CST) Replacement Water Sources	**Modify fault tree to include a new HEP event, having a failure probability of 1.0 x 10^{-3}, to align an alternate water source for the CST. Assign an unavailability probability of 1.0 x 10^{-4} for the alternative water source, which is assumed to be the fire water system.**	**3**	**1**	**72K**	**160K**	**50K**
49 – Upgrade Fire Barriers in Battery Charger Room 3A	**Reduce the fire CDF contribution from battery charger room 3A by a factor of 10.**	**Not Estimated**		**1.0M**	**2.2M**	**150K**
51 – Upgrade or Improve Engineering Analysis to Qualify the EFIC Cabinets to a Higher Temperature	**Reduce the probability of loss of all EFW from 0.5 to 0.1 due to a loss of HVAC that results in the EFW valves failing closed.**	**20**	**6**	**460K**	**1.0M**	**100K**

SAMA	Modeling Assumptions	% Risk Reduction		Total Benefit ($)[c]		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty	
52[b] – Install Parallel Flowpath for DHR Drop Line	Modify fault tree to include a new basic event, having a failure probability of 1.0×10^{-3}, representing the unavailability of the backup DHR system.	<1	-1	-5.5K	-12K	5.0M

(a) SAMAs in bold are potentially cost-beneficial
(b) Retained as a Phase II SAMA in response to RAI 3.d (Progress Energy, 2009a)
(c) Estimated benefits reflect revised values provided in response to RAI 3.d (Progress Energy, 2009a) and a 3 percent discount rate

F.5. Cost Impacts of Candidate Plant Improvements

FPC developed plant-specific costs of implementing the 25 Phase I candidate SAMAs. The cost estimates conservatively did not include the cost of replacement power, during extended outages, required to implement the modifications (Progress Energy, 2008). The Staff requested that FPC provide additional explanation of the process for developing the implementation costs (NRC, 2009). In response to the RAI, FPC clarified that CR-3 engineering personnel reviewed each SAMA to assess the work scope associated with implementing each SAMA, and then the implementation cost was estimated by benchmarking the SAMA work scope to other projects of similar scope.

The Staff reviewed the bases for the applicant's cost estimates (presented in Section E.6 of Attachment E to the ER). 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. In response to an RAI requesting a more detailed description of the changes associated with SAMAs 4, 5, 15, 35, and 49, FPC provided additional information detailing the analysis and plant modifications included in the cost estimate of each improvement (Progress Energy, 2009a). The Staff reviewed the costs and found them to be reasonable, and generally consistent with estimates provided in support of other plants' analyses.

The Staff requested additional clarification on the estimated cost of $5 million for implementation of SAMA 16, "enhance procedures and make design changes as required to facilitate crosstying DH and DHCC," which is high for what is described as a procedure modification (NRC, 2009). In response to the RAI, FPC further described this SAMA as involving modifications to plant safety systems to cross-connect the DH and DHCC systems, in addition to the procedure changes (Progress Energy, 2009a). Based on this additional information, the Staff considers this estimated cost to be reasonable and acceptable for purposes of the SAMA evaluation.

The Staff concludes that the cost estimates provided by FPC are sufficient and appropriate for use in the SAMA evaluation.

F.6. Cost-Benefit Comparison

FPC's cost-benefit analysis and the Staff's review are described in the following sections.

F.6.1 Florida Power Corporation's Evaluation

The methodology used by FPC was based primarily on NRC's guidance for performing cost-benefit analysis (i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook*) (NRC, 1997a). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) - COE where,

APE = present value of averted public exposure ($)
AOC = present value of averted offsite property damage costs ($)
AOE = present value of averted occupational exposure costs ($)
AOSC = present value of averted onsite costs ($)
COE = cost of enhancement ($)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA, which is not considered cost-beneficial. FPC's derivation of each of the associated costs is summarized below.

