U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437
Supplement 63

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 63

Regarding License Renewal for Clinton Power Station, Unit 1

Draft Report for Comment

Office of Nuclear Material Safety and Safeguards

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Regarding License Renewal for Clinton Power Station, Unit 1

Draft Report for Comment

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COMMENTS ON DRAFT REPORT

Proposed Action Issuance of renewed Facility Operating License No. NPF-62 for Clinton Power Station, Unit 1, in Clinton, Illinois

Type of Statement Draft Supplemental Environmental Impact Statement

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC, the Commission) staff prepared this supplemental environmental impact statement as part of its environmental review of Constellation Energy Generation, LLC's application to renew the operating license for Clinton Power Station, Unit 1 for an additional 20 years. This supplemental environmental impact statement evaluates the environmental impacts of the license renewal and alternatives to license renewal. The alternatives evaluated in detail were the replacement power alternatives of natural gas, a combination of renewable and natural gas, and purchased power, which were determined to be commercially viable, and the no-action alternative. The NRC staff's preliminary recommendation is that the adverse environmental impacts of license renewal for Clinton are not so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable. The NRC staff based its preliminary recommendation on the following:

- the analysis and findings in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (LR GEIS)
- the environmental report submitted by Constellation Energy Generation, LLC
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments received during the scoping process

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EXECUTIVE SUMMARY

Background

By letter dated February 14, 2024, Constellation Energy Generation, LLC (CEG) submitted to the U.S. Nuclear Regulatory Commission (NRC, the Commission) an application requesting renewal of the operating license for Clinton Power Station, Unit 1 (CPS), for an additional 20-year period (CEG 2024-TN10806).

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 51.20(b)(2) (TN10253), the renewal of a power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an EIS. In addition, 10 CFR 51.95(c) (TN10253), "Operating License Renewal Stage," states that, in connection with the renewal of a power reactor operating license, the NRC staff shall prepare an EIS, which is a supplement to the Commission's NUREG-1437, Revision 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Final Report*, dated August 2024 (LR GEIS) (NRC 2024-TN10161).

NRC staff found CEG's application acceptable for docketing on April 11, 2024 (NRC 2024-TN11065), as announced in the *Federal Register* (FR) on April 18, 2024 (89 FR 27805-TN10825). The NRC staff began the environmental review process described in 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions" (TN10253), by publishing a notice of intent to prepare a supplemental environmental impact statement (SEIS) and to conduct scoping for CPS license renewal (89 FR 33400-TN10841). Thereafter, the NRC staff:

- conducted two public scoping meetings as online webinars on May 7 and May 9, 2024
- conducted a virtual environmental site audit during the week of August 26, 2024, a virtual severe accident mitigation alternatives (SAMA) audit on September 3, 2024, and an onsite environmental site audit on September 24, 2024
- reviewed CEG's environmental report (ER) (CEG 2024-TN10806) and compared it to the LR GEIS
- consulted with Federal, State, Tribal, and local agencies
- conducted a review of CEG's application for license renewal following the guidance set forth in NUREG-1555, Supplement 1, Revision 2, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal, Final Report*, dated August 2024 (NRC 2024-TN10251)
- considered public comments received during the scoping process

Proposed Federal Action

CEG initiated the proposed Federal action by submitting an application (CEG 2024-TN10806) for license renewal for CPS, for which the existing facility operating license (NPF-62) includes the expiration date of April 17, 2027. The NRC's Federal action is to decide whether to renew the license for an additional 20 years of operation. If the NRC renews the license, CPS would be authorized to operate until April 17, 2047.

Purpose and Need for the Proposed Agency Action

The purpose and need for the proposed agency action (i.e., renewal of an operating 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 State, utility, system, and, where authorized, Federal (other than the NRC) decision-makers. This definition of purpose and need reflects the Commission's recognition that, absent findings in the safety review required by the Atomic Energy Act of 1954, as amended (42 *United States Code* [U.S.C.] 2011 et seq.-TN663), or in the environmental review required by the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.-TN661), that would lead the NRC to reject a license renewal application, the NRC has no role in the energy-planning decision of power plant owners, State regulators, system operators, and, in some cases, other Federal agencies, as to whether a particular nuclear power plant should continue to operate (61 FR 28467-TN4491; NRC 2024-TN10161).

Environmental Impacts of License Renewal

This SEIS evaluates the potential environmental impacts of the proposed action at CPS and reasonable alternatives to that action. The NRC designates the environmental impacts from the proposed action and reasonable alternatives as SMALL, MODERATE, or LARGE.

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.

Resource-specific effects or impact definitions from applicable environmental laws and executive orders, other than SMALL, MODERATE, and LARGE, are used where appropriate. The LR GEIS evaluates 80 environmental issues related to plant operation and classifies each issue as either a Category 1 issue (generic to all or a distinct subset of nuclear power plants as described below) or a Category 2 issue (specific to individual power plants). Category 1 issues are those that meet all the following criteria:

- The environmental impacts associated with the issue 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 offsite radiological impacts of spent nuclear fuel and high-level waste disposal and offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional nuclear plant-specific (hereafter, plant-specific) mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For Category 1 issues, no additional plant-specific analysis is required in this SEIS unless new and significant information is identified. Table 3-1 in Chapter 3 lists the Category 1 issues that are applicable to CPS, and the significance levels of their impacts. Section 3.14 in Chapter 3 of

this SEIS presents the process for identifying new and significant information. CEG and the NRC staff have identified no information that is both new and significant related to Category 1 issues that would call into question the conclusions in the LR GEIS. This conclusion is supported by the NRC staff's review of CEG's ER and other documentation relevant to CEG's activities, the public scoping process, and the findings from the NRC staff's site audits. Therefore, the NRC staff relied upon the conclusions of the LR GEIS for all Category 1 issues applicable to CPS license renewal.

Category 2 issues are plant-specific issues that do not meet one or more of the criteria for Category 1 issues; therefore, this SEIS documents the results of additional plant-specific review for applicable Category 2 issues. Table ES-1 below summarizes the Category 2 issues relevant to CPS license renewal and the NRC staff's findings related to those issues. If the NRC staff determined that there were no Category 2 issues applicable for a particular resource area, the findings in the LR GEIS, as documented in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN10253), are incorporated for that resource area.

Table ES-1 Summary of NRC Impact Findings Relating to Nuclear Plant-Specific Impacts of License Renewal at the Clinton Power Station

Resource Area	Relevant Category 2 Issue	Impact Finding
Groundwater Resources	Groundwater quality degradation (plants with cooling ponds)	SMALL
Groundwater Resources	Radionuclides released to groundwater	SMALL
Terrestrial Resources	Non-cooling system impacts on terrestrial resources	SMALL
Aquatic Resources	Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Effects of thermal effluents on aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Federally Protected Ecological Resources	Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife Service jurisdiction	See Section 3.8 of this SEIS.
Historic and Cultural Resources	Historic and cultural resources	See Section 3.9 of this SEIS.
Human Health	Microbiological hazards to the public	SMALL
Human Health	Electromagnetic fields (EMFs)[(a)]	Uncategorized (Uncertain Impact)
Human Health	Electric shock hazards	SMALL
Greenhouse Gas Emissions and Climate Change	Climate change impacts on environmental resources	See Section 3.15.3.2.3 of this SEIS.
Cumulative Effects	Cumulative effects	See Section 3.16 of this SEIS.

EMF = electromagnetic field; SEIS = supplemental environmental impact statement.
(a) This issue was not designated as Category 1 or Category 2 and is discussed in Section 3.11.6.2 of this SEIS.
Sources: Table B-1 in Appendix B to Subpart A of 10 CFR Part 51-TN10253; NRC 2024-TN10161.

Severe Accident Mitigation Alternatives

Since the NRC staff has not previously considered SAMAs for CPS in an EIS, a related supplement, or in an environmental assessment, 10 CFR 51.53(c)(3)(ii)(L) (TN10253) requires that CEG submit, with the license renewal application, a consideration of alternatives to mitigate severe accidents. SAMAs are potential ways to reduce the risk or potential impacts of uncommon, but potentially severe, accidents. SAMAs may include changes to plant components, systems, procedures, and training. The NRC staff's review and evaluation of CEG's analysis regarding SAMAs and the staff's independent analyses are documented in Appendix F to this SEIS.

Alternatives to the Proposed Action

As part of its environmental review, the NRC is required to consider alternatives to license renewal and evaluate the environmental impacts associated with each alternative. These alternatives can include other methods of power generation (replacement power alternatives), as well as not renewing the CPS operating license (the no-action alternative).

The NRC staff considered 16 alternatives and dismissed 13 from detailed study due to technical, resource availability, or commercial limitations that currently exist and that are likely to still exist when the CPS operating license expires. Three replacement power alternatives were determined to be reasonable and commercially viable:

- natural gas
- renewable and natural gas combination
- purchased power

These alternatives, along with the no-action alternative, are evaluated in detail in this SEIS.

Recommendation

The NRC staff's preliminary recommendation is that the adverse environmental impacts of license renewal for CPS are not so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable. This preliminary recommendation is based on:

- the analysis and findings in the LR GEIS
- the ER submitted by CEG
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments received during the scoping process

ACRONYMS AND ABBREVIATIONS

ac	acre(s)
AC	alternating current
ACC	averted cleanup and decontamination cost
ACHP	Advisory Council on Historic Preservation
AD	Anno Domini
ADAMS	Agencywide Documents Access and Management System
AEA	Atomic Energy Act
ALARA	as low as is reasonably achievable
ANS	American Nuclear Society
AOC	averted offsite property damage costs
AOE	averted occupational exposure
APE	area of potential effects
AQCR	air quality control region
ASME	American Society of Mechanical Engineers
bgs	below ground surface
BMP	best management practice
BP	before present
BTA	best technology available
BWR	boiling water reactor
CAA	Clean Air Act
CDC	Centers for Disease Control and Prevention
CDF	core damage frequency
CEG	Constellation Energy Generation, LLC
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
cfs	cubic foot/feet per second
CH_4	methane
cm	centimeter(s)
CO	carbon monoxide
CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
CPS	Clinton Power Station, Unit 1

CWA	Clean Water Act
CWIS	cooling water intake system
dB	decibel(s)
dBA	A-weighted decibel(s)
DOE	U.S. Department of Energy
EFH	essential fish habitat
EIA	Energy Information Administration
EIS	environmental impact statement
ELAP	extended loss of AC power
EMF	electromagnetic field
EPA	U.S. Environmental Protection Agency
ER	environmental report
ESA	Endangered Species Act of 1973, as amended
ESP	early site permit
ETE	evacuation time estimate
EXPN	non-essential experimental population
F&O	facts and observations
FESOP	federally enforceable State operating permit
FLEX	Diverse and Flexible Mitigation Capabilities
fps	foot/feet per second
FR	*Federal Register*
ft	foot/feet
F-V	Fussell-Vesely (value)
FWS	U.S. Fish and Wildlife Service
GEIS	generic environmental impact statement
GHG	greenhouse gas
gpm	gallon(s) per minute
GWP	global warming potential
ha	hectare(s)
HCLPF	high confidence low probability of failure
HFE	human failure events
Hz	hertz

IDNR	Illinois Department of Natural Resources
IDPH	Illinois Department of Public Health
IEPA	Illinois Environmental Protection Agency
IM	impingement mortality
in.	inch(es)
IPCC	Intergovernmental Panel on Climate Change
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination of External Events
ISFSI	independent spent fuel storage installation
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
kV	kilovolt(s)
L	liter(s)
lb	pound(s)
LERF	large early release frequency
LLRW	low-level radioactive waste
lpm	liter(s) per minute
LR GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG-1437)
LR	license renewal
LRA	license renewal application
LRS	liquid radwaste system
m	meter(s)
m/s	meter(s) per second
m^2	square meter(s)
m^3	cubic meter(s)
m^3/s	cubic meter(s) per second
Ma	million year(s) ago
MAAP	Modular Accident Analysis Program
MBTA	Migratory Bird Treaty Act
MDCT	mechanical draft cooling towers
MG	million gallon(s)
mg/L	milligram(s) per liter

MGM	million gallons per month
MGY	million gallons per year
mi	mile(s)
mi^2	square mile(s)
MOR	model of records
mrad	millirad(s)
mrem	millirem(s)
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	mean sea level
mSv	millisievert(s)
MT	metric ton/tonne(s)
MW	megawatt(s)
MWe	megawatt(s) electric
MWPH	makeup water pump house
MWt	megawatt(s) thermal
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NE	no effect (as it pertains to the Endangered Species Act)
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act of 1969
NETL	National Energy Technology Laboratory
NGCC	natural gas combined cycle
NHPA	National Historic Preservation Act of 1966
NLAA	not likely to adversely affect (as it pertains to the Endangered Species Act)
NMFS	National Marine Fisheries Service
NMSA	National Marine Sanctuaries Act
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC or Commission	U.S. Nuclear Regulatory Commission
NRCS	U.S. Department of Agriculture Natural Resources Conservation Service
NRHP	National Register of Historic Places

O_3	ozone
ODCM	Offsite Dose Calculation Manual
OECR	offsite economic cost risk
OSHA	Occupational Safety and Health Administration
PAM	primary amebic meningoencephalitis
Pb	lead
pCi/L	picocurie(s) per liter
PDR	population dose risk
PGA	peak ground acceleration
PM	particulate matter
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 µm or less
PRA	probabilistic risk assessment
PV	photovoltaic
RAI	request for additional information
RCIC	reactor core isolation cooling
RCP	representative concentration pathway
rem	roentgen-equivalent-man
REMP	Radiological Environmental Monitoring Program
RGPP	radiological groundwater protection program
RLE	review level earthquake
ROI	region of influence
ROW	right-of-way
RPC	replacement power cost
SAMA	severe accident mitigation alternative
SEIS	supplemental environmental impact statement
SF_6	sulfur hexafluoride
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SPCC	spill prevention, control, and countermeasures
SPEI	standardized precipitation evapotranspiration index
SPUT	Special Purpose Utility
STC	source term category

Sv	sievert(s)
SWPPP	stormwater pollution prevention plan
TCP	traditional cultural property
TMDL	total maximum daily load
U.S.C.	*United States Code*
U-235	uranium-235
USACE	U.S. Army Corps of Engineers
USAR	Updated Safety and Analysis Report
USCB	U.S. Census Bureau
USD	U.S. dollar(s)
USGCRP	United States Global Change Research Program
USGS	U.S. Geological Survey
WCGS	Wolf Creek Generating Station
WinMACCS	MELCOR Accident Consequence Code System

1 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC, the Commission) environmental protection regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51 (TN10253), "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," implement the National Environmental Policy Act of 1969, as amended (42 *United States Code* [U.S.C.] 4321 et seq.-TN661). This Act is commonly referred to as NEPA. The regulations at 10 CFR Part 51 (TN10253) require, in part, that the NRC staff prepare an environmental impact statement (EIS) before deciding whether to issue an operating license or a renewed operating license for a nuclear power plant. The regulations further direct the NRC staff to prepare EISs for renewal of nuclear power plant operating licenses as supplements to the Commission's NUREG-1437, Revision 2, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Final Report*, dated August 2024 (LR GEIS) (NRC 2024-TN10161).

The Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.-TN663) (AEA), specifies that licenses for commercial nuclear power reactors can be granted for up to 40 years. The initial 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility. The NRC regulations specified in 10 CFR 54.29 (TN4878), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," allow for an option to renew such licenses beyond the initial 40-year term for an additional period of time, limited to 20-year increments per renewal. There are no limitations in the AEA or NRC regulations restricting the number of times a license may be renewed.

The decision to seek a license renewal (LR) 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 all safety and environmental requirements. The NRC makes the decision to grant or deny an LR application (LRA) based on whether the applicant has demonstrated that the safety and environmental requirements in the agency's regulations can be met during the period of extended operation.

1.1 Proposed Federal Action

Constellation Energy Generation (CEG) initiated the proposed Federal action by submitting an LRA dated February 14, 2024, for Clinton Power Station, Unit 1 (CPS) (CEG 2024-TN10806). The initial license facility operating license for CPS (NPF-62) is set to expire at midnight on April 17, 2027 (NRC 2010-TN8607). The NRC's Federal action is to decide whether to renew the license for an additional 20 years of operation.

1.2 Purpose and Need for the Proposed Agency Action

The purpose and need for the proposed agency action (i.e., renewal of an operating 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 State, utility, system, and, where authorized, Federal (other than NRC) decision-makers. This definition of purpose and need reflects the Commission's recognition that, absent findings in the safety review required by the AEA or findings in the environmental review required by NEPA that would lead the NRC to reject an LRA, the NRC has no role in energy-planning decisions of power plant owners, State regulators, system operators, and, in

some cases, other Federal agencies as to whether a particular nuclear power plant should continue to operate (61 FR 28467-TN4491; NRC 2024-TN10161).

1.3 Major Environmental Review Milestones

The NRC has established an LR process that can be completed in a reasonable period of time with clear requirements to ensure safe plant operation for up to an additional 20 years of the nuclear power plant's life. The NRC staff conducts a safety review simultaneously with an environmental review and documents the findings of the safety review in a safety evaluation report and the findings of the environmental review in a supplemental environmental impact statement (SEIS). The safety evaluation report and the SEIS are both factors in the NRC's decision to either grant or deny the issuance of a renewed license. Schedules for the safety evaluation report and the SEIS for the CPS LRA are provided on the NRC's project website (NRC 2024-TN10913).

By letter dated February 14, 2024, CEG submitted an LRA to the NRC for CPS, which included an environmental report (ER) (CEG 2024-TN10806). Notice of the receipt of the LRA was published in the *Federal Register* (FR) on March 7, 2024 (Volume 89 of the FR, p. 16591 [89 FR 16591-TN10822]). On April 11, 2024, after reviewing the LRA and ER, the NRC staff accepted the application for a detailed technical review and published an FR notice of acceptability for docketing and opportunity for hearing on April 18, 2024 (89 FR 27805-TN10825). On April 29, 2024, the NRC published a notice of intent in the FR (89 FR 33400-TN10841), informing the public of the NRC staff's intent to conduct an environmental scoping process, which began a 30-day scoping comment period, and to prepare an SEIS.

The NRC staff held two virtual public scoping meetings on May 7 and May 9, 2024. On September 30, 2024, the NRC issued a scoping summary report for the CPS LRA environmental review (NRC 2024-TN10870), which includes the comments received during the scoping process (Appendix A of this SEIS).

To independently verify information in CEG's ER, the NRC staff conducted a virtual environmental audit during the week of August 26, 2024, an onsite audit at CPS during the week of September 23, 2024, and a severe accident mitigation alternatives (SAMA) virtual audit on September 3, 2024. During these audits, the NRC staff held meetings with plant personnel and reviewed site-specific documentation and photos. In a letter dated October 23, 2024, the NRC staff summarized the environmental audits and SAMA audit (NRC 2024-TN10876).

Upon the completion of the scoping period, site audits, and review of CEG's ER and related documents, the NRC staff compiled its findings into this draft SEIS. This document is made available for public comment for 45 days. During that time, the NRC will host one or more public meetings and collect public comments. Based on the information gathered and received during the public comment period, the NRC staff will revise the draft SEIS findings, as necessary, and will then publish a final SEIS. Figure 1-1 shows the major milestones of the NRC's review process for LRAs.

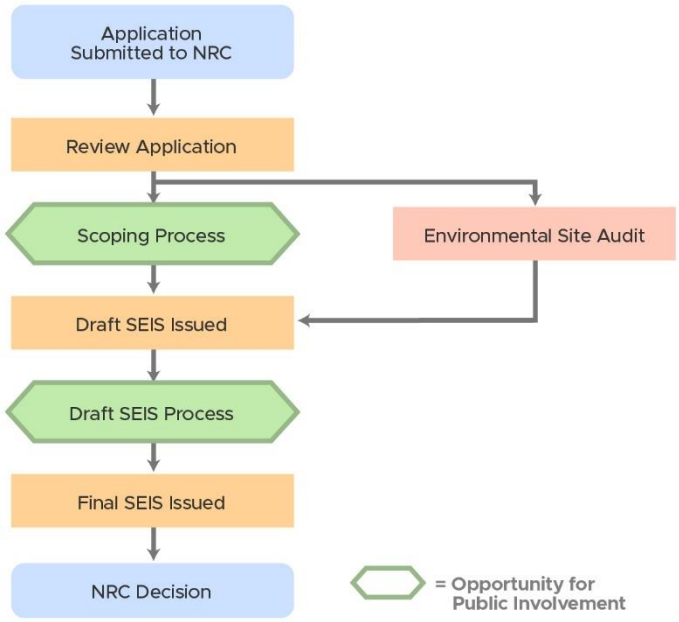

Figure 1-1 Environmental Review Process of the U.S. Nuclear Regulatory Commission (NRC) for Nuclear Power Plants

1.4 Generic Environmental Impact Statement

To improve the efficiency of its LR review process, the NRC staff performed a generic assessment of the environmental impacts associated with LR. The LR GEIS (NRC 2024-TN10161) documents the results of the NRC's systematic approach to evaluating the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years. In the LR GEIS, the NRC staff analyzed in detail and determined the impact of those environmental issues that could be resolved generically.

The LR GEIS establishes separate environmental impact issues for the NRC staff to independently evaluate in LR environmental reviews. Of these issues, the NRC staff determined that some issues are generic to all plants or a specific subset of plants (Category 1). Other issues do not lend themselves to generic consideration and are nuclear plant site-specific (Category 2 or uncategorized). For each LRA, the NRC staff evaluates these issues in a SEIS to the LR GEIS. Table B-1 in Appendix B to Subpart A of 10 CFR Part 51, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," (TN10253) provides a summary of the staff's findings for environmental issues as evaluated in the LR GEIS.

On August 6, 2024, the NRC published a final rule (89 FR 64166-TN10321) revising its environmental protection regulations in 10 CFR Part 51. Specifically, the final rule updated the potential environmental impacts associated with the renewal of an operating license for a nuclear power plant for up to an additional 20 years, which could either be an initial or subsequent LR. The LR GEIS was also revised (NRC 2024-TN10161) as an update to the 2013 LR GEIS (NRC 2013-TN2654) and provided the technical basis for the final rule. The LR GEIS specifically supported the revised list of environmental issues and associated environmental impact findings for LR contained in Table B-1 in Appendix B to Subpart A of the revised 10 CFR Part 51 (TN10253). The LR GEIS and final rule reflect lessons learned, knowledge gained, and

experience from LR environmental reviews performed since the development of the 2013 LR GEIS; consider changes to applicable laws and regulations; and factor in new scientific data and methodology with respect to the assessment of potential environmental impacts of a nuclear power plant LR. The LR GEIS and final rule identify 80 environmental issues (i.e., 59 Category 1, 20 Category 2, and 1 issue that remains uncategorized) that may be associated with nuclear power plant operation and refurbishment during the renewal term.

For the NRC staff, the final rule became effective 30 days after its publication in the FR and thereafter the staff considers the new and modified issues, as applicable, in its LR SEISs. Compliance with the final rule by LR applicants is not required until 1 year following publication in the FR (i.e., LR ERs submitted later than 1 year after publication must be compliant with the new rule).

For each environmental issue addressed in the LR GEIS, the NRC staff:

- describes the activity or aspect of plant operations or refurbishment that affects the environment
- identifies 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 both beneficial and adverse effects
- determines whether the results of the analysis apply to all or a specific subset of plants
- considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants

The NRC's environmental impact standard considers Council on Environmental Quality (CEQ) terminology, including CEQ revisions in Part 1501—NEPA and Agency Planning and Part 1508—Definitions (40 CFR Parts 1500–1508-TN6611). CEQ requires that agencies examine both the context of an action and the intensity of the effects in making a significance determination as to the adverse effect of the proposed action.

In considering whether the incremental environmental effects (impacts) of the NRC's proposed action (initial LR) are significant, the NRC staff analyzes the geographic area and intensity of the effects. The geographic area consists of the characteristics of the area and its resources, such as proximity to unique or sensitive resources. For nuclear power plant-specific (hereafter, plant-specific) environmental issues, significance depends on the effects in the relevant geographic area, including, but not limited to, consideration of short- and long-term effects, as well as beneficial and adverse effects. The NRC staff's analysis of the intensity of effects includes consideration of the degree to which the action may (1) adversely affect public health and safety; (2) adversely affect unique characteristics of historic or cultural resources, parks, Tribal sacred sites, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas; (3) violate relevant Federal, State, Tribal, or local laws or other requirements protecting the environment or be inconsistent with Federal, State, Tribal, or local policies designed for the protection of the environment; (4) have potential effects on the human environment that are highly uncertain; (5) adversely affect resources listed or eligible for listing in the National Register of Historic Places (NRHP); (6) adversely affect an endangered or threatened species or its habitat, including habitat that has been determined to be critical under the Endangered Species Act of 1973 (16 U.S.C. § 1531 et seq.-TN1010); and (7) adversely affect rights of Tribal Nations that have been reserved through treaties, statutes, or Executive Orders (40 CFR Parts

1500–1508-TN6611). Based on this, 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.

These levels are used for describing the environmental impacts of the proposed action as well as for the impacts of a range of reasonable alternatives to the proposed action. Resource-specific effects or impact definitions from applicable environmental laws and executive orders, other than SMALL, MODERATE, and LARGE, are used where appropriate.

The LR GEIS determines whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are assigned a Category 1 (generic to all or a distinct subset of plants) or Category 2 (plant-specific to certain plants only) designation. As established in the LR GEIS, Category 1 issues are those that meet the following three criteria:

- The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants that have 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 offsite radiological impacts of spent nuclear fuel and high-level waste disposal and offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste).
- Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

For generic issues (Category 1), the SEIS requires no additional plant-specific evaluation unless new and significant information has been identified.

- **New information** can be identified from many sources, including the applicant, the NRC, other agencies, or public comments. If a new issue is revealed, the NRC staff will first analyze the issue to determine whether it is within the scope of the LR environmental evaluation. If the NRC staff determines that the new issue bears on the proposed action, the staff will then determine the significance of the issue for the plant and analyze the issue in the SEIS.
- **New and significant information**. To merit additional review, information must be both new and significant, and it must bear on the proposed action or its impacts.

Section 3.14 of this SEIS further describes the process for identifying new and significant information for plant-specific analysis. Plant-specific issues (Category 2) are those that do not meet one or more of the three criteria of Category 1 issues; therefore, the SEIS requires additional plant-specific review for these issues.

The LR GEIS, Revision 2, evaluates 80 environmental issues, provides generically applicable findings for numerous issues (subject to the consideration of any new and significant information on a site-specific basis), and concludes that a plant-specific analysis is required for 20 of the 80 issues. Figure 1-2 illustrates the LR environmental review process. The results of that plant-specific review are documented in the SEIS.

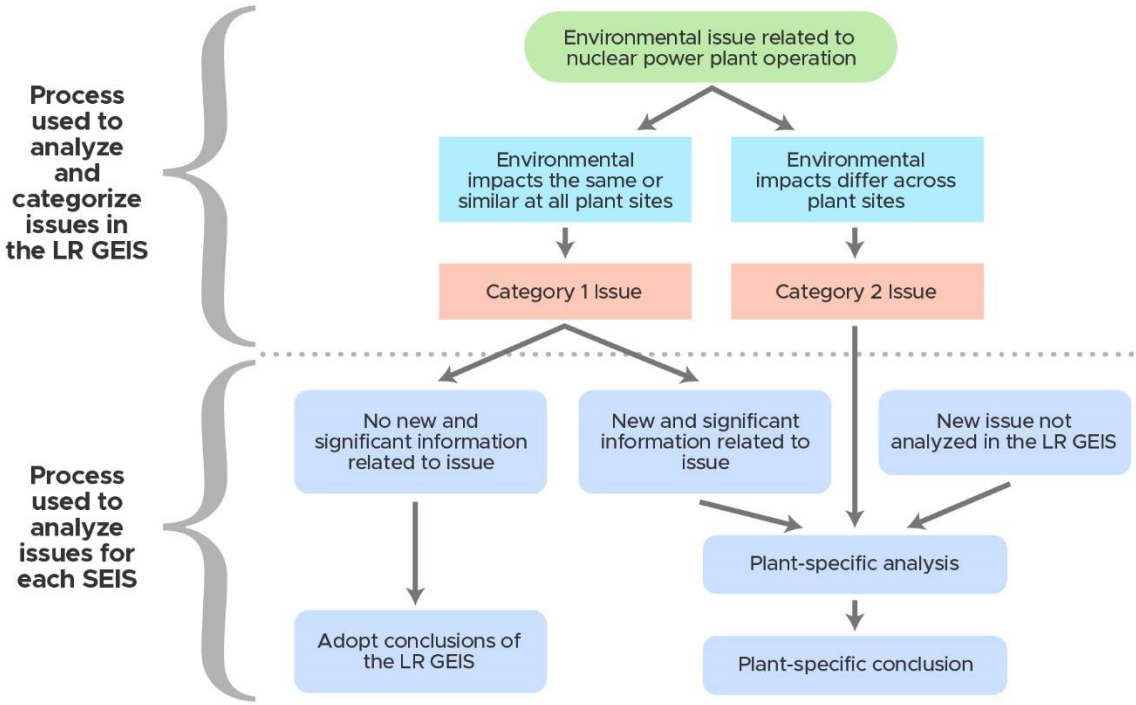

Figure 1-2 Environmental Issues Evaluated for License Renewal of Nuclear Power Plants

1.5 Supplemental Environmental Impact Statement

This SEIS presents the NRC staff's analysis of the environmental effects of the continued operation of CPS during the LR term, alternatives to LR, and mitigation measures for minimizing adverse environmental impacts. Chapter 2 describes the proposed action and alternatives to the proposed action. Chapter 3 contains an analysis and comparison of the potential environmental impacts from LR and alternatives to LR. Chapter 4 presents the NRC's preliminary recommendation on whether the adverse environmental impacts of LR for CPS are so great that preserving the option of LR for energy-planning decision-makers would be unreasonable. The NRC staff will make its recommendation to the Commission regarding the environmental impacts of CPS LR in the final SEIS, after considering comments received on the draft SEIS during the public comment period.

The NRC staff based its preliminary recommendation on:

- the analysis and findings in the LR GEIS
- the ER submitted by the applicant
- the NRC staff's consultation with Federal, State, Tribal, and local agencies

- the NRC staff's independent environmental review
- the NRC staff's consideration of public scoping comments

1.6 Decision to Be Supported by the SEIS

This SEIS supports the NRC's decision on whether to renew the operating license for CPS for an additional 20 years. The regulation in 10 CFR 51.103(a)(5) (TN10253) that specifies the NRC's decision standard with respect to its environmental review states:

> In making a final decision on a license renewal action pursuant to [10 CFR] Part 54 of this chapter, the Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable (10 CFR 51.103(a)(5)-TN10253).

There are many factors that the NRC takes into consideration when deciding whether to renew the operating license of a nuclear power plant. The analysis of environmental impacts in this SEIS will provide the NRC's decision-makers (the Commission) with important environmental information for consideration in deciding whether to renew the CPS operating license.

1.7 Cooperating Agencies

During the scoping process, the NRC staff did not identify any Federal, State, Tribal, or local agencies as cooperating agencies for this SEIS.

1.8 Consultations

LR environmental reviews may require consultation with other Federal, State, regional, and local agencies and Indian Tribes. For LR, the NRC staff must consider the effects of its actions on ecological resources protected under Federal statutes, including the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. § 1531 et seq.-TN1010), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. § 1801-TN9966). Section 106 of National Historic Preservation Act of 1966, as amended (NHPA) (54 U.S.C. § 300101 et seq.-TN4157) requires Federal agencies to take into account the effects of their undertakings on historic properties. See Appendix C to this SEIS for a list of the agencies and groups with which the NRC staff consulted and a description of the consultations and related correspondence.

1.9 Correspondence

Appendix D to this SEIS chronologically lists correspondence the NRC staff sent and received with external parties as part of the agency's environmental review of the CPS LRA, excluding the consultation correspondence listed in Appendix C to this SEIS and public comments referenced in Appendix A.

1.10 Status of Compliance

CEG is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements. Appendix F to the LR GEIS describes some of the major applicable Federal statutes (NRC 2024-TN10161). Numerous permits and licenses are issued by

Federal, State, and local authorities for activities at CPS. Appendix B to this SEIS contains further information about CEG's status of compliance.

1.11 Related Federal and State Activities

The NRC staff reviewed the possibility that activities (projects) of other Federal agencies might impact the renewal of the operating license for CPS. Any such activities could result in cumulative environmental impacts and the potential need for the Federal agency to become a cooperating agency for preparing this SEIS. The NRC staff has determined that there are no Federal projects that would make it necessary for another Federal agency to be a cooperating agency in the preparation of this SEIS (10 CFR 51.10(b)(2)-TN10253). Section 3.16 of this SEIS identifies past, present, and reasonably foreseeable future actions considered in the cumulative effects analysis for this LRA.

The NRC is required under Section 102(2)(C) of NEPA (TN661) to consult with and obtain comments from any Federal agency or designated authority that has jurisdiction by law or special expertise with respect to any environmental impact involved in the subject matter of the NRC's EISs. As explained in Section 1.8, Appendix C to this SEIS provides a complete list of consultation correspondence.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

Although the NRC's decision-making authority is limited to deciding whether to renew a nuclear power plant's operating license, the agency's implementation of NEPA (42 U.S.C. 4321 et seq.-TN661) requires consideration of the environmental impacts of that action as well as the environmental impacts of reasonable alternatives to that action. Although the ultimate decision about which alternative (or the proposed action) to implement falls to the power plant owners and State, utility, system, and, where authorized, Federal (other than NRC) energy-planning decision-makers, comparing the environmental impacts of renewing the operating license to the environmental impacts of alternatives allows the NRC to determine whether the environmental impacts of LR are so great that preserving the option of LR for energy-planning decision-makers would be unreasonable (10 CFR 51.95(c)(4)-TN10253).

Energy-planning decision-makers and power plant owners ultimately decide whether the nuclear power plant will continue to operate, and economic and environmental considerations play important roles in this decision. In general, the NRC's responsibility is to ensure the safe operation of nuclear power plants, not to formulate energy policy, promote nuclear power, or encourage or discourage the development of alternative power generation. The NRC does not engage in energy-planning decisions, and it makes no judgment as to which replacement power alternatives would be the most likely alternative selected in any given case.

This chapter of the SEIS describes (1) the CPS site and its operation, (2) the proposed action (renewal of the CPS operating license), (3) reasonable alternatives to the proposed action (including the no-action alternative), and (4) alternatives eliminated from detailed study.

2.1 Description of Nuclear Power Plant Facility and Operation

CPS is a single unit nuclear power plant located in DeWitt County, Illinois. It began commercial operation in April 1987. Unless otherwise noted, the NRC staff drew information about CPS' facilities and operation from CEG's ER (CEG 2024-TN10806).

2.1.1 External Appearance and Setting

CPS is located approximately 60 miles (mi) (100 kilometers [km]) northeast of Springfield, Illinois (Figure 2-1 below). The CPS site consists of approximately 13,626 acres (ac) [5,514 hectares (ha)] located in the eastern half of DeWitt County, roughly equidistant between St. Louis, Missouri and Chicago, Illinois. The property boundary places it in several townships: Harp, Wilson, Rutledge, DeWitt, Creek, Nixon, and Santa Anna (Figure 2-2 below). CPS sits on the manmade cooling reservoir, Clinton Lake. Clinton Lake is the predominant physical feature in the region which covers 4,895 ac (1,981 ha). The area surrounding CPS is not heavily industrialized, consisting primarily of the entirety of Clinton Lake, woodlands, pastureland, cultivated farmland, and Clinton Lake Recreational areas.

Figure 2-3 below shows the structures within the CPS site boundary. The principal structures at CPS are the following: containment, auxiliary building, fuel building, turbine building, radioactive waste building, control building, diesel generator and heating, ventilation, and air conditioning (HVAC) building, circulating water screen house, service building, makeup water pump house (MWPH), switchyard, mechanical draft cooling towers (MDCTs), outdoor storage tanks, permanent warehouse, and the gatehouse. The containment building is formed by an upright cylinder, founded on a soil-supported flat concrete slab, and covered with a hemispherical dome.



Figure 2-1 Clinton Power Station Site and 50 mi (80 km) Radius. Source: CEG 2024-TN10806: Figure 3.1-4.

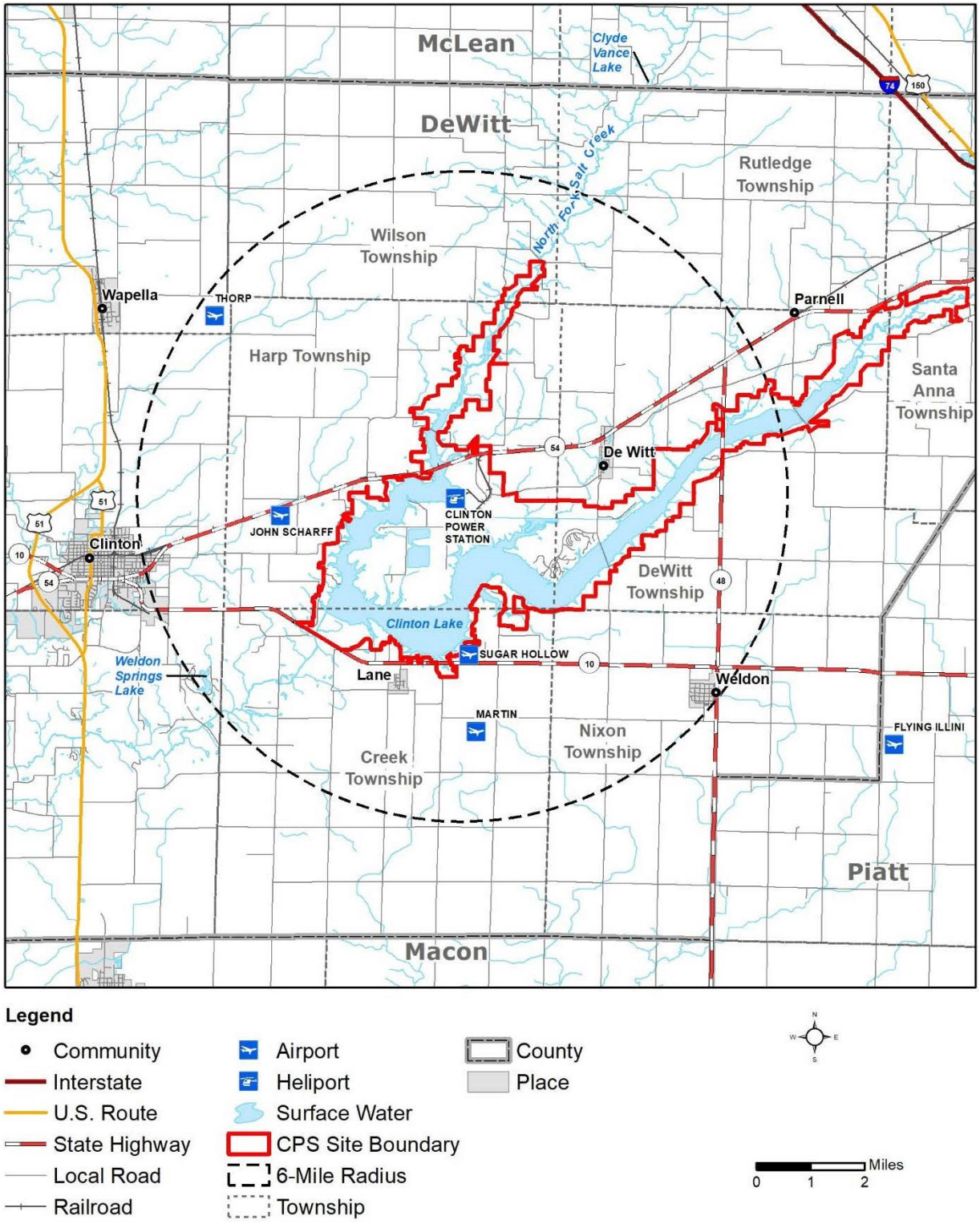

Figure 2-2 Clinton Power Station (CPS) Site and 6 mi (10 km) Radius. Source: CEG 2024-TN10806: Figure 3.1-3.

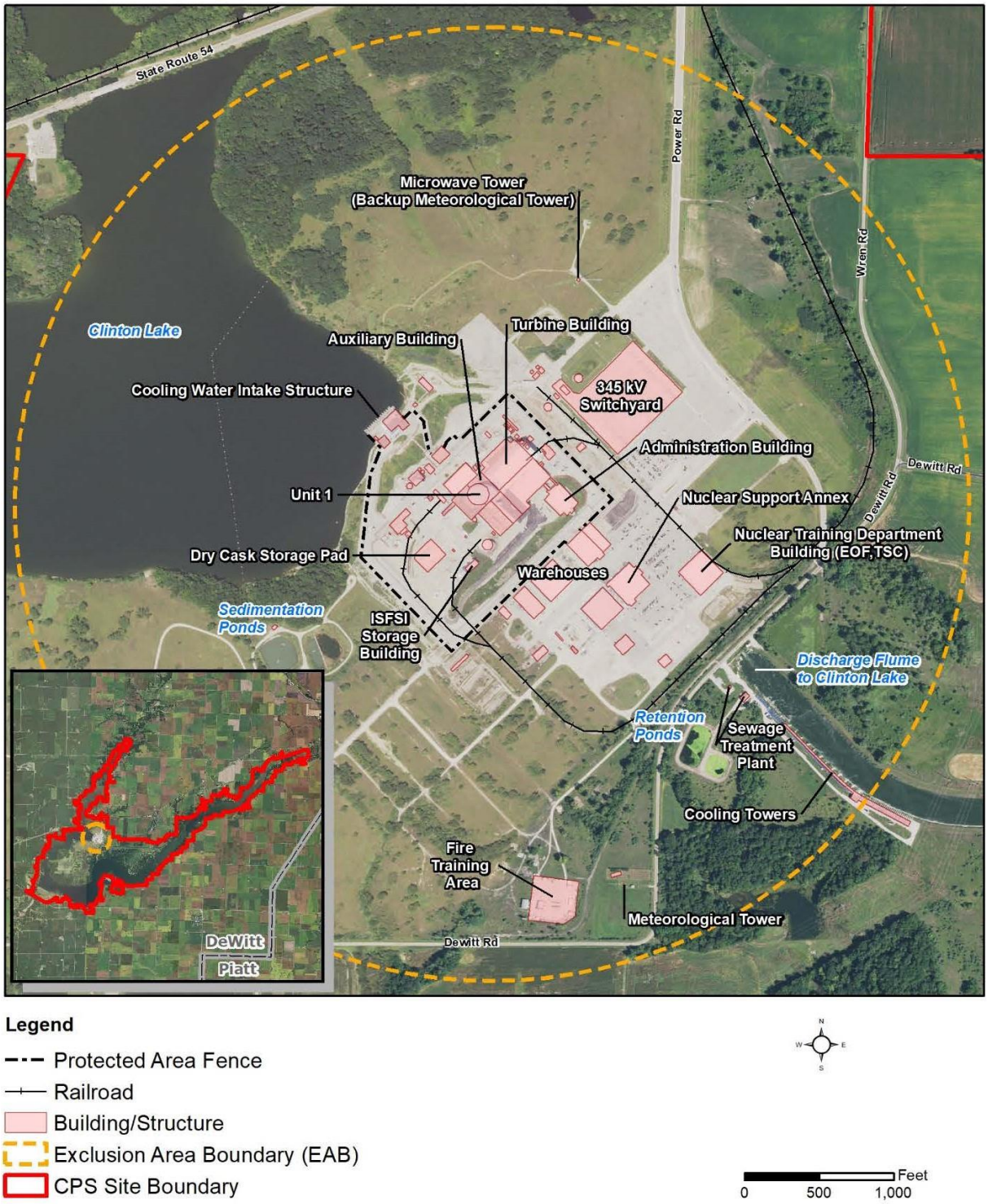

Figure 2-3 Clinton Power Station (CPS) Site Layout. Source: CEG 2024-TN10806: Figure 3.1-1. EOF = emergency operations facility; ISFSI = Independent Spent Fuel Storage Installation; TSC = technical support center.