NUREG/BR-0058 has recently been revised to reflect the agency's 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). FPC provided a base set of results using the 3 percent discount rate and a sensitivity study using the 7 percent discount rate (Progress Energy, 2008).

Averted Public Exposure (APE) Cost

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)
x monetary equivalent of unit dose ($2,000 per person-rem)
x present value conversion factor (15.04 based on a 20-year period with a 3-percent discount rate)

As stated in NUREG/BR-0184 (NRC, 1997a), the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, FPC calculated an APE of approximately $114,000 for the 20-year license renewal period (Progress Energy, 2008).

Averted Offsite Property Damage Cost (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor

This term represents the sum of the frequency-weighted offsite economic costs for each release category, as obtained for the Level 3 risk analysis. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, FPC calculated an annual offsite economic cost of about $6,600 based on the Level 3 risk analysis. This results in a discounted value of approximately $100,000 for the 20-year license renewal period.

Averted Occupational Exposure (AOE) Cost

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
x occupational exposure per core damage event
x monetary equivalent of unit dose
x present value conversion factor

FPC derived the values for averted occupational exposure from information provided in Section 5.7.3 of NUREG/BR-0184 (NRC, 1997a). Best estimate values provided for immediate occupational dose (3,300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2,000 per person-rem, a real discount rate of 3 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, FPC calculated an AOE of approximately $3,100 for the 20-year license renewal period (Progress Energy, 2008).

Averted Onsite Cost (AOSC)

AOSCs include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. FPC derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184 (NRC, 1997a).

FPC divided this cost element into two parts – the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs, and the replacement power cost.

Averted cleanup and decontamination costs (ACCs) were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
x present value conversion factor

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, FPC calculated an ACC of approximately $96,000 for the 20-year license renewal period.

Long-term replacement power costs (RPC) were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
x factor to account for remaining service years for which replacement power is required
x reactor power scaling factor

FPC based its calculations on the rated CR-3 net electric output of 903 megawatt-electric (MWe) and scaled down from the 910 MWe reference plant in NUREG/BR-0184 (NRC, 1997a).

Therefore, FPC applied a power scaling factor of 903/910 to determine the replacement power costs. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, FPC calculated an RPC of approximately $27,000 and an AOSC of approximately $124,000 for the 20-year license renewal period.

Using the above equations, FPC estimated the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at CR-3 to be about $341,000. Use of a multiplier of 2 to account for external events increases the value to $682,000 and represents the dollar value associated with completely eliminating all internal and external event severe accident risk at CR-3, also referred to as the modified maximum averted cost risk (MMACR).

Florida Power Corporation's Results

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was considered not to be cost-beneficial. In the baseline analysis contained in the ER (using a 3 percent discount rate), FPC identified one potentially cost-beneficial SAMA. Based on the consideration of analysis uncertainties, FPC identified three additional potentially cost-beneficial SAMAs. In response to Staff RAIs, FPC provided the results of a revised baseline analysis multiplying the internal events benefits by 12 to account for the additional external events benefits. The revised baseline analysis resulted in the identification of four additional potentially cost-beneficial SAMAs. FPC also provided a revised uncertainty analysis using the multiplier of 12 to account for external events benefits, which resulted in the identification of four additional potentially cost-beneficial SAMAs.

The potentially cost-beneficial SAMAs for CR-3 are the following:

- SAMA 4 – Automate start of auxiliary feedwater pump FWP-7 when required to supply feedwater to the OTSGs in the event the automated EFW system is unavailable (cost-beneficial in revised analysis, with uncertainties).

- SAMA 5 – Improve availability of auxiliary feedwater pump FWP-7 to supply feedwater to the OTSGs in the event that other EFW pumps are unavailable (cost-beneficial in revised analysis, with uncertainties).

- SAMA 8 – Provide a temporary pump to provide a backup supply of cooling water in lieu of RWP in the event it is unavailable (cost-beneficial in revised analysis, with uncertainties).

- SAMA 9 – Proceduralize additional responses to DHV-11 and DHV-12 in the event remote opening of these valves fails (cost-beneficial in revised analysis).

- SAMA 10 – Proceduralize additional responses to MUV-23, MUV-24, MUV-25, and MUV-26 failures in the event of a common mode failure of all four of these motor-operated valves (MOVs) (cost-beneficial with uncertainties).

- SAMA 15 – Provide control room capability to realign power to makeup pump 1B remotely, in lieu of local manual operation (cost-beneficial in revised analysis, with uncertainties).

- SAMA 33 – Proceduralize manual operation of DHV-42 and DHV-43 in the event remote operation of these MOVs fails (cost-beneficial in revised analysis).
- SAMA 34 – Improve procedures for manual operation of EFW valves in order to maintain acceptable steam generator water levels in the event the automatic level control system fails.
- SAMA 35 – Update PORV controls to open automatically when operator action was previously required to open the PORV (cost-beneficial in revised analysis).
- SAMA 38 – Additional condensate storage tank replacement water sources are aligned through operator actions to provide backup for the EFW system when the CST is rendered unavailable (cost-beneficial in revised analysis).
- SAMA 49 – Upgrade fire barriers in battery charger room 3A (cost-beneficial with uncertainties).
- SAMA 51 – Upgrade or improve engineering analysis to qualify the EFIC cabinets to a higher temperature, thereby increasing the reliability of the EFIC system (cost-beneficial with uncertainties).

In response to a Staff RAI, FPC identified two additional cost-beneficial SAMAs related to improvements to upgrade the fire compartment barriers in 4.16 kV switchgear bus rooms 3A and 3B (Progress Energy, 2009b). The potentially cost-beneficial SAMAs, and FPC's plans for further evaluation of these SAMAs, are discussed in more detail in Section F.6.2.

F.6.2 Review of Florida Power Corporation's Cost-Benefit Evaluation

The cost-benefit analysis performed by FPC was based primarily on NUREG/BR-0184 (NRC, 1997a) and discount rate guidelines in NUREG/BR-0058 (NRC, 2004), and was executed consistent with this guidance.

FPC considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, FPC presents the results of an uncertainty analysis of the internal events CDF for CR-3, which indicates that the 95th percentile value is a factor of 2.18 greater than the point estimate CDF for CR-3. FPC reexamined both the Phase I and Phase II SAMAs to determine if any would be potentially cost-beneficial if the baseline benefits were increased by an additional factor of 2.18 (in addition to the multiplier of 2 for external events).

In the analysis reported in the ER and summarized above, FPC multiplied the internal event benefits by a factor of 2 for each SAMA (except for one SAMA that specifically addressed fire risk) to account for the additional benefits in external events. In the RAIs, the Staff pointed out that the external events multiplier should be 12 rather than 2 (based on the fire CDF of 4.2×10^{-5} per year, a seismic CDF of 1.2×10^{-5} per year as estimated by the Staff, a negligible high winds, floods, and other (HFO) contribution, and an internal events CDF of 5.0×10^{-6} per year), and requested FPC to provide an assessment of the impact on the SAMA evaluation of using the multiplier of 12 or a smaller multiplier for which adequate justification is provided (NRC, 2009). In response to the RAIs, FPC revised the baseline benefit values by applying a multiplier of 12 to the estimated SAMA benefits in internal events to account for potential SAMA benefits in both internal and external events (Progress Energy, 2009a). FPC further reexamined the initial set of

SAMAs to determine if any additional Phase I SAMAs would be retained for further analysis if the benefits (or MMACR) were increased by a factor of 12. None of the Phase I SAMAs were found to be potentially cost-beneficial. As a result of the revised baseline analysis of the Phase II SAMAs (using a multiplier of 12 and a 3 percent real discount rate), FPC found four additional SAMAs (SAMAs 9, 33, 35, and 38) to be potentially cost-beneficial. In response to these same RAIs, FPC reexamined the Phase I and Phase II SAMAs to determine if any would be potentially cost-beneficial, if the revised baseline benefits were increased by an additional factor of 2.18 (in addition to the multiplier of 12 for external events) to account for uncertainties. As a result, four additional SAMAs became potentially cost-beneficial in FPC's analysis (SAMAs 4, 5, 8, and 15).