2.1.2 Nuclear Reactor Systems

CPS is a single unit (Unit 1) reactor. The CPS operating license was issued in September 1986, and commercial operation commenced on April 17, 1987. Unit 1 has a boiling water reactor (BWR) nuclear steam supply system designed and supplied by the General Electric Company. The containment system, designed by Sargent & Lundy, employs the drywell/pressure suppression features of the BWR-Mark III containment concept. The NRC staff incorporates this information here by reference (CEG 2024-TN10806).

CPS was originally licensed with reactor core thermal power rated at 2,894 megawatts thermal (MWt); however, in 2002, the NRC approved an extended power update to increase the maximum reactor core power level to 3,473 MWt. The unit is designed to operate at a gross electrical power output of approximately 1,138.5 megawatts electric (MWe) with a net generation of 1,080 MWe.

2.1.3 Cooling and Auxiliary Water Systems

CEG's cooling and auxiliary water systems include the Circulating Water System, Component Cooling Water System, Turbine Building Closed Cooling Water System, Fuel Pool Cooling and Cleanup System, Service Water System, Ultimate Heat Sink, Condensate Storage and Transfer System, Raw Water Treatment Plant and Makeup Water Treatment System, Potable and Sanitary Water System, and Fire Protection System. Section 2.2.3 of CEG's ER provides an expanded description of these systems (CEG 2024-TN10806).

CPS uses Clinton Lake, a human-made, run-of-the-river impoundment of water as its source of cooling water. Clinton Lake is a 4,895 ac (1,981 ha) freshwater lake created by the construction of an earthen dam 1,200 feet (ft) (370 meters [m]) downstream of the confluence of Salt Creek and the North Fork of Salt Creek.

2.1.4 Radioactive Waste Management Systems

The NRC licenses nuclear power plants with the expectation that they will release a limited amount of radioactive material to both the air and water during normal operations. CPS uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a byproduct of nuclear power plant operations. Section 2.2.6 of the CEG ER provides an expanded description of CPS' radioactive waste management systems (CEG 2024-TN10806). The NRC staff discusses the radioactive waste management systems in Section 3.13.1 of this SEIS.

2.1.5 Nonradioactive Waste Management Systems

CPS generates nonradioactive waste as a result of nuclear power plant maintenance, cleaning, and operational processes. CPS manages nonradioactive wastes in accordance with applicable Federal and State regulations, as implemented through its corporate procedures. Section 2.2.7 of the CEG ER provides an expanded description of CPS' nonradioactive waste management systems (CEG 2024-TN10806). The NRC staff discusses the nonradioactive waste management systems in Section 3.13.2 of this SEIS.

2.1.6 Utility and Transportation Infrastructure

The utility and transportation infrastructure at nuclear power plants typically interfaces with public infrastructure systems available in the region. Such infrastructure includes utilities, such as suppliers of electricity, fuel, and water; as well as roads and railroads that provide access to the site. The following sections briefly describe the existing utility and transportation infrastructure at CPS. Plant-specific information in this section is derived from CEG's ER unless otherwise cited (CEG 2024-TN10806).

2.1.6.1 Electricity

Nuclear power plants generate electricity for other users; however, they also use electricity to operate. Offsite power sources provide power to engineered safety features and emergency equipment in the event of a malfunction or interruption of power generation at the plant. Planned independent backup power sources provide power in the event that power is interrupted from both the plant itself and offsite power sources.

Two offsite power systems provide electrical power to the station: the 138 kilovolt (kV) offsite power system, and the 345 kV offsite power station. Section 2.2.5 of the CEG ER provides an expanded description of CEG's power transmission system (CEG 2024-TN10806).

2.1.6.2 Fuel

The CPS nuclear unit is operated using low-enriched uranium dioxide fuel with enrichment up to 4.9 percent by weight of uranium-235 (U-235). CPS is currently licensed for maximum enrichment of 5 percent by weight of U-235. The maximum rod burnup limit for loading fuel in casks is 61.75 gigawatt-days per metric ton of uranium. Scheduled refueling outages commonly last approximately 19 days, and one refueling cycle is scheduled every 24 months. Storage space for spent fuel is provided at the onsite independent spent fuel storage installation (ISFSI), in the fuel building spent fuel pool, and in the upper containment fuel storage pool (as well as the cask storage pool when it is utilized to hold stow storage racks to extend core offload capacity). Section 2.2.6.4 of the CEG ER provides an expanded description of CEG's spent nuclear fuel (CEG 2024-TN10806).

2.1.6.3 Water

In addition to cooling and auxiliary water, CPS uses potable water for plant personnel sanitary and everyday activities (e.g., drinking, showering, cleaning, doing laundry, operating toilets, and operating eye washes). CPS obtains potable water from Clinton Lake at the screen house. The MWPH pretreating system use up-flow filtration and reverse osmosis to provide filtered and potable water for station needs. The MWPH also contains a mixed bed polisher system (demineralizer). The combination of reverse osmosis and mixed bed polishers provides a supply of demineralized water for station equipment and systems. Section 3.6.3.1 of the CEG ER provides an expanded description of CEG's surface water use (CEG 2024-TN10806). In this SEIS, Section 2.1.3 describes the CPS industrial water systems.

2.1.6.4 Transportation Systems

Nuclear power plants are served by controlled access roads that are connected to U.S. highways and Interstate highways. In addition to roads, many plants also have railroad connections for moving heavy equipment and other materials. Plants located on navigable waters may have facilities to receive and ship loads on barges. In this SEIS, Section 3.10.6 describes the CPS transportation systems.

2.1.6.5 Power Transmission Systems

For LR, the NRC evaluates, as part of the proposed action, the continued operation of those CPS power transmission lines that connect to the substation where it feeds electricity into the regional power distribution system (NRC 2024-TN10161). The transmission lines that are in scope for the CPS LR environmental review are onsite and are not accessible to the general public. The NRC also considers the continued operation of the transmission lines that supply outside power to the nuclear plant from the grid. In this SEIS, Section 3.11.4 describes these transmission lines.

2.1.7 Nuclear Power Plant Operations and Maintenance

Maintenance activities conducted at CPS include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. These activities include in-service inspections of safety-related structures, systems, and components; quality assurance and fire protection programs; and radioactive and nonradioactive water chemistry monitoring.

Additional programs include those implemented to meet technical specification surveillance requirements and those implemented in response to NRC generic communications. Such additional programs include various periodic maintenance, testing, and inspection procedures necessary to manage the effects of aging on structures and components. Certain program activities are performed during the operation of the power plant, whereas others are performed during refueling outages, scheduled on a 24-month cycle (CEG 2024-TN10806).

2.2 Proposed Action

As stated in Section 1.1 of this SEIS, the NRC's proposed Federal action is to decide whether to renew the CPS operating license for an additional 20 years. Section 2.2.1 below provides a description of normal power plant operations during the LR term.

2.2.1 Nuclear Power Plant Operations During the License Renewal Term

Plant operation activities during the LR term would be the same as, or similar to, those occurring during the current license term. CEG's ER states that CPS will continue to operate during the LR term in the same manner as during the current license term except for additional aging management programs, as necessary. Such programs would address structure and component aging in accordance with 10 CFR Part 54 (TN4878), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." Section 2.1 of this SEIS further describes the activities specific to the operation of CPS.

2.2.2 Refurbishment and Other Activities Associated with License Renewal

Refurbishment activities include replacement and repair of major structures, systems, and components. As described in the LR GEIS, most major refurbishment activities are actions that would typically take place only once in the life of a nuclear plant, if at all (NRC 2024-TN10161). Refurbishment activities may have an impact on the environment beyond those that occur during normal operations and may require evaluation, depending on the type of action and the plant-specific design.

As part of its LRA, CEG evaluated major structures, systems, and components in accordance with 10 CFR 54.21 (TN4878), "Contents of Application—Technical Information," to identify major refurbishment activities necessary for the continued operation of CPS during the proposed 20-year period of extended operation. As stated in Section 2.3 of the CEG ER, CEG has identified no LR-related refurbishment or replacement actions needed to maintain the functionality of systems, structures, and components, consistent with the current licensing basis, during the proposed LR term (CEG 2024-TN10806).

2.2.3 Termination of Nuclear Power Plant Operation and Decommissioning After the License Renewal Term

NUREG-0586, Supplement 1, Volumes 1 and 2, "*Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors*" (the decommissioning GEIS) (NRC 2002-TN665), describes the environmental impacts of decommissioning. The majority of plant operations activities would cease with reactor shutdown. Some activities (e.g., security and oversight of spent nuclear fuel) would remain unchanged, whereas others (e.g., waste management, administrative work, laboratory analysis, surveillance, monitoring, and maintenance) would continue at reduced or altered levels. Systems dedicated to reactor operations would cease operations. However, if these systems are not removed from the site after reactor shutdown, their physical presence may continue to impact the environment. Impacts associated with dedicated systems that remain in place, or with shared systems that continue to operate at normal capacities, could remain unchanged.

Decommissioning will occur whether CPS is shut down at the end of its current operating license or at the end of the period of extended operation 20 years later. There is no plant-specific issue related to decommissioning. The LR GEIS concludes that LR would have a negligible (SMALL) effect on the impacts of terminating operations and decommissioning on all resources (NRC 2024-TN10161).

2.3 Alternatives

NEPA requires the NRC to consider reasonable alternatives to the proposed action of renewing the CPS operating license. For a replacement power alternative to be reasonable, it must be either (1) commercially viable on a utility scale and operational before the facility's operating license expires, or (2) expected to become commercially viable on a utility scale and operational before the facility's operating license expires.

The first alternative to the proposed action of renewing the CPS operating license is for the NRC to not issue the renewed license. This is called the no-action alternative and is described in Section 2.3.1 of this SEIS. In addition to the no-action alternative, this section identifies three reasonable replacement power alternatives for detailed study. As described in Section 2.3.2,

these alternatives would replace CPS' generating capacity by meeting the region's energy needs through other means or sources of energy.

2.3.1 No-Action Alternative

At some point, all operating nuclear power plants will permanently cease operations and undergo decommissioning. Under the no-action alternative, the NRC would not renew the CPS operating license, and the reactor unit would shut down on or before the expiration of the current license on April 17, 2024.

After permanent reactor shutdown, nuclear power plant operators will initiate decommissioning in accordance with 10 CFR 50.82, "Termination of License" (TN249). The decommissioning GEIS (NRC 2002-TN665) describes the environmental impacts from decommissioning a nuclear power plant and related activities. The analysis in the decommissioning GEIS bounds the environmental impacts of decommissioning when CEG terminates reactor operations at CPS. A licensee is required to assess the environmental effects of decommissioning activities in their post-shutdown decommissioning activities report and inform the NRC whether planned activities could result in significant environmental impacts not previously reviewed. Section 2.2.3 of this SEIS describes the incremental environmental effects of LR on future decommissioning activities.

Termination of reactor operations would result in the total cessation of electrical power production at CPS. Because it does not provide a means of delivering baseload power to meet future electric system needs, assuming there is a need for the electrical power generated by CPS, the no-action alternative (not renewing the operating license) would create a need for replacement power. In addition, Section 102(2)(C)(iii) of NEPA (TN661), amended by the Fiscal Responsibility Act of 2023, requires "an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no action alternative." The negative environmental impacts of not renewing the CPS operating license (no-action alternative) and the need for replacement power are described in the replacement power alternatives impact sections for each of the analyzed resource areas in Chapter 3 of this SEIS.

2.3.2 Replacement Power Alternatives

The following sections describe replacement power alternatives. The potential environmental impacts of these alternatives are described in Chapter 3 of this SEIS. Although the NRC's authority only extends to deciding whether to renew the CPS operating license, replacement power alternatives represent possible options that energy planning decision-makers may need to consider if the CPS operating license is not renewed. In evaluating replacement power alternatives, the NRC staff considered energy-generating technologies in commercial operation, as well as technologies likely to be commercially available by the time the current CPS operating license expires. Because energy-generating technologies continually evolve in capability and cost, and because regulatory structures change to either promote or impede the development of certain technologies, this evaluation considered which replacement power alternatives would be available and commercially viable when the current CPS operating license expires.

CEG's ER describes possible replacement power alternatives. In addition, information from the following sources was considered in the replacement power analysis:

- U.S. Department of Energy (DOE) offices, including the Energy Information Administration (EIA)

- the U.S. Environmental Protection Agency (EPA)
- industry sources and publications

In total, the NRC staff considered 16 replacement power alternatives to the proposed agency action and eliminated 13 from detailed study because of technical, resource availability, or commercial limitations. These limitations are likely to continue when the current CPS operating license expires, rendering these alternatives not feasible or commercially viable. The alternatives considered, but eliminated from detailed study were as follows:

- new nuclear
- solar power
- wind power
- biomass power
- hydroelectric power
- geothermal power
- ocean wave, current, and tide energy
- municipal solid waste-fired power
- petroleum-fired power
- coal-fired power
- fuel cells
- delayed retirement of other power-producing facilities
- demand-side management/energy conservation/energy efficiency

The three replacement power alternatives remaining for detailed study were:

- natural gas
- renewable and natural gas combination
- purchased power

Section 2.4 of this SEIS briefly describes the 13 alternatives eliminated from detailed study and provides the basis for each elimination. Section 2.5 compares the impacts of the proposed action, no action, and replacement power alternatives. The following sections describe the key characteristics of the three replacement power alternatives considered in this SEIS. The order in which this SEIS presents the different alternatives does not imply increasing or decreasing level of impact; nor does the order imply that an energy-planning decision-maker would be more (or less) likely to select any given alternative.

2.3.2.1 Natural Gas Alternative

The natural gas alternative would consist of a natural gas combined cycle (NGCC) plant constructed at the CPS site with a design capacity of 1,241 MWe to replace the 1,080 MWe of power currently generated by CPS based on a capacity factor of 87 percent (EIA 2022-TN10537). The NGCC plant would use MDCTs.

The NGCC plant would be sited on approximately 54 ac (22 ha) of land within a 96 ac (39 ha) parcel on the CPS site previously analyzed in a 2006 EIS for the Exelon early site permit (ESP) for siting an additional unit that was never built (NRC 2006-TN672). Existing onsite transmission

line infrastructure and corridors would be used. A 16 mi (26 km) pipeline connection to an existing gas pipeline would be needed to supply natural gas to the NGCC plant.

2.3.2.2 Renewable and Natural Gas Combination Alternative

The renewable and natural gas combination alternative would consist of:

- An NGCC plant constructed at the CPS site with a design capacity of 1,000 MWe to yield approximately 870 MWe (assuming an 87 percent capacity factor) (EIA 2022-TN10537). The NGCC plant would use MDCTs.
- Onsite wind energy installations with battery storage of 652 MW (assuming a 41.4 percent capacity factor) (DOE 2021-TN9562).
- Onsite (and offsite, if needed) solar energy installations with battery storage of 216 MW (assuming a 25 percent capacity factor).

The NGCC plant would be constructed on approximately 35 ac (14 ha) within the footprint for a standalone NGCC plant described in Section 2.3.2.1, and would require the construction of a 16 mi (26 km) pipeline to supply natural gas to the NGCC plant.

Wind turbines would be installed onsite on 1,610 ac (650 ha) of land (using DOE estimates of 2.47 ac [1.00 ha] per MW for the construction footprint [DOE 2015-TN8757]).

Solar panels would be installed on 1,620 ac (660 ha) of land at multiple onsite (and offsite locations, if needed) (assuming 7.5 ac [3.0 ha] per MW). Solar panels would be installed among the wind turbines in order to maximize the available land.

2.3.2.3 Purchased Power Alternative

Purchased power involves the importation of electric energy into the CPS service area from multiple existing, operating energy generating sources (e.g., nuclear, natural gas-fired, solar, and wind energy) under long-term contract to replace CPS' net generation. Long-term power purchase agreements must comply with the Illinois Power Agency Act (IL Stat. 20-TN11209: 1-75), which focuses on renewable power (ICC 2022-TN10809).

2.4 Alternatives Considered but Dismissed

2.4.1 New Nuclear

Construction and operation of a new nuclear facility was considered but eliminated from detailed study because the Illinois State Legislature has passed legislation prohibiting the construction of nuclear power plants in Illinois (IL Stat. 220-TN11210). Until this moratorium is lifted, construction and operation of a new nuclear facility is not a reasonable alternative for detailed study.

2.4.2 Solar Power

Solar power, including photovoltaic (PV) and concentrating solar power technologies, generate power from sunlight. Solar PV components convert sunlight directly into electricity using solar cells made from silicon or cadmium telluride. Concentrating solar power uses heat from the sun to boil water and produce steam. Steam drives a turbine connected to a generator to produce electricity (NREL Undated-TN7710).

Solar generators are considered an intermittent electrical power resource because their availability depends on exposure to the sun, also known as solar insolation. Further, to be viable, a utility-scale solar power alternative must replace the amount of electrical power that CPS currently provides. Assuming a capacity factor of 25 percent (DOE/EIA 2023-TN8821), approximately 4,320 MW of additional solar energy capacity would need to be installed to replace the 1,080 MW of electricity generated by CPS. Based on CEG's estimate of up to 7.5 ac (3.0 ha) of land per MW, this would require over 32,000 ac (13,000 ha) of land.

If the CPS operating license is not renewed, it is unlikely that CPS' generating capacity would be replaced by a single type of intermittent electricity generation, including a non-baseload resource such as utility-scale solar. A combination of energy sources, including sources described in Section 2.3.2.2 of this SEIS, could complement each other and reduce issues such as the intermittency of wind and utility-scale solar power.

The impacts of utility-scale solar development are described in the renewable and natural gas combination alternative described in Section 2.3.2.2 of this SEIS. The types of impacts of a standalone solar energy alternative would be similar to these alternatives, although the magnitude of such impacts may differ based on the amount of solar energy capacity to be constructed. Given the intermittency of solar power, a standalone solar alternative was considered but eliminated from detailed study. However, solar power generation, in combination with other energy generating technologies, could be a reasonable alternative to CPS LR, as explained in Section 2.3.2.2 of this SEIS.

2.4.3 Wind Power

As is the case with other renewable energy sources, the feasibility of wind energy providing baseload power depends on the location (relative to electricity users), value, accessibility, and constancy of the resource. Wind energy must be converted to electricity at or near the point where it is used, and there are limited energy storage opportunities available to overcome the intermittency and variability of wind resources.

The American Clean Power Association reports a total of more than 122,000 MW of installed wind energy capacity nationwide as of December 31, 2020 (DOE Undated-TN8431). To be considered a reasonable replacement power alternative to CPS' LR, a wind power alternative would have to replace the amount of electrical power that CPS provides. Assuming a capacity factor of 41.4 percent for onshore wind facilities (DOE 2021-TN9562), land-based wind energy facilities would need to generate approximately 2,600 MW of electricity to replace 1,080 MWe of CPS' generating capacity. Using DOE metrics of 0.74 ac (0.30 ha) per MW for permanent structures, 2.47 ac (1.00 ha) per MW for construction footprint, and 85 ac (34 ha) per MW for wind farm boundaries, onshore wind farms could require approximately 230,000 ac (90,000 ha) of land (DOE 2015-TN8757). Additionally, because wind is an intermittent energy source, energy storage would be needed, increasing land requirements.

The impacts of utility-scale wind development are described in the renewable and natural gas combination alternative described in Section 2.3.2.2 of this SEIS. The types of impacts of a standalone wind energy alternative would be similar to the effects of onsite wind energy generation under the combination alternative, but the magnitude of such impacts may differ based on the amount of wind energy capacity to be constructed. Given the intermittency of wind power, a standalone wind alternative was considered but eliminated from detailed study. However, wind power generation, in combination with other energy generating technologies, could be a reasonable alternative to CPS LR, as explained in Section 2.3.2.2 of this SEIS.

2.4.4 Biomass Power

Biomass resources used for biomass fuel-fired power generation include agricultural residues, animal manure, wood wastes from forestry and industry, residues from food and paper industries, municipal green wastes, dedicated energy crops, and methane from landfills (IEA 2007-TN8436). Using biomass fuel-fired generation for baseload power depends on the geographic distribution, available quantities, constancy of supply, and energy content of biomass resources. For this analysis, biomass fuel would be combusted for power generation in the electricity sector.

As of 2022, 15 biomass facilities in Illinois generated approximately 56 MW of electricity, mostly from waste and methane gas from municipal landfills (2024 EIA-TN10937). For utility-scale biomass fuel-fired electricity generation, technologies used for biomass energy conversion would be similar to the technologies used in fossil fuel-fired power plants, including the direct combustion of biomass fuel in a boiler to produce steam (NRC 2024-TN10161). Accordingly, biomass generation is considered a carbon-emitting technology.

Biomass energy generation is generally more cost effective when co-located with coal-fired power plants (IEA 2007-TN8436). However, most biomass fuel-fired power plants generally only reach capacities of 50 MWe, which means that replacing CPS' generating capacity, using only biomass fuel, would require the construction of 19 power plants.

Increasing biomass fuel-fired generation capacity by expanding existing or constructing new units by the time CPS' current operating license expires is unlikely. For these reasons, biomass fuel-fired generation is not a reasonable alternative to CPS LR.

2.4.5 Hydroelectric Power

As of 2020, there were approximately 2,300 operating hydroelectric facilities operate in the United States (DOE Undated-TN7701). Hydropower technologies capture the energy of flowing water and direct it to turbines and generators to produce electricity (NRC 2024-TN10161). There are three variants of hydroelectric power generation: (1) run of the river (diversion) facilities that redirect the natural flow of a river, stream, or canal through a hydroelectric power facility; (2) store and release facilities that block the flow of the river by using dams that cause water to accumulate in an upstream reservoir; and (3) pumped storage facilities that use electricity from other power sources to pump water to higher elevations during off-peak hours to be released during peak load periods to generate electricity (EIA 2020-TN8352, EIA 2021-TN8353).

Although EIA projects that hydropower will remain a leading source of renewable power generation in the United States through 2040, there is little expected growth in large-scale hydropower capacity (DOE/EIA 2013-TN2590). The potential construction of large new hydropower facilities has diminished because of public concern over flooding, habitat alteration and loss, and the impact on natural rivers (NRC 2024-TN10161).

The dam with the greatest potential to produce hydropower electricity in Illinois is the Ohio River Locks and Dam at the Illinois/Kentucky border (ORNL 2012-TN8440). Based on an estimated 40 percent capacity factor, there would not be the scale of development needed to replace CPS' generation capacity.

Because of the lack of potential sites and the environmental constraints associated with the development of a new hydroelectric power facility in Illinois, a hydroelectric power alternative was eliminated from detailed study.

2.4.6 Geothermal Power

Geothermal technologies extract heat from geologic formations to produce steam to drive steam turbine generators. Electricity production from geothermal energy have demonstrated 95 percent or greater capacity factors, making geothermal energy a potential source of baseload electric power. However, the feasibility of geothermal power generation to provide baseload power depends on the regional quality and accessibility of geothermal resources. Utility-scale power generation requires geothermal reservoirs with a temperature above 200°F (93°C). Such utility-scale geothermal resources are concentrated in the western United States, specifically Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming and most assessments of geothermal power generation resources have been conducted in these States (DOE Undated-TN7698; USGS 2008-TN7697). There is currently no utility-scale geothermal power production in the CPS region. Given its low potential, geothermal power generation is not a reasonable alternative to CPS LR.

2.4.7 Ocean Wave, Current, and Tide Energy

Ocean waves, currents, and tides are generally predictable and reliable, making them attractive candidates for potential renewable energy generation. Four major technologies can be used to harness wave energy: (1) terminator devices that range from 500 kilowatts to 2 MW, (2) attenuators, (3) point absorbers, and (4) overtopping devices (BOEM Undated-TN7696). Point absorbers and attenuators use floating buoys to convert wave motion into mechanical energy, driving generators to produce electricity. Overtopping devices trap a portion of a wave at a higher elevation than the sea surface; waves enter a tube and compress air that is then used to drive a generator producing electricity (NRC 2024-TN10161). Some of these technologies are undergoing demonstration testing at commercial scales, but none are currently used to provide baseload power (BOEM Undated-TN7696). In the United States, there are currently several projects licensed or seeking permits, the largest of which is 20 MW (Duke Energy 2021-TN8897).

While Illinois borders Lake Michigan, application of wave energy technologies would not be viable, as wave and ocean energy-generation technologies are still in development and currently lack commercial application (EPRI 2011-TN8442). Therefore, wave and ocean energy power generation is not a reasonable alternative to CPS LR.

2.4.8 Municipal Solid Waste-Fired Power

Energy recovery from municipal solid waste converts nonrecyclable waste materials into usable heat, electricity, or fuel through combustion. The three primary municipal solid waste combustion technologies are mass burning, modular systems, and refuse-derived fuel systems. Mass burning is the method used most frequently in the United States. The heat released from combustion is used to convert water to steam, which is then used to drive turbine generators to produce electricity. Ash is collected and taken to a landfill, and particulates are captured through a filtering system (EPA 2023-TN8443).

Currently, 75 waste-to-energy power plants are in operation in 21 States, processing approximately 29 million tons (26,000 million kilograms [kg]) of waste per year. These waste-to-

energy power plants have an aggregate capacity of 2,725 MWe (Michaels and Krishnan 2019-TN7700). Although some power plants have expanded to handle additional waste and to produce more energy, only one new municipal solid waste combustion power plant has been built in the United States since 1995 (Maize 2019-TN7699). The average waste-to-energy power plant produces about 50 MWe, which is a very small fraction of the energy produced by CPS.

The decision to burn municipal solid waste to generate electricity is usually driven by the need for a waste disposal alternative to landfills, rather than a need to generate energy. Stable supplies of municipal solid waste would be needed to support multiple waste-to-energy power plants. Based on this information, municipal solid waste-fired power is not a reasonable alternative to CPS LR.

2.4.9 Petroleum-Fired Power

The variable costs and environmental impacts of petroleum-fired electrical power generation tend to be greater than those of natural gas-fired generation. The historically higher cost of oil also has resulted in a steady decline in its use for electricity generation, and the EIA forecasts no growth in capacity using petroleum-fired power plants through 2040 (DOE/EIA 2013-TN2590, DOE/EIA 2015-TN4585). Based on this information, petroleum-fired electricity generation is not a reasonable alternative to CPS LR.

2.4.10 Coal-Fired Power

Although coal has historically been the largest source of electricity in the United States, both natural gas generation and nuclear energy generation surpassed coal generation at the national level in 2020. Coal-fired electricity generation in the United States has continued to decrease as coal-fired units have been retired or converted to use other fuels and as the remaining units have been used less often (DOE/EIA 2021-TN7718).

Baseload coal-fired power units have proven their reliability and can routinely sustain capacity factors as high as 85 percent. Among the available technologies, pulverized-coal boilers producing supercritical steam (supercritical pulverized-coal boilers) have become increasingly common, given their generally high thermal efficiencies and overall reliability.

Supercritical pulverized-coal facilities are more expensive to build than subcritical coal-fired power plants but consume less fuel per unit output. Integrated gasification combined cycle combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is cleaner than conventional pulverized-coal plants because some of the major pollutants are removed before combustion. Although several smaller, integrated gasification combined-cycle power plants have been in operation since the mid-1990s, large-scale projects have experienced setbacks, and public opposition has hindered it from being fully integrated into the energy market. Based on these considerations, coal-fired power plants are not a reasonable alternative to CPS LR.

2.4.11 Fuel Cells

Fuel cells oxidize fuels without combustion and, therefore, without the environmental side effects of combustion. Fuel cells use a fuel (e.g., hydrogen) and oxygen to create electricity through an electrochemical process. The only byproducts are heat, water, and carbon dioxide (depending on the hydrogen fuel type) (DOE Undated-TN7695). Hydrogen fuel can come from a

variety of hydrocarbon resources, including natural gas. As of October 2020, the United States had only 250 MW of fuel cell power generation capacity (EIA 2022-TN8955).

Currently, fuel cells are not economically or technologically competitive with other electricity generating alternatives. The EIA estimates that fuel cells may cost $6,639 per installed kilowatt (total overnight capital costs in 2021 dollars), which is high compared to other replacement power alternatives (DOE/EIA 2022-TN7694). In June 2021, DOE launched an initiative to reduce the cost of hydrogen production to spur fuel cell and energy storage development over the next decade (DOE 2021-TN7693). However, it is unclear whether or to what degree this initiative will lead to increased future development and deployment of fuel cell technologies.

More importantly, fuel cell units used for power production are likely to be small (approximately 10 MW). The world's largest industrial hydrogen fuel cell power plant is a 50 MWe plant in South Korea (Larson 2020-TN8401). Using fuel cells to replace the power that CPS provides would require the construction of approximately 108 units. Given the limited deployment and high cost of fuel cell technology, fuel cells are not a reasonable alternative to CPS LR.

2.4.12 Delayed Retirement of Other Generating Facilities

Delaying the retirement of a power plant enables it to continue supplying electricity. Because some power generators are required to adhere to regulations requiring significant reductions in power plant emissions, some owners may opt to retire older, less efficient units rather than incur the cost for compliance. Retirements also may be driven by low competing commodity prices (such as low natural gas prices), slow growth in electricity demand, and EPA Mercury and Air Toxics Standards for fossil-fueled power plants (DOE/EIA 2015-TN4585; EPA 2020-TN8379). Because of these conditions, delayed retirement of older power generating units is not a reasonable alternative to CPS LR.

2.4.13 Demand-Side Management/Energy Conservation/Energy Efficiency

Demand-side management refers to energy conservation and efficiency programs that do not require the addition of new generating capacity. Demand-side management programs can include reducing energy demand through consumer behavioral changes or through altering the characteristics of the electrical load. These programs can be initiated by a utility, transmission operators, the State, or other load serving entities. In general, residential electricity consumers have been responsible for the majority of peak load reductions, and participation in most demand-side management programs is voluntary (NRC 2024-TN10161).

The existence of a demand-side management program does not guarantee that reductions in electricity demand will occur. The LR GEIS concludes that, although the energy conservation or energy efficiency potential in the United States is substantial, there have been no cases in which an energy efficiency or conservation program alone has been implemented expressly to replace or offset a large baseload generation station (NRC 2024-TN10161). Therefore, demand-side management programs alone are not a reasonable alternative to the CPS LR. However, in combination with other power generating technologies, demand-side management could be a reasonable alternative to CPS LR.

2.5 Comparison of Alternatives

In this chapter, the NRC staff presents three alternatives to the proposed action (CPS LR): (1) natural gas, (2) renewable and natural gas combination, and (3) purchased power.

Chapter 3 describes the environmental impacts of the proposed action and alternatives to the proposed action. Table 2-1 below summarizes these environmental impacts. The NRC assigns an environmental impact significance level of SMALL, MODERATE, or LARGE for nuclear plant-specific issues. For ecological resources subject to the ESA (16 U.S.C. 1531 et seq.-TN1010) and the MSA (16 U.S.C. 1801 et seq.-TN9966), and historic and cultural resources subject to the NHPA (54 U.S.C. 300101 et seq.-TN4157), the impact significance determination language is specific to the respective law.

The environmental impacts of the proposed action would be SMALL for all environmental issues. In comparison, the replacement power alternatives would have environmental impacts in at least three resource areas with the potential to be greater than the environmental impacts of the proposed action. If the NRC does not renew the CPS operating license (i.e., the no-action alternative), energy-planning decision-makers would have to choose a replacement power alternative similar to those evaluated in this SEIS. Based on the review of the replacement power alternatives, the no-action alternative, and the proposed action, the environmentally preferred alternative is the proposed action. Therefore, the NRC staff's preliminary recommendation is to renew the CPS operating license.

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and Alternatives at Clinton Power Station

Resource	Proposed Action – License Renewal	No-Action	Natural Gas	Renewable and Natural Gas Combination	Purchased Power
Land Use	SMALL	SMALL	SMALL	LARGE	SMALL
Visual Resources	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL
Air Quality	SMALL	SMALL	MODERATE	MODERATE	SMALL to LARGE
Noise	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL
Geologic Environment	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Water Resources	SMALL	SMALL	SMALL	SMALL	SMALL
Terrestrial Resources	SMALL	SMALL	SMALL to MODERATE	SMALL to LARGE	SMALL to LARGE
Aquatic Resources	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Federally Protected Ecological Resources	SEE NOTE[a]	SEE NOTE[b]	SEE NOTE[c]	SEE NOTE[c]	SEE NOTE[c]
Historic and Cultural Resources	SEE NOTE[d]	SEE NOTE[e]	SEE NOTE[f]	SEE NOTE[f]	SEE NOTE[f]
Socioeconomics	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL to MODERATE	SMALL
Transportation	SMALL	SMALL	SMALL to LARGE	SMALL to LARGE	SMALL
Human Health	SMALL[g]	SMALL	SMALL	SMALL	SMALL
Waste Management	SMALL[h]	SMALL[h]	SMALL	SMALL	SMALL
Greenhouse Gas Emissions and Climate Change	SMALL	SMALL	MODERATE	MODERATE	SMALL TO MODERATE

(a) May affect but is not likely to adversely affect northern long-eared bat, Indiana bat, whooping crane, monarch butterfly, western regal fritillary, rusty patched bumble bee, and eastern prairie fringed orchid. No effect on salamander mussel.

(b) Overall, the effects on federally listed species would likely be smaller under the no-action alternative than the effects under continued operation but would depend on the specific shut down activities as well as the listed species present when the no-action alternative is implemented.

(c) The types and magnitudes of adverse impacts to species listed in the Endangered Species Act of 1973, as amended (TN1010) would depend on the proposed alternative site, facility design and operation, as well as listed species and habitats present when the alternative is implemented. Therefore, the NRC staff cannot forecast a level of impact for this alternative.

Table 2-1 Comparison of Environmental Impacts of the Proposed Action and Alternatives at Clinton Power Station (Continued)

Resource	Proposed Action – License Renewal	No-Action	Natural Gas	Renewable and Natural Gas Combination	Purchased Power

(d) Based on no new physical or visual modifications to the landscape, Tribal consultation, and the applicant's administrative procedures, the proposed action will result in No Adverse Effect to historic properties, as defined in 36 CFR 800.5(b) (TN513); there would be no impact to historic and cultural resources.

(e) Until the post-shutdown decommissioning activities report is submitted, the NRC staff cannot determine whether historic properties and/or historic and cultural resources would be affected outside the existing industrial site boundary by decommissioning activities after the nuclear power plant ceases operations.

(f) Potential impacts of this alternative would be dependent on the power source, type of facilities, and location chosen. The NRC does not license natural gas or renewable energy facilities; therefore, the NRC would not be responsible for National Historic Preservation Act (NHPA) Section 106 consultations for this alternative. If the project has a Federal nexus (i.e., license, permit), the Federal agency would need to make a reasonable effort to identify historic properties within the Area of Potential Effect and consider the effects of their undertaking on historic properties, in accordance with Section 106 of the NHPA. If historic properties are present and could be affected by the undertaking, adverse effects would be assessed, determined, and mitigated with the State Historic Preservation Officer and any Tribe(s) that attach religious and cultural significance to identified historic properties through the Section 106 consultation process.

(g) The effects of electromagnetic fields on human health associated with operating nuclear power and other electricity generating plants are uncertain.

(h) NUREG-2157, *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel* (NRC 2014-TN4117), discusses the environmental impacts of spent fuel storage for the timeframe beyond the licensed life for reactor operations.

3 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

3.1 Introduction

In conducting its review of the environmental effects of the proposed action of renewing the CPS operating license for an additional 20 years, the NRC staff describes the environment that could be affected by the proposed action. The NRC staff also evaluates the environmental consequences of the proposed action as well as alternatives to the proposed action.

In this chapter, the affected environment is the environment that currently exists at and around CPS. Because existing conditions are at least partially the result of past construction and nuclear power plant operations, this chapter considers the nature and impacts of past and ongoing operations and evaluates how, together, these actions have shaped the current environment. This chapter also describes reasonably foreseeable environmental trends. The effects of ongoing reactor operations at CPS have become well established as environmental conditions have adjusted to the presence of the facility.[1]

Sections 3.2 through 3.13 of this SEIS describe the affected environment for each resource area, followed by the NRC staff's evaluation of the environmental consequences of the proposed action and alternatives to the proposed action on each associated environmental issue. The NRC compares the environmental impacts of the proposed action with those of the no-action alternative and replacement power alternatives to determine whether the adverse environmental impacts of the proposed action are so great that preserving the option for energy-planning decisionmakers would be unreasonable.

The evaluation of environmental consequences includes the following:

- impacts associated with continued operations of CPS during the period of extended operation
- impacts of replacement power alternatives to the proposed action and the no-action alternative (not issuing the renewed license)
- impacts common to all alternatives: (1) fuel cycle, including uranium fuel cycle, (2) terminating CPS operations and decommissioning, and (3) greenhouse gas (GHG) emissions and climate change
- impacts of postulated accidents (design-basis accidents and severe accidents)
- cumulative effects of the proposed action
- resource commitments associated with the proposed action, including unavoidable adverse impacts, the relationship between short-term use and long-term productivity, and irreversible and irretrievable commitment of resources
- new and potentially significant information about environmental issues related to the impacts of continued operations during the LR term.

[1] Where appropriate, the NRC staff has summarized referenced information (incorporated information by reference) in this SEIS. This allows the staff to focus on new and potentially significant information identified since previous NEPA documentation became available for CPS.

As stated in Sections 1.4 and 1.5, this SEIS documents the NRC staff's environmental review of the CPS LRA (CEG 2024-TN10806) as a supplement to the LR GEIS (NRC 2024-TN10161). The LR GEIS identifies 80 issues (divided into Category 1 [generic] and Category 2 [nuclear plant-specific] issues) to be evaluated for the proposed action. Section 1.4 of this SEIS provides an explanation of the criteria for Category 1 issues and Category 2 issues, as well as the definitions of SMALL, MODERATE, and LARGE impact significance.

For the evaluation of Category 1 issues in this SEIS, the NRC staff relied on the analysis in the LR GEIS unless otherwise noted. Table 3-1 below lists the impact findings for Category 1 issues applicable to CPS LRA. For these issues, which are discussed in Sections 3.2 to 3.13 of this SEIS, the NRC staff did not identify any new and significant information that would change the conclusions of the LR GEIS. Section 3.14 of this SEIS describes the NRC staff's process for evaluating new and significant information.

Table 3-1 Applicable Category 1 (Generic) Impact Findings Regarding the Clinton Power Station License Renewal

Environmental Issue	LR GEIS Section	Impact Finding
Land Use – Onsite land use	4.2.1.1.1	SMALL
Land Use – Offsite land use	4.2.1.1.2	SMALL
Visual Resources – Aesthetic impacts	4.2.1.2.1	SMALL
Air Quality – Air quality impacts	4.3.1.1.1	SMALL
Air Quality – Air quality effects of transmission lines	4.3.1.1.2	SMALL
Noise – Noise impacts	4.3.1.2.1	SMALL
Geologic Environment – Geology and soils	4.4.1.1	SMALL
Surface Water Resources – Surface water use and quality (non-cooling system impacts)	4.5.1.1.1	SMALL
Surface Water Resources – Altered current patterns at intake and discharge structures	4.5.1.1.2	SMALL
Surface Water Resources – Altered thermal stratification of lakes	4.5.1.1.4	SMALL
Surface Water Resources – Scouring caused by discharged cooling water	4.5.1.1.5	SMALL
Surface Water Resources – Discharge of metals in cooling system effluent	4.5.1.1.6	SMALL
Surface Water Resources – Discharge of biocides, sanitary wastes, and minor chemical spills	4.5.1.1.7	SMALL
Surface Water Resources – Surface water use conflicts (plants with once-through cooling systems)	4.5.1.1.8	SMALL
Surface Water Resources – Effects of dredging on surface water quality	4.5.1.1.10	SMALL
Surface Water Resources – Temperature effects on sediment transport capacity	4.5.1.1.11	SMALL
Groundwater Resources – Groundwater contamination and use (non-cooling system impacts)	4.5.1.2.1	SMALL
Terrestrial Resources – Exposure of terrestrial organisms to radionuclides	4.6.1.1.2	SMALL
Terrestrial Resources – Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)	4.6.1.1.3	SMALL

Table 3-1 Applicable Category 1 (Generic) Impact Findings Regarding the Clinton Power Station License Renewal (Continued)

Environmental Issue	LR GEIS Section	Impact Finding
Terrestrial Resources – Cooling tower impacts on terrestrial plants	4.6.1.1.4	SMALL
Terrestrial Resources – Bird collisions with plant structures and transmission lines	4.6.1.1.5	SMALL
Terrestrial Resources – Transmission line right-of-way (ROW) management impacts on terrestrial resources	4.6.1.1.7	SMALL
Terrestrial Resources – Electromagnetic fields on terrestrial plants and animals	4.6.1.1.8	SMALL
Aquatic Resources – Entrainment of phytoplankton and zooplankton	4.6.1.2.3	SMALL
Aquatic Resources – Infrequently reported effects of thermal effluents	4.6.1.2.6	SMALL
Aquatic Resources – Effects of non-radiological contaminants on aquatic organisms	4.6.1.2.7	SMALL
Aquatic Resources – Exposure of aquatic organisms to radionuclides	4.6.1.2.8	SMALL
Aquatic Resources – Effects of dredging on aquatic resources	4.6.1.2.9	SMALL
Aquatic Resources – Non-cooling system impacts on aquatic resources	4.6.1.2.11	SMALL
Aquatic Resources – Impacts of transmission line right-of-way (ROW) management on aquatic resources	4.6.1.2.12	SMALL
Socioeconomics – Employment and income, recreation and tourism	4.8.1.1	SMALL
Socioeconomics – Tax revenue	4.8.1.2	SMALL
Socioeconomics – Community services and education	4.8.1.3	SMALL
Socioeconomics – Population and housing	4.8.1.4	SMALL
Socioeconomics – Transportation	4.8.1.5	SMALL
Human Health – Radiation exposures to plant workers	4.9.1.1.1	SMALL
Human Health – Radiation exposures to the public	4.9.1.1.1	SMALL
Human Health – Chemical hazards	4.9.1.1.2	SMALL
Human Health – Microbiological hazards to plant workers	4.9.1.1.3	SMALL
Human Health – Physical occupational hazards	4.9.1.1.5	SMALL
Postulated Accidents – Design-basis accidents	4.9.1.2.1	SMALL
Postulated Accidents – Severe accidents	4.9.1.2.1	SMALL[a]
Waste Management – Low-level waste storage and disposal	4.11.1.1	SMALL
Waste Management – Onsite storage of spent nuclear fuel	4.11.1.2	SMALL
Waste Management – Offsite radiological impacts of spent nuclear fuel and high-level waste disposal	4.11.1.3	[b]
Waste Management – Mixed waste storage and disposal	4.11.1.4	SMALL
Waste Management – Nonradioactive waste storage and disposal	4.11.1.5	SMALL
Greenhouse Gas Emissions and Climate Change – Greenhouse gas impacts on climate change	4.12.1	SMALL
Uranium Fuel Cycle – Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste	4.14.1.5	SMALL
Uranium Fuel Cycle – Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste	4.14.1.5	[c]
Uranium Fuel Cycle – Nonradiological impacts of the uranium fuel cycle	4.14.1.5	SMALL

Table 3-1 Applicable Category 1 (Generic) Impact Findings Regarding the Clinton Power Station License Renewal (Continued)

Environmental Issue	LR GEIS Section	Impact Finding
Uranium Fuel Cycle – Transportation	4.14.1.5	SMALL
Termination of plant operations and decommissioning	4.14.2.1	SMALL

CFR = *Code of Federal Regulation*; LR GEIS = license renewal generic environmental impact statement; NEPA = National Environmental Policy Act; ROW = right-of-way; SEIS = supplemental environmental impact statement.

(a) Although 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, the topic of SAMA analysis is separately considered in this SEIS as if it were a Category 2 issue (see Appendix F of this SEIS) because the NRC staff has not previously considered a SAMA analysis for CPS as part of an environmental review and because 10 CFR 51.53(c)(3)(ii)(L) states that, "[i]f the staff has not previously considered severe accident mitigation alternatives for the applicant's plant, in an environmental impact statement or related supplement or in an environmental assessment, a consideration of alternatives to mitigate severe accidents must be provided" (TN10253).

(b) The ultimate disposal of spent fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this review. Per 10 CFR Part 51 (TN10253) Subpart A, the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants.

(c) There are no regulatory limits applicable to collective doses to the general public from fuel cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel cycle facilities are designed and operated to meet the applicable regulatory limits and standards. As stated in the LR GEIS, "The Commission concludes that the 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" (NRC 2024-TN10161).

Sources: Table B-1 in Appendix B to Subpart A of 10 CFR Part 51-TN10253; NRC 2024-TN10161.

The NRC staff analyzed the applicable Category 2 (nuclear plant-specific) issues for CPS and assigned impacts for these issues as shown in Table 3-2 below.

Table 3-2 Applicable Category 2 (Nuclear Plant-Specific) Impact Findings Regarding the Clinton Power Station License Renewal

Issue	LR GEIS Section	Impact Finding[(a)]
Groundwater Resources – Groundwater quality degradation (plants with cooling ponds)	4.5.1.2.6	SMALL
Groundwater Resources – Radionuclides released to groundwater	4.5.1.2.7	SMALL
Terrestrial Resources – Non-cooling system impacts) on terrestrial resources	4.6.1.1.1	SMALL
Aquatic Resources – Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2.1	SMALL

Table 3-2 Applicable Category 2 (Nuclear Plant-Specific) Impact Findings Regarding the Clinton Power Station License Renewal (Continued)

Issue	LR GEIS Section	Impact Finding(a)
Aquatic Resources – Effects of thermal effluents on aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2.4	SMALL
Federally Protected Ecological Resources – Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife Service jurisdiction	4.6.1.3.1	See Section 3.8 of this SEIS.
Historic and Cultural Resources	4.7.1	See Section 3.9 of this SEIS.
Human Health – Microbiological hazards to the public	4.9.1.1.3	SMALL
Human Health – Electromagnetic fields (EMFs)(b)	4.9.1.1.4	Uncategorized (Uncertain Impact)
Human Health – Electric shock hazards	4.9.1.1.5	SMALL
Greenhouse Gas Emissions and Climate Change – Climate change impacts on environmental resources	4.12.2	See Section 3.15.3.2.3 of this SEIS.
Cumulative Effects – Cumulative effects	4.13	See Section 3.16 of this SEIS

LR GEIS = license renewal generic environmental impact statement; SEIS = supplemental environmental impact statement.
(a) Impact determinations for Category 2 issues based on findings described in Sections 3.2 to 3.13 of this SEIS, as applicable, for the proposed action.
(b) This issue was not designated as Category 1 or Category 2 and is discussed in Section 3.11.6.2 of this SEIS.
Sources: Table B-1 in Appendix B to Subpart A of 10 CFR Part 51-TN10253; NRC 2024-TN10161.

3.2 Land Use and Visual Resources

This section describes land use and visual resources in the vicinity of the CPS site as well as the potential impacts from the proposed action of LR and alternatives to the proposed action. Section 3.2 of CEG's ER describes current CPS onsite and offsite land use conditions as well as visual resources (CEG 2024-TN10806).

3.2.1 Land Use

CPS is located on a 13,626 ac (5,514 ha) site encompassing Clinton Lake in DeWitt County, Illinois. Excluding five areas not owned by CEG, CEG owns approximetly 13,531 ac (5,475 ha) within the CPS site. The town of DeWitt is approximately 3 mi (4.8 km) east-northeast of the CPS, and the city of Clinton is located approximately 7 mi (11 km) west of the CPS. The CPS site is roughly equidistant between St. Louis, and Chicago. The cities of Springfield, Bloomington, Champaign, Decatur, Normal, Pekin, and Urbana are all within 50 mi (80 km) of the CPS site.

The sections below describe onsite and offsite land use within a 6 mi (10 km) radius of CPS.

3.2.1.1 Onsite Land Use

The CPS site comprises the reactor facilities, as well as two farms, a cemetery, a former pipeline pumping station, Illinois Route 54, and an adjacent railroad line. As shown in Table 3-3 below, the predominant land cover category within the CPS site is the open water of Clinton Lake (36 percent), decidious forest (23 percent), cultivated crops (12 percent), and mixed forest (11 percent).

Table 3-3 Land Use/Land Cover within the Clinton Power Station Site

Category	Acres	Percentage
Open Water	4,922.0	36.1
Developed, Open Space	223.3	1.6
Developed, Low Intensity	299.3	2.2
Developed, Medium Intensity	120.1	0.9
Developed, High Intensity	98.1	0.7
Barren Land (Rock/Sand/Clay)	7.1	0.1
Deciduous Forest	3,061.3	22.5
Evergreen Forest	85.2	0.6
Mixed Forest	1,470.9	10.8
Shrub/Scrub	31.6	0.2
Grassland/Herbaceous	397.0	2.9
Hay/Pasture	1,047.3	7.7
Cultivated Crops	1,671.5	12.3
Woody Wetlands	160.8	1.2
Emergent Herbaceous Wetlands	30.0	0.2
Total	**13,625.5**	**100.0**

Source: CEG 2024-TN10806: Table 3.2-1.

DeWitt County has zoned the power generating portion of the CPS site as a General Industrial District (I); the remainder of the site is zoned primarily as a Rural Development District-2, with a small portion being zoned as a Rural Development District-1 (DC 2018-TN11039). Access to CPS is via Illinois Route 54, which merges with Interstate 57 in Onarga, Illinois. Additional road access is from Wren Road on the northeast of the site. The Canadian National/Illinois Central Railroad runs parallel to Illinois Route 54 and traverses the CPS site, with a rail spur to the station from the north of the site boundary. There is a heliport on the CPS site, as well as five airfields within 10 mi (6 km) of CPS.

3.2.1.2 Offsite Land Use

The vicinity (6 mi [10 km]) surrounding CPS includes portions of DeWitt County. Portions of McLean, and Macon Counties are within a 50 mi (80 km) radius. As shown in Table 3-4 below, the largest land use/land cover category in the vicinity is cultivated crops (73 percent), followed by deciduous forest (7 percent), open water (6 percent), and hay/pasture (4 percent).

Table 3-4 Land Use/Land Cover within a 6 mi (10 km) Radius of the Clinton Power Station Site

Category	Acres	Percentage
Open Water	4,566.2	6.3
Developed, Open Space	1,566.8	2.2
Developed, Low Intensity	1,908.8	2.6
Developed, Medium Intensity	424.8	0.6
Developed, High Intensity	161.7	0.2
Barren Land (Rock/Sand/	24.7	0.03
Deciduous Forest	5,291.9	7.3
Evergreen Forest	47.8	0.1
Mixed Forest	1,779.8	2.5
Shrub/Scrub	40.3	0.1
Grassland/Herbaceous	438.1	0.6
Hay/Pasture	2,781.0	3.8
Cultivated Crops	53,157.9	73.4
Woody Wetlands	176.1	0.2
Emergent Herbaceous Wetlands	29.6	0.04
Total	**72,395.5**	**100.0**

Source: CEG 2024-TN10806: Table 3.2-2.

DeWitt County is approximately 254,431 ac (102,965 ha), of which 185,936 ac (75,246 ha) (73 percent) are farmland. McLean County is approximately 757,274 ac (306,458 ha), of which 620,056 ac (250,928 ha) (82 percent) are farmland. Macon County is approximately 371,640 ac (150,397 ha), of which 277,429 ac (112,272 ha) (75 percent) are farmland. Major crops in these counties include soybeans, corn, forage, oats, and wheat. Livestock such as cattle, poultry, hogs and pigs, and sheep and lambs are also raised.

Each of the counties (DeWitt, McLean, and Macon) has issued a comprehensive plan (DC 2018-TN11039; MCRPC 2009-TN11040; CDI 2009-TN11041) to support protecting the counties' rural character while promoting development and economic growth.

3.2.2 Visual Resources

As discussed above, CPS is located on Clinton Lake in DeWitt County, Illinois. Predominant visual features include the reactor containment dome, turbine building, and meteorological and microwave towers. The tallest building on site is the reactor containment dome, which is approximately 191 ft (58 m) high. The primary meteorological tower is 205 ft (62 m) high, and the backup meteorological tower is 250 ft (76 m) high; both towers are lighted and are visible at night. Structures on the CPS site are generally screened by terrain and wooded areas, but can be seen from portions of Clinton Lake, along Route 10 south of Clinton Lake, along portions of Illinois Route 54, and along portions of Birkbeck Road.

3.2.3 Proposed Action

As explained in Section 4.2.1.2.1 of the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 above, land use and visual resource impacts of LR (and the continued operation of CPS) would be SMALL. Three Category 1 land use and visual resource issues were evaluated in the LR GEIS. These Category 1 issues are:

- onsite land use
- offsite land use
- aesthetic impacts

The LR GEIS did not identify any nuclear plant-specific Category 2 land use and visual resource issues that require consideration (NRC 2024-TN10161). The NRC staff's independent review did not identify any new and significant land use and visual resource information that would change the impact findings in the LR GEIS concerning CPS LR. Additionally, the NRC staff did not identify any additional land use and visual resource issues beyond those listed in Table 3-1 of this SEIS.

3.2.3.1 Onsite Land Use

Operational activities during the LR term would be similar to those already occurring at CPS. Based on this information, the NRC staff concludes that the impact of continued nuclear power plant operations on onsite land use during the CPS LR term would be SMALL. In addition, the NRC staff did not identify any new onsite land use information that would alter this conclusion.

3.2.3.2 Offsite Land Use

LR activities have little to no effect on offsite land use in communities near nuclear power plants. Operational activities during the LR term, including periodic nuclear refueling outages requiring temporary staff, would be similar to those already occurring at the plant and would not affect offsite land use beyond what has already been affected. Based on this information, the NRC staff concludes that the impact of continued nuclear power plant operations on offsite land use during the CPS LR term would be SMALL. In addition, the NRC staff did not identify any new offsite land use information that would alter this conclusion.

3.2.3.3 Visual Resources

The visual appearance of the most visible CPS structures and associated transmission lines has been consistent throughout the plant's operational life and is not likely to change during the LR term. The NRC staff concludes that the visual impact of continued nuclear power plant operations at CPS during the LR term would be SMALL because the visual appearance of nuclear power plant structures, transmission lines, and vapor plume from the cooling towers would not change appreciably. In addition, the NRC staff did not identify any new information during the environmental review that would alter this conclusion.

3.2.4 No-Action Alternative

3.2.4.1 Land Use

Under the no-action alternative, the NRC would not renew the CPS operating license, and reactor power generating operations would cease on or before the expiration of the current

operating license. However, maintenance activities (e.g., maintaining, inspecting, and testing plant equipment) would continue before and after the expiration of the license. Decommissioning activities would begin after the expiration of the license. Under this alternative, existing onsite land uses would continue during the remaining period of operation under the current license. Plant structures and other facilities would remain in place until decommissioning. Transmission lines and rights-of-way (ROWs) would remain in place after the cessation of reactor operations. Based on this information, the NRC staff concludes that land use impacts under the no-action alternative would be SMALL.

3.2.4.2 Visual Resources

Termination of reactor operations because of the nonrenewal of the operating license under the no-action alternative would not immediately change the visual appearance of the CPS site. The most visible structures are the reactor containment dome, turbine building, and meteorological and microwave towers; these structures would likely remain in place for some time during decommissioning until they are eventually dismantled. There would be no further operational impacts such as the vapor plumes associated with the cooling towers. As a result, the NRC staff concludes that visual resource impacts from the no-action alternative would be SMALL.

3.2.5 Replacement Power Alternatives: Common Impacts

3.2.5.1 Land Use

Land use impacts are determined by the change in use and the amount of land affected by the construction and operation of a replacement power generating facility, infrastructure, and other installations. Table 3-5 below summarizes land use impacts of the replacement power alternatives.

Table 3-5 Land Use Impacts of Replacement Power Alternatives for Clinton Power Station

Alternative	Resource Requirements	Impacts	Discussion
Natural Gas Alternative	54 ac at the CPS site	SMALL	Construction and operations activities would be limited to the CPS site; little to no additional land would be needed for new infrastructure. The nearest natural gas pipeline is the Gulf Coast Natural Gas Pipeline, requiring a 16 mi extension.
Renewable and Natural Gas Combination Alternative	NGCC: 35 ac at the CPS site Solar: approximately 1,620 ac at multiple onsite and offsite locations (if needed) Wind: approximately 1,610 ac onsite	LARGE	Construction and operations activities of NGCC, some solar and wind installations would be limited to the CPS site. Offsite land may be needed for additional solar installations and transmission lines.

Table 3-5 Land Use Impacts of Replacement Power Alternatives for Clinton Power Station (Continued)

Alternative	Resource Requirements	Impacts	Discussion
Purchased Power Alternative	Power would be purchased from existing energy generating facilities.	SMALL	No change in land use since power would be purchased and imported from existing operating energy facilities.

CPS = Clinton Power Station; NGCC = natural gas combined cycle.

3.2.5.2 Visual Resources

Visual impacts are determined by the degree of contrast between the replacement power generating facility and surrounding landscapes.

Construction

Installation of power generating facilities and support structures at existing power plant sites would be consistent with visual appearance of the industrial site. Construction of a replacement power generating facility may require clearing, excavation, and the use of construction equipment. Temporary visual impacts may occur if cranes and other construction equipment are in use. Visual impacts would be minimal if new facilities are constructed at the CPS site. However, new solar and wind turbine installations could result in visual impacts. As such, the NRC staff concludes that natural gas installation would have a SMALL visual impact and the renewable and natural gas combination alternative, involving the installation of solar and wind energy facilities and associated transmission infrastructure, would have a MODERATE TO LARGE visual impact. Visual impacts of purchased power from existing operating energy generating facilities would be SMALL.

Operations

Visual impacts during operation of any of the replacement power generating facilities would be similar. Wind turbines and solar panels depending on their heights, could be seen from a distance, depending on screening vegetation. New transmission lines would be visible, unless screened. Vapor plumes from MDCTs would be noticeable and would be visible from a distance. Aircraft warning lights on power plant stacks, towers, or wind turbines would be visible at night. The NRC staff concludes that operations of replacement power facilities would have a SMALL visual impact.

3.3 Meteorology, Air Quality, and Noise

3.3.1 Meteorology and Climatology

The climate in the State of Illinois is continental, characterized by cold winters and warm summers. The lack of mountains to the north and south result in the movement of cold air masses from the Artic in the winter and humid air masses from the Gulf of Mexico in the summer (Frankson et al. 2022-TN11050). During fall, winter, and spring, the polar jet stream is located near or over northeastern Illinois, which causes large-scale synoptic storms to move through the area bringing precipitation, winds, and often dramatic temperature changes (ISC 2024-TN10952). Temperature and precipitation conditions vary widely throughout Illinois with a noticeable north-south contrast. Annual average temperature difference ranges 10°F (5.6°C) across north to south. Average precipitation ranges

from 50 inches (in.) (1.27 m) a year in the south part of the State to 35 in. (0.89 m) in the north part of the State (Frankson et al. 2022-TN11050).

CEG maintains a meteorological monitoring system comprising of a primary meteorological tower and backup meteorological tower that are located onsite. CPS' meteorological monitoring system measures temperature, wind speed, wind direction, dew point, and precipitation. In its ER, CEG provided meteorological observations (temperature, wind conditions, and precipitation) from the meteorological system for the 2005–2021 period (CEG 2024-TN10806). The NRC staff obtained meteorological observations from the Springfield, Illinois weather station. The station is approximately 50 mi (80 km) from CPS and used to characterize the region's climate because of its relative location and long period of record.

The mean annual temperature from CPS' onsite meteorological tower for the 2005–2021 period is 53°F (11.7°C) with a mean monthly temperature ranging from a low of 27.1°F (-2.7°C) in January and high of 75.2°F (24°C) in July. The mean annual temperature from Springfield's weather station for the 1901–2022 period is 53.3°F (11.8°C) with a mean monthly temperature ranging from a low of 27.0°F (-2.8°C) in January to a high of 77.1°F (25.1°C) in July (NCEI 2022-TN10953). The mean total precipitation from CPS' onsite meteorological tower for the 2005–2021 period is 40.4 in. (1.02 m), with a mean monthly precipitation ranging from 1.96 in. (5.0 centimeters [cm]) in February to 4.65 in. (11.8 cm) in May. The mean total precipitation from Springfield's weather station for the 1901–2022 period is 35.7 in. (90.7 cm), with a mean monthly precipitation ranging from 1.79 in. (4.5 cm) in February to 4.10 in. (10.4 cm) in June (NCEI 2022-TN10953). The mean annual wind speed from CPS' onsite meteorological tower is 8.4 miles per hour (5.3 kilometers per hour) with a prevailing wind direction from the south. The mean annual wind speed from Springfield, Illinois' weather station for the 1984–2022 period is 9.3 miles per hour (5.8 kilometers per hour) with a prevailing wind direction from the south (NCEI 2022-TN10953).

DeWitt County experiences severe weather, particularly thunderstorms. Thunderstorms are common during summer months and accompanied by heavy showers. The average year has about 50 thunderstorms of which two-thirds occur during the months of May through August (NCEI 2022-TN10953).

3.3.2 Air Quality

The EPA has set primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50-TN1089) for six common criteria pollutants to protect sensitive populations and the environment. The NAAQS criteria pollutants include carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM). Particulate matter is further categorized by size—PM_{10} (diameter of 10 micrometers [µm] or less) and $PM_{2.5}$ (diameter of 2.5 µm or less).

The EPA designates areas of attainment and nonattainment with respect to meeting NAAQS. Areas for which there are insufficient data to determine attainment or nonattainment are designated as unclassifiable. Areas that were once in nonattainment, but are now in attainment, are called maintenance areas; these areas are under a 10-year monitoring plan to maintain their attainment designation status. States have primary responsibility for ensuring attainment and maintenance of the NAAQS. Under Clean Air Act (CAA) Section 110 (42 U.S.C. 7410-TN1141) and related provisions, States are to submit, for EPA approval, State implementation plans that provide for the timely attainment and maintenance of the NAAQS.

In Illinois, air quality designations are made at the county level. For the purpose of planning and maintaining ambient air quality with respect to the NAAQS, the EPA has developed air quality control regions (AQCRs). AQCRs are intra-State or inter-State areas that share a common airshed. CPS is located in DeWitt County, which is part of the East Central Illinois Intrastate AQCR (40 CFR Part 81.263-TN7226). With respect to NAAQS, the EPA designated DeWitt County in attainment for all NAAQS (EPA 2024-TN10954).

The Illinois Environmental Protection Agency (IEPA) regulates air emissions at CPS under a federally enforceable State operating permit (FESOP) (FESOP Number 039804AAC). The air permit expired April 18, 2024; however, CEG submitted a FESOP renewal application to IEPA on April 10, 2024 (CEG 2024-TN10914). CPS' FESOP is administratively extended and remains in effect (CEG 2024-TN10914). CPS' permit renewal application did not request additional sources be added to its FESOP permit (CEG 2024-TN10914). CPS' permitted air emissions are listed in Table 3-6 below.

Table 3-6 Permitted Air Emission Sources at Clinton Power Station

Equipment	Permit Conditions
Five diesel powered generators (2,305 hp, 2,305 hp, 3,070 hp, 3,070 hp and 3,070 hp)	May burn distillate fuel oil only containing no more than 0.28% by weight sulfur. Distillate fuel usage limited to 26,390 gallons/month and 211,125 gallons per year. Carbon monoxide limited to 12.56 tons/year. Nitrogen oxides limited to 47.29 tons/year. Particulate matter limited to 1.48 tons/year. Sulfur dioxide limited to 4.18 tons/year. Volatile organic matter limited to 1.21 tons/year.
Diesel powered generating set (755 hp)	May burn distillate fuel oil only containing no more than 0.05% by weight sulfur. Distillate fuel usage limited to 2,175 gallons/month and 17,400 gallons per year. Carbon monoxide limited to 1.04 tons/year. Nitrogen oxides limited to 1.87 tons/year. Particulate matter limited to 0.01 tons/year. Sulfur dioxide limited to 0.06 tons/year. Volatile organic matter limited to 0.10 tons/year.
Three diesel-power fire pumps (380 hp, 340 hp, 240 hp), diesel-powered generating set (255 hp, 68 hp, 47 hp), and small generator	May burn distillate fuel oil only containing no more than 0.28% by weight sulfur. Distillate fuel usage limited to 4,009 gallons/month and 32,075 gallons per year. Carbon monoxide limited to 2.13 tons/year. Nitrogen oxides limited to 9.90 tons/year. Particulate matter limited to 0.70 tons/year. Sulfur Dioxide limited to 0.65 tons/year. Volatile organic matter limited to 0.81 tons/year.
Gasoline above ground storage tank (1,500 gallons), used oil storage tanks (15,000 gallon and 2,000 gallons), oil separators (18,000 gallons and 13,000 gallons)	Volatile organic matter emissions limited to 0.1 lb./hr. and 0.44 tons/year.
Parts Washers	Volatile organic matter emission limited to 0.08 tons/month and 0.75 tons/year.

hp = horsepower; hr = hour.
Source: CEG 2024-TN10806.

Table 3-7 below presents annual air emissions for 2018 through 2023 for the permitted sources at CPS. The contributions of air emissions from permitted sources at CPS represent a fraction of DeWitt County's annual emissions. CEG reports that it has not received any notices of violation of noncompliance associated with CPS' air permit between 2018 and November 2024 (CEG 2024-TN10806 and CEG 2024-TN10914). The NRC staff reviewed the EPA's Enforcement and Compliance History Online website for 3 year (January 2022 through December 2024) compliance history for CPS and no violations were identified related to CPS' air permit (EPA 2024-TN10955).

Table 3-7 Annual Air Emissions from Permitted Sources at Clinton Power Station (tons per year)

	PM_{10}	$PM_{2.5}$	SO_2	NO_x	CO
2023	0.23	0.23	0.07	6.02	1.55
2022	0.22	0.22	0.04	6.4	1.67
2021	0.15	0.15	0.03	4.28	1.11
2020	0.28	0.28	0.08	8.25	2.16
2019	0.21	0.21	0.11	5.18	1.31
2018	0.26	0.26	0.09	7.19	1.87
DeWitt County 2020 Emissions (tons)	3,839	597	38	884	2,780

CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a mean aerodynamic diameter of 10 µm or less; $PM_{2.5}$ = particulate matter with a mean aerodynamic diameter of 2.5 µm or less; SO_2 = sulfur dioxide.
Sources: CEG 2024-TN10806, CEG 2024-TN10914, and EPA 2020-TN11059

In addition to the permitted sources listed above in Table 3-7, CPS uses mechanical cooling towers (a total of 46 cooling cells) that emit particulate matter. CEG estimates that operation of the cooling towers can emit up to 6.75 tons of particulate matter per year (CEG 2024-TN10914). Additionally, small amounts of ozone and substantially smaller amounts of nitrogen oxides are produced during corona, a phenomenon that occurs when air ionizes near isolated irregularities on the conductor surface of transmission lines. During corona, ozone is approximately 90 percent of the oxidants generated, and nitrogen oxides are approximately 10 percent (BLM 2010-TN9626). CEG has not conducted field tests of ozone or nitrogen oxide emissions generated by CPS' 138 kV and 345 kV in-scope transmission lines. However, field studies have shown that high voltage lines up to 765 kV do not generate emissions above ambient measurements (Lee et al. 1989-TN7481; TVA 2013-TN7899; NRC 2015-TN5842).

The EPA promulgated the Regional Haze Rule to improve and protect visibility in national parks and wilderness areas from haze, which is caused by numerous, diverse air pollutant sources located across a broad region (40 CFR Part 51-TN1090). Specifically, 40 CFR Part 81, Subpart D, "Identification of Mandatory Class I Federal Areas Where Visibility Is an Important Value," lists mandatory Federal areas where visibility is an important value. The Regional Haze Rule requires States to develop State implementation plans to reduce visibility impairment at Class I Federal Areas. The are no Class I Federal Areas within 100 mi (160 km) of CPS. Therefore, the NRC staff concludes emissions from CPS would not adversely affect the air quality of Class I Federal Areas.

3.3.3 Noise

Noise is unwanted sound and can be generated by various sources. Sound intensity is measured in logarithmic units called decibels (dB). A dB is the ratio of the measured sound pressure level to a reference level equal to a normal person's threshold of hearing. Most people barely notice a difference of 3 dB or less. Another characteristic of sound is frequency or pitch. Noise may be composed of many frequencies, but the human ear does not hear very low or very high frequencies. To represent noise as closely as possible to the noise levels people experience, sounds are measured using a frequency-weighting scheme known as the A-scale. Sound levels measured on this A-scale are given in units of A-weighted decibels (dBA). Levels can become annoying at 80 dBA and very annoying at 90 dBA. To the human ear, each increase of 10 dBA sounds twice as loud (EPA 1981-TN7412).

Several different terms are commonly used to describe sounds that vary in intensity over time. The equivalent sound intensity level represents the average sound intensity level over a specified interval, often 1 hour. The day-night sound intensity level is a single value calculated from hourly equivalent sound intensity level during a 24-hour period, with the addition of 10 dBA to sound levels from 10 p.m. to 7 a.m. This addition accounts for the greater sensitivity of most people to nighttime noise. Statistical sound level is the sound level that is exceeded n percent of the time during a given period. For example, L90 is the sound level exceeded 90 percent of the time and is considered the background level.

The State of Illinois has noise regulations that stipulate allowable daytime and nighttime octave band sound pressure levels (dB) emitted from a property line source to any receiving land (IAC 35-TN11236: Part 901). The IEPA, however, no longer runs a noise pollution program and no longer investigates alleged noise pollution (IPCB 2015-TN11211). However, a formal noise complaint can be filed with the Illinois Pollution Control Board (IPCB 2015-TN11211).

Primary offsite noise sources in the immediate vicinity of CPS include traffic and agricultural equipment. The nearest resident is approximately 0.74 mi (1.2 km) southwest of CPS (measured from the HVAC vent stack). Primary noise sources at CPS include cooling towers and the turbine building (CEG 2024-TN10806).

CEG monitors noise at CPS on an as-needed basis and has procedures in place that provide personnel with regulatory requirements related to the Noise Control Act of 1972 (42 USC 4901-TN4294), and noise control regulations in 40 CFR 201-211 (TN7030). When a noise complaint is received, it is documented in accordance with CEG's Corrective Action Program procedures. From 2018 to September 26, 2024 (at the time of the NRC staff's site audit), there was one noise complaint from a resident in August 2021 documented in CEG's internal tracking system. In 2019, while there were no documented noise complaints in CEG's internal tracking system, site representatives were aware that there were concerns from residents related to operation of the cooling towers (which were installed in 2018 and 2019). The CPS site representatives met with residents and the County Board representatives to hear and address concerns related to operation of the cooling towers. In response to the noise concerns, CEG developed a sound mitigation plan that consisted of installing sound baffles on top of the cooling towers and the planting of trees near the towers to serve as a sound barrier. CEG presented the mitigation plan to residents and the County Board during a meeting and CEG reported that the residents and the County Board representative were satisfied with the mitigation plan (CEG 2024-TN10914). In May and June of 2019, sound baffles were installed and trees were planted. CEG commissioned noise monitoring around the cooling towers before and after baffle installation. Sound levels taken after baffle installation showed a reduction of 1 to 6 dBA. In August 2021, a

resident located approximately 1.4 mi (2.3 km) of the cooling towers, submitted a noise complaint related to the cooling towers. In response to this complaint, CEG took sound readings along the cooling tower trains and recorded a maximum reading of 83 dBA (CEG 2024-TN10914). For every doubling of distance from the sound source, sound pressure levels decreased by 6 dBA. Therefore, given the distance of the resident from the cooling tower (1.4 mi [2.3 km]), the NRC staff estimates a noticeable decrease in the sound pressure levels at the residence from those measured along the cooling tower trains.

3.3.4 Proposed Action

3.3.4.1 Air Quality

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for the two generic issues related to air quality, the impacts of the nuclear power plant LR and continued operations would be SMALL. The NRC staff's review did not identify any new and significant information related to air quality that would change the conclusion in the LR GEIS. Thus, as concluded in Section 4.3.1.2.1 of the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation of CPS on air quality would be SMALL. There are no plant-specific (Category 2) air quality issues applicable to CPS.

3.3.4.2 Noise

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for the generic issue related to noise, the impacts of a nuclear power plant LR and continued operations would be SMALL. The NRC staff's review did not identify any new and significant information related to noise that would change the conclusion in the LR GEIS. CEG does not anticipate future upgrades or replacement activities during the LR term to support plant operation that could introduce new noise sources or increases in sound levels. Thus, as concluded in the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation of CPS on noise would be SMALL. There are no plant-specific (Category 2) noise issues applicable to CPS.

3.3.5 No-Action Alternative

3.3.5.1 Air Quality

Under the no-action alternative, the permanent cessation of CPS operations would reduce overall air emissions (e.g., diesel generators and vehicle traffic). Therefore, the NRC staff concludes that if emissions decrease, the impact on air quality from the shutdown of CPS would be SMALL.

3.3.5.2 Noise

The permanent cessation of CPS operations would result in a reduction in noise from the cooling towers and turbine. As site activities are reduced, the NRC staff expects the impact on ambient noise levels to be less than current plant operations; therefore, the NRC staff concludes that impacts on noise levels from the no-action alternative would be SMALL.

3.3.6 Replacement Power Alternatives: Common Impacts

3.3.6.1 Air Quality

Construction

Construction of a replacement power alternative would result in temporary impacts on local air quality. Air emissions include criteria air pollutants (e.g., PM, NO_x, CO, and SO_2), volatile organic compounds, hazardous air pollutants, and GHGs. Air emissions would be intermittent and would vary based on the level and duration of specific activities throughout the construction phase. During the construction phase, the primary sources of air emissions would consist of engine exhaust and fugitive dust emissions. Engine exhaust emissions would be from heavy construction equipment and commuter, delivery, and support vehicular traffic traveling to and from the facility as well as within the site. Fugitive dust emissions would be from soil disturbances by heavy construction equipment (e.g., earthmoving, excavating, and bulldozing), vehicle traffic on unpaved surfaces, concrete batch plant operations, and, to a lesser extent, wind erosion. Various mitigation techniques and best management practices (BMPs) (e.g., watering disturbed areas, reducing equipment idle times, and using ultra-low sulfur diesel fuel) could be used to minimize air emissions and to reduce fugitive dust.

Operations

The impacts on air quality from operation of a facility for a replacement power alternative would depend on the energy technology (e.g., natural gas or renewable). Worker vehicles, auxiliary power equipment, and mechanical cooling towers would result in air emissions.

3.3.6.2 Noise

Construction

Construction of a replacement power facility would be similar to the construction of any industrial facility in that they all involve many noise-generating activities. In general, noise emissions would vary during each phase of construction, depending on the level of activity, types of equipment and machinery used, and site-specific conditions. Typical construction equipment, such as dump trucks, loaders, bulldozers, graders, scrapers, air compressors, generators, and mobile cranes, would be used, and pile-driving and blasting activities could take place. Other noise sources include construction worker vehicle and truck delivery traffic. However, noise from vehicular traffic would be intermittent.

Operations

Noise generated during operations could include noise from transformers, MDCTs, turbines, equipment, speakers, as well as offsite sources, such as employee and delivery vehicular traffic. Noise from vehicles would be intermittent.

3.3.7 Natural Gas Alternative

3.3.7.1 Air Quality

For the natural gas alternative, air emissions and sources for construction would include those identified as common to all replacement power alternatives in Section 3.3.6.1. of this SEIS. The natural gas alternative would be located at the CPS site. Use of the existing infrastructure would be maximized, but a 16 mi (27 km) pipeline extension to supply gas to the

plant would be necessary. Overall, air emissions from construction of the natural gas alternative would be intermittent, short-term, and temporary.

Operation of a natural gas alternative would result in emissions of criteria pollutants. The NRC staff estimated air emissions for the natural gas alternative using emission factors developed by the DOE's National Energy Technology Laboratory (NETL 2022-TN10530). The NRC staff estimates the following annual air emissions would result from operation from of a natural gas alternative with a design capacity of 1,241 MWe (gross):

- carbon monoxide—65 tons (59 metric tons [MT])
- nitrogen oxides—119 tons (108 MT)
- sulfur dioxide—32 tons (30 MT)
- particulate matter—65 tons (59 MT)

Operation of MDCTs and worker vehicles would result in additional air emissions. A new natural gas alternative would need to secure a permit from the IEPA for air pollutants associated with its operation. The natural gas alternative would have the potential to emit 100 tons per year of a criteria air pollutant and would thus qualify as a major emitting industrial facility. As such, the new natural gas plant would be subject to Prevention of Significant Deterioration and Title V air permitting requirements under the Clean Air Act of 1970, as amended (42 U.S.C. 7661 et seq.-TN1141), to ensure that air emissions are minimized and that the local air quality is not degraded substantially. In comparing criteria air emissions from the proposed action to those of the natural gas alternative, emissions from the natural gas alternative are 1 to 2 orders of magnitude greater. Additionally, NO_x emissions from operation of a natural gas plant could be significant. Therefore, the NRC staff concludes that the overall air quality impacts associated with operation of a natural gas alternative would be MODERATE.

3.3.7.2 Noise

Noise generated during the construction and operation of a natural gas plant would be similar to noise for all replacement power alternatives as discussed in Section 3.3.6.2 of this SEIS. Noise impacts during construction would be limited to the immediate vicinity of the CPS site and along the corridor of the 16 mi (26 km) pipeline extension. Noise generated as a result of construction of a natural gas alternative at the CPS site would not be noticeable given the existing industrial setting, distance of noise-sensitive receptors from the site (approximately 0.74 mi [1.2 km]) and consideration of noise attenuation from the construction site. However, depending on the distance of noise sensitive receptors to the pipeline corridor, while short-term, noise may be noticeable during construction of the pipeline extension.

During operations, noise sources from a natural gas alternative would include those discussed in Section 3.3.6.2 of this SEIS, as well as offsite mechanical noise from compressor stations and pipeline blowdowns. Most of the noise-producing equipment (e.g., turbines, pumps, and MDCTs) would be located inside the power block. Since the natural gas alternative would be located at the CPS site, the NRC staff does not anticipate noise levels at noise-sensitive receptors to be significantly greater than currently or previously experienced from operation of CPS. The Federal Energy Regulatory Commission requires that any new compressor station, compression added to an existing station, or any modification, upgrade, or update of an existing station must not exceed day–night sound intensity level of 55 dBA at any pre-existing noise-sensitive area (18 CFR 25 157.206(b)(5)(i)-TN7483). As discussed in Section 3.3.3 of this SEIS, the State of Illinois has noise regulations that stipulate allowable daytime and nighttime

octave band sound pressure levels (dB) emitted from a property line source to any receiving land. Noise from pipeline blowdowns would constitute a new noise source. Depending on the distance of noise sensitive receptors to the pipeline corridor, noise from pipeline blowdowns may be noticeable. Therefore, the NRC staff concludes that the noise impacts from construction and operation of a natural gas alternative would be SMALL to MODERATE.

3.3.8 Renewable and Natural Gas Combination Alternative

3.3.8.1 Air Quality

Air emissions associated with construction of the natural gas portion of the combination alternative would be similar to those associated with the natural gas alternative discussed in Section 3.3.7.1 of this SEIS, given the design capacity of the natural gas portion, and that it would be located at the CPS site. Air emissions and sources for construction of the renewable portion of this alternative would include those identified as common to all replacement power alternatives in Section 3.3.6.1 of this SEIS. The solar and wind portions with battery storage would not have power block buildings. Accordingly, the number of heavy equipment and workforce, level of activities, and construction duration would be lower and consequently less air emissions would be generated. However, offsite installations of the solar portion would require construction of new transmission lines. Additionally, a significant amount of land would be required for installation for the wind and solar portions. This can result in noticeable particulate air emissions during the construction phase.

Air emissions associated with operation of the natural gas portion of the combination alternative would be similar, but less than, those associated with the natural gas alternative discussed in Section 3.3.7.1, since it would consist of a 1,000 MWe natural gas plant at the CPS site. The NRC staff estimated air emissions for the natural gas alternative using emission factors developed by the DOE's National Energy Technology Laboratory (NETL) (NETL 2022-TN10530). The NRC staff estimates the following annual air emissions would result from the operation of a natural gas component with a design capacity of 1,000 MWe (gross):

- carbon monoxide—53 tons (48 MT)
- nitrogen oxides—96 tons (87 MT)
- sulfur dioxide—26 tons (24 MT)
- particulate matter—53 tons (48 MT)

Operation of MDCTs and worker vehicles would result in additional air emissions. Direct air emissions associated with operation of the solar and wind portions with battery storage of this alternative are negligible because no fossil fuels are burned to generate electricity. Emissions would include fugitive dust and engine exhaust from worker vehicles and heavy equipment associated with site inspections, maintenance activities, and wind erosion from cleared lands and access roads. Emissions would be localized and intermittent.

In comparing criteria air emissions from the proposed action to those of the renewable and natural gas combination alternative, emissions from the renewable and natural gas combination alternative are 1 to 2 orders of magnitude greater. Therefore, NRC staff concludes that the overall air quality impacts associated with operation the combination alternative would be MODERATE.

3.3.8.2 Noise

Construction-related noise sources for the natural gas portion of the combination alternative would be similar to the natural gas alternative discussed in Section 3.3.7.2 of this SEIS. The solar and wind with battery portions of this alternative would have no power block buildings requiring construction. The number of heavy equipment and workforce involved, level of activities, and construction duration would be lower compared to that of other alternatives. However, noise levels generated by construction activities of a solar facility can range from 70 to 80 dBA at 50 ft (15 m) (BLM 2019-TN8386). Blasting may be required during construction for turbine foundations (WAPA/FWS 2015-TN8725; BLM 2013-TN8882). Depending on the distance from the site and associated transmission lines corridor to nearby receptors, noise levels may be noticeable during construction of the offsite (not located at the CPS site) solar component

Operation-related noise sources for the natural gas portion of the combination alternative would be similar to the natural gas alternative discussed in Section 3.3.7.2 of this SEIS. Noise generated by wind turbines would include aerodynamic noise from the blades and mechanical noise from turbine drivetrain components (generator and gearbox). Depending on the location, layout, and proximity of wind turbines to noise sensitive receptors, noise associated with operation of the wind portion of the combination alternative could be noticeable. Because the solar with battery storage portion of this alternative would have no power block or cooling towers, a minimal number of noise sources, such as transformers and vehicular traffic, would be associated with maintenance and inspection activities.

Given that noise levels may be noticeable during construction of the offsite solar component and noise levels may be noticeable during operation of wind turbines, the NRC staff concludes that the overall noise impacts associated with the renewable and natural gas combination alternative would be SMALL to MODERATE.

3.3.9 Purchased Power Alternative

3.3.9.1 Air Quality

As discussed in Chapter 2, the purchased power alternative would consist of the importation of power from multiple existing operating energy generating sources. Therefore, this alternative would not require construction of new facilities. However, air emissions could result from necessary modifications or upgrades at existing facilities to support additional generation. Activities to support modifications would be short-term and therefore air quality impacts would be temporary and not significant.

The purchased power alternative would consist of importation of power into the service area from multiple energy sources (e.g., nuclear, natural gas-fire, solar, and wind energy). Using the 2023 EIA State of Illinois electricity mix profile emission factors and CPS' 2023 generation (8,101,628 megawatt-hours), the NRC staff estimates the following annual emissions:

- sulfur dioxide—1,620 tons (1,490 MT)
- nitrogen oxides—810 tons (730 MT)
- carbon dioxide—2,114,520 tons (1,917,870 MT)

Illinois' Public Act 102-0062 (Climate and Equitable Jobs Act of 2021-TN11284) commits to reduce GHG emissions and co-pollutant emissions to zero from electricity generating units by

2045. PA 102-0662 expands Illinois' Renewable Portfolio Standard. Therefore, the estimated emissions presented above are bounding in that it considers a mix of energy sources, which include fossil fuel energy sources that would be phased out. As fossil fuel energy sources are phased out in accordance with PA 102-0662 and power generation from renewable energy sources increases, emissions would decrease over time.

Given the initial potential significant increase (three orders of magnitude) in emissions from purchased power, the NRC staff concludes that air quality impacts from purchased power would be SMALL to LARGE.

3.3.9.2 Noise

There would be no construction of new facilities associated with purchased power since all the power would come from existing operating energy generating sources using existing transmission lines. However, additional noise sources can result from necessary modifications at existing facilities to support additional generation. Any additional noise, however, would be limited to the site and be temporary. No additional noise generation would result from operation of existing facilities. Therefore, purchased power from existing energy generating facilities would not have noticeable noise impacts and the impacts would be SMALL.

3.4 Geologic Environment

This section summarizes descriptive information related to the geologic environment of the CPS site and vicinity as provided in Section 3.5 of CEG's ER (CEG 2024-TN10806). The descriptive information addresses regional geology and physiography, site geology, geologic resources, soils, and seismic setting and history. The analysis by NRC staff related to evaluation of potential environmental impacts on geology and soils from the proposed action (i.e., CPS LR) and alternatives to the proposed action follows this information summary.

3.4.1 Regional Geology and Physiography

The CPS site is located in eastern Illinois within the Central Lowlands physiographic province, which covers approximately 585,000 square miles (mi^2) (1,520,000 square kilometers [km^2]). The site specifically lies in the Bloomington Ridged Plain sector of the Till Plains section of that province. The CPS area consists of a gently rolling upland developed on glacial deposits dissected by the Salt Creek and the North Fork of Salt Creek. Topographic relief varies from approximately 10 ft (3 m) on the upland to a maximum of about 80 ft (24 m) between the upland and the valley bottoms.

The Central Lowlands region was subjected to repeated Pleistocene (2.58 to 0.012 million years ago [Ma]) glaciations and is characterized by a low-relief surface formed by glacial deposits consisting of alluvial outwash, windblown loess, lakebed clays and silts, and ice-deposited tills (CEG 2024-TN10806). The glacial deposits are Quaternary in age (2.58 Ma to present) and estimated to be 170 to 360 ft (50 to 110 m) thick at the CPS site and up to about 250 ft (76 m) in the site region. The Quaternary glacial deposits overlie gently dipping Paleozoic age (541.0 to 251.9 Ma spanning the Cambrian through the Permian Periods) sandstones, shales, limestones, conglomerates, and coals. In southeastern Illinois, the deepest part of the Illinois Basin, the Paleozoic sedimentary rock units are 12,000 to 14,000 ft (3,700 to 4,300 m) thick. Precambrian age (> 541.0 Ma) igneous and metamorphic basement rocks underlie the Paleozoic units (CEG 2024-TN10806).

The Central Lowlands physiographic province lies in a tectonically stable area of the North American continent that has generally remained stable since the end of the Paleozoic. The Paleozoic sedimentary units are gently dipping at the site because CPS is located on the northwestern flank of the Illinois Basin that formed during the Paleozoic due to intermittent slow subsidence and gentle uplift. The Illinois Basin underlies about 70 percent of Illinois and is one of several broad regional basins separated by intervening broad arches. Locally, folds and faults have been superimposed on this broad fold pattern. The north-south trending LaSalle Anticlinal Belt lies east of CPS. The belt extends more than 200 mi (300 km) across Illinois and is about 15 to 20 mi (24 to 30 km) from the site at its closest point (CEG 2024-TN10806).