FPC provided the results of additional sensitivity analyses in the ER, including use of a 7 percent discount rate, variations in MACCS2 input parameters (as discussed in Section F.2.2), and an NRC-approved 1.6 percent thermal power uprate. These analyses did not identify any additional potentially cost-beneficial SAMAs. In response to a followup RAI, FPC provided the results of a sensitivity analysis of a planned increase in the licensed power level of CR-3 by approximately 20 percent, in an EPU to be implemented before the renewal period (Progress Energy, 2009b), as discussed in Section F.2.2. FPC reevaluated each Phase II SAMA using the increased dose and economic consequences and determined that the results of the SAMA evaluation are not impacted by the EPU (i.e., no additional candidate SAMAs would become cost beneficial).

The Staff noted that SAMA 15, "provide control room ability to realign power to MUP-1B," involves a hardware modification estimated to cost $400,000 and that this SAMA addresses basic event HHUMBACY, "operator fails to switch MUP-1B power source," which has an exceptionally high failure probability (1.0) for an operator action. The Staff asked FPC to provide an assessment of a lower cost alternative to improve training and procedures in lieu of SAMA 15 (NRC, 2009). In response to the RAI, FPC clarified that the failure probability of 1.0 was assigned after its dependency with other operator actions was evaluated and that the actual failure probability is 0.28. FPC further clarified that this high failure probability is based on the long manipulation time to perform the action relative to the time available to perform the action and that any procedure and training enhancements would have a negligible impact on the failure probability.

The Staff also noted that SAMA 18, "add another EDG," involves a hardware modification estimated to cost $5,000 and that this SAMA addresses basic event APWNR01R, "both EDGs FTS [failure to start], both EFPs [emergency feedwater pumps] FTS," which has a high failure probability of 0.64 reflecting the likelihood that AC power will not be recovered in time to prevent FTS of the EDGs and EFPs. The Staff asked FPC to provide justification for why a lower cost SAMA to improve procedures and training was not considered in lieu of SAMA 18 (NRC, 2009). In response to the RAI, FPC further clarified that this basic event is not a human performance error probability but a non-recovery factor for LOOP, based on plant experience (Progress Energy, 2009b). The Staff agrees that a SAMA to improve procedures and training would not provide a measureable benefit for basic event APWNR01R.

In the same RAI, the Staff also asked FPC to provide an assessment of providing AC power from one of the other Crystal River Power Plants in lieu of SAMA 18. FPC responded that Units 1, 2, 4, and 5 already provide power to the CR-3 switchyard and, instead, provided an assessment for installing a dedicated line from these other units to CR-3. The cost of this alternative was estimated to be $25 million, which included installation of a dedicated buried line, to ensure availability during weather-related events, an additional transformer, and additional steps required to ensure that the dedicated line is available when needed since none of the Crystal River power plants are black start units. Since the estimated cost is greater than the estimated benefit (using a multiplier of 12, a 3 percent real discount rate, and an uncertainty factor of 2.18), FPC concluded that this alternative would not be cost-beneficial (Progress Energy, 2009a).