3.4.2 Site Geology

The main station of CPS lies in the uplands where the terrain is characterized by gently rolling, low-relief topography with an average ground surface elevation of about 740 ft (230 m) above mean sea level (MSL) (CEG 2024-TN10806). General stratigraphy underlying CPS consists of overburden deposits about 260 ft (190 m) thick overlying Pennsylvanian age (323.2 to 298.9 Ma) sedimentary bedrock units. Hydrogeologic system units at the CPS are indicated in Table 3-8. The structures for CPS sit atop structural backfill placed in Wisconsinan glacial till of the Wedron Formation, which is underlain by glacial till of the Glasford Formation. The Wedron and Glasford tills are separated by a thin layer of silt, and the Glasford till is divided into an upper weathered layer and lower unaltered layer. The Banner Formation overlies the erosional Pennsylvanian bedrock surface, with an average elevation beneath CPS of 550 ft (170 m) above MSL (CEG 2024-TN10806) and beneath the power block area of 490–510 ft (150–155 m) above MSL (Constellation 2022-TN8102). The Pennsylvanian sequence includes laterally persistent limestone and coal units. Although limestone occurs at depth beneath the site, there is no known karst development at the CPS site or in the site vicinity. Precambrian crystalline basement rocks beneath CPS are estimated to be at a depth of about 6,700 ft (2,000 m) below ground surface at an elevation of approximately -6,000 ft (-2,000 m) below MSL. Table 3-8 provides a brief description of the stratigraphic units at the CPS main station area.

Table 3-8 Summary of the Geologic Units at Clinton Power Station

Stratigraphic Unit	Description	Hydrogeologic System	Approximate Elevation Range (ft MSL)	Notes
Richland Loess	Clayey-silt	-	740–730	Variably eroded
Wedron Formation	Clayey sandy silt till with lenses of silt, sand, and gravel	Wisconsinan Deposits	730–698	Continuous fine sand layer exposed in power block excavation at approximately 725 ft MSL
Robien Silt	Silt with trace clay and fine sand	Illinoian Deposits	698–695	-
Weathered Glasford Formation	Glacial Till of silty clay and clayey silt with lenses of silts, sands, or sandy silts	Illinoian Deposits	695–685	Discontinuous lenses of sand present near the contact between the weathered and unaltered Glasford Formation

Table 3-8 Summary of the Geologic Units at Clinton Power Station (Continued)

Stratigraphic Unit	Description	Hydrogeologic System	Approximate Elevation Range (ft MSL)	Notes
Unaltered Glasford Formation	Sandy silty till with lenses of silt, gravel and sand.	Illinoian Deposits	685–570	Base of screen house and reactor buildings terminate in this unit
Banner Formation	-	Kansan Deposits (also referred to as Pre-Illinoian Till)	570–480	Contains buried outwash deposits of Mahomet Valley where present
Varied Formations (Bond, Modesto, Carbondale, Spoon, and Abbott)	Shale with thin beds of limestone, sandstone, siltstone, underclay, and coal	Pennsylvanian Bedrock	510–360	Deepest investigative boreholes on site terminated in the Pennsylvanian bedrock

MSL = mean sea level.
"-" denotes no data in table cell.
Source: Constellation 2022-TN8102.

3.4.3 Geologic Resources

The CEG ER notes that geologic resources in Illinois include coal, oil, natural gas, and industrial materials (sand, gravel, and sandstone). The U.S. Geological Survey (USGS) lists the following non-fuel commodities for Illinois: cement, magnesium compounds, sand and gravel for construction and industrial use, and crushed stone (USGS 2023-TN10591). There are two oil fields located in the vicinity of CPS. The Wapella East field is located 6 mi (9.7 km) to the northwest, and the Parnell field is located 7 mi (10 km) to the northeast (CEG 2024-TN10806). Five gas storage projects are also located within 35 mi (56 km) of the CPS site. There have been no reported instances of uplift, subsidence, or collapse associated with these gas storage projects. Sand and gravel have been produced on the CPS site using surficial mining operations (CEG 2024-TN10806).

3.4.4 Soils

Natural soils and weathered rock material across the CPS site were graded and disturbed during plant construction. Where soils are present and undisturbed in the CPS site boundary, mapping by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) shows they consist primarily of silt and loam from parent materials of glacial deposits. The largest contributions are from the Birbeck silt loam, which formed on slopes of 2–5 percent and is prime farmland; the Senachwine silt loam, which formed on slopes of 18–35 percent not prime farmland; and the Russel silt loam, Bloomington Ridged Plain, which formed on slopes of 5–10 percent and is farmland of statewide importance (USDA 2024-TN11020). These soil units comprise about 15, 10 and 7 percent of the area of interest, respectively. Water comprises about 32 percent of the area of interest and the remaining 36 percent of the area consists of silts, silt loams, and loams (USDA 2024-TN11020).

The NRCS rates the soils on the CPS site as somewhat to very limited for site development with shallow excavations (USDA 2024-TN11020). The erosion potential of the soils varies from slight

to very severe as rated by the NRCS. Soils at low slope angles (0–2 percent) are generally considered to have slight erosion potential and comprise about 10 percent of the area of interest. Steep slopes of 18–60 percent are generally considered to have very severe erosion potential, such as the Senachwine silt loam, which formed on slopes of 18 to 35 percent. About 14 percent of the CPS site has soils at very severe risk of erosion. Soils on slopes from 2–20 percent vary in their erosion potential from moderate to severe. Soils with moderate erosion potential comprise about 35 percent of the area of interest such as the Birbeck silt loam, which formed on slopes of 2–5 percent, and the Russel silt loam, Bloomington Ridged Plain, which form on slopes of 5–10 percent. Soils with severe erosion potential comprise about 5 percent of the area of interest (USDA 2024-TN11020). Stabilization measures are in place at CPS and BMPs are implemented and maintained as part of a stormwater pollution prevention plan (SWPPP). The use of BMPs is evaluated annually based on inspections (CEG 2024-TN10806).

3.4.5 Seismic Setting and History

The CPS site and most of the area within a 200 mi (322 km) radius lie within the Central Stable Region of the North American continent that is generally characterized by a lack of significant seismic activity. Illinois has two major seismic source zones: the Wabash Valley Seismic Zone in southeastern Illinois on the border with Indiana, and the New Madrid Seismic Zone at the southern border with Missouri and Kentucky (Marshak et al. 2016-TN10810). Figure 3.5-5 from the CEG's ER shows the locations of historic seismic events that occurred from 1970 to May 2023 (CEG 2024-TN10806). Between 1970 and August 9, 2024, 75 earthquakes with a magnitude greater than or equal to 3.0 have been recorded within 200 mi (322 km) of the CPS site (USDA 2024-TN11020). The largest earthquakes were two events with magnitudes of 5.2. The first occurred about 98 mi (160 km) southwest of CPS on June 10, 1987. The second occurred on April 18, 2008, about 114 mi (184 km) southwest of CPS.

No tectonic deformation features were observed in the Pleistocene deposits exposed in the excavations at the CPS site and no glacial deposits show evidence of lineaments or offsets that suggest faulting. No evidence exists for surface faulting at the CPS site or within 200 mi (322 km) of the site and no faults mapped in Illinois show evidence of Quaternary displacement (CEG 2024-TN10806). The nearest confirmed fault is the Sandwich Fault Zone, which is located approximately 90 mi (140 km) northeast of CPS. The last movement on that fault most likely occurred in the late Paleozoic (Exelon 2020-TN10993: Section 2.5).

Seismic hazard (i.e., peak ground acceleration) for a specific location due to shaking induced by an earthquake is expressed as a percentage of *g*, the gravitational acceleration near the Earth's surface, to assess the potential impact of the earthquake on engineered structures. Several factors, including the properties of rock and sedimentary materials through which the earthquake waves travel, as well as earthquake magnitude and location, control the level of ground shaking that can occur. Based on the 2023 seismic hazard maps published by the USGS, the CPS site is in an area with a predicted peak horizontal ground acceleration between 0.24 and 0.28 *g* for a 2 percent probability of exceedance in 50 years that indicates a return period of about 2,500 years (Petersen et al. 2023-TN11233). That acceleration corresponds to a Modified Mercalli Intensity level of VI for a 2 percent probability of exceedance in 50 years, indicating a very low risk for damaging ground shaking of intensity VI or greater in the next 50 years. Previous peak horizontal acceleration estimates and intensity levels for the site were 0.2–0.28 *g* and VI, respectively (Rukstales and Petersen 2019-TN7279).

The impacts of natural phenomena associated with geologic and seismic hazards on nuclear power plant systems, structures, and components are outside the scope of the NRC staff's LR environmental review. The CPS was originally sited, designed, and licensed with due consideration for applicable geologic and seismic criteria. Seismic issues at operating nuclear power plants are assessed as part of the NRC's ongoing regulatory oversight. Furthermore, the NRC requires all licensees to consider seismic activity to maintain safe operating conditions at all nuclear power plants. When new seismic hazard information becomes available, NRC staff evaluates that information to determine whether any changes are necessary at existing nuclear power plants. This reactor oversight process, which considers seismic safety, is separate and distinct from the NRC staff's LR environmental review.

3.4.6 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, the impacts of the CPS LR and the continued operation of CPS on the generic Category 1 issue related to geology and soils would be SMALL.

The LR GEIS did not identify any plant-specific Category 2 issues related to geology and soils that require consideration for LR of nuclear power plants, including CPS (NRC 2024-TN10161).

NRC staff independently reviewed applicable information for geology and soils in CEG's ER (CEG 2024-TN10806) and associated references therein, including the CPS Revision 21 to Updated Safety Analysis Report (Exelon 2020-TN10993: Chapter 2, Site Characteristics, Section 2.5); considered information discussed during site audits and the scoping process; and evaluated other sources of available information (e.g., USGS 2023-TN10591 for geologic resources and Petersen et al. 2023-TN11233 for seismic hazard maps). NRC staff did not identify any new and significant information related to geology and soils that would change the environmental impact finding stated in the LR GEIS with respect to the CPS LR. No significant impacts on geology and soils are anticipated during the LR term to implement the proposed action that would be different from those occurring during the current license term. Additionally, NRC staff did not identify any additional geology and soil issues beyond those listed in Table 3-1 of this SEIS that are applicable to the CPS LR.

3.4.7 No-Action Alternative

Under the no-action alternative, the NRC would not renew the CPS operating license. With the subsequent cessation of operations, there would be little or no incremental impacts on geology and soils onsite associated with closure of the CPS. Prior to initiation of decommissioning activities, little or no new ground disturbance would occur at the CPS site as operational activities are reduced and eventually cease. Any contamination of onsite geology or soils would be assessed during decommissioning, whether at the end of the current licensing period or at the end of the LR term. A license termination plan would describe any necessary actions needed for site-specific cleanup before release of the CPS site. As a result, NRC staff concludes that the impact of the no-action alternative on geology and soils would be SMALL.

3.4.8 Replacement Power Alternatives: Common Impacts

Construction

Construction activities associated with replacement power alternatives might result in temporary impacts on geology and soils if excavations for facility foundations or slope stabilization are necessary. Potential impacts would vary based on depth of excavations for impacts on geology

and acreage of the area disturbed for impacts on soils. NRC staff anticipates that aggregate materials (e.g., crushed stone, riprap, sand, and gravel) needed to construct buildings, foundations, roads, parking lots, pad sites, transmission lines, and other supporting infrastructure would be obtained from local suppliers. Therefore, NRC staff concludes that any impacts from construction of replacement power alternatives on geology and soils would be localized and short in duration. Potential impacts would be avoided or mitigated by implementation of BMPs and Federal, State, and local permitting requirements.

Operations

NRC staff anticipates that only negligible amounts of aggregate materials or topsoil would be needed for maintenance purposes during normal operation of the replacement power alternatives Therefore, NRC staff concludes that operational activities associated with the replacement power alternatives would not result in detrimental impacts on geology and soils because there would be only minor effects on geology and soils during normal operation of the alternatives.

3.4.9 Natural Gas Alternative

The impacts on geologic and soil resources from construction and operations associated with the natural gas alternative are expected to be similar to those described and assumed as being common to all alternatives described in Section 3.4.8 of this SEIS. According to CEG's ER, the NGCC plant would be constructed on the CPS site (CEG 2024-TN10806). The NRC staff estimated the land use requirements for the NGCC plant as noted in Section 3.2.5.1 of this SEIS, MDCTs, and associated structures including but not limited to support structures and exhaust stacks. Construction of a new 16 mi (26 km) pipeline extension would be necessary at CPS.

Implementation of the natural gas alternative would use existing transportation and transmission line infrastructure, which would reduce construction impacts and related impacts on site geology and soils, as well as consumption of geologic resources. Disturbance of geologic strata and soil erosion and loss under this alternative would generally be localized to the construction sites, and offsite soil erosion impacts would be mitigated by using BMPs in accordance with applicable State and local permitting requirements. Based on these considerations, the NRC staff concludes that the potential impacts on geology and soil resources from the NGCC would be SMALL.

3.4.10 Renewable and Natural Gas Combination Alternative

Under the renewable and natural gas combination alternative, the impacts on geologic and soil resources are expected to be similar to, but greater in overall magnitude, compared to those described and assumed to be common to all alternatives described in Section 3.4.8 of this SEIS, and greater than those under the natural gas alternative described in Section 3.4.9 of this SEIS. This greater potential for impacts is driven primarily by the substantial land area that would be disturbed onsite for new wind energy installations, on and offsite for new solar energy installations, transmission lines, and development of new transmission corridors, in addition to the impacts associated with the natural gas component of this alternative. Overall impacts would be driven by the potential for soil erosion and loss of natural soils and sediments from the conversion of land to industrial uses for the buildout of the solar and wind components of this alternative. NRC staff anticipates that potential soil erosion impacts would be mitigated by the implementation of BMPs in accordance with applicable State and local permitting requirements.

Based on these considerations, NRC staff concludes that potential impacts on geology and soil resources from the combination alternative could range from SMALL to MODERATE.

3.4.11 Purchased Power Alternative

As discussed in Section 2.3.2.3 of this SEIS, purchased power would likely come from the most common types of existing electric power generating technologies including nuclear, natural gas-fired, coal, solar, and wind energy. Long term sources of purchased power must be from renewable energy sources and would need to comply with the Illinois Power Agency Act (ICC 2022-TN10809). Purchased power may rely on older and less efficient power plants operating at higher levels of power generation than current operations.

If additional power generation-related construction activities are required, NRC staff expects impacts would be mainly on soils, temporary, and minimized by implementation of BMPs in accordance with applicable State and local permitting requirements. Therefore, NRC staff concludes that geology and soil impacts from the purchased power alternative would be SMALL.

3.5 Water Resources

This section describes surface water and groundwater resources at and around the CPS site. The description is followed by the NRC staff's analysis of the potential impacts of the proposed action (LR), and alternatives to the proposed action, on surface water and groundwater resources.

3.5.1 Surface Water Resources

3.5.1.1 Surface Water Hydrology

Surface water encompasses all water bodies that occur above the ground surface, including rivers, streams, lakes, ponds, and human-made reservoirs or impoundments.

3.5.1.1.1 Local and Regional Hydrology

The dominant hydrological feature of the CPS site is Clinton Lake (see Figure 3-1 of this SEIS). The 4,895 ac (1,981 ha) freshwater lake was created in 1978, with the primary purpose of providing cooling water to operate CPS (Exelon 2006-TN11232) (CEG 2024-TN10806). The watershed upstream of Clinton Lake drains 296 mi^2 (767 km^2) of predominately agricultural fields, with very little topographic relief. The CPS site is located between the two arms of Clinton Lake, which was formed by the impoundment of Salt Creek and the North Fork of Salt Creek behind an earthen dam, located 1,200 ft (365 m) downstream of the historical confluence of the two streams. The pool formed behind Clinton Lake Dam has a volume of 74,200 ac-foot (91,524,216 cubic meters [m^3]) at the normal pool level elevation of 690 ft (210 m) above MSL (Exelon 2020-TN10993). Figure 3-2 of this SEIS presents the Clinton Lake monthly average water level from 2009 to 2023 (USGS 2025-TN10991). The maximum, minimum and average monthly lake levels occurring from 2008 to 2022 are 691.6, 688.0, and 690.2 ft (210.7, 209.7, and 210.4 m) above MSL, respectively (CEG 2024-TN10806). The average depth of Clinton Lake is approximately 15 ft (4.6 m) with a maximum depth of 45 ft (13.7 m). Clinton Lake has a retention time of approximately 146 days (IEPA 2021-TN11237).

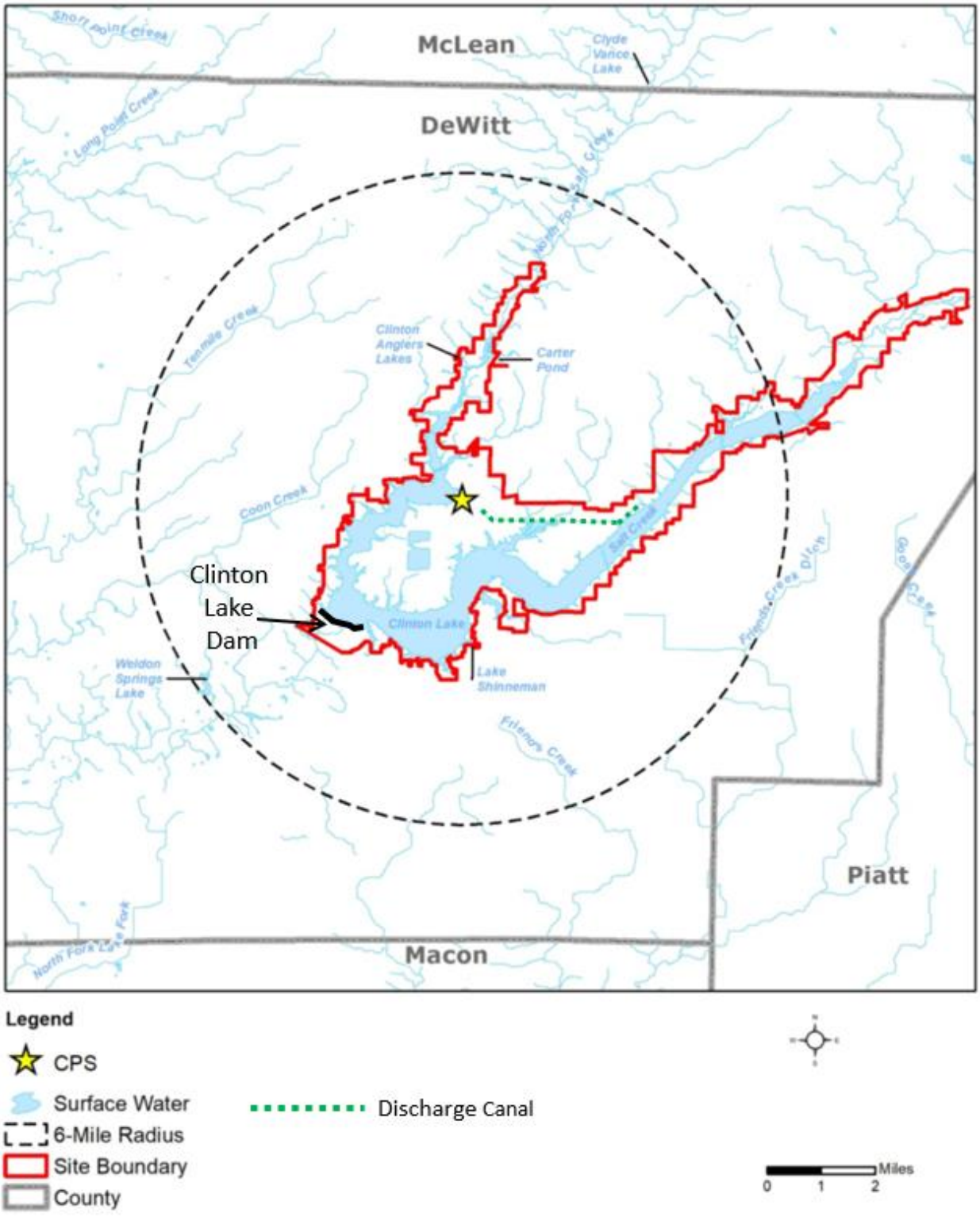

Figure 3-1 Major Surface Water Features Near the Clinton Power Station (CPS) Site. Adapted from: CEG 2024-TN10806.

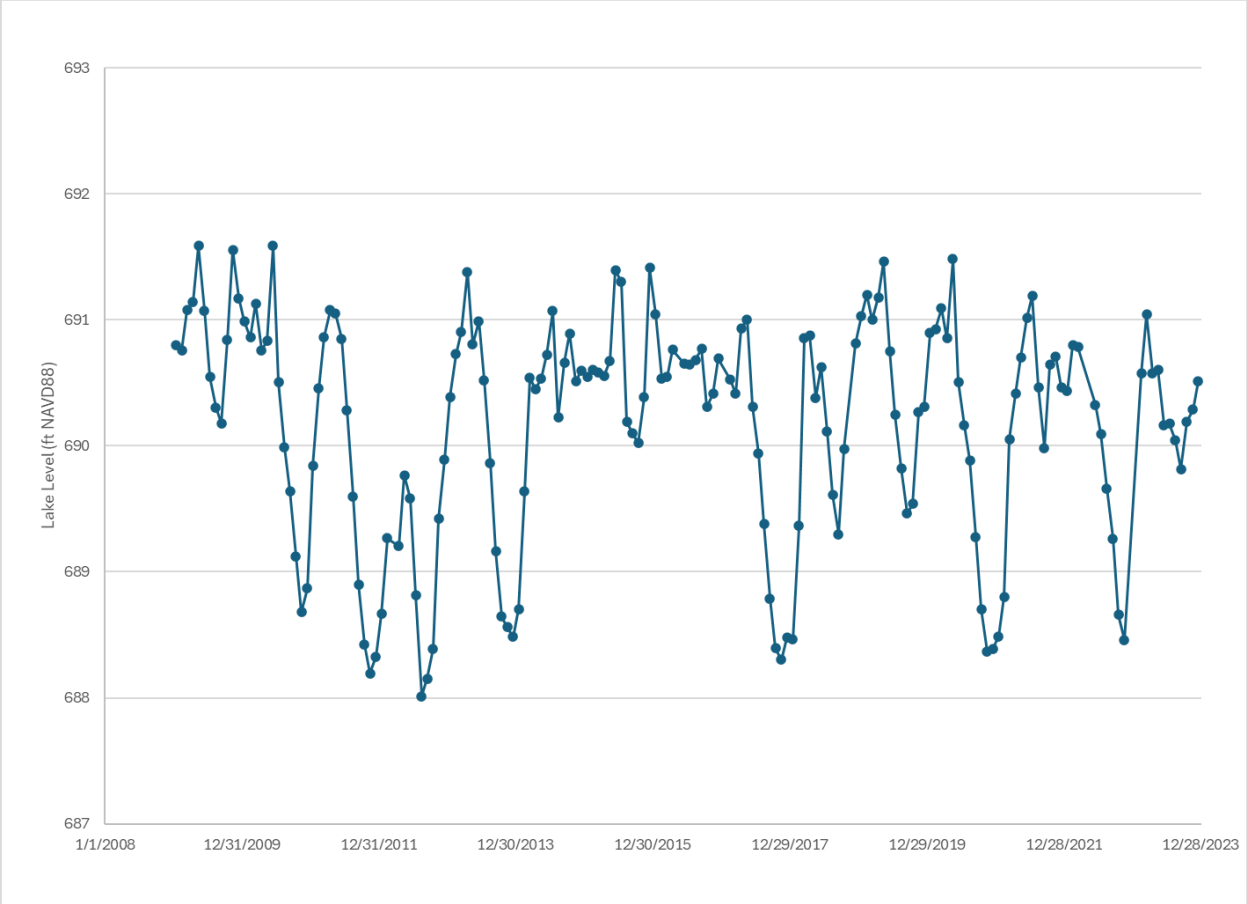

Figure 3-2 Monthly Average Clinton Lake Water Level (2009 to 2023) (USGS 2025-TN10991).

An auxiliary spillway is located on the east abutment of the Clinton Lake Dam to pass floods more severe than 100 year flood events, including the probable maximum flood (CEG 2024-TN10806). A discharge structure is located near the western abutment to provide a minimum downstream release of 5 cubic feet per second (cfs) (0.14 cubic meters per second [m^3/s]) (CEG 2024-TN10914). Water released from Clinton Lake Dam continues to flow downstream via Salt Creek until it joins the Sangamon River. CPS operates, inspects, and maintains Clinton Lake Dam and its associated infrastructure in accordance with approved plans, and the latest edition of the "Rules for Construction and Maintenance of Dams" adopted by the Illinois Department of Transportation (CEG 2024-TN10914).

CPS withdraws cooling water from the North Fork arm of Clinton Lake and discharges it to the Salt Creek arm of Clinton Lake through an unlined, earthen canal. When the inflow of water to the North Fork arm of Clinton Lake is less than the withdraw of water by the CPS cooling system, circulation of water between the inflow and outflow of CPS occurs. ER Figure 2.2-1 illustrates the CPS site water balance and is incorporated here by reference (CEG 2024-TN10806).

There is no commercial traffic on Clinton Lake, Salt Creek, or North Fork Creek. Clinton Lake is part of the Clinton Lake State Recreation Area, spanning approximately 9,300 ac (3,800 ha). The Clinton Lake State Recreation Area is completely owned by CEG and has been operated by the Illinois Department of Natural Resources (IDNR) since 1978 via a long-term lease with

CEG (CEG 2024-TN10806). Clinton Lake is used for recreational boating and fishing, and a marina is present to support said recreational uses. As discussed in Section 3.7.2.4 of the ER, approximately 5,000 ac (2,000 ha) of wetlands have been identified within a 6 mi (9.7 km) radius of CPS (CEG 2024-TN10806).

3.5.1.1.2 Flooding

In accordance with the NRC's general design criteria (Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 [TN249], "Domestic Licensing of Production and Utilization Facilities"), nuclear power plant structures, systems, and components important to safety must be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions.

Additionally, the NRC staff evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations through its Reactor Oversight Process, which is separate from the NRC's LR review process. If new information about changing environmental conditions becomes available, the NRC staff will evaluate the new information to determine if any safety-related changes are needed. The NRC staff also evaluates new information important to flood projections and independently confirms that a licensee's actions appropriately consider potential changes in flooding hazards at the site.

As shown in Figure 3-1 of this SEIS, the Federal Emergency Management Agency has delineated flood hazard areas in the vicinity of the CPS site. According to the Federal Emergency Management Agency's analysis, the CPS site, except for a small portion of the cooling water intake area located on the western edge of the protected area, is designated as Zone X (unshaded), which represents areas of minimal flood hazard. This area lies outside the 0.2 percent annual chance flood (500 year flood level). The probable maximum flood of Clinton Lake, when accounting for maximum wave runup elevation, is 711.8 ft (216.96 m). This level is well below the CPS finished plant grade of 736 ft (224.33 m), thus, a probable maximum flood event within the lake is not expected to impact CPS (Exelon 2020-TN10993).

3.5.1.2 Surface Water Use

Clinton Lake was constructed to provide water required to operate CPS (CEG 2024-TN10806) and was sized to support two units (NRC 2006-TN672). Withdrawals of surface water from Clinton Lake by CPS between 2018 and 2023 are summarized in Table 3-9 below. Withdrawals from 2018 to 2023 were relatively consistent, at an average monthly withdrawal rate of 23,012 million gallons per month (MGM) (87,109 million liters per month). Per the State of Illinois Water Use Act of 1983, CPS does not have an explicit annual limit on water withdrawals from Clinton Lake (CEG 2024-TN10914). However, the State of Illinois mandates annual reporting of withdrawals at or exceeding 70 gallons per minute (gpm) (265 liters per minute [lpm]). During the summer, CPS withdrawals water from Clinton Lake at approximately 565,000 gpm (2,138,757 lpm). In winter, CPS withdrawals an average of 445,000 gpm (1,684,508 lpm) from Clinton Lake (CEG 2024-TN10806). CPS is the only significant water user of Clinton Lake (CEG 2024-TN10806).

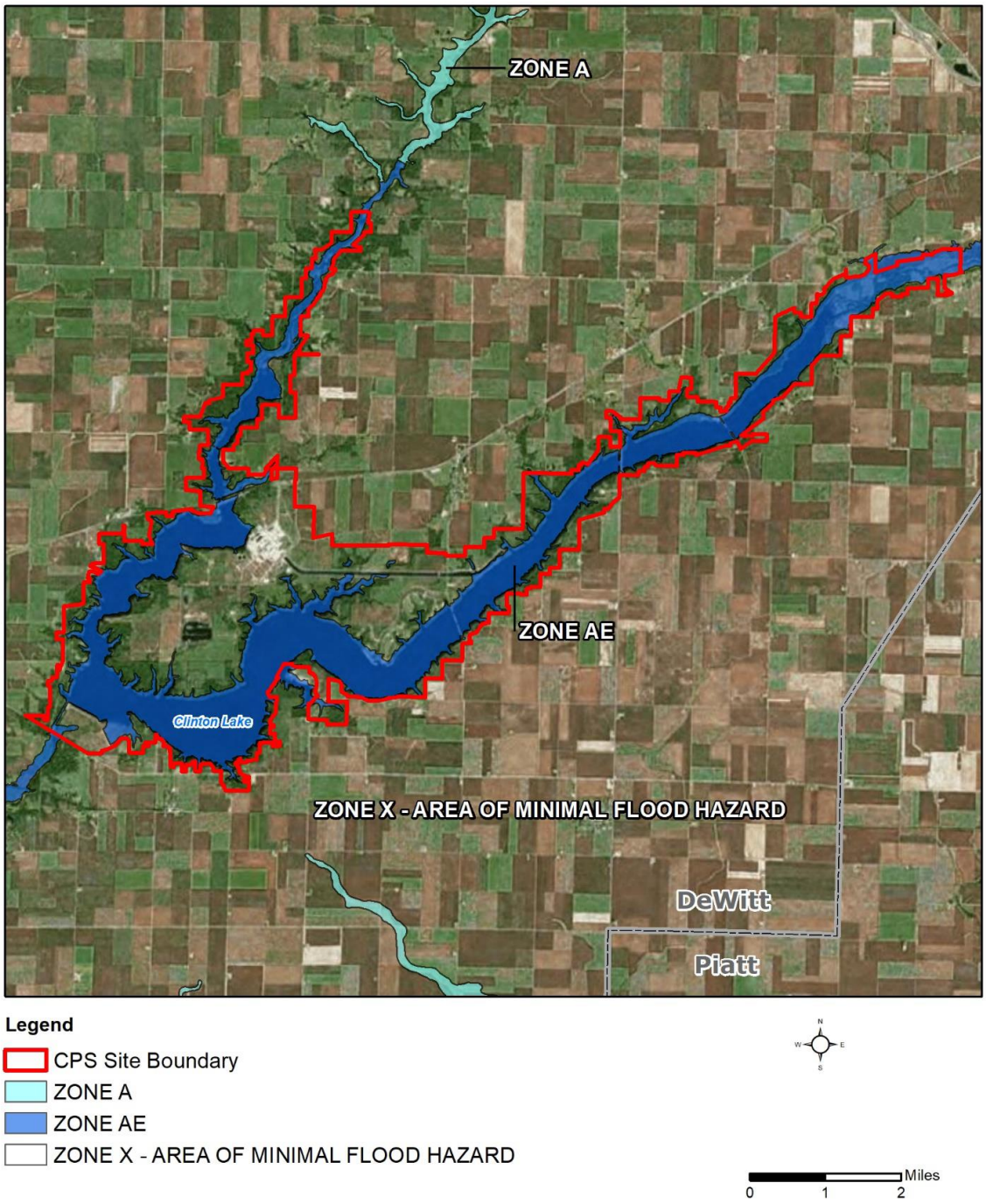

Figure 3-3 Federal Emergency Management Agency Flood Zone Classification for the Clinton Power Station (CPS) Site. Adapted from: CEG 2024-TN10806.

In an average year, the total precipitation onsite is approximately equal to the natural evaporation occurring onsite (35.6 in., 90.4 cm) (CEG 2024-TN10806). The highest natural evaporative losses occur in the summer months, and the least occur during the winter months (Exelon 2020-TN10993). In addition to natural evaporation, induced lake evaporation results from heat added to the waters of Clinton Lake from the CPS heat dissipation system. Additional

consumptive use results from evaporative losses due to operation of cooling towers. CPS operates two banks of MDCTs, located along the south bank of the discharge flume. Installed in 2018 and 2019, these helper cooling towers are able to decrease cooling water discharge temperatures by approximately 5°F (2.8°C) (CEG 2024-TN10914). They are typically operated between May and September, to keep thermal discharges within permitted limits (CEG 2024-TN10806). CEG does not have estimates of the amount of water consumed from the operation of cooling towers (CEG 2024-TN10806).

Table 3-9 Surface Water Withdrawals from Clinton Lake for Clinton Power Station Operations

Year	Monthly Average (MGM)	Monthly Minimum (MGM)	Monthly Maximum (MGM)	Yearly Total (MGY)
2018	23,273	11,801	28,975	279,284
2019	21,795	12,053	28,975	261,547
2020	24,118	20,193	28,975	289,421
2021	22,448	7,822	28,975	269,387
2022	24,477	19,496	28,975	293,736
2023	21,963	12,667	28,975	263,564

Sources: CEG 2024-TN10806 and CEG 2024-TN10914.

CPS obtains potable and sanitary water from Clinton Lake. The water is treated onsite, as required, to meet Illinois Department of Public Health (IDPH) drinking water standards. Municipalities and rural residents in the vicinity of CPS obtain potable water from municipal systems or private wells, primarily sourced from groundwater. The closest user of downstream surface water for drinking purposes is Alton, Illinois, on the Mississippi River, approximately 240 river miles (386 km) from CPS (CEG 2024-TN10806). The primary source of irrigation for farming in the vicinity of CPS is groundwater (Exelon 2020-TN10993).

In 2015, total surface water withdrawals in DeWitt County were reported as approximately 750 million gallons per day (2,839 million liters per day), nearly all of which was used for power generation. There were no reported surface water withdrawals in Piatt County to the west of CPS (Dieter et al. 2018-TN9686).

3.5.1.3 Surface Water Quality and Effluents

3.5.1.3.1 Water Quality Assessment and Regulation

In accordance with Section 303(c) of the Federal Water Pollution Control Act (i.e., Clean Water Act of 1972, as amended (CWA) (33 U.S.C. 1251-1387; TN662), States have the primary responsibility for establishing, reviewing, and revising water quality standards for the Nation's navigable waters. Such standards specify the designated uses of a water body or water body segment, the water quality criteria necessary to protect those designated uses, and an anti-degradation policy with respect to ambient water quality. As established under Section 101(a) of the CWA, water quality standards are intended to restore and maintain the chemical, physical, and biological integrity of U.S. waters and to attain a level of water quality that provides for designated uses. The EPA reviews each State's water quality standards to ensure they meet the goals of the CWA and Federal water quality standards and regulations (40 CFR Part 131 [TN4814], "Water Quality Standards").

Section 303(d) of the CWA requires States to identify all “impaired” waters for which effluent limitations and pollution control activities are not sufficient to attain water quality standards in such waters. Similarly, CWA Section 305(b) requires States to assess and report on the overall quality of waters in their State. States prepare a CWA Section 303(d) list that identifies the water quality limited stream segments that require the development of total maximum daily loads (TMDLs) to assure future compliance with water quality standards. The list also identifies the pollutant or stressor causing the impairment and establishes a priority for developing a control plan to address the impairment. The TMDLs specify the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Once established, TMDLs are often implemented through watershed-based programs administered by the State, primarily through permits issued under the National Pollutant Discharge Elimination System (NPDES) permit program, pursuant to Section 402 of the CWA, and associated point and nonpoint source water quality improvement plans and associated BMPs. States are required to update and resubmit their impaired waters list every 2 years, which ensures that impaired waters continue to be monitored and assessed by the State until applicable water quality standards are met.

Based on IEPA’s 2020/2022 303(d) list of impaired waters and the IEPA Integrated Report Web Application, five impaired waters were identified within a 6 mi (10 km) radius of CPS (IEPA 2025-TN11270: 2020/2022, Appendix C-2). These waters and associated factors for impairment are:

- Clinton Lake — aesthetic quality impaired by total phosphorus and cause unknown.
- Coon Creek — aesthetic quality and aquatic life impaired by oil and dissolved oxygen.
- Friend Creek — aquatic life impaired by dissolved oxygen.
- North Fork Salt Creek — aquatic life impaired by cause unknown.
- Salt Creek — aquatic life impaired by dissolved oxygen.

In its ER, CEG states that CPS operations do not contribute to these impairments. A review of CPS Annual Radiological Environmental Operating Reports from 2019 through 2023 shows that all surface water samples collected from Clinton Lake were below applicable lower limits of detection for tritium and gamma-emitting nuclides (Exelon 2020-TN10997, Exelon 2021-TN10999, CEG 2022-TN11000, CEG 2023-TN11001, CEG 2024-TN11002). Potable water withdrawn from Clinton Lake via the screen house is sampled at the Service Building water compositor quarterly for tritium and monthly for isotopic activity. Isotopic activity has not been detected in samples and tritium concentrations have not been measured above the required lower limit of detection of 2,000 picocuries per liter (pCi/L) for the last 5 years (CEG 2024-TN10914). CPS has not discharged through the liquid radwaste system (LRS) since 1992 (CEG 2024-TN10806). Over the past 5 years, CPS has not had an abnormal liquid release of radioactivity (CEG 2024-TN10806, CEG 2024-TN10914).

Over the past 5 years, CPS has had one reportable spill of nonradioactive material. This spill was due to a burst pipe which released approximately 1,450 to 3,400 gallons (5,489 to 12,870 L) of a sodium bisulfate solution. The spill was discovered and reported to the Illinois Emergency Management Agency and Office Homeland Security on September 18, 2023 and the affected soil was removed and appropriately disposed. As described further in Section 3.13.2, CEG is tracking actions to eliminate or prevent a spill reoccurrence in its Corrective Action Program.

3.5.1.3.2 Pollutant Discharge Eliminating System Permitting Status and Plant Effluents

To operate a nuclear power plant, NRC licensees must comply with the CWA, including associated requirements imposed by the EPA or the State, as part of the NPDES permitting system under Section 402 of the CWA. The Federal NPDES permit program addresses water pollution by regulating point sources (i.e., pipes, ditches) that discharge pollutants to waters of the United States. The NRC licensees must also meet State water quality certification requirements under Section 401 of the CWA. The EPA or the States set the limits for effluents and operational parameters in plant-specific NPDES permits, and the NRC has no role in this process. Nuclear power plants cannot operate without a valid NPDES permit and a current Section 401 Water Quality Certification.

As described in an IEPA letter dated February 3, 2023, contained in Attachment E to CEG's ER (CEG 2024-TN10806), IEPA received CEG's request for Agency determination under CWA Section 401 Water Quality Certification for CPS Unit 1 on December 2, 2022. The request concerns the prior authorization under CWA Section 401 issued on August 11, 1975. In their letter dated February 3, 2023, IEPA determined that reevaluation and certification of CPS Unit 1 is not necessary and issued a waiver of CWA Section 401 Water Quality Certification. Based on the NRC staff's review of this correspondence and applicable regulatory requirements in effect at the time the IEPA rendered its CWA Section 401 determination, the NRC staff has determined that the certification remains valid, and no further action is required by the NRC as the responsible Federal licensing or permitting agency as related to the CWA Section 401 certification process.

CPS has a NPDES permit (No. IL0036919) with the State of Illinois to discharge stormwater and process wastewater to Clinton Lake. As a part of this permit, chemical additives listed in the 2016 NPDES permit application are approved to be used to control the pH, scale, and corrosion in the circulating water system and control of biofouling of equipment (CEG 2024-TN10806). Chemicals are also utilized in raw water treatment, component cooling system treatment and sewage treatment. In accordance with the requirements of 35 Ill. Admin. Code 309.104 and 40 CFR 122.21, on September 30, 2024, CEG submitted an application to renew NPDES Permit No. IL0036919 to IEPA. This application is under review by IEPA (CEG 2024-TN10914).

As shown in Figure 3-4 below, 11 outfalls—two internal (A02 and B02) and nine external (002, 003, 004, 005, 006, 007, 008, 011, and 015)—discharge into Clinton Lake (CEG 2024-TN10806). External outfall 002 discharges to the east arm of Clinton Lake and represents the primary plant discharge with an average flow of 965 million gallons per day (3,653 million liters per day) (CEG 2024-TN10806). Outfall 002 discharge consists of main condenser cooling water, station service water, makeup water treatment system water, screen house sump discharges, and discharges from internal outfalls A02 (sewage treatment effluent) and B02 (radwaste system effluent). Note that CPS has not discharged through the liquid radwaste system since 1992 (CEG 2024-TN10806).

CEG's NPDES permit requires continuous thermal monitoring and limits discharge temperatures at Outfall 002, the second drop on the discharge flume. The maximum daily average thermal discharge limit is 110.7°F (43.7°C). In addition, daily average discharge temperatures are permitted to exceed 99°F (37.2°C) for no more than 90 days per calendar year (Exelon 2021-TN10992). The helper cooling towers located along the south bank of the discharge flume operate as needed (typically from May to September) to assist meeting these thermal discharge limits. Since the towers were installed, three down powers have occurred to ensure that the number of days with a daily average discharge temperature greater than 99°F (37.2°C) met the

NPDES permit limit (CEG 2024-TN10914). CEG submitted a CWA Section 316(a) Demonstration study dated March 28, 2016, as part of a NPDES permit renewal application, to justify continued operations under the permitted thermal limits (CEG 2024-TN10806). Figure 3-5 below presents monthly average intake water temperatures from 2000 to 2024 from Clinton Lake. There is no apparent trend in average intake water temperature over the 23-year period.

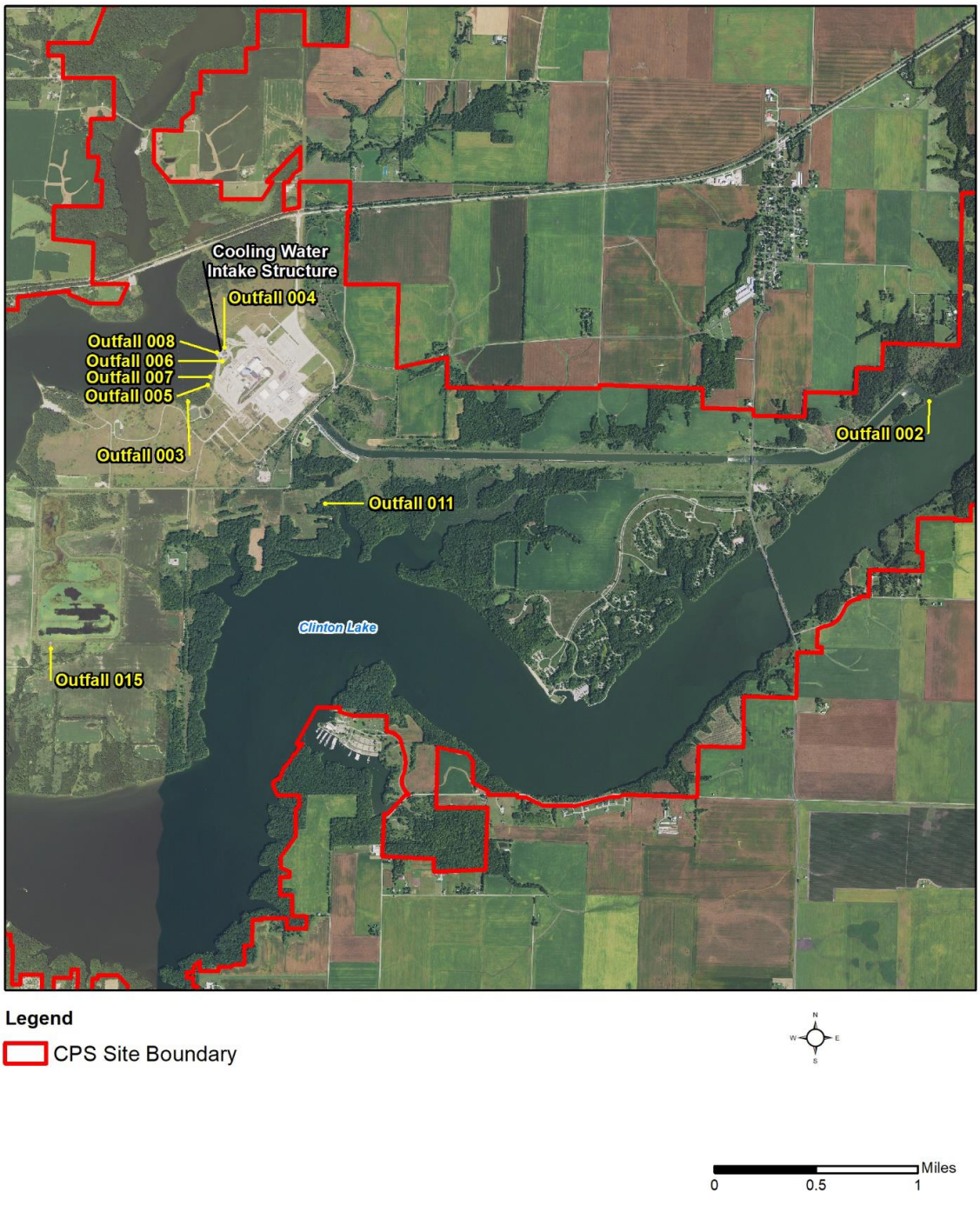

Figure 3-4 Clinton Power Station (CPS) Pollutant Discharge Elimination System Permitted External Outfalls. Adapted from: CEG 2024-TN10806.

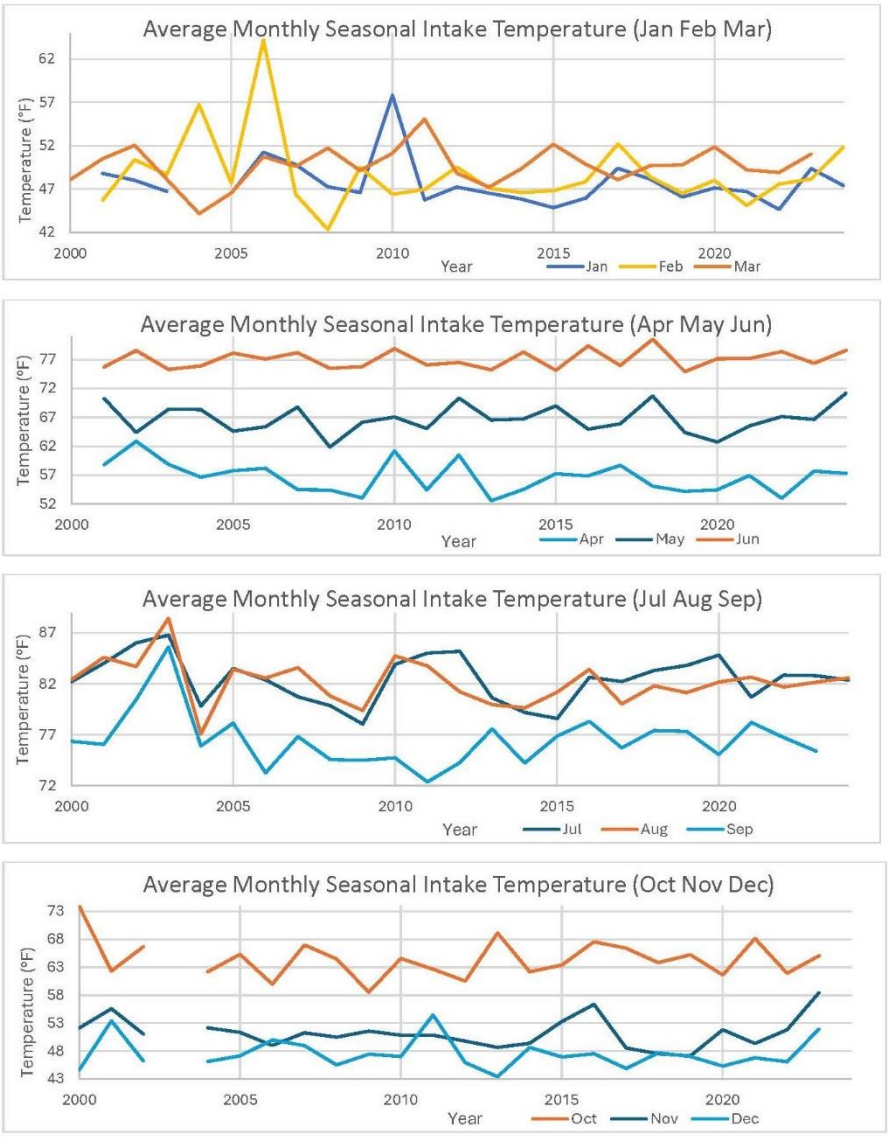

Figure 3-5 Monthly Average Intake Water Temperatures from Clinton Lake for Clinton Power Station, 2000–2024. Adapted from: CEG 2024-TN10914.

CPS has not received any notices of violation associated with wastewater discharges to receiving surface waters over the past 5 years (CEG 2024-TN10806, CEG 2024-TN10914). Two NPDES non-compliance issues occurred in 2023. The first related to a total residual chlorine sample which had an analytical result of less that the detection limit but was collected approximately 30 minutes outside the required sampling timeframe. The second non-compliance issue related to CEG notifying the IDNR Region III Office and the IEPA Champaign Regional Office of the planned September 2023 shutdown due to refueling by less than the 1 week prior to the shutdown criteria required by Special Condition 22 of CEG's NPDES permit. CEG revised internal procedures to prevent re-occurrence of these two non-compliances (CEG 2024-TN10914).

3.5.1.3.3 Other Surface Water Resources Permits and Approvals

Stormwater associated with CPS industrial activities is regulated by NPDES Permit No. IL00036919. Surface water generally drains to the south through the stormwater system and human-made ditches through Outfalls 004, 005, and 011. CEG maintains and implements a SWPPP that identifies potential sources of pollution reasonably expected to affect the quality of stormwater and identifies BMPs to prevent uncontrolled stormwater runoff to Clinton Lake. The CPS NPDES permit requires CEG to conduct an annual facility inspection to verify that all elements of the plan, including the site map, potential pollutant sources, and structural and non-structural controls to reduce pollutants in industrial stormwater discharges are accurate. The annual stormwater inspections conducted over the last 5 years have found that the facility was operating in compliance with the SWPPP and no changes to the stormwater pollution practices or SWPPP were deemed necessary (CEG 2024-TN10914).

Under CWA Section 311(j)(1)(C), CPS is required to develop a spill prevention, control, and countermeasures (SPCC) plan. The CPS SPCC plan identifies and describes the procedures, materials, equipment, and facilities to minimize the frequency and severity of any oil spills (CEG 2024-TN10806). Discharge of oil in quantities exceeding those identified in CWA Section 311(b)(4) must be reported to the EPA's national response center. Over the last 5 years, there have been no releases at CPS that have triggered this notification requirement (CEG 2024-TN10806, CEG 2024-TN10914). CEG does not have any CWA Section 404 permits in place because they do not perform routine dredging. CEG anticipates that dredging of the ultimate heat sink will be needed during the LR term. CEG would be required to obtain the necessary permits prior to conducting any dredging related activities.

CPS is supplied with potable and sanitary water from Clinton Lake. CPS withdraws potable water from Clinton Lake and treats it in an onsite system, Water System No. L3111153. This system is regulated as a non-community non-transient public water system. The water is treated, as required, to meet IDPH drinking water standards. Sanitary waste from the station area is treated to meet the requirements of the NPDES permit.

3.5.2 Groundwater Resources

This section of the SEIS describes the groundwater flow systems (aquifers), groundwater use, and groundwater quality in and around the CPS site. An aquifer is a geologic formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and/or springs.

3.5.2.1 Local and Regional Groundwater Resources

Sections 3.5 and 3.6.2 of the ER (CEG 2024-TN10806) describe the geologic environment and groundwater resources, respectively, in the vicinity of the CPS site. NRC staff also evaluated information related to groundwater resources during the site audit, the scoping process, and during its review of other available information, as cited in this SEIS.

The CPS site, located in DeWitt County, is in the Central Lowland physiographic province in central Illinois. The province's low-relief surface was formed by glacial till, outwash plains, and glacial-lake plains which completely bury the preglacial topographic features (Lloyd and Lyke 1995-TN4988). Glacial deposits are thickest in the deepest bedrock valleys and thinnest above the sides of the valleys and bedrock uplands (Larson et al. 2001-TN10995). These glacial deposits, along with consolidated bedrock of sandstone, limestone and dolomite, are the

predominant aquifers in the region. The CPS site overlies the productive, sand and gravel Mahomet Aquifer, which is a designated sole source aquifer (EPA 2024-TN10996). The Mahomet Aquifer is the primary source of drinking water for more than 500,000 people across 15 counties. It provides an estimated 220 million gallons of water per day for domestic, municipal, agricultural, and industrial water use (IEPA 2020-TN11205). There are no other sole source aquifers in Illinois.

The CPS site is bordered by Clinton Lake to the west. Clinton Lake was constructed as the cooling pond for the site by damming Salt Creek downstream of its confluence with the North Fork of Salt Creek. As described in Section 3.4.2 of this SEIS, the site is generally flat, averaging between 735 and 740 ft (224 and 230 m) MSL. A grass embankment leads from the main reactor-building compound to the cooling water intake structure and lake; the elevation change is approximately 35 ft (10.6 m) over approximately 160 ft (48.8 m). The Unit 2 Pit, which is the abandoned excavation of the planned Unit 2 reactor building, is an exception to the site's characteristic low relief. The excavation is approximately 35 ft (10.6 m) deep and the footprint of the administration building, as shown in Figure 2-3 of this SEIS, is within the Unit 2 Pit. The pit extends 700 ft (213 m) in a south-west to north-east orientation.

As described in Section 3.4.2 and summarized in Table 3-8 of this SEIS, CPS site geology includes unconsolidated overburden deposits overlying Pennsylvanian age (323.2 to 289.9 Ma) bedrock of limestone and coal units. The overburden deposits, in order of increasing age, consist of stream alluvium, windblow loess, and glacial drift. Alluvial deposits of fine-grained floodplain deposits overlying coarse-grained outwash are present only in the valleys of Salt Creek and North Fork Salt Creek, including in the ultimate heat sink. In the main plant compound area, overburden deposits are approximately 225–260 ft (69–190 m) thick and are subdivided into the following units: Richland Loess (brown, clayey silt with sand), Wedron Formation glacial till (stiff to very stiff clayey sandy silt till with discontinuous lenses of sand, silt, or gravel), Robein Silt (organic-rich silt, though it may be absent locally due to erosion), Glasford Formation (Illinonian-age; 191,000–130,000 years ago) glacial till which occurs as highly weathered for the first 10 to 15 ft (3 to 4.6 m) (silty clay and clayey silt with local discontinuous lenses of silts, sands, or sandy silts) before transitioning to an unaltered strata (sandy silty till with lenses of silt, gravel and sand), and Banner Formation (Kansan Stage; 0.9-0.7 Ma) glacial till (complex unit of clay till, reworked till, and outwash and glacio-lacustrine silt), which is also referred to as Pre-Illinonian till.

A nearly continuous layer of fine sand at the top of the Wedron Formation was exposed during excavation of the power block. Other discontinuous sand lenses predominantly occur between 650 and 730 ft (198 and 222.5 m) MSL, and range in thickness from 0.5 to 22 ft (0.2 to 6.7 m). During construction, discontinuous sand deposits near the contact between the weathered and unaltered Glasford Formation seeped varying amounts of groundwater into the excavation, though the seepage from clayey till soils was very low (Constellation 2022-TN8102). The site's Updated Safety and Analysis Report (USAR) (Constellation 2022-TN8102) states excavations for CPS did not extend below the unaltered Glasford Formation. The Mahomet Sand Member (part of Kansan Stage glacial outwash), which comprises the Mahomet aquifer, is variably present (0–140 ft [0–42.7 m] thick) across the site at the base of the Banner Formation (Constellation 2022-TN8102). The unit is absent in the area of the power block, where glacial till directly overlays bedrock. The Pennsylvanian bedrock occurs at the CPS site at approximately 490–510 ft (150–155 m) MSL (185–190 ft [56–58 m] below ground surface [bgs]) in the area of the power block (Constellation 2022-TN8102).

The major aquifer systems in the vicinity of the site occur within the alluvial deposits along streams, glacial drift (including sand and gravel lenses), glacial outwash (Kansan Stage), and bedrock. Groundwater at the site is unconfined, predominantly occurring in the upper glacial deposits (Wedron Formation) within 15 ft (4.6 m) bgs (CEG 2024-TN10806). Groundwater in the Glasford and Kansan deposits is artesian. Groundwater in the Pennsylvanian bedrock (shale and siltstone interbedded with limestone, sandstone, underclay, and coal) can also occur under artesian conditions. This groundwater is either discharged to the underlying bedrock formation or to overlying glacial drift, depending on the difference in hydraulic head between the two units. While there are no springs noted at the CPS site, Weldon Springs State Park, a natural spring originating from groundwater within a shallow silty sand and gravel deposit, is approximately 5.5 mi (8.9 km) to the south-west (Panno and Hackley 2001-TN11055). Groundwater in the Pennsylvanian is most commonly present within 100 ft (30.5 m) of the bedrock surface due to decreased weathering and increased mineralization with depth. Drift aquifers are generally utilized more frequently than bedrock aquifers in the region due to larger well yields and improved water quality (Lloyd and Lyke 1995-TN4988). Transmissivity of the surficial aquifers is controlled by aquifer thickness and hydraulic connection to large bodies of water. Potential well yields range from less than 100 gpm where surficial deposits are thin, to several thousand gpm when a well is hydraulically connected to a river and induces groundwater flow reversal through pumping (Lloyd and Lyke 1995-TN4988).

Precipitation, underflow through the bedrock and bedrock valleys, and induced infiltration from streambeds recharges groundwater within the glacial drift. Sand and gravel lenses within the drift are recharged primarily via vertical leakage of infiltrating precipitation. Regionally, groundwater moves from the glacial drift to intersecting streams, underlying glacial deposits and Pennsylvanian bedrock (via downward flow), or to pumping wells (CEG 2024-TN10806). At the site, construction activities altered baseline hydraulic conditions. This includes the creation of Clinton Lake, which increased the regional water table, and excavation activities for the turbine and reactor buildings and the shutdown service water system intake pipe. The deep excavations hydraulically connected shallow groundwater (water table) within the Wedron Formation and intermediate-depth groundwater within the Glasford Formation. Beyond the boundary of the protected area, relatively impermeable layers of clay till have not been excavated, reducing the potential vertical migration of groundwater (CEG 2024-TN10806).

Potentiometric surface maps for shallow groundwater in the Wedron Formation and intermediate-depth groundwater in the Glasford Formation at the CPS site during May 2018 are provided in Figure 3-6 and Figure 3-7 of this SEIS. Groundwater flow is impacted by the Unit 2 Pit, which creates a hydraulic low point within the power block area. A passive drainage system within the Unit 2 Pit serves as a continual collection point for shallow groundwater and stormwater (CEG 2024-TN10914: Attachment 21). Beneath the base of the pit, collection pipes and a concrete trough direct inflowing groundwater and stormwater to a single discharge pipe. The pipe is routed under the Reactor Building and discharges to Clinton Lake, immediately south of the screen house (CEG 2024-TN10914). The flow rate of the discharge system is unknown; however, flows above 50 gpm (189 lpm) are considered unlikely based on historical data indicating that a 135 minute storm event in October 1991 resulted in an approximate flow rate of 47.5 gpm (180 lpm) (CEG 2024-TN10914). Outside of the influence of the Unit 2 Pit drainage system, shallow groundwater flow radially away from the power block area, ultimately toward Clinton Lake to the west or toward the discharge flume and the Salt Creek arm of Clinton Lake to the east (Figure 3-6 of this SEIS).

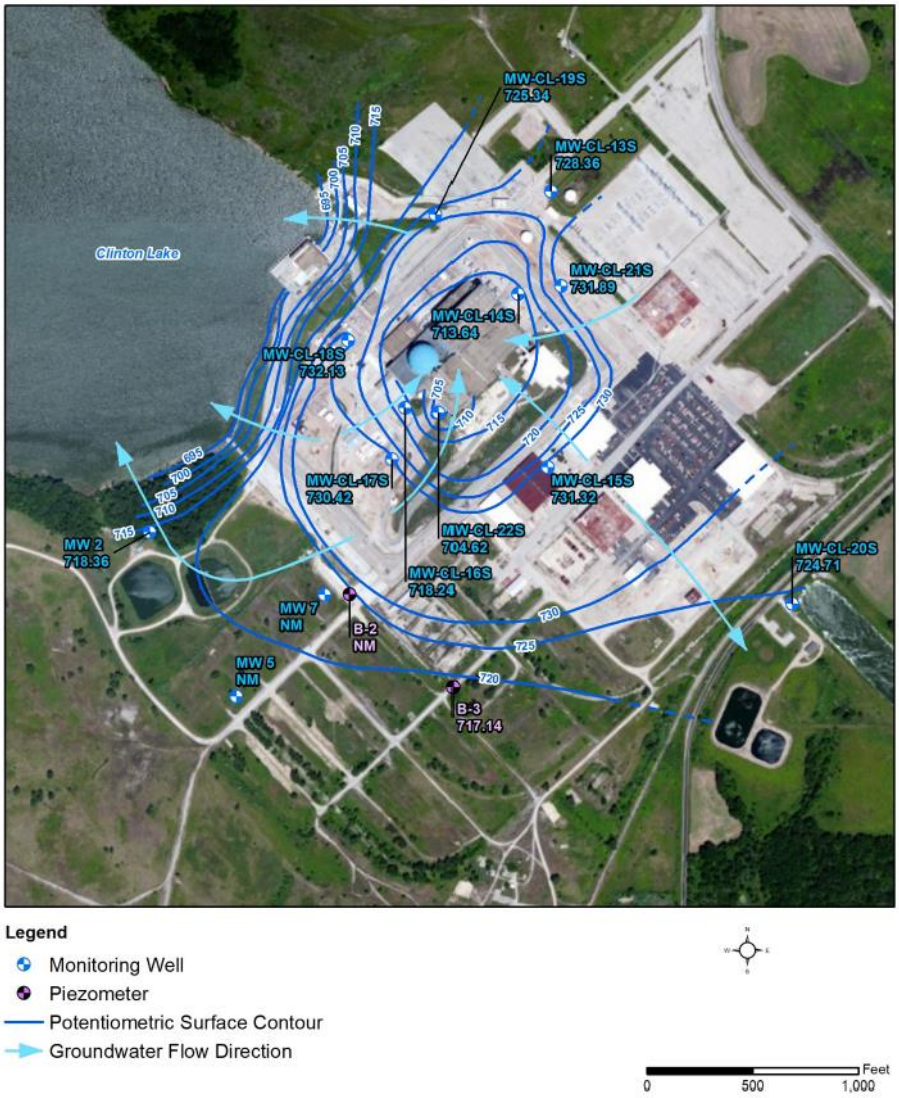

Figure 3-6 Onsite Monitoring Wells and Groundwater Level Contours Based on May 2018 Groundwater Elevation Data from the Unconfined Aquifer, and the General Path of Groundwater Flow at the Clinton Power Station Site. Source: CEG 2024-TN10806: Figure 3.6-8.

Potential spills to groundwater would likely occur at ground surface or at the structures, systems, and components most at risk of a leak within the power block. As stated in Table 3-8, the excavation of the power block extends from ground surface to the Unaltered Glasford Formation, thereby connecting groundwater between the Richland Loess, Wedron Formation, Robein Silt, and Glasford Formation. Vertical groundwater flow is downward toward the Robein Silt and the Weathered Glasford Formation, which are of higher hydraulic conductivity than the Wedron Formation (Constellation 2022-TN8102). These units would likely act as the quickest pathway for potential spills to reach Clinton Lake via horizontal groundwater flow. The USAR provides hydrogeologic property values for the Robein Silt and Weathered Glasford Formation together as one unit, referred to as the “interglacial zone” (Constellation 2022-TN8102). In order to estimate travel times of potential spills to groundwater, the NRC staff calculated groundwater velocity for groundwater within this “interglacial zone” using the reported property values.

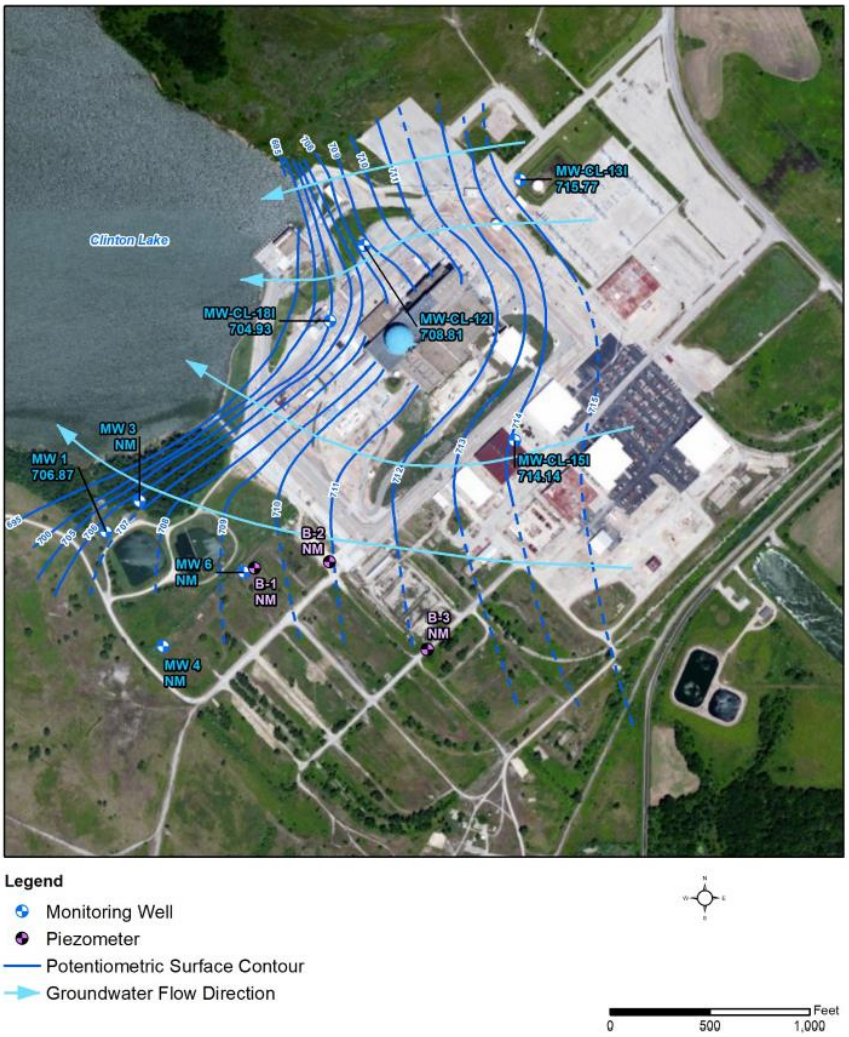

Figure 3-7 Onsite Monitoring Wells and Groundwater Level Contours Based on May 2018 Groundwater Elevation Data from Semi-Confined Groundwater within the Sandy, Silty Lenses of the Wedron Formation, and the General Path of Groundwater Flow at the Clinton Power Station Site. Source: CEG 2024-TN10806: Figure 3.6-9.

Field values were not reported for the Robein Silt and weathered Glasford Formation, but laboratory testing estimated the average hydraulic conductivity and porosity to be 6.9 ft/day (2.1 m/day) and 0.27, respectively, in the area of the earthen dam (Constellation 2022-TN8102). Assuming these values apply to the power block area and a hydraulic gradient of 0.04 based on groundwater contour data presented in Figure 3-7, the NRC staff calculated the average linear velocity of groundwater within the Robein Silt and Weathered Glasford Formation would be about 0.13 to 1.2 ft/day (14.5 to 134 m/year). Using the upper estimate of groundwater velocity, potential inadvertent releases in the power block area would travel the 1,000 ft (305 m) to Clinton Lake in about 2.5 years. This is likely a conservative estimate because groundwater flow will depend on the connectivity of the more permeable sand lenses near the top of the Glasford Formation, and vertical groundwater flow is expected to be much less than horizontal flow. Estimated horizontal travel time of groundwater within the Wedron Formation and Unaltered Glasford Formation is greatly reduced (by more than 700 years) due to relatively impermeable soils.

3.5.2.2 Local and Regional Water Consumption

CPS does not use groundwater for plant operations and there is no active dewatering onsite. Cooling and potable water for the site is sourced from Clinton Lake. A passive drainage system collects shallow groundwater and stormwater within the Unit 2 Pit and discharges to Clinton Lake (CEG 2024-TN10914). The system is not monitored, but discharge is expected to be minimal and mainly occurring during storms due to rainwater collection in the concrete base of the pit. A flow rate of 47.2 gpm (179 lpm) during a 135 minute storm event was recorded from the Unit 2 Pit outfall pipe in 1991 (CEG 2024-TN10914).

Two potable groundwater wells are within the CPS property boundary: (1) well API 120392153600 is located approximately 1 mi (2 km) west of the screen house intake structure and is utilized during summer months for a recreational beach area; and (2) well API 120392062100 is located approximately 1 mi (2 km) south of the main power block area and serves as the main source of potable water for the village of DeWitt with an average pumping rate of 350 gpm (1,325 lpm). The exact groundwater use rate of the recreational beach supply is unknown, but it is considered unlikely groundwater withdrawals from these wells would have a noticeable impact on site groundwater conditions due to the small number of users served and hydraulic connection to Clinton Lake.

Withdrawal of fresh groundwater in DeWitt County totaled 2.0 million gallons (MG) (7.6 million liters [L]) in 2015 (Dieter et al. 2018-TN9686). Of this total, the largest uses were for public supply, 1.31 MG (5.0 million L) and domestic supply, 0.42 MG (1.6 million L), with the remaining use split between livestock, 0.21 MG (0.8 million L) and irrigation, 0.06 MG (0.23 million L). Groundwater is the exclusive source of public and domestic supply in the region of the CPS site. Public groundwater suppliers within 15 mi (24 km) of the site predominantly withdraw from the productive Mahomet aquifer, followed by glacial drift aquifers. Within 2 mi (3 km) of the CPS site domestic groundwater users predominantly withdraw water from wells installed within unconsolidated deposits at depths less than 400 ft (122 m) bgs (ISGS 2024-TN11053). Data from the Illinois State Geological Survey indicate there are approximately 451 water wells (including the two supply wells detailed above) within a 2 mi (3 km) distance of the CPS site (Figure 3-8 of this SEIS) (ISGS 2024-TN11053). Of these wells, 61 are indicated to be located within the CPS site boundary. The USAR states many wells on site property were abandoned and sealed in accordance with State requirements during plant construction; however, those wells used by tenant farmers and a limited number of private residence wells were expected to remain in use during plant operation (Constellation 2022-TN8102).

3.5.2.2.1 Groundwater Quality

The typical constituents and quality of groundwater in Illinois are generally dependent on the source aquifer and thickness of overburden deposits. Across the State, groundwater serves as a primary source of private drinking water and is the principal source of industry and agriculture (Gibb and O'Hearn 1980-TN11074). Groundwater quality and yield is typically better from wells installed in overburden deposits, as groundwater within bedrock aquifers may become mineralized (e.g., higher in concentration of chloride, sulfate, and sodium) with depth. In nearby Piatt Country, a study characterized groundwater chemical quality within the Wedron Formation as moderately hard (250 milligrams per liter [mg/L]) to extremely hard (500 mg/L) and elevated in iron content (0.2–3.0 mg/l) (Sanderson 1971-TN11076). Elevated iron content is thought to be associated with glacial moraine deposits in the area (Gibb and O'Hearn 1980-TN11074). Only wells insufficiently protected from surface sources of nitrate (e.g., septic tanks, feedlots) registered high nitrate content. Groundwater quality in the deeper glacial deposits of the

Glasford Formation is reported to be more mineralized due to percolation through relatively thick overlying till. Chlorine content can also be elevated in this stratum when sandy gravel deposits of the Banner Formation are thin or absent and groundwater discharges upward from bedrock (Gibb and O'Hearn 1980-TN11074). Additionally, groundwater from wells in Piatt Country and in test wells completed for CPS site planning has tested high for naturally occurring methane gas (Gibb and O'Hearn 1980-TN11074 and CEG 2024-TN10806).

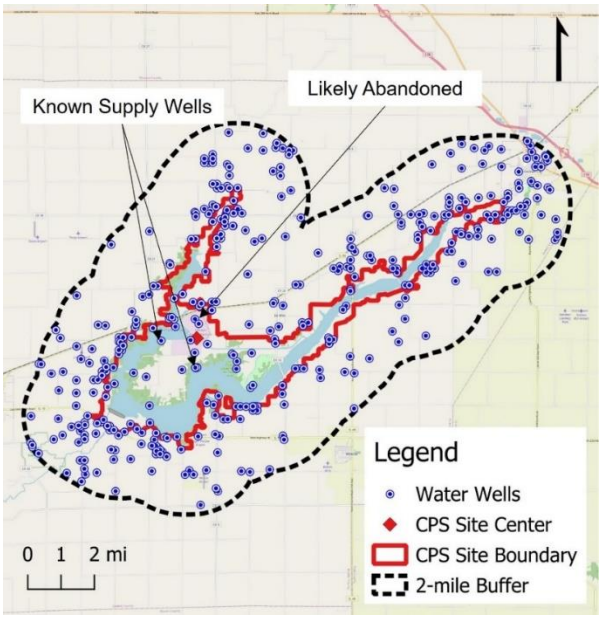

Figure 3-8 Registered Water Wells (Including Supply) Within 2 mi of the Clinton Power Station (CPS) (ISGS 2024-TN11053)

3.5.2.2.2 Nonradiological Spills

CEG controls the use and storage of chemicals associated with CPS maintenance and operations in accordance with CEG procedures and a site-specific SPCC plan. Nonradioactive waste is also managed in accordance with a site-specific waste management procedure that utilizes BMPs such as preparedness and prevention control measures (CEG 2024-TN10806). Some liquid nonradioactive wastewater generated by CPS is discharged to Clinton Lake, following treatment by the sediment pond filter house system in accordance with the NPDES permit (CEG 2024-TN10806). One spill of nonradioactive material was recorded between January 2018 and October 2024. On September 18, 2023, a spill of 40 percent sodium bisulfite was discovered and traced to a pipe burst. Approximately 1,450 to 3,390 gallons (5,489 to 12,833 L) of material was released to ground in the flume detox building. The top layer of impacted soil was removed, and the area was rinsed. Soil sampling confirmed all impacted soil had been removed. A complete description of this incident is described in Section 3.13.2 of this SEIS.

3.5.2.2.3 Historical Radiological Spills and Tritium in Groundwater

Groundwater Protection Program

Based on the Industry Groundwater Protection Initiative (NEI 2019-TN6775), a program to evaluate the impact of station operations on groundwater and surface water was initiated in 2006 by CPS (CEG 2024-TN10914). This program constituted an initial hydrogeologic

investigation report prepared as part of Exelon's fleetwide program to determine whether groundwater had been adversely impacted by any releases of radionuclides at its power plants. The investigation included the installation of 14 monitoring wells at CPS which are screened in both the Wedron and Glasford Formations. This report continues to be updated every 5 years and was most recently updated in 2023. In 2020, the corporate radiological groundwater protection program (RGPP) was redeveloped to better align the groundwater monitoring programs at CEG plants with the objectives of the Industry Groundwater Protection Initiative (CEG 2024-TN10914). The updated RGPP at CPS includes 17 monitoring well locations (14 monitoring wells installed in 2006 and 3 that were onsite prior to 2006). Table 3-10 below summarizes RGPP monitoring locations, purpose, and sampling frequency.

Table 3-10 Radiological Groundwater Protection Program Sampling Location Summary for Clinton Power Station

Target Unit and Monitoring Well ID(s)	Location and Purpose	Sampling Frequency
– Wedron Formation: MC-CL-15S, MW-CL-20S – Glasford Formation: MW-CL-15l	– Designed to monitor background radionuclide concentrations. – Upgradient of potential sources of licensed material.	– Annually for tritium. – Every 2 years for gamma-radionuclides.
– Wedron Formation: B-3, MW-CL-2 (aka MW-2) – Glasford Formation: MW-CL-1 (aka MW-1), MW-CL-13l	– Designed to monitor radionuclide concentrations at the perimeter of high-risk systems and components. – Downgradient or cross-gradient to protected area and sedimentation ponds.	– Annually for tritium. – Every 2 years for gamma-radionuclides.
– Wedron Formation: MW-13S, MW-CL-14S, MW-CL-16S, MW-CL-17S, MW-CL-18S, MW-CL-19S, MW-CL-21S, MW-CL-22S – Glasford Formation: MW-CL-12l, MW-CL-18l	– Designed to monitor radionuclide concentrations near to high risk systems or components where leak detection capability is recommended. – Generally within the protected area.	– Quarterly for tritium – Annually for Sr-89/Sr-90. – Every 2 years for gamma- and gross-alpha radionuclides. – Every 5 years for Fe-55 and Ni-63.

Fe = iron; ID = identification; Ni = nickel; Sr = strontium.
Source: Adapted from CEG 2024-TN10806.

Surface water sampling locations, including from Clinton Lake, were included in the RGPP prior to 2020, but are no longer monitored as part of groundwater protection objectives. Station procedure CY-CL-170-2110 is used to monitor tritium and gamma emitters from the onsite potable water source described in the CPS Annual Radiological Environmental Operating Reports. Potable water withdrawn from Clinton Lake via the screen house is sampled at the Service Building water compositor quarterly for tritium and monthly for isotopic activity. CEG also utilizes the site-specific procedure, "Potentially Contaminated System Controls Program" to monitor groundwater that collects in onsite cable vaults. The cable vaults are in the vicinity of the north-west corner of the turbine building and extend from ground surface to approximately 725 ft (23 m) MSL. Grab samples are collected from the cable vault sumps quarterly and analyzed for tritium.

Radiological Releases

Annual Radiological Effluent Release Reports are submitted to the NRC (per 10 CFR 50.36a [TN249]) to report the quantities of radionuclides released from liquid and gaseous effluents. The NRC staff reviewed 5 years of effluent release reports (2019–2023) for CPS (Exelon 2020-TN10997, Exelon 2021-TN10999; CEG 2022-TN11000, CEG 2023-TN11001, CEG 2024-TN11002). These reports state that while CPS is licensed to release radioactive liquid effluents in batch mode, no batch releases or abnormal releases were reported between 2019 and 2023. Furthermore, CEG confirmed there were no unplanned radiological releases as of the audit date of August 28, 2024 (CEG 2024-TN10914). One historical release of tritium in 2006 from the cycle condensate storage tank is described in ER Section 3.6.4.2.1 (CEG 2024-TN10806). A concentration of 7,000 pCi/L was measured in a pit near to the tank, which was located upgradient of MW-CL-14S (shown in Figure 3-9 below). The tank was replaced in 2013.

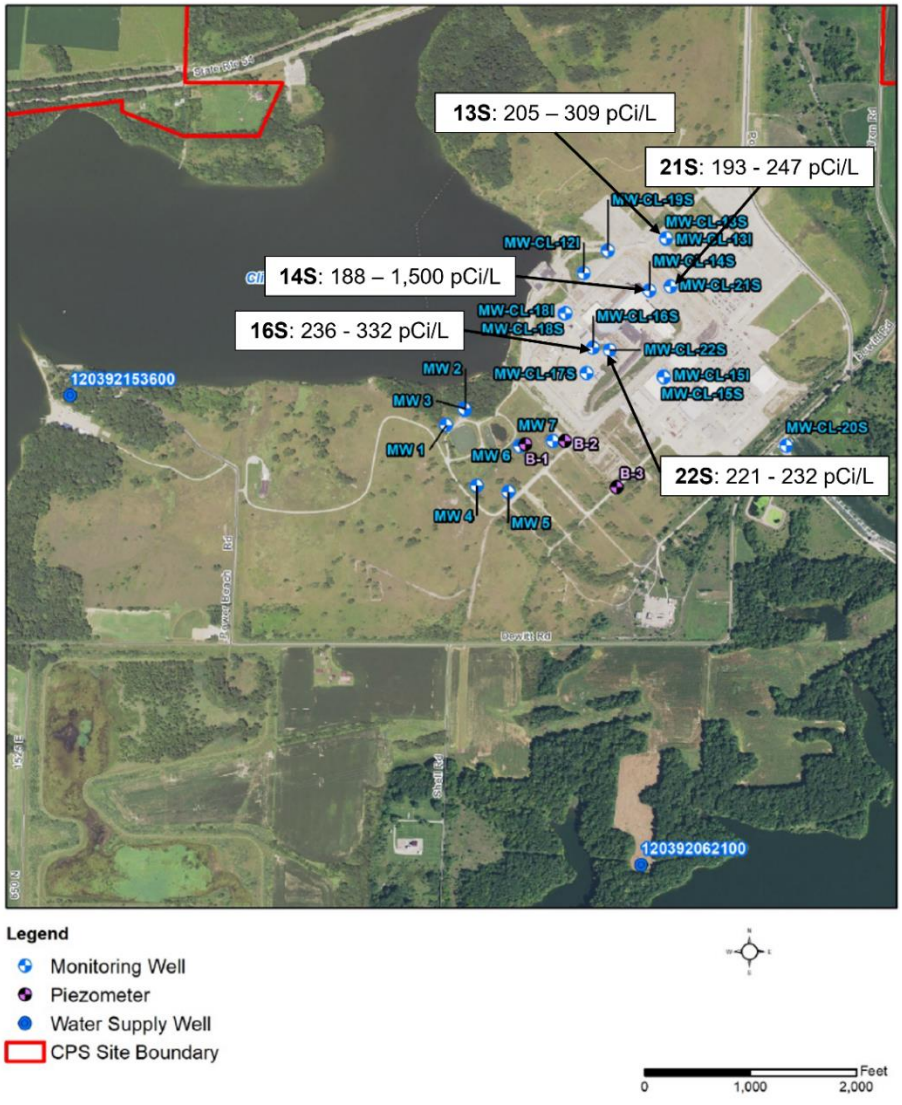

Figure 3-9 Tritium Detections Above 200 pCi/L in Groundwater Samples at the Clinton Power Station (CPS) Site, 2018–2023. Adapted from CEG 2024-TN10806: Figure 3.6-7.

Tritium has been detected at concentrations below 2,000 pCi/L in onsite wells from 2018 to 2023. The maximum detected tritium concentration in onsite groundwater samples reported between September 2018 and March 2023 was 1,500 pCi/L, sampled in March 2021. Reported tritium concentrations above 200 pCi/L sampled in onsite wells between 2018 and 2023 are depicted in Figure 3-9 above. All tritium concentrations measured above 200 pCi/L have occurred in monitoring locations targeting shallow groundwater within the Wedron Formation. In 2013, tritium was first detected in MW-CL-12I, which targets groundwater in the Glasford Formation, at a concentration of 345 pCi/L (CEG 2024-TN10914). Tritium concentrations have been sampled below 1,500 pCi/L in onsite groundwater since March 2021, which is below the EPA drinking water standard and NRC reporting limit of 20,000 pCi/L, and no ongoing leak is suspected (CEG 2024-TN10914). Gamma-radionuclides have not been detected at concentrations above detection limits in onsite groundwater since 2006 (CEG 2024-TN10806). The site also monitors dissolved and suspended gross-alpha as part of the RGPP. No gross-alpha has been detected above the alert level (three times the ongoing average gross-alpha concentration at each respective location) since 2019 (CEG 2024-TN10806). Additionally, the NRC staff reviewed 5 years of the CPS Annual Radiological Environmental Operating Reports (2019–2023), which confirmed no radionuclides were measured above reporting thresholds in offsite samples (Exelon 2020-TN10997, Exelon 2021-TN10999; CEG 2022-TN11000, CEG 2023-TN11001, CEG 2024-TN11002). This includes the site's potable water supply sourced from Clinton Lake and three offsite groundwater wells.

3.5.3 Proposed Action

3.5.3.1 Surface Water Resources

As documented in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1 of this SEIS, for generic surface water resources issues, the impacts of nuclear power plant LR and continued operations would generally be SMALL for Category 1 issues applicable to CPS. These issues include:

- surface water use and quality (non-cooling system impacts)
- altered current patterns at intake and discharge structures
- altered thermal stratification of lakes
- scouring caused by discharged cooling water
- discharge of metals in cooling system effluent
- discharge of biocides, sanitary wastes, and minor chemical spills
- surface water use conflicts (plants with once-through cooling systems)
- effects of dredging on surface water quality
- temperature effects on sediment transport capacity

The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS. The one generic surface water resources issue listed in the LR GEIS (NRC 2024-TN10161) that does not apply to CPS is "Altered Salinity Gradients" because LR GEIS Section 4.5.1.1.3 identified that this issue is related to nuclear power plants located on estuaries where cooling system water withdrawals and discharges may cause changes in salinity. As discussed in Section 3.5.1, CPS is located on an inland freshwater lake created with the primary purpose of providing cooling water to operate CPS (Exelon 2006-

TN11232; CEG 2024-TN10806). Because Clinton is located on a freshwater lake, rather than an estuary, the Altered Salinity Gradients issue does not apply.

The LR GEIS lists one Category 2 issue for surface water resources—surface water use conflicts (plants with cooling ponds or cooling towers using makeup water from a river) (NRC 2024-TN10161). The water required to operate CPS is sourced from Clinton Lake, rather than from a river (CEG 2024-TN10806) Therefore, the Category 2 issue related to surface water resources does not apply to CPS.

3.5.3.2 Groundwater Resources

As documented in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1 of this SEIS, for generic groundwater resources issues, the impacts of nuclear power plant LR and continued operations would be SMALL for the Category 1 issue applicable to CPS: groundwater contamination and use (non-cooling system impacts).

The applicable Category 1 issue was determined to result in a SMALL impact in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN10253). No significant groundwater impacts with respect to Category 1 (generic) issues are anticipated during the LR term that would be different from those occurring during the current license term. As discussed in Section 3.5.2 of this SEIS, NRC staff performed a review of groundwater use and quality. This review, including the independent review of the ER, the scoping process, the audit, and evaluation of available information, did not identify any new and significant information that would change the conclusion reached in the LR GEIS. Based on this review, the NRC staff concludes the following:

> No dewatering for groundwater control is expected during the renewal period. No discharges to groundwater requiring permits by regulatory agencies are expected during the renewal period. There are currently no regulated discharges to groundwater, and none were identified by the applicant to occur during the renewal period.

As a result, as concluded in the LR GEIS (NRC 2024-TN10161) for these Category 1 (generic) issues that are reported in Table 3-1 of this SEIS, the impacts on groundwater resources of continued operation of CPS would be SMALL.

As shown in Table 3-2 of this SEIS, the NRC staff identified two site-specific Category 2 issues related to groundwater resources applicable to CPS during the LR term. The Category 2 issues, groundwater quality degradation (plants with cooling ponds) and radionuclides released to groundwater, are analyzed below.

3.5.3.2.1 Groundwater quality degradation (plants with cooling ponds)

The LR GEIS combines two issues from the 2013 LR GEIS which both considered the possibility of groundwater quality becoming degraded as a result of the migration of contaminants discharged to cooling ponds. The issue of groundwater quality degradation (plants with cooling ponds) was discussed and evaluated in CEG's response to the NRC staff's request for available information (CEG 2024-TN10914: Attachment 59). CPS discharges process wastewaters to both the west and east arms of Clinton Lake in accordance with the site's NPDES permit (No. IL0036919; CEG 2024-TN10806: Appendix B). As described in Section 3.5.1.3 of this SEIS, the water quality of Clinton Lake is controlled and assessed by multiple programs, including Section 303(b) and 303(d) of the CWA, NPDES permit, and the

Radiological Environmental Monitoring Program (REMP). In 2020 and 2022, Clinton Lake was classified as “impaired” by the IEPA for aesthetic quality and total phosphorous. Additionally, all surface water samples collected from Clinton Lake as part of the site’s REMP were below applicable lower limits of detection for tritium and gamma-emitting nuclides for the past 5 years. CEG implements site-specific procedures for reducing the potential for onsite spills to impact offsite resources, (e.g., SWPPP, SPCC) and utilizes BMPs to prevent or reduce pollutant discharges. Therefore, the NRC staff concludes that the impacts of continued operation of CPS during the LR term on groundwater degradation from cooling pond operation would be SMALL.