In response to a Staff RAI, FPC provided an evaluation of improvements to upgrade the fire compartment barriers in 4.16 kV switchgear bus rooms 3A and 3B (Progress Energy, 2009b). FPC's analysis estimated the cost of implementation of each of these improvements to be about $150,000. Using the same evaluation methodology for these improvements that was used to evaluate SAMA 49, FPC estimated the total baseline benefit (using a multiplier of 12 and a 3 percent real discount rate) to be $500,000 for 4.16 kV switchgear bus room 3A and $470,000 for 4.16 kV switchgear bus room 3A. FPC further estimated the benefit to be $1.1 million and $1 million for switchgear bus rooms 3A and 3B, respectively, after accounting for uncertainties. Since the estimated benefit is greater than the estimated implementation cost for both improvements, FPC determined these improvements to be potentially cost-beneficial.

FPC stated in Section 4.20 of the ER that the four SAMAs (SAMAs 10, 34, 49, and 51) determined to be potentially cost-beneficial in either the baseline analysis or uncertainty analysis, will be considered for further evaluation using the appropriate CR-3 design process. In response to a Staff RAI, FPC clarified that the CR-3 design process involves tracking evaluation of each SAMA within the CR-3 corrective action program wherein a more detailed evaluation of the implementation cost and benefits of each SAMA is performed, and those SAMAs found to merit further study or implementation are entered into the CR-3 long range plan and tracked as a project. FPC further clarified that SAMAs found to be potentially cost-beneficial, as a result of responses to the Staff's RAIs, (SAMAs 4, 5, 8, 9, 15, 33, 35, 38, and improvements to fire barriers in 4.16 kV switchgear bus rooms 3A and 3B discussed above) will also be evaluated within the CR-3 corrective action program (Progress Energy, 2009a), (Progress Energy, 2010).

The Staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the other SAMAs evaluated would be higher than the associated benefits.

F.7. Conclusions

FPC compiled a list of 25 SAMAs based on a review of the most significant basic events from the plant-specific PSA, insights from the plant-specific IPE and IPEEE, Phase II SAMAs from license renewal applications for other plants, and review of other industry documentation. A qualitative screening removed SAMA candidates that: (1) modified features not applicable to CR-3 due to design differences or (2) were judged to have a low benefit relative to the cost of implementation. Based on this screening, 10 SAMAs were eliminated, leaving 15 candidate SAMAs for evaluation.

For the remaining SAMA candidates, a more detailed design and cost estimate was developed as shown in Table F-5. The cost-benefit analyses showed that one of the SAMA candidates was potentially cost-beneficial in the baseline analysis (SAMA 34). FPC performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment. As a result, three additional SAMAs were identified as potentially cost-beneficial in the ER (SAMAs 10, 49, and 51). In response to the Staff's RAIs, FPC further identified 8 additional SAMAs (SAMAs 4, 5, 8, 9, 15, 33, 35, and 38), and fire-related enhancements to switchgear bus rooms 3A and 3B discussed in Section F.6.2, as being potentially cost-beneficial. FPC has indicated that all 12 potentially cost-beneficial SAMAs, as well as the fire-related enhancements to switchgear bus rooms 3A and 3B, will be further evaluated using the appropriate CR-3 design process.

The Staff reviewed the FPC analysis 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 FPC 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.

The Staff concurs with FPC's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of the identified, potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the Staff agrees that further evaluation of these SAMAs by FPC is warranted. However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the *Code of Federal Regulations*, Part 54.

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11. ABSTRACT *(200 words or less)*

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Florida Power Corporation, doing business as Progress Energy Florida, Inc., to renew the operating license for Crystal River Unit 3 Nuclear Generating Plant (CR-3) for an additional 20 years.

The draft SEIS includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from a new supercritical coal-fired plant, a new natural gas-fired combined-cycle plant, a combination of alternatives that includes some natural gas-fired capacity and energy conservation, and not renewing the license (the no-action alternative).

The NRC's preliminary recommendation is that the adverse environmental impacts of license renewal for CR-3 are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on: (1) the analysis and findings in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants"; (2) the environmental report submitted by Florida Power Corporation; (3) consultation with Federal, State, and local agencies; (4) the NRC's environmental review; and (5) consideration of public comments received during the scoping process.

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