3.5.3.2.2 Radionuclides released to groundwater

The issue of radionuclides released to groundwater was considered in the LR GEIS (NRC 2024-TN10161) due to accidental releases of liquids containing radioactive material into the groundwater at power reactor sites (NRC 2023-TN9980). Most of the inadvertent releases that have occurred at operating plants involved leaks of water containing tritium or other radioactive isotopes from spent fuel pools, buried piping, or failed valves on effluent discharge lines. In 2006, the NRC released a report titled, “Liquid Radioactive Release Lessons Learned Task Force Report,” documenting lessons learned from a review of these incidents that ultimately concluded that these instances had not adversely affected public health and safety (NRC 2006-TN1000). This report concluded, in general, that groundwater affected by radionuclide releases is expected to remain onsite, but that instances of offsite migration have occurred. Therefore, the LR GEIS (NRC 2024-TN10161) determined that impacts on groundwater quality from the release of radionuclides could be SMALL or MODERATE, depending on the magnitude of the leak, the radionuclides involved, hydrogeologic factors, distance to receptors, and the response time of plant personnel to identify and stop the leak. Consistent with the LR GEIS, this is a Category 2 issue requiring a site-specific evaluation and that evaluation with respect to CPS LR is provided below.

The issue of radionuclides released to groundwater was discussed and evaluated in Sections 3.6.4.2 and 4.5.5 of the ER (CEG 2024-TN10806). CEG monitors groundwater at the CPS site for inadvertent releases as part of its radiological groundwater protection program, which was implemented to conform to Nuclear Energy Institute (NEI) 07-07 (NEI 2019-TN6775) and to satisfy the requirements of 10 CFR 20.1501 (TN283). Section 3.6.4.2 of the ER (CEG 2024-TN10806) describes the detection of low levels (less than 1,500 pCi/L) of tritium in site groundwater samples. Based on its review of the available information, the NRC staff concludes that low levels of tritium present in in groundwater samples are not indicative of inadvertent releases from the plant but likely residual tritium in groundwater from a historical release in 2006 from an old cycled condensate storage tank. The detections of tritium in groundwater do not occur in an increasing trend, and no tritium has not been detected in deeper, semi-confined groundwater in the Glasford Formation above 200 pCi/L from 2018 to 2023. The NRC staff concludes that these sample results do not indicate an inadvertent release of radionuclides to groundwater. Moreover, if a significant release occurred to groundwater that reaches the site boundary, it would be discharged to Clinton Lake either via groundwater discharge or the Unit 2 Pit outfall. Any discharge from the plant would be mixed and diluted by the water in the lake, which is also monitored for tritium as part of the REMP.

Therefore, the NRC staff concludes that groundwater resource impacts due to the release of radionuclides to groundwater would be SMALL during the CPS LR term.

3.5.4 No-Action Alternative

3.5.4.1 Surface Water Resources

Under the no-action alternative, the NRC would not renew the CPS operating license and CPS operations would cease at the end of the current license term. With the cessation of operations, there would be a large reduction in the amount of water withdrawn from the Clinton Lake. Wastewater discharges would also greatly decrease. Stormwater runoff would continue to be discharged from the site. As a result, CPS shutdown would reduce the overall impacts on surface water use and quality. Therefore, the NRC staff concludes that the impact of the no-action alternative on surface water resources would be SMALL.

3.5.4.2 Groundwater Resources

Under the no-action alternative, the NRC would not renew the CPS operating license and CPS operations would cease at the end of the current license term. With the cessation of operations, there would be little or no additional impact on groundwater quality. Any contamination of onsite soil and groundwater would be assessed during decommissioning, whether the plant is decommissioned at the end of the current licensing period or at the end of the initial LR term. A license termination plan would describe actions needed for site remediation to meet the NRC criteria for radiologic dose and site-specific clean up criteria to be met before release of the CPS site. Groundwater use for site maintenance prior to decommissioning would be no greater than current use. Therefore, the NRC staff concludes that the impact of the no-action alternative on groundwater resources would be SMALL.

3.5.5 Replacement Power Alternatives: Common Impacts

3.5.5.1 Surface Water Resources

Construction

Construction activities associated with replacement power alternatives may cause temporary impacts on surface water quality by increasing sediment loading to water bodies and waterways. Construction of intake and discharge structures, if needed, could result in water activities including dredge-and-fill, underwater construction, and tunneling. Construction activities might also affect surface water quality through pollutants in stormwater runoff from disturbed areas and excavations, spills and leaks from construction equipment, and from sediment and other pollutants disturbed due to associated dredge-and-fill activities. These pollutants could be detrimental to downstream surface water quality, where applicable, and to ambient water quality in waterways near work sites.

Facility construction activities might alter surface water drainage features within the construction footprints of replacement power facilities, including any wetland areas. Impervious areas may increase, resulting in a potential for greater and quicker surface runoff. Potential hydrologic impacts would vary depending on the nature and acreage of the land area disturbed and the intensity of excavation work. Changes in stormwater runoff volume, timing, and quality are usually controlled and managed with applicable Federal, State, and local permits and the implementation of BMPs.

The NRC staff assumes that construction contractors would implement BMPs for soil erosion and sediment control to minimize water quality impacts in accordance with applicable Federal,

State, and local permitting requirements. These measures would include spill prevention and response procedures, such as measures to avoid and respond to spills and leaks of fuels and other materials from construction equipment and activities. Surface water use during construction is generally related to concrete preparation, dust suppression, and potable and sanitary water for the workforce and is limited to the construction duration. These water needs are usually small compared to cooling water needs during thermoelectric plant operation.

Operations

Thermoelectric generation requires surface water for the cooling of plant components which, may require new water use permits from and agreements with State and local agencies if the construction of permanent intake structures are required. Potable and sanitary water use for the plant would depend on the workforce size and, therefore, may also require new potable water use permits from and sanitary water disposal agreements with local agencies or municipalities.

Discharge of wastewater including cooling system discharges would require permits from Federal, State, and local agencies, including a certification that the discharges are consistent with State water quality standards. Wastewater discharges would be subject to treatment, monitoring and reporting requirements of relevant permitting agencies. The NRC staff assumes that plant operations would follow the requirements of any applicable Federal, State, and local permits.

3.5.5.2 Groundwater Resources

Construction

Excavation dewatering for foundations and substructures during construction of power generation facilities, as applicable, may be required to stabilize slopes and permit placement of foundations and substructures below the water table or in areas of perched groundwater. Groundwater levels in the immediate area surrounding an excavation may be temporarily affected, depending on the duration of dewatering and the methods (e.g., cofferdams, sheet piling, sumps, and dewatering wells) used for dewatering. The NRC staff expects that any impacts on groundwater flow and quality caused by dewatering would be highly localized, would be of short duration, and would not affect offsite groundwater users. Discharges resulting from dewatering operations would be released in accordance with applicable State and local permits, as described above.

Although foundations, substructures, and backfill may alter onsite groundwater flow patterns, local and regional trends would remain unaffected. Construction of power generating facilities may contribute to onsite changes in groundwater infiltration and quality due to the removal of vegetation and construction of buildings, parking lots, and other impervious surfaces. The potential impacts of increased runoff and subsurface pollutant infiltration or discharge to nearby water bodies would be prevented or mitigated through implementation of BMPs and a SWPPP.

In addition to construction dewatering, onsite groundwater could be used to support construction activities (e.g., dust abatement, soil compaction, and water for concrete batch plants). Groundwater withdrawal during construction could temporarily affect local water tables or groundwater flow, and these withdrawals and resulting discharges would be subject to applicable permitting requirements.

Operations

Due to the relatively low hydraulic conductivity of the glacial till at the CPS site, it is considered unlikely that dewatering for building foundations and substructures would be required during the operational life of the power facility. However, operational dewatering rates, if required due to the intersection of more conductive sand and gravel lenses, would likely be lower than the rates required for construction and would be managed subject to applicable permitting requirements. Dewatering discharges and treatment would be properly managed in accordance with applicable NPDES permitting requirements. NRC staff expects that any impacts on groundwater flow and quality affected by dewatering would be highly localized, and that there would be no effects on offsite groundwater users due to the site location adjacent to Clinton Lake.

Effluent discharges (e.g., cooling water, sanitary wastewater, and stormwater) from a facility are subject to applicable Federal, State, and other permits specifying discharge standards and monitoring requirements. Adherence to proper procedures by power facility operators during all material, chemical, and waste handling and conveyance activities would reduce the potential for any releases to the environment, including releases to the subsurface and groundwater.

Groundwater use during operation for the replacement power alternatives is assumed to be less than 100 gpm (380 lpm), which would likely have a minimal impact on surrounding offsite groundwater use or quality. Onsite groundwater withdrawals would be subject to applicable State water appropriation, permitting, and registration requirements.

3.5.6 Natural Gas Alternative

3.5.6.1 Surface Water Resources

This alternative consists of an NGCC plant with a design capacity of 1,241 MWe (gross)/ 1,080 MWe (assuming an 87 percent capacity factor) constructed at the CPS site (EIA 2022-TN10537). The NGCC plant would use MDCTs with Clinton Lake as the source of makeup water. As described in Section 3.5.1.2, Clinton Lake was constructed to provide water required to operate CPS, which is its only significant water user (CEG 2024-TN10806). CPS does not have an explicit annual limit on water withdrawals from Clinton Lake (CEG 2024-TN10914: Attachment 13). The hydrologic and water quality assumptions for construction and operation described in Section 3.5.5.1 of this SEIS as common impacts to all replacement power alternatives also apply to this alternative.

The water withdrawal rates of the proposed NGCC plant would be less than that of the current CPS unit, although its consumptive water use would be higher (CEG 2024-TN10806). NGCC water use would be primarily associated with cooling water makeup. While the proposed NGCC plant has a higher water consumption rate than the current CPS unit, it is less than that of an equivalent conventional light-water reactor nuclear plant with cooling towers. NRC staff notes that the LR GEIS (NRC 2024-TN10161) classifies surface water use conflicts for a conventional light-water reactor nuclear plant with cooling towers which does not receive makeup water from a river as a Category 1 issue. The NRC previously assessed the water use impact from the addition of nuclear units at CPS with a capacity of 2,200 MWe (NRC 2006-TN672). The NRC determined the impact of increasing water use of Clinton Lake from additional nuclear units would be SMALL except in years of below-average precipitation, when it could be MODERATE (NRC 2006-TN672: Section 5.3.2). The NRC staff notes that for the current analysis, the NGCC plant would replace, rather than supplement, the existing CPS unit. The operational work force needed for a NGCC plant is less than that currently at CPS; therefore, the potable and sanitary water demands should also be less.

Some water quality impacts could result from erosion and runoff associated with construction and operations that would be controlled by implementation of BMPs and compliance with stormwater permits along with applicable regulations. The use of Clinton Lake for plant discharges would require compliance with appropriate NPDES permits. Based on this analysis, the NRC staff concludes that the overall impacts on surface water resources from construction and operation under the NGCC alternative would be SMALL.

3.5.6.2 Groundwater Resources

The new NGCC plant required for this activity would be constructed on an available land parcel originally analyzed in the 2006 EIS for an ESP at the CPS site (NRC 2006-TN672) for siting an additional nuclear unit. The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5 of this SEIS as being common to all replacement power alternatives also apply to this alternative. Although water withdrawal and consumptive demands would likely be less than what is required by the current site, it is unlikely groundwater use would occur due to the abundant surface water sources (i.e., Clinton Lake) and potentially poor-quality groundwater due to naturally occurring methane in the vicinity of the site. Therefore, NRC staff concludes that the impacts to groundwater resources from construction and operation under the natural gas alternative would be SMALL.

3.5.7 Renewable and Natural Gas Combination Alternative

3.5.7.1 Surface Water Resources

This alternative includes a proposed 1,000 MWe/870 MWe (87 percent capacity factor) NGCC plant located at the CPS site, 652 MW of onsite and offsite wind installations with battery storage, and 216 MW of onsite and offsite solar installations with battery storage. The surface water use and quality impacts for the combination NGCC plant would be less than those described for the NGCC alternative discussed in Section 3.5.6.1 of this SEIS due to its smaller generating capacity.

The construction of the solar fields, wind turbines, and transmission lines would require water for dust suppression, equipment washing, and sanitary systems. No water is required for operation of wind or solar installations beyond a small amount for periodic washing of the solar panels. Water demands during construction and operation of the onsite portion of the replacement options would be sourced from Clinton Lake, while offsite needs could be met by trucked-in water or onsite or nearby surface or groundwater resources (CEG 2024-TN10806). The operational work force needed for the renewables and natural gas alternative is less than that currently at CPS, therefore, the potable and sanitary water demands should also be less. Based on the above analysis, the NRC staff concludes that the overall impacts on surface water resources from construction and operations of the renewables and natural gas alternative would likely be SMALL.

3.5.7.2 Groundwater Resources

The hydrologic and water quality assumptions and implications for construction and operations described in Section 3.5.5.2 (of this SEIS) as being common to all replacement power alternatives would apply to the renewable and natural gas combination alternative. The NRC staff assumes that the cooling water for the NGCC plant would be sourced from Clinton Lake or nearby surface water sources (i.e., not derived from a groundwater source). The wind and solar systems as part of this alternative do not require cooling systems. The NRC staff did not identify

any impacts on groundwater resources for this alternative beyond those discussed above as being common to all replacement power alternatives. Therefore, NRC staff concludes that the impacts on groundwater resources from construction and operations under the renewable and natural gas combination alternative would be SMALL.

3.5.8 Purchased Power Alternative

3.5.8.1 Surface Water Resources

The impacts of purchased power on surface water resources are likely to be similar to the common impacts discussed in Section 3.5.5.1 of this SEIS and bounded by the operational impact description for the renewable and natural gas combination alternative. Certain types of power generation would withdraw and consume various quantities of water for cooling purposes. Additionally, operation of these facilities are expected to result in permitted discharges of pollutants typically associated with industrial activities. Pollutants may also impact surface water resources via stormwater; however, it is expected that these impacts would be mitigated via adherence to stormwater permits, implementation of stormwater BMPs and maintenance of stormwater infrastructure. Therefore, based on this information, the NRC staff concludes that the impacts of this alternative on surface water resources would be SMALL.

3.5.8.2 Groundwater Resources

The impacts of purchased power on groundwater resources are likely to be similar to the common impacts discussion in Section 3.5.5.2 of this SEIS and bounded by the operational impact description for the renewable and natural gas combination alternative. Operation of energy generating facilities would not be expected to result in incremental impacts on groundwater use and quality. Therefore, based on this information, NRC staff concludes that the impacts of this alternative on groundwater resources would be SMALL.

3.6 Terrestrial Resources

This section describes the terrestrial resources of the CPS site and the surrounding landscape based on the NRC staff's independent review for the initial CPS operating license (NRC 1982-TN11190), the applicant's ER (CEG 2024-TN10806), and other publicly available information. Following the description, the NRC staff analyzes the potential impacts on terrestrial resources from the proposed action of LR and alternatives to the proposed action.

3.6.1 Ecoregion

The Central Corn Belt Plains (EPA Level III Ecoregion 54) consist of extensive prairie communities intermixed with oak-hickory forests that were native to the glaciated plains, with natural vegetation gradually replaced by agricultural type (EPA 2013-TN9981, EPA 2013-TN8737). Farms in this region mainly produce corn and soybeans and raise cattle, sheep, poultry, and especially hogs. The CPS site lies within a subregion of the Central Corn Belt Plains known as the Illinois/Indiana Prairies (EPA Level IV Ecoregion 54a) (Woods et. al. 2006-TN10788), which includes vast, glaciated, flat to rolling plains characterized by dark, very fertile soils that developed under tall-grass prairie; in addition, marshes and wet prairies naturally occurred in poorly drained areas, and forests grew on concentric moraines and floodplains.

The U.S. Army Corps of Engineers (USACE) defines wetlands as areas either inundated or saturated by surface or groundwater at a frequency and duration sufficient to support (and that

under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions (16 U.S.C. § 3902(5)-TN10912). In its ER (CEG 2024-TN10806: Section 3.7.2.4), CEG characterizes the National Wetlands Inventory features within a 6 mi (10 km) radius of the CPS site as follows:

- lakes—4,450 ac (1,801 ha)
- freshwater forested/shrub wetland—304 ac (123 ha)
- riverine waters—288 ac (117 ha)
- freshwater ponds—91 ac (37 ha)
- freshwater emergent wetlands—63 ac (25 ha)

3.6.2 Clinton Power Station Site

The CPS site consists of 13,626 ac (5,514 ha) adjacent to Clinton Lake. About 5.4 percent of the CPS site consists of developed land cover types, 36.1 percent is open water, and the remaining 58.5 percent of the site is vegetated (CEG 2024-TN10806: Table 3.2-1). Forests and agriculture are the dominant vegetation cover types, covering about 33.9 percent and 20.0 percent of the CPS site. Deciduous forest cover is about 22.5 percent, mixed forest is about 10.8 percent, and evergreen forest is about 0.6 percent. About 12.3 percent of the site consists of cultivated crops, and 7.7 percent is hay/pasture. All other vegetation types cover less than 4.6 percent of the site: grassland/herbaceous, wetlands (woody wetlands and emergent herbaceous wetlands), shrub/scrub, and barren land.

The descriptions in the ER (CEG 2024-TN10806: Section 3.7.2.3) characterize the terrestrial habitats within the CPS site boundary. Habitat descriptions of associated tree, shrub, and herbaceous strata are incorporated here by reference: upland forests, upland pastures, and open fields.

The CPS site boundary contains a total of 5,210 ac (2,108 ha) of wetlands, lakes, ponds, and riverine waters (CEG 2024-TN10806: Section 3.7.2.4). Table 3-11 below summarizes the area and percentage of wetlands and surface water features on the CPS site as documented in the National Wetlands Inventory. Figure 3-10 below shows the location of the National Wetland Inventory wetlands on a map of the CPS site.

Table 3-11 Wetlands and Surface Water Features on the Clinton Power Station Site

Wetland or Water Feature	Acres	Percent of Onsite Wetland Habitat
Lakes	4,837	92.84
Freshwater Forested/Shrub Wetlands	231	4.43
Riverine Waters	69	1.33
Freshwater Emergent Wetlands	45	0.86
Freshwater Ponds	28	0.54
Total	**5,210**	**100.00**

Source: CEG 2024-TN10806: Section 3.7.2.4.



Figure 3-10 Wetlands on the Clinton Power Station (CPS) Site as Documented by the National Wetlands Inventory. Source: CEG 2024-TN10806: Figure 3.7-2.

Two wetland delineations, one in 2014 and another in 2018, were performed at the CPS site to determine the presence, extent, and quality of wetlands and waters of the United States (CEG 2024-TN10806: Section 3.7.2.4). In 2014, the wetland delineators evaluated approximately 32 ac (13 ha) and delineated two features: Area 1 (approximately 0.48 ac [0.19 ha], determined to be an isolated regulatory wetland not regulated by USACE) and Area 2 (approximately 0.91 ac [0.37 ha], determined to be a wetland subject to USACE regulation). In 2018, the wetland delineators evaluated approximately 9 ac (4 ha) and delineated two features, which were both drainage ditches (totalling approximately 0.38 ac [0.15 ha]). Both drainage ditches were identified as humanmade and excavated for construction of the discharge flume.

Wildlife species occurring on the CPS site consist of those species typically found around the central Illinois region (CEG 2024-TN10806: Section 3.7.2.5). Table 3.7-4 in CEG's ER presents a list of terrestrial species likely to be observed in DeWitt County and is incorporated by reference; this list includes 17 mammals, 27 birds, 6 amphibians, and 15 reptiles.

CEG's ER presents a list of terrestrial mammal species known to occur within the vicinity of the CPS site (CEG 2024-TN10806: Section 3.7.2.5). These species include deer mouse (*Peromyscus maniculatus*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), various shrew species (including shorttail and least shrews [*Blarina brevicauda* and *Cryptotis parva*, respectively], white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), beaver (*Castor canadensis*), coyote (*Canis latrans*), fox (*Vulpes fulva* or *Urocyon cinereoargenteus),* muskrat (*Ondatra zibethicus*), opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), mink (*Mustela vison*), and thirteen-lined ground squirrel (*Citellus tridecemlineatus*).

Birds on the CPS site and vicinity include a mix of resident bird species, seasonal residents, and birds stopping briefly during migration (CEG 2024-TN10806: Section 3.7.2.5). The CPS site is located within the Mississippi flyway (FWS 2024-TN10908), an important bird migration route which extends from the Gulf Coast to the Arctic Circle. Migrant birds often fly at night, landing to rest early in the morning. Suitable habitats that allow migratory birds to feed, rest, and avoid predators are called stopovers. Large natural barriers may create crowded stopover locations because flights over the barriers mean long stretches without opportunities to rest or feed. Along the Mississippi flyway, Hudson Bay and the Great Lakes are major barriers. Many species of migratory birds likely use the CPS site and vicinity during the spring and fall migrations.

3.6.3 Important Species and Habitats

3.6.3.1 Federally Listed Species

For a discussion of terrestrial species and habitats that are federally protected under the ESA (16 U.S.C. 1531 et seq.-TN1010), see Section 3.8 of this SEIS.

3.6.3.2 State-Listed Species

CEG (CEG 2024-TN10806: Table 3.7-5) provided a list of species known to occur within DeWitt County that are designated as endangered or threatened by the U.S. Fish and Wildlife Service (FWS) or by the State of Illinois. CEG evaluated the two species that are State-listed but not federally listed separately in its ER (CEG 2024-TN10806: Section 3.7.8.2). In its independent review, the NRC staff determined that other State-listed species occur on site or have the potential to occur to occur site. Table 3-12 below summarizes the NRC staff's analysis of State-listed species occurrence.

Table 3-12 State-Listed Species (That Are Not Also Federally Listed), Potentially Occurring in the Vicinity of Clinton Power Station

Common Name	Scientific Name	Class	State Legal Status
Common Tern[(a)]	*Sterna hirundo*	Birds	Endangered
Northern Harrier[(a)]	*Circus hudsonius*	Bird	Endangered
Snowy Egret[(a)]	*Egretta thula*	Birds	Endangered
Osprey[(a,b)]	*Pandion haliaetus*	Birds	Threatened
Kirtland's Snake[(a)]	*Clonophis kirtlandii*	Reptile	Threatened

(a) Species known to occur within CPS site boundary.
(b) Species known to occur at the CPS site.
Sources: CEG 2024-TN10806: Section 3.7.8.2 and 4.6.6.4; IDNR 2020-TN10910; eBird 2024-TN11176.

Osprey (*Pandion haliaetus*) is State-listed as threatened (IDNR 2020-TN10910). Species information is compiled from Cornell (AAB 2024-TN10911). The widespread decrease observed in osprey population numbers in the early 1950s to 1970s was mainly from the use of the pesticide DDT. Osprey feed almost exclusively on fish. Nests are built in open areas, on tall trees, snags, cliffs, or human-built structures. An osprey nest occurs on the primary meteorological tower onsite (CEG 2024-TN10914: Attachment 25). No young have been observed since the nest was first documented in August 2021. CEG has no plans to remove the nest. Should removal become necessary, CEG would coordinate with the State and a contracted vendor with a valid migratory bird permit (CEG 2024-TN10914: Attachment 28).

Kirtland's snake (*Clonophis kirtlandii*) is State-listed as threatened (CEG 2024-TN10806: Section 3.7.8.2.3). Its threatened status is mainly due to habitat loss from impacts to prairie wetlands and reduction of earthworm populations. This snake uses aquatic habitats, but it is often found on land, living in or near wet meadows, swamps, wooded hillsides, and adjacent meadows, parks, and urban areas. It hides under rocks, boards or in crayfish burrows during the day. Mating occurs in May and the female gives birth in August or September. During a transect survey conducted in 2019, south of the Salt Creek dam in the southern end of the CPS property, a total of five Kirtland's snakes were observed, and a breeding population was identified with the presence of male, female, and juvenile individuals.

The northern harrier (*Circus hudsonius*) is State-listed as endangered (CEG 2024-TN10806: Section 3.7.8.2.2). The northern harrier is a common migrant and uncommon winter and summer resident in Illinois, wintering in Central and South America. The northern harrier lives in marshes or fields. Spring migration begins in late February, and nesting occurs from May through July. Fall migrants begin appearing in July. Northern harrier was observed in November 2024 at the Clinton Lake State Recreation Area Upper Lake Flats area (eBird 2024-TN11176).

Common tern (*Sterna hirundo*) is State-listed as endangered (IDNR 2020-TN10910). Species information is compiled from IDNR (2025-TN11178)._Common terns are a common migrant statewide but are a rare summer resident on Lake Michigan. They nest in colonies on sand or gravel and have nested on small islands offshore of Lake Michigan. Fall migrations begin in August. Common terns winter in the southern United States to South America. Common tern was observed in May 2024 at the Clinton Lake State Recreation Area Mascoutin Beach and Boat Ramp (eBird 2024-TN11176).

Snowy egret (*Egretta thula*) is State-listed as endangered (IDNR 2020-TN10910). Species information is compiled from IDNR 2025-TN11179. Snowy egrets are a rare Illinois migrant and are summer residents along the Mississippi River. They live near wetlands and water bodies, as well as flooded fields, lowland thickets, and forests. This wading bird feeds on amphibians, crayfish, fish, and insects. Snowy egret was observed in August 2024 at the Clinton Lake State Recreation Area Upper Lake Flats (eBird 2024-TN11176).

3.6.3.3 Species Protected under the Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d et seq.-TN1447) extends regulatory protections to the bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*). The Act prohibits anyone without a permit from the Secretary of the Interior from "taking" bald eagles or golden eagles, including their parts, nests, or eggs.

CEG describes eagle occurrences and nesting in the vicinity (CEG 2024-TN10806: Section 3.7.8.3). Bald eagles have been observed in the vicinity of the CPS site, at the Clinton

Lake Marina (eBird 2024-TN11176). CEG reports no bald eagles or bald eagle nests at the CPS operating station itself. Golden eagles are not expected to occur on the site or vicinity (FWS 2024-TN11003).

3.6.3.4 Species Protected under the Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918, as amended (MBTA) (16 U.S.C. 703 et seq.-TN3331), makes it illegal for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale any migratory bird or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued under Federal regulations. FWS designates certain migratory bird species as Birds of Conservation Concern (BCC) (FWS 2021-TN8740), to represent their highest conservation priorities for those birds that are not already designated as federally threatened or endangered.

Of the 299 bird species known to occur in DeWitt County (eBird 2024-TN11176), 290 are protected by the MBTA (88 FR 49310-TN9704). The known range of several federally listed migratory birds overlaps with the CPS site (Section 3.8 of this SEIS), and four State-Listed birds have been documented to occur within the CPS site boundary. CEG's ER states that 96 bird species have been identified in the vicinity during the spring and fall (ER Section 3.7.2.5, incorporated by reference). FWS (2024-TN11003) provided a list of 20 migratory birds that could occur within the CPS site and are of particular concern for the project because they are an eagle or are on the BCC list: bald eagle, American golden-plover (*Pluvialis dominica*), blackbilled cuckoo (*Coccyzus erythropthalmus*), bobolink (*Dolichonyx oryzivorus*), cerulean warbler (*Dendroica cerulea*), chimney swift (*Chaetura pelagica*), grasshopper sparrow (*Ammodramus savannarum perpallidus*), Henslow's sparrow (*Ammodramus henslowii)*, Hudsonian godwit (*Limosa haemastica*), Kentucky warbler (*Oporornis formosus*), lesser yellowlegs (*Tringa flavipes*), pectoral sandpiper (*Calidris melanotos*), prothonotary warbler (*Protonotaria citrea*), red-headed woodpecker (*Melanerpes erythrocephalus*), ruddy turnstone (*Arenaria interpres morinella*), rusty blackbird (Euphagus carolinus), semipalmated sandpiper (*Calidris pusilla*), short-billed dowitcher (*Limnodromus griseus*), upland sandpiper (*Bartramia longicauda*) and wood thrush *(Hylocichla mustelina*). Of these 20 species, 8 breed elsewhere and 12 potentially breed within the site (FWS 2024-TN11003).

As described in CEG's ER (CEG 2024-TN10806: Sections 2.2.5.3, 3.7.8.4), CEG has a corporate avian and wildlife management plan and incorporates industry BMPs to minimize interactions, deaths, and injuries to migratory birds. The plan contains measures, precautions, and guidance for handling dead or injured migratory birds. CEG coordinates with Federal and State officials regarding migratory bird issues and contracts with vendors who have migratory bird permits to handle migratory birds and their nests (CEG 2024-TN10914: Attachment 28). Although Agrilaser systems were purchased in 2020 to deter nesting geese (CEG 2024-TN10806: Section 3.7.8.4; CEG 2024-TN10914: Attachment 27), they were never installed due to potential worker safety concerns. To deter Canada goose (*Branta canadensis*) nesting, CEG uses an external vendor with a valid migratory bird permit.

Tall structures and buildings can pose a collision hazard to migratory birds. CEG has a number of tall structures and buildings onsite (CEG 2024-TN10914: Attachments 23 and 24). Both meteorological towers are guyed, lit, and over 200 ft above ground height. The tallest building is 191 ft above ground height. CEG has documented 23 bird deaths in 12 incidents from 2013-2024 (CEG 2024-TN10914: Attachment 61).

3.6.3.5 Invasive Species

Executive Order 13751 identifies invasive species as nonnative organisms whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health (81 FR 88609-TN8375). Executive Order 13112 directs Federal agencies to not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species unless the Federal agency determines that the benefits of the action clearly outweigh the harm from invasive species and that all feasible and prudent measures to minimize risk of harm are taken (64 FR 6183-TN4477: Section 2).

In its ER (CEG 2024-TN10806: Section 3.7.5), CEG stated that it has procedures for monitoring and control of invasive species for specific areas of its property: areas under in-scope transmission lines and areas where active grassland restoration has occurred. The following terrestrial invasive species are known to occur within DeWitt County (ER Section 3.7.5):

- Mammals: feral swine (*Sus scrofa*)
- Insects: emerald ash borer (*Agrilus planipennis*), Asian longhorned beetle (*Anoplophora glabripennis*), gypsy moth (*Lymantria dispar*)
- Plants: poison hemlock (*Conium maculatum),* tree-of-heaven (*Ailanthus altissima*), mimosa (*Albizia julibrissin*), autumn olive (*Elaeagnus umbellate*), glossy buckthorn (*Frangula alnus*), Japanese barberry (*Berberis thunbergia*), Amur honeysuckle (*Lonicera maackii*), Morrow's honeysuckle (*Lonicera morrowii*), Tartarian honeysuckle (*Lonicera tatarica*), Callery pear (or Bradford pear; *Pyrus calleryana*), princess tree (*Paulownia tomentosa*), European buckthorn (common buckthorn; *Rhamnus cathartica*), black locust (*Robinia pseudoacacia*), multiflora rose (*Rosa multiflora*), winged burning bush (*Euonymus alatus*), Chinese privet (*Ligustrum sinense*), Japanese chaff flower (*Achyranthes japonica*), garlic mustard (*Alliaria petiolata*), musk thistle (*Carduus nutans*), spotted knapweed (*Centaurea stoebe* ssp. *micranthos*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), black dog-strangling vine (*Vincetoxicum nigrum*), common teasel (*Dipsacus fullonum*), cut-leaved teasel (*Dipsacus laciniatus*), leafy spurge (*Euphorbia esula*), giant hogweed (*Heracleum mantegazzianum),* bicolor lespedeza (*Lespedeza bicolor*), sericea lespedeza (*Lespedeza cuneata*), crownvetch (*Securigera varia*), Japanese stiltgrass (*Microstegium vimineum*), chocolate vine (*Akebia* sp.) (*Akebia quinata*), Oriental bittersweet (*Celastrus orbiculatus*), Chinese yam (*Dioscorea polystachya*), Japanese hop (*Humulus japonicus*), Japanese honeysuckle (*Lonicera japonica*), kudzu (*Pueraria montana* var. *lobata*), winter creeper (*Euonymus fortunei*)

3.6.3.6 Important Habitats

Important habitats include any wildlife sanctuaries, refuges, preserves, or habitats identified by State or Federal agencies as unique, rare, or of priority for protection; wetlands and floodplains; and land areas identified as critical habitat for species listed by the FWS as threatened or endangered. No designated critical habitat for federally listed species overlaps the CPS site. See Section 3.8 of this SEIS for further details.

Important habitats on and around the CPS site include the Clinton Lake State Recreation Area, Weldon Springs State Recreation Area, and wetlands recognized in the National Wetland Inventory database (CEG 2024-TN10806: Section 3.7.4).

CEG has an active grassland restoration on site and has a cooperative agreement with FWS and Pheasants Forever (a non-profit organization focused on conservation) for the project (CEG 2024-TN10914: Attachment 62, Enclosure 1). The project objective is to establish a native prairie habitat that would attract and benefit pollinators. The project has been ongoing since 2019 and covers approximately 65 ac (26 ha). CEG has no plans to terminate the project during the proposed LR term. Project partners have adopted practices and guidelines for maintaining the restored habitat, including conducting site visits to identify benefits and management needs, controlling invasive and undesirable plant species, adopting BMPs for herbicide mixing and application, and other procedures to benefit grassland species and pollinators.

3.6.4 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, the impacts of the CPS LR and the continued operation of CPS on the six applicable generic Category 1 issues related to terrestrial resources would be SMALL. These Category 1 issues are:

- Exposure of terrestrial organisms to radionuclides.
- Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds).
- Cooling tower impacts on terrestrial plants.
- Bird collisions with plant structures and transmission lines.
- Transmission line ROW management impacts on terrestrial resources.
- Electromagnetic fields on terrestrial plants and animals.

The NRC staff did not identify any new and significant information related to terrestrial resources that would change the environmental impact findings stated in the LR GEIS with respect to the CPS LR. Additionally, the NRC staff did not identify any additional terrestrial resource issues beyond those listed in Table 3-1 of this SEIS that are applicable to the CPS LR.

As described in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-2 of this SEIS, there is one plant-specific Category 2 issue related to terrestrial resources that is applicable to CPS during the LR term: effects on terrestrial resources (non-cooling system impacts). This Category 2 issue is analyzed below. CPS does not draw makeup water from a river. Therefore, the plant-specific (Category 2) issue related to water use conflicts with terrestrial resources (plants with cooling ponds or cooling towers using makeup water from a river) does not apply.

3.6.4.1 Effects on terrestrial resources (non-cooling system impacts)

According to the LR GEIS, non-cooling system impacts on terrestrial resources can include impacts that result from site and landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that would occur during the LR term on and near a nuclear power plant site (NRC 2024-TN10161: Section 4.6.1.1.1). The NRC staff based its analysis in this section on information derived from CEG's ER (CEG 2024-TN10806), unless otherwise cited. CEG has not identified any refurbishment activities during the proposed relicensing term (CEG 2024-TN10806). No further analysis of potential impacts from refurbishment activities is therefore necessary.

CEG states that it would conduct ongoing operational and maintenance activities at CPS throughout the LR term, including landscape maintenance activities, stormwater management, piping installation, and fencing CEG 2024-TN10806: Sections 3.5.3.2, 4.6.5.4.2). The NRC staff expects that physical disturbances would be limited to paved or disturbed areas or to areas of mowed grass or early successional vegetation and would not encroach into wetlands or into the remaining areas of mixed forest. The NRC staff therefore concurs with CEG that the anticipated activities would have only minimal effects on terrestrial resources.

CEG (2024-TN10806: Sections 4.6.5.4.2, 9.6) states that it has administrative controls in place at CPS to ensure that it reviews operational changes or construction activities and minimizes environmental impacts through BMPs, permit modifications, or new permits, as needed. CEG (2024-TN10806: Section 4.6.5.4.2) further states that regulatory programs for issues like stormwater management, spill prevention, dredging, and herbicides further minimize impacts on terrestrial resources. The NRC staff concurs that continued adherence to environmental management practices and BMPs already established for CPS would continue to protect terrestrial resources during the LR term. The NRC staff presumes that CEG would continue to comply with applicable requirements of Federal and State regulatory programs. CEG has procedures and policies relating to the handling and management of migratory birds (CEG 2024-TN10806: Sections 3.7.8.5 and 4.6.6.4.4).

Operational noise from CPS facilities extends into the remaining natural areas on the plant site. However, the CPS has exposed these habitats to similar operational noise levels since it began construction approximately 55 years ago. The NRC staff therefore expects that wildlife in the affected habitats have long ago acclimated to the noise and human activity of CPS operations and adjusted behavior patterns accordingly. Continued operational noise at similar levels during the 20-year LR term is therefore unlikely to noticeably change the patterns of wildlife movement and habitat use.

Based on its independent review, the NRC staff concludes that the landscape maintenance activities, stormwater management, elevated noise levels, and other ongoing operations and maintenance activities that CEG might undertake during the LR term would primarily be confined to already disturbed areas of the CPS site. These activities would neither have noticeable effects on terrestrial resources nor would they destabilize any important attribute of the terrestrial resources on or in the vicinity of the site. Accordingly, the NRC staff concludes that non-cooling system impacts on terrestrial resources from non-cooling system activities during the relicensing term would be SMALL.

3.6.5 No-Action Alternative

Under the no-action alternative, the NRC would not renew the operating license, and CPS would shut down on or before the expiration of the current facility operating license. Much of the operational noise and human activity at CPS would cease, thereby reducing disturbance to wildlife in forest cover, grasslands, wetlands, and other natural vegetation on and near the site. However, some continued maintenance of CPS would still be necessary; thus, at least some human activity, noise, and herbicide application would continue at the site with possible impacts resembling, but perhaps of a lower magnitude than, those described for the proposed action. Shutdown itself is unlikely to noticeably alter terrestrial resources. Reduced human activity and frequency of operational noise may constitute minor beneficial effects on wildlife inhabiting nearby natural habitats. The NRC staff therefore concludes that the impacts of the no-action alternative on terrestrial resources during the proposed LR term would be SMALL.

3.6.6 Replacement Power Alternatives: Common Impacts

The analysis of terrestrial resource impacts focuses on the amount of land area that would be affected by the construction and operation of a replacement power-generating facility or facilities, as well as the species that use terrestrial habitats. The NRC staff assumes that the power source originates within Illinois.

Construction would require the permanent commitment of land chosen for industrial use at the site(s) and supporting infrastructure. Material laydown areas and onsite concrete batch plants could also result in temporary land use changes. Existing transmission lines and infrastructure would support each of the replacement power alternatives, thus reducing the need for additional land commitments.

Operation of new power-generating facilities would have impacts associated with the amount of land committed for the permanent use of the replacement power facilities, as well as the effects on the terrestrial resources from emissions, wastes, and noise (NRC 2024-TN10161). Terrestrial biota can interact with plant buildings, structures, powerlines, and vehicle (NRC 2024-TN10161). The NRC staff assumes that the applicant would conduct required ecological surveys and develop any needed mitigation plans for any protected terrestrial species. The applicant would also have to conduct wetland delineations of affected lands and apply for permits for any wetland fill from the USACE and the State of Illinois. The NRC staff expects that any Federal or State permits authorizing wetland impacts would require mitigation. Wetland losses of this magnitude can typically be mitigated through various forms of compensatory wetland mitigation, such as mitigation banks. The MBTA makes it illegal to take any migratory bird (or parts, nests, or eggs), except under a valid permit issued under Federal regulations. The applicant may need to commission avian impact studies and obtain a permit for the take of MBTA-protected bird species.

3.6.7 Natural Gas Alternative

For the natural gas alternative, the NRC staff assumes that the applicant would replace the generating capacity of CPS with an NGCC plant with a design capacity of 1,241 Mwe (gross)/1,080 MWe. The NGCC facility and MDCTs would be sited on a 96 ac (39 ha) parcel of land on the CPS site, with a 54 ac (22 ha) land requirement. No new transmission corridors would be built. A new 16 mi (26 km) pipeline extension with an assumed 200 ft (60 m) width would be needed, totaling 388 ac (157 ha) of ground disturbance.

The NGCC plant would be sited within the existing fenced industrial area, which was previously disturbed for the construction of CPS (CEG 2024-TN10806: Section 7.2.3.1.7). The clearing of vegetation and tree removal within the industrial area and for the extension of the natural gas pipeline could displace wildlife.

Because the natural gas facility would use existing transmission lines, the NRC staff expects no increased potential in wildlife injury from transmission lines. However, the NGCC plant would require adding new, tall structures to the landscape. The addition of tall structures on the CPS site might result in increased bat or bird mortality or injury from collisions. Construction noise could affect wildlife use on site and adjoining areas. Operational noise from the new cooling towers could also affect wildlife use. However, these noise impacts are unlikely to be different than current conditions.

Based on the preceding analysis, the NRC staff concludes that impacts on terrestrial resources from the NGCC alternative would be SMALL to MODERATE for construction and SMALL for operations.

3.6.8 Renewable and Natural Gas Combination Alternative

The second replacement power alternative combines renewable energy (solar and wind) and natural gas to replace the generating power of CPS. This alternative proposes to construct and operate an NGCC plant with a design capacity of 1,000 MWe (gross), solar installations with battery storage totaling 652 MW, and wind installations with battery storage totaling 540 MW. The total land requirement for this alternative is about 3,714 ac (1,503 ha). The NGCC facility would be sited on a 96 ac (39 ha) parcel of land on the CPS site, with an assumed 35 ac (14 ha) land requirement. No new transmission corridors would be built for the NGCC facility. A new 16 mi (26 km) natural gas pipeline extension with an assumed 200 ft (60 m) width would be needed, totaling ground disturbance spread over 388 ac (157 ha). The wind energy component would require 1,610 ac (650 ha) of land, and the solar component would require 1,620 ac (660 ha) of land. Wind energy installations would be constructed on the CPS site, while solar energy components would be installed at multiple onsite and offsite locations (as needed). Additional acreage would be needed if new transmission line corridors are constructed.

Natural Gas Component

Effects of the natural gas component of the alternative would be similar to those of the natural gas alternative described above in Section 3.6.7. However, because the proposed facility has a design capacity of 1,000 MWe, rather than 1,241 MWe, many of the operational impacts related to natural gas combustion would be less than the natural gas alternative. The NRC staff concludes that the impacts on terrestrial resources from construction of the NGCC portion of the alternative would be SMALL to MODERATE.

Solar Component

About 1,620 ac (660 ha) would be required for the solar energy component of this alternative. Additional acreage would be needed if new transmission line corridors are constructed. Impacts on terrestrial habitats and biota from the construction and operation of solar PV plants would depend largely on the amount of land required and its location. If the lands chosen for the plant's offsite solar installations were previously cleared and used for industrial activity, the impacts on terrestrial resources would be less than if the lands supported undisturbed or minimally disturbed forest, grassland, or wetland habitats containing important species. Vegetation clearing and tree removal would displace wildlife to nearby habitats, but some species would return at the end of construction when temporarily disturbed land is restored. Once in operation, solar plants pose special hazards to birds through collisions with PV equipment and transmission lines, electrocution by substation and distribution lines, and predation by other animals when birds are injured and stunned on the ground after collision (Hathcock 2019-TN8470). Another less understood cause of bird collisions is known as the lake effect theory. Birds, especially migrating waterfowl and shorebirds, perceive the horizontally polarized light of PV solar panels as bodies of water and are injured or killed when they attempt to land on the panels as if they were water (Horvath et al. 2009-TN897). Water seeking insects can also collide with the panels for the same reasons. In large enough numbers, such insect deaths may affect food webs. The Multiagency Avian-Solar Collaborative Working Group is a collection of Federal and State agencies identifying information needs and best practices for reducing the avian impacts of solar energy. Collaboration with government agencies on best practices in the construction and siting of the solar installations can mitigate their impacts on

birds. The NRC staff concludes that the impacts on terrestrial resources from the solar portion of this alternative would be MODERATE to LARGE based on the land requirement for solar generation facilities and transmission corridors, resulting in the significant loss of wildlife, habitats, and vegetation and the increased mortality risk to birds from collisions with solar PVs and new transmission lines.

Wind Component

About 1,610 ac (650 ha) of land would be required for the wind portion of this alternative. Additional acreage would be needed if new transmission line corridors are constructed.

Impacts on terrestrial habitats and biota from the construction and operation of wind farms as part of the combination alternative would depend largely on the amount of land required and location of the land. CEG proposes that wind turbines would be installed entirely onsite. Much of the land that would be cleared is likely to be providing terrestrial habitat (CEG 2024-TN10806: Section 7.2.3.2.7). If the lands chosen for the plants were previously cleared and used for industrial activity, the impacts on terrestrial resources would be less significant than if the lands were forests or grasslands containing important species and habitats. Vegetation clearing and tree removal would displace wildlife to nearby habitats, though some species would return at the end of construction when temporarily disturbed land is restored.

Operation of wind farms would likely cause the injury and/or death of bats and birds that collide with wind turbines (Allison et al. 2019-TN8847). Species composition of deaths varies regionally. Bat collision mortality appears to be largest for migratory tree-roosting species and lowest in areas with the greatest grassland cover around the onshore wind farm (Thompson et al. 2017-TN8746). Most of the observed bird deaths at onshore wind farms are small songbirds (57 percent of deaths) or diurnal raptors (9 percent) (Allison et al. 2019-TN8847). Given that turbines would be placed close to Clinton Lake and that the lake has many birding hotspots for aquatic birds (eBird 2024-TN11176), waterfowl, shorebirds, and waterbirds could also be negatively impacted by siting a wind facility on the CPS site.

Based on the preceding analysis, the NRC staff concludes that impacts on terrestrial resources from construction and operation of the wind portion of this alternative would be MODERATE to LARGE. Construction of the wind farms would result in the loss of vegetation and wildlife habitat, and operational impacts would negatively impact bird and bat populations.

3.6.9 Purchased Power Alternative

The purchased power alternative could have wide-ranging environmental effects that are difficult to assess because this alternative could include a mixture of nuclear, coal and natural gas-fired (until 2045), solar, and wind energy generation across many different sites. The types of operational impacts would likely be similar to the environmental effects discussed in Section 3.6.6 of this SEIS. This alternative could prolong or in some cases intensify environmental effects on terrestrial resources from continued operation of existing generating facilities, such as facilities remaining in operation longer than previously planned or if purchased power relies on older and less-efficient power plants operating at higher levels of power generation than current operations. However, these facilities would likely have BMPs and other procedures in place to ensure that any operational effects to the environment are minimized. Based on this information, terrestrial resource impacts from the purchased power alternative would be SMALL to LARGE depending on location, infrastructure, amount of land required, and operational impacts to birds and bats.

3.7 Aquatic Resources

This section describes the aquatic resources of the affected environment, which are associated with Clinton Lake Reservoir on Salt Creek and North Fork Salt Creek. The NRC staff previously characterized these resources in Section 4.3.4.2 of the 1982 Final Environmental Statement for the Operation of Clinton Power Station (NRC 1982-TN11190) and in Section 2.7.2 of the 1974 Draft Environmental Statement for the Construction of Clinton Power Station (AEC 1974-TN11145), which analyzed impacts to the aquatic environment. Following the description of the aquatic environment, the NRC staff analyzes the potential impacts on these resources that would occur from the proposed action (LR) and alternatives.

3.7.1 Clinton Lake

Clinton Lake is a 4,895 ac (1,981 ha) reservoir located in DeWitt County, Illinois (IDNR 2024-TN10807). The reservoir was created in 1977 and filled in 1978, the year after the construction of the earthen dam across Salt Creek, to provide the cooling water for CPS (CEG 2024-TN10806). The lake has a maximum depth of 40 ft (12 m) near the dam and an average depth of 15 ft (4.5 m). The earthen dam is not equipped with fish passage facilities and fish migration upstream to the reservoir is restricted. The Clinton Lake State Recreation Area surrounds Clinton Lake and encompasses a 9,300 ac (3,764 ha) area monitored and managed by the IDNR for public recreation. The recreational area is mainly used by guests for boating, swimming, and fishing (IDNR 2024-TN10807). Clinton Lake seasonal high water temperatures reach up to 85°F (29.4°C) in the summer and reach seasonal lows around 32°F (0°C) in the winter (USGS 2024-TN10808).

3.7.1.1 Biological Communities

The trophic structure of Clinton Lake includes primary producers (plankton, macrophytes, and periphyton), primary consumers (zooplankton and benthic macroinvertebrates), and bottom feeding, planktivorous, and piscivorous fish that serve as secondary and tertiary consumers. Primary producers are organisms that capture solar energy and synthesize organic compounds from inorganic chemicals. They form the trophic structure's foundation by producing the organic nutrients and energy used by consumers. Primary producers in lake systems include phytoplankton, aquatic macrophytes, and periphyton. Of the three, phytoplankton are the major producers in all but very shallow lakes. Figure 3-11 below illustrates the trophic structure of Clinton Lake.

Plankton

Plankton are small and often microscopic organisms that drift or float in the water column. Phytoplankton are single-celled plant plankton and include diatoms (single-celled, yellow algae) and dinoflagellates (single-celled organism with two flagella). Phytoplankton live suspended in the water column and occur in the limnetic (open water) zone of a lake.

The Illinois Power Company conducted an environmental monitoring program from 1978 to 1986 in the newly created Clinton Lake (IPC 1989-TN10805). Diatoms, green algae, dinoflagellates, and blue-green algae comprised the majority of phytoplankton in Clinton Lake. Shifts in dominant groups from blue-green algae to diatoms to green algae occurred in Clinton Lake throughout this time period.

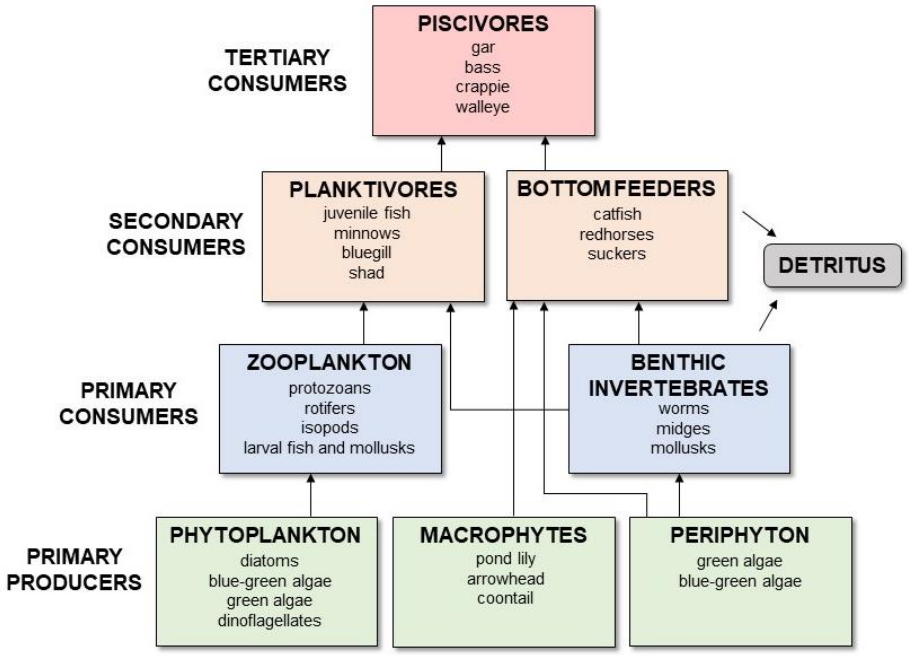

Figure 3-11 Trophic Structure of Clinton Lake's Aquatic Ecosystem

From 1983 to 1991, the CPS environmental monitoring program conducted surveys of the phytoplankton community in Clinton Lake (CEG 2024-TN10914: Attachment 64, Enclosure 2). The 1991 data shows that the average phytoplankton density was around 8.7 million individuals per liter. Researchers identified 54 phytoplankton taxa, which is a normal level of diversity for a freshwater lake. The most abundant taxa were the *Stephanodiscus* (diatom) and *Chlamydomonas* (green algae) genera.

Zooplankton are animals that either spend their entire lives as plankton (e.g., holoplankton) or exist as plankton for a short time during development (e.g., meroplankton). Zooplankton include rotifers, isopods, protozoans, marine gastropods, polychaetes, small crustaceans, and the eggs and larval stages of insects and other aquatic animals.

Between 1978 to 1986, the CPS environmental monitoring program characterized the zooplankton community (IPC 1989-TN10805). Rotifera, Cladocera (water fleas), and Copepoda dominated the community. Their composition suggested productive conditions in Clinton Lake. Over time, the community gradually changed, becoming more similar to those in other Illinois reservoirs as Clinton Lake aged. Dominant organisms and communities showed similar distributions in mid-lake areas, while headwater communities also exhibited similarity. Most of the dominant organisms had greater abundances during spring and fall.

Researchers characterized the zooplankton community along with the phytoplankton surveys conducted from 1983 to 1991 as part of the Clinton Power Station Environmental Monitoring Plan (CEG 2024-TN10806). They found that Clinton Lake contained approximately 186,000 zooplankton per cubic meter, with the most abundant being from the orders Cyclopoida (type of Copepoda), Calanoida (type of Copepoda), and Cladocera.

Illinois researchers studying climate change examined the effect of heated effluent in power plant lakes on zooplankton and other things from 1999 to 2007 (Mulhollem et al. 2016-TN10986). They observed that, despite warmer water temperatures, Clinton Lake's phosphorus, chlorophyll *a*, and water clarity were similar to those in control lakes. However, zooplankton communities differed for power plant lakes, including Clinton, and averaged a concentration of 17 zooplankton per liter, whereas control lakes averaged 61 zooplankton per liter. Power plant lakes, including Clinton, also lacked spring zooplankton peaks. Zooplankton consisted primarily of Calanoida, Cyclopoida, *Bosmina* (type of Cladocera), and *Daphnia*.

Macrophytes and Periphyton

Aquatic macrophytes are large plants, both emergent and submerged, that inhabit shallow water areas. Periphyton consists of single-celled or filamentous species of algae that attach to benthic or macrophytic surfaces. Macrophytes and periphyton occur in the littoral (nearshore and shallow) zone. They tend to be highly productive because they have more access to nutrients through their roots than do phytoplankton. Common periphyton found in Clinton Lake include blue-green algae (*Schizothrix calcicole*), filamentous green algae (*Cladophora* sp.), golden-brown algae (*Stephanodiscus* sp.), boat-shaped diatoms (*Navicula* sp.) (CEG 2024-TN10806).

Benthic Invertebrates

Benthic invertebrates inhabit the bottom of rivers and mainly consume periphyton. They include certain zooplankton and macroinvertebrates such as insects, mussels, crayfish, snails, clams, and polychaetes. Benthic invertebrates are primary consumers and are important indicators of the health of an aquatic system.

In 1991, the Clinton Power Station Environmental Monitoring Plan surveyed benthic invertebrates and found that three taxa, Oligochaeta, Chaoboridae, and Chironomidae, comprised 96.5 percent of the benthic fauna (CEG 2024-TN10914: Attachment 64, Enclosure 2). The surveys also revealed a benthic invertebrate density of approximately 1,900 per square meter, consisting of 39 total taxa. The last time the intake was inspected in 2003, no live *Corbicula* or zebra mussels (*Dreissena polymorpha*) were observed and no live or dead salamander mussels were observed (CEG 2024-TN10914: Attachment 33 and Attachment 64, Enclosure 2). Most recently, researchers collected *Corbicula* samples in February and March 2007 from the main Unit 1 screen house basin (CEG 2024-TN10914: Attachment 64, Enclosure 2). They found 31 live *Corbicula* and 28 relic shells on the pump side of the traveling screens but did not find any on the lake side or in the shutdown service water system basin. The most recent information published by IDNR states that zebra mussels are not present in Clinton Lake (IDNR 2023-TN10804).

Ichthyoplankton

Ichthyoplankton are the eggs and larvae of fish. Exelon Generation Company, LLC completed an entrainment abundance characterization study from 2019 to 2020 that included looking at types and abundance of ichthyoplankton in Clinton Lake (CEG 2024-TN10914: Attachment 63, Enclosure 3). Gizzard shad were the most abundant species with gizzard shad larvae accounting for 88 percent of the fish collected. Freshwater drum eggs and larvae comprised 7 percent, followed by sunfish larvae (2.2 percent), and crappie larvae (1.4 percent).

Juvenile and Adult Fish

In 2017 and 2018, researchers coordinated with IDNR fisheries biologists to sample populations of walleye, sauger (*Sander canadensis*), and Saugeye (hybrid of walleye and sauger) in Clinton Lake using Fyke nets and direct current electrofishing (Stein et al. 2021-TN10799). Fish were measured in total length (millimeters) and weighed to the nearest gram. The second dorsal fin ray was removed for age estimation, and a subsample of fish were sacrificed and brought back to the laboratory for otolith extraction, tissue sampling, and gender identification. The walleye population, the only one of the three species caught in Clinton Lake, typically comprised of fish aged 1–4 years, with few fish reaching older ages. Length at age comparisons demonstrated the limiting effect on statewide harvest regulations (14 in. or 35.5 cm minimum size limit, 6 fish bag limit) on growth in the population. No walleye smaller than stock length were sampled in Clinton Lake and no sauger or Saugeye were found.

As part of managing the Clinton Lake recreational area, IDNR has stocked the lake, since 1979, with recreational species to boost sportfishing opportunities for the public. According to their records, the IDNR has stocked largemouth bass, hybrid striped bass, white bass, black crappie, blacknose crappie, white crappie, blue catfish, and walleye in the lake at some point (IDNR 2023-TN10801). In 2023, IDNR stocked Clinton Lake with black crappie, white crappie, blue catfish, hybrid striped bass, and walleye. Most recently, in 2024 blue catfish, white bass × striped bass hybrid, and walleye were stocked.

Largemouth bass is the most popular sportfish in Clinton Lake and across the State of Illinois due to its abundance, fighting ability, larger size, and status as a top predator (IDNR 2019-TN10798). In Clinton Lake, largemouth bass are the most common type of bass although there is a remnant population of smallmouth bass from North Fork and Salt Creek. Largemouth bass spawn when water temperatures exceed 60°F (15.6°C), typically in May or June, although spawning may occur earlier in warmer parts of the lake by the CPS cooling water system discharge. A mature female largemouth bass produces 10,000 to 40,000 eggs which hatch in 8 to 12 days. After hatching, the fry (i.e., bass hatchlings) feed on zooplankton and insects until they reach 3 to 4 in. (7.6 to 10 cm) in length, at which point they begin feeding on other fish. Gizzard shad is the primary food source for adult largemouth bass although they also feed on bluegill. Largemouth bass typically live 8 to 10 years.

Bluegill is the second most abundant species in Clinton Lake, behind the gizzard shad. Spawning begins as early as late May and continues through August, peaking when water temperatures reach the upper 60s (°F) (or above approximately 18°C). Females produce 2,500 to 38,000 eggs which the male guards until they hatch 2 to 5 days after laying. Bluegill typically live for 5 to 6 years.

In Clinton Lake, 82 percent of the crappies (black or white) are black crappies (IDNR 2019-TN10798). Spawning occurs in May and June with females laying between 11,000 to 188,000 eggs that will hatch in about 3 days. The adult male stays with the newly hatched crappies until they grow to about half an inch, after which the young move to the middle of the lake to feed on zooplankton. As they grow to 6 to 8 in. (15 to 20 cm), many crappies shift their diet to gizzard shad, small fish, and aquatic insects, while some continue to feed on invertebrates. On average, crappies live 4 to 5 years.

The channel catfish fishery in Clinton Lake developed in the mid-1980s and has become an important part of the lake's fishery (IDNR 2019-TN10798). Channel catfish spawn in June or July when water temperatures reach 75°F (23.9°C). Catfish primarily feed on crayfish, insects

and their larvae, worms and live or dead fish. During the summer catfish stay in deep, cooler, and darker holes during the day and feed in the shallows overnight.

Walleye has become a popular species in Illinois, including Clinton Lake, which is credited to IDNRs' ongoing efforts to stock them in lakes statewide (IDNR 2019-TN10798). Unlike other fish in Clinton Lake, walleye do not spawn naturally there so the population relies on annual stocking by IDNR. After hatching, walleye fry feed on zooplankton before switching to young-of-the-year fish and insects. As adults they primarily each gizzard shad, crayfish, and insects. Walleye typically live for up to 10 years.

Hybrid striped bass in Clinton Lake are created by crossing pure striped bass with white bass and do not produce viable eggs or sperm, so their presence relies entirely on stocking (IDNR 2019-TN10798). These fish are attracted to currents and tend to concentrate near the discharge canal and the CPS intake, both of which are restricted zones where boating and fishing are prohibited.

White bass were not present in Clinton Lake when it was built, but they have since become prevalent, with thousands caught annually (IDNR 2019-TN10798). White bass spawn in the two creeks that form Clinton Lake once water temperatures reach 58 to 65°F (14.4 to 18.3°C). A large female can produce 500,000 to 900,000 eggs and will return to the lake after spawning. Their eggs hatch within 3 to 6 days. White bass fry initially feed on microscopic crustaceans, then shift to small insects, larvae, and tiny fish as they grow. As adults, fish become the primary component of their diet. White bass typically live for 5 to 6 years. Table 3-13 below lists fish species known to occur in Clinton Lake based on sampling and stocking efforts.

Table 3-13 List of Fish Species in Clinton Lake, DeWitt County, Illinois

Common Name	Scientific Name	Stocked
bigmouth buffalo	*Ictiobus cyprinellus*	No
black bullhead	*Ameiurus melas*	No
black crappie	*Pomoxis nigromaculatus*	Yes
blacknose crappie	*Pomoxis nigromaculatus*	Yes
blackstripe topminnow	*Fundulus notatus*	No
bluegill	*Lepomis macrochirus*	No
blue catfish	*Ictalurus furcatus*	Yes
channel catfish	*Ictalurus punctatus*	No
common carp	*Cyprinus carpio*	No
flathead catfish	*Pylodictis olivaris*	No
freshwater drum	*Aplodinotus grunniens*	No
gizzard shad	*Dorosoma cepedianum*	No
golden redhorse	*Moxostoma erythrurum*	No
golden shiner	*Notemigonus crysoleucas*	No
green sunfish	*Lepomis cyanellus*	No
hybrid sunfish	-	-
largemouth bass	*Micropterus salmoides*	Yes
pumpkinseed	*Lepomis gibbosus*	No
quillback	*Sebastes maliger*	No

Table 3-13 List of Fish Species in Clinton Lake, DeWitt County, Illinois (Continued)

Common Name	Scientific Name	Stocked
red shiner	*Cyprinella lutrensis*	No
river carpsucker	*Carpiodes carpio*	No
shorthead redhorse	*Moxostoma macrolepidotum*	No
smallmouth bass	*Micropterus dolomieu*	No
spotted sucker	*Minytrema melanops*	No
walleye	*Stizostedion vitreum*	Yes
white bass	*Morone chrysops*	Yes
white bass × striped bass hybrid	*Morone saxatilis* × *Morone chrysops*	Yes
white crappie	*Pomoxis annularis*	Yes
yellow bullhead	*Ameiurus natalis*	No

"-" denotes no entry in table cell.
Sources: IPC 1991-TN11175; CEG 2024-TN10914: Attachment 63, Enclosure 5; and IDNR 2019-TN10798.

3.7.1.2 Important Species and Fisheries

This section summarizes important Clinton Lake fisheries and State-protected and other special status species.

Commercially Important Fisheries

There are no commercial fisheries in Clinton Lake.

Recreationally Important Fishes

The most popular sport fish found in Clinton Lake include black crappie, white crappie, channel catfish, largemouth bass, walleye, white bass, hybrid striped bass, striped bass, bluegill, flathead catfish, and bullheads (IDNR 2019-TN10798). Other fish species occasionally caught by anglers include green sunfish, small mouth bass, carp, and freshwater drum. Fish species present in the lake but not usually caught by anglers include big mouth buffalo, shorthead redhorse, golden red horse, quillback, spotted sucker and gizzard shad.

Clinton Lake is managed by IDNR for recreational fishing activities and stocked yearly. Bass, crappie, and catfish tournaments are held there throughout the year. In 2020, 62 fishing tournaments were held at Clinton Lake (Stein et al. 2021-TN10799). Five crappie tournaments caught 109 fish weighing 64.94 pounds (lb) (29.46 kg), eight catfish tournaments caught 140 fish weighing 819.48 lb (371.71 kg), and 49 largemouth bass tournaments caught 1,270 fish weighing 3,459.78 lb (1,569.33 kg).

State-Protected and Other Special Status Species

The IDNR has regulatory authority for fish and wildlife in Illinois including endangered species. The Illinois Endangered Species Protection Act (IL Stat. 520-TN10800) authorized the creation of a Board, the Illinois Endangered Species Protection Board, whose mission is to protect those species of plants and animals native to Illinois which are in danger of being lost from the wild in Illinois. In addition to protecting federally listed endangered or threatened species, the Illinois Endangered Species Protection Board also develops an "Illinois List," or list of animals and

plants for listing at the State of Illinois level as endangered or threatened. The Illinois Endangered Species Protection Board last updated their State-listed species list in June 2024; Table 3-14 below lists species that could occur in DeWitt County in the vicinity of CPS (INHD 2024-TN10792).

Table 3-14 Illinois List of Aquatic Species Listed as Threatened or Endangered in DeWitt County, Illinois

Common Name	Scientific Name	Illinois Status	Type	Last Observed
American brook lamprey	*Lethenteron appendix*	Listed Threatened	Fish	1983
monkeyface mussel	*Quadrula metanevra*	Listed Threatened	Mollusk	2003
spike	*Elliptio dilatata*	Endangered	Mollusk	2009

Source: INHD 2024-TN10792.

The American brook lamprey is listed at the State level as threatened and is present in DeWitt County. IDNR has not observed any individuals present in Clinton Lake likely as a result of the preference of adults to live in fast riffles of large creeks and small rivers that have clear water (IDNR 2024-TN10793).

The monkeyface mussel has a rounded, thick shell with knobs along it (ISM 2012-TN10794). Its surface is green to light brown with zigzag markings, and it can grow up to 4 in. (10 cm) in length. This mussel inhabits the gravel or mixed sand and gravel beds of medium to large rivers and has been found throughout Illinois, except in the Chicago area.

The spike mussel has a thick, elongated shell with a rounded end (ISM 2012-TN10795). Its smooth surface is greenish brown, and it can grow up to 5 in. (13 cm) in length. This mussel inhabits the mud or gravel beds of streams and occasionally lives in lakes throughout Illinois.

3.7.1.3 Invasive and Nuisance Species

Non-native species are those species that are present only because of introduction and that would not naturally occur either currently or historically in an ecosystem. Invasive species are animals, plants or other organisms that are inadvertently introduced to a new area beyond their natural range. They often take away space and resources from the native species (IDNR 2025-TN11183). Higher temperatures and changes in growing seasons will attract novel species to Illinois (IDNR 2025-TN11183).

As of 2016, the IDNR has 14 aquatic plant and animal species listed. There are four plant species of concern which may occur in Clinton Lake (Brazilian egeria, hydrilla, Eurasian milfoil, and curlyleaf pondweed) and three animal species (spiny waterflea, Asian carp, round goby, and Asian clam) (University of Georgia 2016-TN10796). Of these invasive species identified at the State level, curly leaf pondweed (*Potamogeton crispus*) has been observed in Salt Creek, downstream of Clinton Lake (USGS 2024-TN10797). This pondweed is a perennial, submerged aquatic plant native to Eurasia. Asian carp, which includes silver carp (*Hypophthalmichthys molitrix*), are also identified as an invasive species according to IDNR and has been observed within Clinton Lake (IPC 1991-TN11175).

The primary invasive species of concern related to CPS operations is biofouling of the cooling water intake system by invasive bivalves, such as Asian clams (*Corbicula*). The Asian clam is a small, yellow-brown to black, triangular shelled bivalve that grows to 1 to 1.5 in. (2.5 to 4 cm) in size. The Asian clam lives in the silt, mud, sand, or gravel bottoms of lakes and streams. It has free-swimming larva and filters small organisms from the water for food. Introduced in the 1920s and 1930s, the Asian clam spread throughout most of the United States including all areas of Illinois (IDNR 2024-TN10791). Recently, researchers collected *Corbicula* samples in February and March 2007 from the main Unit 1 screen house basin (CEG 2024-TN10914: Attachment 64, Enclosure 2). They found 31 live *Corbicula* and 28 relic shells on the pump side of the traveling screens but did not find any on the lake side or in the shutdown service water system basin.

3.7.2 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, the impacts of the CPS LR and the continued operation of CPS on all generic Category 1 issues related to aquatic resources would be SMALL.

NRC staff did not identify any new and significant information related to aquatic resources that would change the environmental impact findings stated in the LR GEIS with respect to the CPS LR Category 1 (SMALL) issues. Additionally, the NRC staff did not identify any additional aquatic resource issues beyond those listed in Table 3-1 of this SEIS that are applicable to the CPS LR.

As described in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-2 of this SEIS, there are two plant-specific Category 2 issues related to aquatic resources that are applicable to CPS during the LR term. These issues are (1) impingement mortality and entrainment of aquatic organisms) plants with once-through cooling systems or cooling ponds) and (2) effects of thermal effluents on aquatic organisms (plants with once-through cooling systems or cooling ponds). These Category 2 issues are analyzed below.

3.7.2.1 Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)

Impingement occurs when organisms are trapped against the outer part of an intake structure's screening device (79 FR 48300-TN4488). The force of the intake water traps organisms against the screen, and individuals are unable to escape. Impingement can kill organisms immediately or cause exhaustion, suffocation, injury, and other physical stresses that contribute to mortality later. The potential for injury or death is generally related to the amount of time an organism is impinged, its fragility (susceptibility to injury), and the physical characteristics of the screen wash and fish return systems of the intake structure. The EPA found that impingement mortality (IM) is typically less than 100 percent if the cooling water intake system includes fish return or backwash systems (79 FR 48300-TN4488). Because impingeable organisms are typically fish with fully formed scales and skeletal structures and well-developed survival traits, such as behavioral responses to avoid danger, many impinged organisms can survive under proper conditions (79 FR 48300-TN4488).

Entrainment occurs when organisms pass through the screening device and travel through the entire cooling system, including the pumps, condenser or heat exchanger tubes, and discharge pipes (79 FR 48300-TN4488). Organisms susceptible to entrainment are of smaller size, such as ichthyoplankton, larval stages of shellfish and other macroinvertebrates, zooplankton, and phytoplankton. During travel through the cooling system, entrained organisms experience

physical trauma and stress, pressure changes, excess heat, and exposure to chemicals (Mayhew et al. 2000-TN8458). Because organisms that get entrained generally possess fragile life stages (e.g., eggs, which exhibit poor survival after interaction with cooling water intake structures; or early larvae, which lack a skeletal structure and swimming ability), the EPA has concluded that for purposes of assessing the impacts of a cooling water intake system on the aquatic environment, all entrained organisms are assumed to die (79 FR 48300-TN4488).

Entrainment susceptibility is highly dependent on life history characteristics. For example, broadcast spawners with non-adhesive, free floating eggs that drift with the water current may become entrained in a cooling water intake system. Nest building species or species with adhesive, demersal eggs are less likely to be entrained in early life stages. Susceptibility of larval life stages to entrainment depends on body morphology and swimming ability.

A species can be susceptible to both impingement and entrainment if several life stages of the species occupy the same source water. For instance, adults and juveniles of a given species of fish may be impinged against the intake screens, while larvae and eggs may pass through the screening device and be entrained through the cooling system. The susceptibility to either impingement or entrainment relates to the size of the individual relative to the size of the mesh on the screening device. The EPA considers aquatic organisms that can be collected or retained on a sieve with 0.56 in. (1.4 cm) diagonal openings to be susceptible to impingement (79 FR 48300-TN4488). This equates to screen device mesh openings of 0.5 in. × 0.25 in. (1.3 cm × 0.635 cm), which is slightly larger than the openings on the typical 0.375 in. (0.95 cm) square mesh found at many nuclear power plants. Organisms smaller than the 0.56 in. (1.4 cm) mesh are considered susceptible to entrainment.

The magnitude of the impact that impingement and entrainment create on the aquatic environment depends on the plant-specific characteristics of the cooling system as well as the local aquatic community. Relevant plant-specific characteristics include location of the cooling water intake structure, intake velocities, withdrawal volumes, screening device technologies, and the presence or absence of a fish return system. Relevant characteristics of the aquatic community include species present in the environment, life history characteristics, population abundances and distributions, special species statuses and designations, and regional management objectives.

Clinton Power Station Cooling Water Intake System

The CPS cooling water intake system (CWIS) impinges and entrains aquatic organisms as it withdraws water from Clinton Lake. Section 2.1.3 of this SEIS describes the cooling and auxiliary water systems in detail. Features relevant to the impingement and entrainment analysis are summarized below.

Clinton Lake water is drawn into the CWIS from the North Fork of Salt Creek side of the lake. It enters one of seven bays; six provide cooling water to the three circulating water pumps and one provides water to the two service water pumps (CEG 2024-TN10806). The intake structure has a 14 bar grill, spaced with 4 to 6 in. (10 to 15 cm) diagonal opening squares, to prevent large debris from entering the bays where the water moves through 12 traveling screens, each 42 ft (13 m) high by 11.75 ft (4 m) wide composed of 12 gauge galvanized steel wire with a square mesh opening of ⅜ in. (1 cm) that rotate at a speed between 2.8 and 11.2 feet per minute (0.01 to 0.06 meter per second [m/s]) (AEC 1974-TN11145; CEG 2024-TN10914: Attachment 63, Enclosure 1). The actual intake through-screen velocity is 1.05 feet per second (fps) (0.32 m/s) at normal lake levels and can get as high as 1.22 fps (0.37 m/s) during low water levels (CEG 2024-TN10914: Attachment 63, Enclosure 1). Organisms that are too large to

pass through the traveling screen mesh, such as juvenile and adult fish not able to swim away and shellfish, could become impinged on the screens. CPS does not have a fish return system, so all impinged organisms are washed into a trough and travel along a sluiceway that empties into a collection basket that is disposed of as solid waste along with other debris (CEG 2024-TN10914: Attachment 63, Enclosure 1).

Organisms small enough to pass through the traveling screen mesh, such as fish eggs, larvae, and other zooplankton, are entrained into the cooling water system and pass through the entire system. After leaving the condensers, circulating water is discharged to a 3.1 mi (5 km) long open flume. In 2018 and 2019, MDCTs were installed along the discharge flume to provide additional cooling during the warmer months and ensure compliance with the NPDS permit temperature limits. When the temperature in the discharge flume hits 109°F (42.8°C), the cooling towers automatically operate. While in operation, the MDCTs are capable of decreasing the discharge temperature up to 5.4°F (3°C) (CEG 2024-TN10914: Attachment 32). There are two banks of MDCTs that typically operate from May to September and can operate up to 153 days annually (CEG 2024-TN10914: Attachment 31). At the end of the discharge flume, water reenters Clinton Lake on the Salt Creek arm. During this process, entrained organisms are subject to mechanical, thermal, and toxic stress.

Clean Water Act Section 316(b) Requirements for Existing Facilities

Section 316(b) of the CWA addresses the adverse environmental impacts caused by the intake of cooling water from waters of the United States. This section of the CWA grants the EPA the authority to regulate cooling water intake structures to minimize adverse impacts on the aquatic environment. Under CWA Section 316(b), the EPA has issued regulations for existing facilities, such as CPS, at 40 CFR Part 122 (TN2769) and 40 CFR Part 125 (TN254), Subpart J. Existing facilities include power generation and manufacturing facilities that are not new facilities as defined at 40 CFR 125.83 (TN254) and that withdraw more than 2 million gallons per day (7.6 million liters per day) of water from waters of the United States and use at least 25 percent of the water they withdraw exclusively for cooling purposes.

Under the CWA Section 316(b) regulations, the location, design, construction, and capacity of cooling water intake structures of regulated facilities must reflect the BTA for minimizing impingement mortality and entrainment. The EPA, or authorized States and Tribes, impose BTA requirements through NPDES permitting programs. In Illinois, the IEPA administers the NPDES program and issues NPDES permits to regulated facilities.

With respect to IM, the BTA standard requires that existing facilities comply with one of the following seven alternatives (40 CFR 125.94(c) [TN254]):

1. operate a closed-cycle recirculating system, as defined at 40 CFR 125.92(c) (herein referred to as “IM Option 1”)
2. operate a cooling water intake structure that has a maximum through-screen design intake velocity of 0.5 fps (0.15 m/s)
3. operate a cooling water intake structure that has a maximum actual through-screen intake velocity of 0.5 fps (0.15 m/s)
4. operate an offshore velocity cap, as defined at 40 CFR 125.92(v), that was installed on or before October 14, 2014

5. operate a modified traveling screen that the NPDES Permit Director determines meets the definition at 40 CFR 125.92(s) and that the NPDES Permit Director determines is the BTA for impingement reduction at the site
6. operate any other combination of technologies, management practices, and operational measures that the NPDES Permit Director determines is the BTA for impingement reduction (herein referred to as “IM Option 6”)
7. achieve a 12-month IM performance standard of all life stages of fish and shellfish of no more than 24 percent mortality, including latent mortality, for all non-fragile species

Options (1), (2), and (4) above are preapproved technologies requiring either no demonstration or only minimal demonstration that the flow reduction and control measures are functioning as the EPA envisioned. Options (3), (5), and (6) require detailed information to be submitted to the permitting authority before the permitting authority may specify it as BTA for a given facility. Under Option (7), the permitting authority may also review site-specific data and conclude that a de minimis rate of impingement exists; and, therefore, no additional controls are warranted to meet the BTA IM standard.

With respect to entrainment, the CWA Section 316(b) regulations do not prescribe a single nationally applicable entrainment performance standard, because the EPA did not identify a technology for reducing entrainment that is effective, widely available, feasible, and does not lead to unacceptable non-water-quality impacts (79 FR 48300-TN4488). Instead, the permitting authority must establish the BTA entrainment requirement for each facility on a site-specific basis. In establishing site-specific requirements, the regulations direct the permitting authority to consider the following factors (40 CFR Part 125-TN254):

8. numbers and types of organisms entrained, including the numbers and species (or lowest taxonomic classification possible) of federally listed, threatened and endangered species, and designated critical habitat (e.g., prey base)
9. impact of changes in particulate emissions or other pollutants associated with entrainment technologies
10. land availability in as much as it relates to the feasibility of entrainment technology
11. remaining useful plant life
12. quantified and qualitative social benefits and costs of available entrainment technologies when information on both benefits and costs is of sufficient rigor to make a decision

In support of entrainment BTA determinations, facilities must conduct site-specific studies and provide data to the permitting authority to aid in its determination of whether site-specific controls would be required to reduce entrainment and which controls, if any, would be necessary.

Analysis Approach

When available, the NRC staff relies on the expertise and authority of the NPDES permitting authority with respect to the impacts of impingement and entrainment. Therefore, if the NPDES permitting authority has made BTA determinations for a facility pursuant to CWA Section 316(b) in accordance with the current regulations specified in 40 CFR Part 122 (TN2769) and 40 CFR Part 125 (TN254), which were promulgated in 2014 (79 FR 48300-TN4488), and that facility has implemented any associated requirements or those requirements would be implemented before the proposed LR term; then, the NRC staff assumes that adverse impacts on the aquatic

environment will be minimized. In such cases, the NRC staff concludes that the impacts of either impingement, entrainment, or both would be SMALL for the proposed LR term.

In cases in which the NPDES permitting authority has not made BTA determinations, the NRC staff analyzes the potential impacts of impingement, entrainment, or both using a weight of evidence approach. In this approach, the NRC staff considers multiple lines of evidence to assess the presence or absence of ecological impairment (i.e., noticeable or detectable impact) on the aquatic environment. For instance, as its lines of evidence, the NRC staff might consider characteristics of the cooling water intake system design, the results of impingement and entrainment studies performed at the facility, and trends in fish and shellfish population abundance indices. The NRC staff then considers these lines of evidence together to predict the level of impact (SMALL, MODERATE, or LARGE) that the aquatic environment is likely to experience during the proposed LR term.

Baseline Condition of the Resource

For the purposes of this analysis, the NRC staff assumes that the baseline condition of the resource is the aquatic community of Clinton Lake as it occurs today, which is described in Section 3.7.1 of this SEIS. All fish and benthic invertebrate populations are self-sustaining or stocked as needed (Stein et al. 2021-TN10799; IDNR 2019-TN10798; CEG 2024-TN10914: Attachment 63, Enclosure 5). Although species richness, evenness, and diversity within the community may change or shift between now and when the proposed LR term would begin, the NRC staff finds the present aquatic community to be a reasonable surrogate in the absence of fishery and species-specific projections.

3.7.2.1.1 Impingement

Impingement Mortality BTA

In the 2021 NPDES permit, IEPA, in consultation with EPA, determined that CPS meets the administrative criteria of a closed-cycle recirculating system consistent with the definition in 40 CFR 125.92(c)(2) (TN254) (CEG 2024-TN10806: Appendix B). Under the regulatory definition, a closed-cycle recirculating system is one that passes cooling water through the condenser and other components of the cooling system and reuses the water for cooling multiple times. Such a system can include impoundments of waters of the United States where the impoundment was constructed before October 1, 2014, and was created for the purpose of serving as part of the cooling water system.

Clinton Lake was built in 1978 by the Illinois Power Company to supply cooling water to CPS. Accordingly, CPS is eligible to meet the IM reduction standard through Compliance Alternative 1 (40 CFR 125.94(c)(1)-TN254) described previously in this section. In the current NPDES permit, IEPA confirmed that CPS meets the BTA for IM (CEG 2024-TN10806: Attachment B).

Impingement Studies

Fish Impingement Study, 1987–1988

The Illinois Power Company conducted impingement monitoring from May 1987 to April 1988 shortly after CPS began operation as required by the NPDES permit special condition 9 (Pallo 1988-TN11079). Researchers collected samples every 2 weeks of all accumulated fish in the traveling screen trash basket over a 24-hour period. Data on species, number, length, and weight were collected and used to calculate monthly impingement.

Eight species of fish were collected, with gizzard shad comprising 99 percent by count and weight, primarily young of year (Pallo 1988-TN11079. Impingement of other species was minimal and included black bullhead, channel catfish, hybrid striped bass, bluegill, largemouth bass, white crappie, and freshwater drum. Impingement levels rose in winter and to a lesser extent in early spring, particularly December, January, February, and March when water temperatures declined to 4 to 6°C (39 to 43°F). Researchers estimated that 43 million fish per year, or 616,748 lb (279,752 kg) of fish per year are impinged.

Impingement Study, 2005–2007

From April 2005 to March 2007, Strategic Environmental Actions Inc. conducted an impingement mortality characterization study at Clinton Lake in connection with the CPS CWA Section 316(b) requirements (CEG 2024-TN10914: Attachment 63, Enclosure 4). Researchers collected 24-hour impingement samples at CPS at least weekly from April 5, 2005 until March 29, 2007. Impinged fish were identified, counted, weighed (grams), and measured for total length (millimeter).

Twenty-four species of fish were collected during the study with gizzard shad comprising 91.8 percent of impinged fish in the first year and 99.99 percent in the second year (CEG 2024-TN10914: Attachment 63, Enclosure 4). The other four most frequently impinged species in descending order were freshwater drum, bluegill, white bass, and black crappie. This is different than the fish composition of Clinton Lake; lake-wide the five most abundant species are gizzard shad, bluegill, largemouth bass, carp, and green sunfish. Researchers estimated that 615,278 fish were impinged in the first year and 16,575,647 were impinged the second year due to a drastic increase in numbers of gizzard shad due to cooler water temperatures earlier in the year (October vs. December) (CEG 2024-TN10914: Attachment 63, Enclosure 4).

Impingement Conclusion

Because Compliance IM Option 1 is a preapproved alternative under CWA Section 316(b) regulations, and because the EPA and IEPA have confirmed that CPS meets the criteria for a closed-cycle recirculating system for purposes of CWA Section 316(b) compliance, the NRC staff finds that the adverse impacts on the aquatic environment associated with impingement are minimized. This indicates that impingement is unlikely to cause noticeable or detectable impacts on Clinton Lake's aquatic populations. Accordingly, the NRC staff finds that the impacts of impingement during the proposed LR term would neither destabilize nor noticeably alter any important attribute of the aquatic environment and would, therefore, result in SMALL impacts on aquatic resources.

3.7.2.1.2 Entrainment

Entrainment Best Technology Available

The CWA Section 316(b) regulations direct the permitting authority to establish BTA entrainment requirements for each facility on a site-specific basis. In the 2021 NPDES permit, the IEPA in consultation with EPA, determined that the CPS CWIS meets the equivalent of BTA for entrainment in accordance with the Best Professional Judgement provisions of 40 CFR 125.90(b) and 125.98(b)(5) (TN254). As required by 40 CFR 122.21(r)(9) (TN2769), CEG must submit the results of the 2019–2020 entrainment abundance characterization study (CEG 2024-TN10914: Attachment 63, Enclosure 3) (CEG 2024-TN10806: Appendix B).

The Illinois Power Company completed entrainment studies of phytoplankton and zooplankton at CPS in 1983 to 1991 and, more recently, Exelon Generation Company, LLC completed entrainment studies in 2019 to 2020 for the CWA 316(b) study (CEG 2024-TN10914: AQU-24 doc). Gizzard shad is the most susceptible species and planktonic fish larvae is the most susceptible life stage to entrainment. This species is in abundance in Clinton Lake and are very fertile. There are no threatened or endangered aquatic species or designated critical habitat present.

Entrainment Studies

Entrainment Study, 2019-2020

HDR Engineering, Inc. conducted an entrainment abundance study in the spring and summer of 2019 and 2020 for Exelon Generation Company, LLC (CEG 2024-TN10914: AQU-24 doc). The purpose of the study was to collect ichthyoplankton density data from Clinton Lake in the area of hydraulic influence of the CPS CWIS and to estimate the number of ichthyoplankton potentially entrained by actual CWIS withdrawals during the fish spawning season. The CWIS area of hydraulic influence extends approximately 100 ft (30.5 m) out into the reservoir with a width of 120 ft (37 m) and includes any areas with a measurable flow toward the intake. Sampling was conducted weekly over a 24-hour period, from March to September in 2019 and April to September in 2020, using paired plankton nets (333 micrometer mesh) to collect daytime and nighttime samples.

Researchers collected 2,892 organisms in 2019 and 1,719 organisms in 2020 (3 fewer sampling weeks) consisting of six species of fish and one species of mollusk (CEG 2024-TN10914: Attachment 63, Enclosure 3). Gizzard shad larvae was the most abundant species in both years making up 88 percent of samples. Freshwater drum eggs and larvae were the second most abundant (7.2 percent) followed by common sunfish post yolk-sac larvae (2.2 percent), crappie post yolk-sac larvae (1.4 percent), sunfish post yolk-sac larvae (0.2 percent), quillback larvae (0.1 percent), and juvenile fingernail clams (0.2 percent). CPS entrains an estimated average 242,798,485 organisms annually under actual intake flow. Under the design intake flow, the projected annual entrainment would average 301,584,200 organisms.

Entrainment Conclusion

Because water withdrawals, and the associated risk of entrainment, would remain the same under the proposed action as under the current license, the NRC staff anticipates similar (i.e., nondetectable) effects during the proposed LR term. Further, the IEPA determined that CPS meets the equivalent of BTA for entrainment in accordance with the Best Professional Judgement provisions of 40 CFR 125.90(b) and 125.98(b)(5) (TN254) as part of issuing the 2021 NPDES permit (CEG 2024-TN10806: Appendix B). CEG has since completed the required Entrainment Abundance Characterization Study (special condition 10) and submitted it and their NPDES permit renewal application to the IEPA (CEG 2024-TN10914: Attachment 63, Enclosures 2 and 3).

For the reasons described above, the NRC staff finds that the impacts of entrainment of aquatic organisms resulting from the proposed LR of CPS would be SMALL.

Impingement and Entrainment Conclusion

Based on the discussion summarized under “Impingement Conclusion” and “Entrainment Conclusion,” of this SEIS the NRC staff concludes that the impacts of impingement and

entrainment on aquatic organisms resulting from the proposed Clinton LR term would be SMALL.

3.7.2.2 Effects of thermal effluents on aquatic organisms (plants with once-through cooling systems or cooling ponds)

The primary form of thermal impact of concern at CPS is heat shock. Heat shock occurs when water temperature meets or exceeds the thermal tolerance of an aquatic species for some duration of the exposure (NRC 2024-TN10161). In most situations, fish can avoid areas that exceed their thermal tolerance limits, although some aquatic species or life stages lack such mobility. Heat shock is typically observable only for fish because fish tend to float when dead. In addition to heat shock, thermal plumes resulting from thermal effluent can create barriers to fish passage, which is of particular concern for migratory species. Thermal plumes can also reduce the available aquatic habitat or alter habitat characteristics in a manner that results in cascading effects on the local aquatic community.

Clinton Power Station Effluent Discharge

As described in Section 3.5.1.3.2, CPS' NPDES permit establishes thermal limits for heated effluent discharges into Clinton Lake (Exelon 2021-TN10992; CEG 2024-TN10806: Appendix B). CPS discharges heated effluent down a 3.1 mi (5 km) discharge flume, which includes three tiered, drop structures to dissipate heat, back into Clinton Lake. When the temperature in the discharge flume reaches or exceeds 109°F (42.8°C), the MDCTs automatically operate. While operating, the MDCTs are capable of decreasing the discharge temperature by 5.4°F (3°C) (CEG 2024-TN10914: Attachment 32). There are two banks of MDCTs that typically operate from May to September and can be run up to 153 days annually (CEG 2024-TN10914: Attachment 31). Prior to the installation of the MDCTs in 2018 and 2019, there were no instances when discharge temperatures exceeded NPDES permit limits (CEG 2024-TN10914: Attachment 30). The NPDES permit limits the daily average temperature at the second drop structure of the discharge flume to not exceed 99°F (37.2°C) for more than 90 days in a calendar year and to not exceed 110.7°F (43.7°C) for any given day (CEG 2024-TN10806). In 2023 CPS exceeded 99°F (37.2°C) for 82 days; in 2022 for 86 days; in 2021 for 85 days; and in 2020 for 82 days (CEG 2024-TN10806: Appendix B; CEG 2024-TN10914: Attachment 31).

Clean Water Act of 1972 Section 316(a) Requirements for Point Source Discharges

The CWA Section 316(a) addresses the adverse environmental impacts associated with thermal discharges into waters of the United States. This section of the CWA grants the EPA the authority to impose alternative, less-stringent, facility-specific effluent limits (called "variances") on the thermal component of point source discharges. To be eligible, facilities must demonstrate, to the satisfaction of the NPDES permitting authority, that facility-specific effluent limitations will assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the receiving body of water. CWA Section 316(a) variances are valid for the term of the NPDES permit (i.e., 5 years). Facilities must reapply for variances with each NPDES permit renewal application. The EPA issued regulations under CWA Section 316(a) at 40 CFR 125, Subpart H (TN254).

Analysis Approach

When available, the NRC staff relies on the expertise and authority of the NPDES permitting authority with respect to thermal impacts on aquatic organisms. Therefore, if the NPDES permitting authority has made a determination under CWA Section 316(a) that thermal effluent limits are sufficiently stringent to ensure the protection and propagation of a balanced,

indigenous population of shellfish, fish, and wildlife in and on the receiving body of water, and that facility has implemented any associated requirements; then, the NRC staff assumes that adverse impacts on the aquatic environment will be minimized. In such cases, the NRC staff concludes that thermal impacts on aquatic organisms would be SMALL for the proposed LR term.

Baseline Condition of the Resource

For the purposes of this analysis, the NRC staff assumes that the baseline condition of the resources is the Clinton Lake aquatic community as it occurs today, which is described in Section 3.7.1 of this SEIS. Although species richness, evenness, and diversity within the community may change or shift between now and when the proposed LR term would begin, the NRC staff finds the aquatic community as it occurs today to be a reasonable surrogate in the absence of fishery and species-specific projections.

CWA 316(a) Thermal Variance

The IEPA regulates thermal discharge temperatures at CPS through the NPDES permit (CEG 2024-TN10806: Appendix B). In accordance with the Illinois Pollution Control Board Order 92-142 in accordance with 35 Ill. Adm. Code 106.1180, the temperature of the discharge to Clinton Lake from CPS shall be limited to a daily temperature which (1) does not exceed 99°F (37.2°C) for more than 90 days in a calendar year and (2) does not exceed 110.7°F (43.7°C) for any given day.

In 2015, Exelon conducted a thermal modeling study which was submitted as part of the NPDES permit renewal application. This study is detailed in Section 3.7.7.1.5 of CEG's ER (CEG 2024-TN10806) or available in full in Agencywide Documents Access and Management System (CEG 2024-TN10914: Attachment 64, Enclosure 1). On the hottest day of the year, the daily average temperature at the second drop structure in the discharge flume reached 108.1°F (42.3°C). At this peak, surface lake temperatures up to 108°F (42.2°C) were predicted 0.2 mi (0.3 km) upstream and 0.5 mi (0.8 km) downstream of the discharge and across the lake. Surface temperatures dropped to 105°F (40.6°C) 1.2 mi (1.9 km) downstream and below 90°F (32.2°C) 5 mi (8 km) downstream. The maximum daily average at the spillway was 83.1°F (28.4°C). The thermal plume displayed vertical stratification at the discharge and down to the spillway dam.

One fish kill has occurred in Clinton Lake since the 2006 Exelon ESP EIS, in 2014, due to a cold shut down at CPS (NRC 2006-TN672). As part of the CPS Lake Management Agreement, IDNR has the responsibility to patrol the lake and assess any fish kill. Following discussions between CPS and the IDNR State Fish Chief regarding the fish kills that occurred in the early 2000s and in 2014, additional precautions are taken during plant shutdowns to prevent future fish kills related to cold shock (CEG 2024-TN10914: Attachment 36).

Thermal Impacts Conclusion

Because IEPA has granted the CPS plant operator multiple, sequential NPDES permits with temperature limits that are designed to be protective of aquatic life under CWA Section 316(a) and Illinois regulations, the NRC staff concludes that the adverse impacts on the aquatic environment associated with thermal effluents are minimized. Because characteristics of the thermal effluent would remain the same under the proposed action, the NRC staff anticipates similar effects during the proposed LR term. Further, IEPA will continue to review the CWA Section 316(a) variance with each successive NPDES permit renewal and may require additional mitigation or monitoring in a future renewed NPDES permit if it deems such actions to

be appropriate to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in Clinton Lake. The NRC staff assumes that any additional requirements that IEPA imposes would further reduce the impacts of the CPS' thermal effluent over the course of the proposed LR term. For these reasons, the NRC staff finds that thermal impacts during the proposed LR term would neither destabilize nor noticeably alter any important attribute of the aquatic environment and would, therefore, result in SMALL impacts on aquatic organisms.

3.7.3 No-Action Alternative

If CPS were to cease operations, impacts on the aquatic environment would decrease or stop following reactor shutdown. Some withdrawal of water from Clinton Lake would continue during the shutdown period to provide cooling to spent fuel in the spent fuel pool until that fuel could be transferred to dry storage. The amount of water withdrawn for these purposes would be a small fraction of water withdrawals during operations, would decrease over time, and would likely end within the first several years following shutdown. The reduced demand for cooling water would substantially decrease the effects of impingement, entrainment, and thermal effluent on aquatic organisms, and these effects would entirely cease following the transfer of spent fuel to dry storage.The reduced demand for cooling water would substantially decrease the effects of impingement, entrainment, and thermal effluent on aquatic organisms, and these effects would wholly cease following the transfer of spent fuel to dry storage. Effects from cold shock would be unlikely, given the small area of Clinton Lake affected by thermal effluent under normal operating conditions, combined with the phased reductions in withdrawal and discharge of lake water that would occur following shutdown.

The NRC staff concludes that the impacts of the no-action alternative on aquatic resources would be SMALL.

3.7.4 Replacement Power Alternatives: Common Impacts

Construction impacts for many components of either replacement power alternative would be qualitatively and quantitatively similar. Construction could result in aquatic habitat loss, alteration, or fragmentation; disturbance and displacement of aquatic organisms; mortality of aquatic organisms; and increase in human access. For instance, construction-related chemical spills, runoff, and soil erosion could degrade water quality in Clinton Lake and downsteam by introducing pollutants and increasing sedimentation and turbidity. Dredging and other in-water work could directly remove or alter the aquatic environment and disturb or kill aquatic organisms. Because construction effects would be short term, associated habitat degradation would be relatively localized and temporary. Effects could be minimized by the use of existing infrastructure that are onsite at CPS, and the utilization of existing transmission lines, roads, parking areas, and certain buildings. Aquatic habitat alteration and loss could be minimized by siting components of the alternatives farther from water bodies and away from drainages and other aquatic features.

Water quality permits required through Federal and State regulations would control, reduce, or mitigate potential effects on the aquatic environment. Through such permits, the permitting agencies could include conditions requiring CEG to follow BMPs or to take certain mitigation measures if adverse impacts are anticipated. For instance, USACE oversees Section 404 permitting for dredge and fill activities, and IEPA oversees NPDES permitting and general stormwater permitting. CEG would likely be required to obtain each of these permits to construct a new replacement power alternative on the CPS site. Notably, the EPA final rule under Phase I

of the CWA Section 316(b) regulations applies to new facilities and sets standards to limit intake capacity and velocity to minimize impacts on fish and other aquatic organisms in the source water (40 CFR 125.84-TN254). Any new replacement power alternative subject to this rule would be required to comply with the associated technology standards.

With respect to operation of a new replacement power alternative, operational impacts for any of the alternatives would be qualitatively similar but would vary in intensity, based on each alternative's water use and consumption. Non-nuclear facilities generally consume less water during operations.

3.7.5 Natural Gas Alternative

The types of impacts that the aquatic environment would experience from this alternative involving the construction and installation of a new natural gas combined cycle power plant are characterized in the previous section that discusses impacts common to all replacement power alternatives (see Section 3.7.4 of this SEIS).

This alternative would involve construction of a natural gas plant within the existing footprint of the CPS site on a 54 ac (22 ha) parcel that was analyzed in a 2006 EIS for an ESP for an additional nuclear unit and would require no additional land for construction. It would also require construction of a new 16 mi (26 km) natural gas pipeline to supply the site. Although some infrastructure upgrades like new MDCTs may be required, it is assumed that the existing transportation and transmission line infrastructure at CPS would be adequate to support the alternative (CEG 2024-TN10806).

The NRC staff finds that the impacts of construction on aquatic resources would be SMALL because construction effects would be of limited duration and the new plant would use some of the existing site infrastructure and buildings. Required Federal and State water quality permits would likely include conditions requiring BMPs and mitigation strategies to minimize environmental effects.

With respect to operations, Federal and State water quality permits would control and mitigate many of the potential effects on the aquatic environment, including water withdrawal and discharge, such that the associated effects would be unlikely to destabilize or noticeably alter any important attribute of the aquatic environment. Therefore, the NRC staff finds that the impacts of operation on aquatic resources would be SMALL.

Based on the above, the NRC staff concludes that the impacts on aquatic resources from construction and operation of a natural gas alternative would be SMALL.

3.7.6 Renewable and Natural Gas Combination Alternative

This alternative would involve the construction an installation of a new NGCC power plant at the CPS site, multiple onsite and offsite wind turbines with battery storage, and multiple onsite and offsite solar installations with battery storage (CEG 2024-TN10806).

The impacts of construction of new wind, solar, and natural gas of this alternative are discussed in the section that describes common impacts on all alternatives (Section 3.7.4 of this SEIS). These effects would be SMALL to MODERATE, depending on the site(s) selected, the aquatic habitats present, and the extent to which construction would degrade, modify, or permanently alter those habitats.

The operation of the solar PV component would have no discernable effects on the aquatic environment. The operation of the wind turbines could produce leaks of hydraulic fluid, antifreeze, and grease, but the impacts would be SMALL since these leaks occur in relatively small amounts and are managed by State permitting authorities (e.g., spill response and prevention plans). Impacts of operating a new natural gas power plant would be SMALL (see Section 3.7.5 of this SEIS) because the water withdrawals and discharges would be regulated under the CWA and applicable State regulations to ensure that impacts to the aquatic environmental are minimal.

The NRC staff concludes that the impacts on aquatic resources for the renewables and natural gas alternative would be SMALL to MODERATE during construction and SMALL during operation. Impacts from the alternative would be managed and regulated by Federal and State water quality permits.

3.7.7 Purchased Power Alternative

This alternative involves the establishment of a long-term contract to import replacement power into the CPS service area to replace CPS' net generation (CEG 2024-TN10806). Potential environmental impacts depend on the source, type, and location of the energy obtained under such a contract. This could include natural gas power plants although the agreement would have to comply with the Illinois Power Agency Act (IL Stat. 20-TN11209: 1-75), which focuses on renewable power. The operation of solar facilities generally has no discernable effects on the aquatic environment. The operation of the wind turbines could produce leaks of hydraulic fluid, antifreeze, and grease, but the impacts would be SMALL since these leaks occur in relatively small amounts and are managed by State permitting authorities (e.g., spill response and prevention plans). Impacts of additional power generation from existing natural gas plants would be SMALL since the water withdrawals and discharges would be managed by NPDES permits.

The NRC staff concludes that the impacts on aquatic resources for the purchased power alternative would be SMALL. Impacts from the alternative would be managed and regulated by Federal and State water quality permits.

3.8 Federally Protected Ecological Resources

The NRC must consider the effects of its actions on ecological resources protected under several Federal statutes and must consult with the FWS and National Marine Fisheries Service (NMFS) or National Oceanic and Atmospheric Administration (NOAA) prior to acting in cases where an agency action may affect those resources. These statutes include the following:

- ESA (16 U.S.C. § 1531 et seq.-TN1010)
- MSA (16 U.S.C. § 1801 et seq.-TN9966)
- National Marine Sanctuaries Act (NMSA) (16 U.S.C. § 1431 et seq.-TN4482)

This section describes the species and habitats that are federally protected under these statutes and analyzes how the proposed LR and alternatives may affect these resources.

3.8.1 Endangered Species Act

Congress enacted the ESA in 1973 to protect and recover imperiled species and the ecosystems upon which they depend. The ESA provides a program for the conservation of endangered and threatened plants and animals (collectively, listed species) and the habitats in which they are found. The FWS and the NMFS are the lead Federal agencies for implementing

the ESA, and these agencies are charged with identifying species that warrant listing. The following sections describe the CPS action area and the species and habitats that may occur in the action area under each of the Services' jurisdictions.

3.8.1.1 Endangered Species Act: Action Area

The implementing regulations for Section 7(a)(2) of the ESA define "action area" as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02-TN4312). The action area effectively bounds the analysis of federally listed species and critical habitats because only species and habitats that occur within the action area may be affected by the Federal action.

For the purposes of assessing the potential impacts of CPS LR on federally listed species, the NRC staff considers the action area to consist of the following:

CPS Site: The terrestrial region of the action area consists of the 13,531 ac (5,475 ha) CPS site in central Illinois owned by CEG (CEG 2024-TN10806). The area is part of the central lowlands physiographic region. Deciduous forest constitutes the majority of the site's surface area. The developed part of the CPS site lies on the Clinton Lake peninsula between Salt Creek North Form arm and Salt Creek arm approximately 3 mi (5 km) northeast of the dam in DeWitt County. The CPS site primarily consists of deciduous forest (3,061 ac [1,239 ha]), mixed forest (1,471 ac [595.3 ha]), grasslands (397 ac [161 ha]), woody wetlands (161 ac [65.2 ha]), evergreen forests (85 ac [34 ha]), shrub communities (32 ac [13 ha]), and emergent wetlands (30 ac [12 ha]) (CEG 2024-TN10914: Attachment 65).

Clinton Lake: The aquatic region of the action area encompasses the area of Clinton Lake influenced by the intake and discharge systems (described in Section 3.7.1 and 3.7.2 and the area of Clinton Lake that experiences increased temperatures from the discharge of heated effluent. Clinton Lake accounts for 36.1 percent of the total land cover of the action area. Section 3.7.1 of this SEIS describes Clinton Lake in more detail.

The NRC staff recognizes that, although the described action area is stationary, federally listed species can move in and out of the action area. For instance, a migratory bird could occur in the action area seasonally as it forages or breeds within the action area. Thus, in its analysis, the NRC staff considers not only those species known to occur directly within the action area but those species that may passively or actively move into the action area. The NRC staff then considers if the life history and habitat requirements of each species make it likely to occur in the action area where it could be affected by the proposed LR. The following sections first discuss listed species and critical habitats under FWS jurisdiction, followed by those under NMFS jurisdiction.

3.8.1.2 Endangered Species Act: Federally Listed Species and Critical Habitats Under FWS Jurisdiction

The NRC staff identified eight federally listed, proposed, and candidate species that may occur in the action area. The NRC staff reviewed the ER, the FWS's Information for Planning and Conservation database (FWS 2024-TN11003), available ecological surveys, and other records to determine whether suitable habitat for each species occurs in the action area and whether the species itself may occur in the action area. No designated or proposed critical habitats occur within the action area. Table 3-15 lists the relevant species and summarizes the results of the NRC staff's evaluation, including the habitat requirements and information on the occurrence of each species within the action area, as well as information on relevant critical habitats.

In 2005, the NRC staff evaluated the effects of CPS operations on federally listed species as part of the staff's environmental review for the Exelon ESP at the CPS site. The NRC staff prepared a biological assessment that evaluated the Indiana bat (*Myotis sodalist*) and bald eagle (*Haliaeetus leucocephalus*) (NRC 2005-TN11158). The NRC staff concluded that site preparation and limited construction activities were *not likely to adversely affect* (NLAA) the Indiana bat and would have *no effect* (NE) on the bald eagle. Effects to these species were expected to consist of habitat disturbance associated with the proposed action and traffic and transmission line collisions. FWS concurred with the NRC staff's findings in letter dated May 19, 2005 (FWS 2005-TN11159). The FWS's concurrence, in part, relied upon the applicant's development and implementation of an Avian Protection Plan during the initial license period.

With respect to the bald eagle, the FWS delisted this species in 2007 due to recovery. The bald eagle remains federally protected under the Bald and Golden Eagle Protection Act, which is discussed in Section 3.6.3.3 of this SEIS.

The NRC staff has not previously evaluated seven of the federally listed or proposed species identified below in Table 3-15 at the CPS site because these species were not federally listed, were not proposed for listing, or were unlikely to occur within the action area. These seven additional species are the northern long-eared bat, whooping crane, salamander mussel, monarch butterfly, western regal fritillary, rusty patched bumble bee, and the eastern prairie fringed orchid. Accordingly, the NRC staff addresses these species in this SEIS and evaluates the potential effects of LR on these species.

Table 3-15 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats Under U.S. Fish and Wildlife Service Jurisdiction in the Clinton Power Station License Renewal Action Area

Species or Critical Habitat	Federal Status[(a)]	Habitat	Type and Likelihood of Occurrence in Action Area
northern long-eared bat (*Myotis septentrionalis*)	FE	In non-hibernating seasons, northern long-eared bats typically roost individually or in colonies underneath bark or in cavities or crevices of both live trees and snags. Males and nonreproductive females may also roost in cooler locations, including caves and mines. Individuals may use caves and mines during fall swarming (FWS 2022-TN11245).	**Seasonal and occasional.** The action area falls within the general range of the species but does not contain caves, mines, or other features suitable for hibernating. Therefore, bats would not be present in winter. The action area's forested areas contain suitable habitat to support foraging, mating, and sheltering. Because no surveys have been conducted to determine the species' presence, the NRC staff conservatively assumes that the northern long-eared bat could occur within the action area in the spring, summer, and fall. If present during these seasons, individuals would only occur very occasionally and in very low numbers.

Table 3-15 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats Under U.S. Fish and Wildlife Service Jurisdiction in the Clinton Power Station License Renewal Action Area (Continued)

Species or Critical Habitat	Federal Status[(a)]	Habitat	Type and Likelihood of Occurrence in Action Area
Indiana bat (*Myotis sodalis*)	FE	In non-hibernating seasons, Indiana bats typically roost in forested areas under the exfoliating bark of dead or dying trees. Winter hibernaculum consists of underground caves and abandoned mines.	**Seasonal and occasional.** Same as northern long-eared bat above.
whooping crane (*Grus americana*)	EXPN	Illinois stopover habitat includes a variety of coastal marshes, lakes, ponds, wet meadows, and agricultural fields.	**Seasonal and occasional.** The action area falls within the general migration range of this species. Portions of Illinois may be used for stopover habitat during migration season. If present, individuals would only occur very occasionally and in very low numbers.
salamander mussel (*Simpsonaias ambigua)*	FPE	Habitat includes clear, flowing water with flat rocks and bedrock as substrate. Historical distribution includes small streams, large rivers, and Lake Erie. For reproduction, the salamander mussel uses the non-fish host, the mudpuppy (*Necturus maculosus*) for reproduction (FWS 2023-TN11246).	**Not Present.** There have been no observations of the mudpuppy or the salamander mussel by CEG during any aquatic survey of Clinton Lake. Given that this species requires flowing water and the mudpuppy as a host, the NRC assumes that the species is not present within the action area.
monarch butterfly (*Danaus plexippus*)	FPT	Prairies, meadows, grasslands along roadsides across most of North America, especially in areas containing milkweed (FWS 2024-TN11177).	**Seasonal and occasional.** Monarchs occur in Illinois from late April through mid-September. Migrating monarchs may use the action area as stopover habitat, and the species is also known to breed in Illinois. Botanical surveys conducted by CEG in 2020 have shown that milkweed is present onsite within the grassland restoration project area (CEG 2024-TN10914: Attachment 62, Enclosure 1). Consequently, milkweed is presumed present in the undeveloped portions of the action area. Therefore, the NRC staff assumes that the monarch butterfly could occur

Table 3-15 Occurrences of Federally Listed, Proposed, and Candidate Species and Critical Habitats Under U.S. Fish and Wildlife Service Jurisdiction in the Clinton Power Station License Renewal Action Area (Continued)

Species or Critical Habitat	Federal Status[(a)]	Habitat	Type and Likelihood of Occurrence in Action Area
			within the action area in the spring and summer.
western regal fritillary (*Argynnis idalia occidentalis*)	FPT	Prairies, meadows, and grasslands, especially in areas containing violets (*Viola* spp.) and nectar food sources. Habitats in the Midwest are primarily small, isolated patches typically exist as conservation preserves (89 FR 63888-TN10907).	**Seasonal and occasional.** Suitable habitat is likely present in undeveloped portions of the action area to include the grassland restoration project area. Botanical surveys conducted by CEG in 2020 did not confirm the presence of violets. Therefore, the NRC staff conservatively assumes that the western regal fritillary could occur within the action area (CEG 2024-TN10914: Attachment 71).
rusty patched bumble bee (*Bombus affinis)*	FE	Prairies, woodlands, marshes, and gardens. Requires areas that support food requirements including nectar and pollen from flowers and other floral resources. Nesting habitat includes abandoned rodent nests and similar cavities (FWS 2016-TN11192).	**Seasonal and occasional.** Bumble bees located in Illinois belong to the Prairie Division. Suitable habitat is likely present in the undeveloped portions of the action area to include the grassland restoration project area. Because no targeted surveys have been conducted, the NRC staff conservatively assume that the rusty patched bumble bee could occur within the action area.
eastern prairie fringed orchid (*Plantanthera leucophaea*)	FT	Mesic prairie, wetlands, sedge meadows, marsh edges, and bogs with full sun and little to no woody encroachment. Three species of hawkmoths are confirmed pollinators of this species.	**Potentially Present.** There have been no observations of orchids by CEG throughout the action area. There may be suitable habitat present in grassland and wetland habitat without woody encroachment. Because no targeted surveys have been conducted, the NRC staff conservatively assume that the eastern prairie fringed orchid could occur within the action area.

CEG = Constellation Energy Generation, LLC; EXPN = experimental population, non-essential; FE = federally endangered; FPE = proposed for Federal listing as endangered; FPT = proposed for Federal listing as threatened; FT = federally threatened; NRC = U.S. Nuclear Regulatory Commission.
(a) Indicates protection status under the Endangered Species Act.

Grassland Restoration Project

In 2016, CEG initiated plans for a Grassland Restoration Project as part of the Partners for Fish and Wildlife Program in partnership with FWS and Pheasants Forever. The goal of the project is to restore habitat for the benefit of species on private land. The project seeks to establish more than 65 ac (26 ha) of upland and prairie habitat through seeding with native pollinator seeding mix. On April 1, 2017, an agreement was signed between CEG and FWS regarding the project and will continue through 2027 (CEG 2024-TN10914: Attachment 62). Within the agreement, guidelines exist on BMPs, herbicide mixing and application, and other procedures to benefit pollinators. FWS will maintain oversight on the program throughout the agreement term. CEG has no plans on terminating the project within the LR term (CEG 2024-TN10914: Attachment 62).

3.8.1.3 Endangered Species Act: Federally Listed Species and Critical Habitats Under NMFS Jurisdiction

No federally listed species or designated critical habitats under NMFS jurisdiction occur in the action area. Therefore, this SEIS does not discuss any such species or habitats.

3.8.2 Magnuson-Stevens Act Fishery Conservation and Management Act: Essential Fish Habitat

Congress enacted the MSA in 1976 to foster the long-term biological and economic sustainability of the Nation's marine fisheries (TN7841). The MSA directs the Fishery Management Councils, in conjunction with NMFS, to designate areas of essential fish habitat (EFH) and to manage marine resources within those areas. EFH is the coastal and marine waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity (50 CFR Part 600-TN1342). For each federally managed species, the Fishery Management Councils and NMFS designate and describe EFH by life stage (i.e., egg, larva, juvenile, and adult). No coastal or marine waters occur near Clinton. Therefore, this SEIS does not discuss EFH.

3.8.3 National Marine Sanctuaries Act: Sanctuary Resources

Congress enacted the NMSA in 1972 to protect areas of the marine environment that have special national significance. The NMSA authorizes the Secretary of Commerce to establish the National Marine Sanctuary System and designate sanctuaries within that system, which includes 15 sanctuaries and 2 marine national monuments, encompassing more than 600,000 mi^2 (1,000,000 km^2) of marine and Great Lakes waters from Washington State to the Florida Keys and from Lake Huron to American Samoa. Within these areas, sanctuary resources include any living or nonliving resource of a national marine sanctuary that contributes to the conservation, recreational, ecological, historical, educational, cultural, archaeological, scientific, or aesthetic value of the sanctuary. No coastal or marine waters or Great Lakes occur near CPS. Therefore, this SEIS does not discuss national marine sanctuaries or their resources.

3.8.4 Proposed Action

The following sections address the plant-specific environmental impacts of the proposed CPS LR on the environmental issues that relate to federally protected ecological resources.

3.8.4.1 *Endangered Species Act: Federally Listed Species and Critical Habitats Under FWS Jurisdiction*

In Section 3.8.1.2 of this SEIS, the NRC staff determined that four federally listed species, two species proposed for Federal listing as threatened, one species proposed for Federal listing as endangered, and one experimental population non-essential species, may occur in the action area. In the sections below, the NRC staff analyze the potential impacts of the proposed CPS LR on these species. Table 3-16 below summarizes the NRC staff's ESA effect determinations that resulted from the staff's analysis.

Table 3-16 Effect Determinations for Federally Listed Species under U.S. Fish and Wildlife Service Jurisdiction

Species	Federal Status[(a)]	Potentially Present in the Action Area?	Effect Determination[(b)]
northern long-eared bat (*Myotis septentrionalis*)	FE	Yes	NLAA
Indiana bat (*Myotis sodalis*)	FE	Yes	NLAA
whooping crane (*Grus americana*)	EXPN	Yes	NLAA
salamander mussel (*Simpsonaias ambigua)*	FPE	No	NE
monarch butterfly (*Danaus plexippus*)	FPT	Yes	NLAA
western regal fritillary (*Argynnis idalia occidentalis*)	FPT	Yes	NLAA
rusty patched bumble bee (*Bombus affinis)*	FE	Yes	NLAA
eastern prairie fringed orchid (*Plantanthera leucophaea*)	FT	Yes	NLAA

EXPN = experimental population, non-essential; FE = federally endangered; FPE = proposed for Federal listing as endangered; FPT = proposed for Federal listing as threatened; FT = federally threatened; FWS = U.S. Fish and Wildlife Service; NE = no effect; NLAA = may affect but is not likely to adversely affect; NMFS = National Marine Fisheries Service.

(a) Indicates protection status under the Endangered Species Act.

(b) The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the FWS and NMFS Endangered Species Consultation Handbook (FWS and NMFS 1998-TN1031).

In Section 3.8.1.2 of this SEIS, the NRC staff describes several additional federally listed species. The NRC staff explains that these species do not occur in the action area; therefore, the NRC staff does not address these species any further because LR would have no effect on them. Table 3-16 above identifies these species and the NRC's staff's "no effect" findings.

3.8.4.1.1 *Indiana Bat* (FE) *and Northern Long-Eared Bat* (FE)

In Section 3.8.1.2 of this SEIS, the NRC staff concludes that Indiana bat and northern long-eared bat may occur in the action area's forests in spring, summer, and fall. If present, bat occurrence would be rare and in low abundance.

The potential stressors that protected bats could experience from the operation of a nuclear power plant (generically) are as follows:

- mortality or injury from collisions with nuclear power plant structures and vehicles
- habitat loss, degradation, disturbance, or fragmentation, and associated effects
- behavioral changes resulting from refurbishment or other site activities

Mortality or Injury from Collisions with Nuclear Power Plant Structures and Vehicles

Several studies have documented bat mortality or injury resulting from collisions with human-made structures. Saunders (1930-TN8504) reported that five bats of three species—eastern red bat, hoary bat (*L. cinereus*), and silver-haired bat—were killed when they collided with a lighthouse in Ontario, Canada. In Kansas, Van Gelder (1956-TN8505) documented five eastern red bats that collided with a television tower. In Florida, Crawford and Baker (1981-TN8506) collected 54 bats of seven species that collided with a television tower over a 25 year period, Zinn and Baker (1979-TN8507) reported 12 dead hoary bats at another television tower over an 18-year period, and Taylor and Anderson (1973-TN8508) reported 1 dead yellow bat (*Lasiurus intermedius*) at a third Florida television tower. Bat collisions with communications towers have been reported in North Dakota, Tennessee, and Saskatchewan, Canada; with convention center windows in Chicago, Illinois; and with power lines, barbed wire fences, and vehicles in numerous locations (Johnson and Strickland 2003-TN8509).

More recently, bat collisions with wind turbines have been of concern in North America. Bat fatalities have been documented at most wind facilities throughout the United States and Canada (USGS 2016-TN8510). For instance, during a 1996–1999 study at the Buffalo Ridge wind power development project in Minnesota, Johnson et al. (2003-TN8511) reported 183 bat fatalities, most of which were hoary bats and eastern red bats. The USGS Fort Collins Science Center estimates that tens to hundreds of thousands of bats die at wind turbines in North America each year (USGS 2016-TN8510).

Bat collisions with human-made structures at nuclear power plants are not well documented but are likely rare based on available information. In an assessment of the potential effects of the operation of the Davis-Besse Nuclear Power Station (Davis-Besse) in Ohio, the NRC staff (NRC 2014-TN7385) noted that four dead bats were collected at the nuclear power plant during bird mortality studies conducted from 1972 through 1979. Two red bats (*Lasiurus borealis*) were collected at the cooling tower, and one big brown bat and one tricolored bat were collected near other nuclear power plant structures. The NRC staff (NRC 2014-TN7385) found that future collisions of bats would be extremely unlikely and, therefore, discountable, given the small number of bats collected during the study and the marginal suitable habitat that the nuclear power plant site provides. The FWS (2014-TN7605) concurred with this determination. In a 2015 assessment associated with Indian Point Nuclear Generating Units 2 and 3 (Indian Point) in New York, the NRC staff (2015-TN7382) determined that bat collisions were less likely to occur at Indian Point than at Davis-Besse because Indian Point does not have cooling towers or similarly large obstructions. The tallest structures on the Indian Point site are 134 ft (40.8 m) tall turbine buildings and 250 ft (76.2 m) tall reactor containment structures. The NRC staff (2015-TN7382) concluded that the likelihood of bats colliding with these and other nuclear power plant structures on the Indian Point site during the LR period was extremely unlikely to occur and, therefore, discountable. FWS concurred with this determination (2015-TN7612). In 2018, the NRC staff (2018-TN7381) determined that the likelihood of bats colliding with site buildings or structures on the Seabrook Station, Unit 1, site in New Hampshire would be extremely unlikely.

The tallest structures on that site are the 199 ft (61 m) tall containment structure and the 103 ft (31 m) tall turbine and heater bay building. The FWS (2018-TN7610) concurred with the NRC staff's determination. Since that time, the FWS has concurred with similar findings for initial and subsequent LRs at multiple other nuclear power plant sites, including Surry Power Station, Units 1 and 2, in Surry, Virginia (FWS 2019-TN7609); Peach Bottom Atomic Power Station, Units 2 and 3, in Delta, Pennsylvania (FWS 2019-TN9742); Point Beach Nuclear Plant, Units 1 and 2, in Two Rivers, Wisconsin (FWS 2021-TN9740); North Anna Power Station, Units 1 and 2, in Louisa, Virginia (FWS 2023-TN9093); and Perry Nuclear Power Plant, Unit 1, in Perry, Ohio (FWS 2023-TN9741), among others.

The tallest structures on the CPS site include the primary meteorological tower, 205 ft (62 m) above ground level, and the backup meteorological tower, which is 250 ft (76 m) above ground level (CEG 2024-TN10914: Attachment 23). The turbine buildings and transmission lines are also prominent features on the site. To date, CEG has reported no incidents of injury or mortality of any species of bat on the CPS site associated with site buildings or structures. Accordingly, the NRC staff finds the likelihood of future bat collisions with site buildings or structures to be extremely unlikely and, therefore, discountable.

Vehicle collision risk for bats varies depending on factors including time of year, location of roads and travel pathways in relation to roosting and foraging areas, the characteristics of individuals' flight, traffic volume, and whether young bats are dispersing. Although collision has been documented for several species of bats, the Indiana Bat Draft Recovery Plan (FWS 2007-TN934) indicates that bat species do not seem to be particularly susceptible to vehicle collisions. However, the FWS also finds it difficult to determine whether roads pose a greater risk for bats colliding with vehicles or a greater likelihood of decreasing risk of collision by deterring bat activity (FWS 2016-TN7400). In most cases, the FWS expects that roads of increasing size decrease the likelihood of bats crossing the roads and, therefore, reduce collision risk (FWS 2016-TN7400).

During the proposed CPS LR term, vehicular traffic from truck deliveries, site maintenance activities, and personnel commuting to and from the site would continue throughout the LR term as they have during the current licensing period. Vehicle use would occur primarily in areas that bats would be less likely to frequent, such as along established county and State roads or within industrial-use areas of the CPS site. Additionally, most vehicle activity would occur during daylight hours when bats are less active. To date, CEG has reported no incidents of injury or mortality of any species of bat on the CPS site associated with vehicle collisions. Accordingly, the NRC staff finds the likelihood of future bat collisions with vehicles to be extremely unlikely and, therefore, is not considered further.

Habitat Loss, Degradation, Disturbance, or Fragmentation, and Associated Effects

As previously discussed in this SEIS, the CPS action area includes a forested habitat that protected bats may rarely to occasionally inhabit in spring, summer, and fall. In its species status assessment for the northern long-eared bat (FWS 2022-TN11245), the FWS stated that forest removal may result in the following impacts to protected bats: loss of suitable roosting or foraging habitat, longer flights between suitable roosting and foraging habitats because of forest habitat fragmentation, fragmentation of maternity colonies due to loss/fragmentation of travel corridors, and direct mortality or injury during tree removal.

The proposed action would not involve forest removal or management and would generally not disturb the existing forested habitat on the site. Other vegetation maintenance on the site over

the course of the proposed LR term would be of grassy, mowed areas between buildings and along walkways within the industrial portion of the site (CEG 2024-TN10806). CEG would continue to maintain onsite transmission line ROWs in accordance with North American Electric Reliability Corporation standards. CEG does not intend to expand the existing facilities or otherwise perform construction or maintenance activities within the action area. Negative impacts on bats could result if roost trees are removed. Bats could also be directly injured during tree clearing. However, CEG states that tree removal is not expected to occur during the LR term (CEG 2024-TN10806).

The NRC staff finds that infrequent to rare hazardous tree removal in forested areas during the proposed LR term would not measurably affect any potential bat habitat in the action area. Direct injury or mortality to bats during tree removal is also unlikely because CEG company guidance would ensure that personnel take the appropriate measures to avoid this potential impact. The continued preservation of the existing forested areas and the grassland restoration area on the site during the LR term would result in positive impacts on tricolored bats if present within or near the action area.

Behavioral Changes Resulting from Refurbishment or Other Site Activities

Construction or refurbishment and other site activities, including site maintenance and infrastructure repairs, could prompt behavioral changes in bats. Noise, vibration, and general human disturbance are stressors that may disrupt normal feeding, sheltering, and breeding activities (FWS 2016-TN7400). At low noise levels or farther distances, bats initially may be startled but would likely habituate to the low background noise levels. At closer range and louder noise levels, particularly if accompanied by physical vibrations from heavy machinery, many bats would likely be startled to the point of fleeing from their daytime roosts. Fleeing individuals could experience increased susceptibility to predation and would expend increased levels of energy, which could result in decreased reproductive fitness (FWS 2016-TN7400: Table 4-1). Increased noise may also affect foraging success. Schaub et al. (2008-TN8867) found that the foraging success of the greater mouse-eared bat (*Myotis myotis*) diminished in areas with noise mimicking the traffic sounds that would be experienced within 15 m (49 ft) of a highway.

Within the CPS action area, noise, vibration, and other human disturbances could dissuade bats from using the action area's forested habitat during migration, which could also reduce the fitness of migrating bats. However, bats that use the action area have likely become habituated to such disturbances because CPS has been consistently operating for several decades. According to the FWS, bats that are repeatedly exposed to predictable, loud noises may habituate to such stimuli over time (2010-TN8537). For instance, Indiana bats have been documented as roosting within approximately 1,000 ft (300 m) of a busy State route adjacent to Fort Drum Military Installation and immediately adjacent to housing areas and construction activities on the installation (U.S. Army 2014-TN8512). Indiana and northern long-eared bats would likely respond similarly.

Continued operation of CPS during the LR term would not include major construction or refurbishment and would involve no other maintenance or infrastructure repair activities besides routine activities already performed on the site. Levels and intensity of noise, lighting, and human activity associated with continued day-to-day activities and site maintenance during the LR term would be similar to ongoing conditions since CPS began operating, and such activity would only occur on the developed, industrial-use portions of the site. While these disturbances could cause behavioral changes in migrating or summer roosting bats, such as the expenditure

of additional energy to find alternative suitable roosts, the NRC staff assumes that protected bats, if present in the action area, have already acclimated to regular site disturbances. Thus, continued disturbances during the LR term would not cause behavioral changes in bats to a degree that would be able to be meaningfully measured, detected, or evaluated or that would reach the scale where a take might occur.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on Indiana or northern long-eared bats that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- Bat collisions with nuclear power plant structures in the United States are rare, and none have been reported at CPS. Vehicle collisions attributable to the proposed action are also unlikely, and none have been reported at CPS.
- The proposed action would not involve any construction, land clearing, or other ground-disturbing activities.
- Continued preservation of the existing forested areas on the site would result in positive impacts on bats.
- Bats, if present in the action area, have likely already acclimated to the noise, vibration, and general human disturbances associated with site maintenance, infrastructure repairs, and other site activities. During the LR term, such disturbances and activities would continue at current rates and would be limited to the industrial-use portions of the site.

Conclusion for the Indiana Bat

All potential effects on the Indiana bat resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the Indiana bat. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

Conclusion for the Northern Long-eared Bat

All potential effects on the northern long-eared bat resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the northern long-eared bat. In a letter dated December 5, 2024, the FWS concurred with this finding based on the results of the Northern Long-Eared Bat and Tricolored Bat Range-wide Determination Key (FWS 2024-TN11160).

3.8.4.1.2 Whooping Crane (EXPN)

In Section 3.8.1.2 of this SEIS, the NRC staff concludes that whooping cranes may occur in the action area when moving between areas of more suitable habitat. If present, whooping cranes would occur occasionally and for short periods of time. CEG reports neither mortalities nor any occurrence of whooping cranes on site (CEG 2024-TN10914: Attachment 69).

The primary human drivers affecting the whooping crane habitat include activities that cause a loss of wetlands or the degradation of wetland and riverine habitats (FWS 2023-TN8854). CEG proposes no construction or ground disturbance during the LR term that would impact wetland or riparian habitats. All plant operations would continue to occur within already developed land

on the CPS site. CEG would continue to comply with its NPDES permit, and no activities during the LR term would alter Clinton Lake in a manner that could result in the degradation of the riverine habitat for whooping cranes.

During the proposed CPS LR term, vehicular traffic from truck deliveries, site maintenance activities, and personnel commuting to and from the site would continue throughout the LR term as they have during the current license term. Vehicle use would occur primarily in areas that whooping cranes would be less likely to frequent, such as along established county and State roads or within industrial-use areas of the CPS site. Accordingly, the NRC staff finds the likelihood of future whooping crane collisions with vehicles to be extremely unlikely and, therefore, is not considered further.

The risk of collisions with tall structures and in-scope transmission lines poses a threat to whooping cranes and other birds. As described in Section 3.6.3.4 of this SEIS, CEG maintains an avian and wildlife management plan to avoid and minimize bird mortality and injury incidents. CEG states that there have been no documented incidents or encounters with whooping cranes at CPS from 2019 to 2023 (CEG 2024-TN10914: Attachment 69). From 2014 to 2024, there have been 12 bird mortality incidents totaling 23 birds. Of all incidents, only one individual was found stuck and deceased within infrastructure such as security razor wire. Accordingly, the NRC staff finds the likelihood of future whooping crane collisions with buildings, infrastructure, or in scope transmission lines to be extremely unlikely and, therefore, is not considered further.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on whooping cranes that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential wetland habitat for whooping cranes.
- Continued preservation of the existing natural areas on the site would result in positive impacts on whooping cranes.
- Collisions with tall structures or in-scope transmission lines are unlikely. Vehicle collisions attributable to the proposed action are also unlikely, and none have been reported at CPS.

Conclusion for the Whooping Crane

All potential effects on the whooping crane resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* whooping cranes.

The whooping crane is listed as a non-essential experimental population (EXPN) for the CPS action area. FWS has determined a non-essential population is not necessary for the continued existence of the species. For the purposes of consultation, EXPN are treated as a proposed species on private land with no section 7(a)(2) requirements, but Federal agencies must not jeopardize their existence (Section 7(a)(4)). Therefore, the NRC staff conclude that Section 7 ESA obligations are fulfilled for this proposed action.

3.8.4.1.3 Monarch Butterfly (FPT)

In Section 3.8.1.2 of this SEIS, the NRC staff concludes that monarch butterflies may occur in the action area during spring and fall migration when individuals are moving between areas of more suitable habitat. If present, monarchs would occur occasionally and for short periods of time.

The FWS (2024-TN11177) identifies the primary drivers affecting the health of the two North American migratory populations of monarch butterfly as (1) habitat loss and degradation, (2) insecticide exposure, and (3) climate change effects.

Monarch habitat loss and degradation has resulted from the conversion of grasslands to agriculture, widespread use of herbicides, logging/thinning at overwintering sites in Mexico, deterioration and incompatible management of overwintering sites in California, urban development, and drought. The proposed CPS LR would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitats for monarch butterflies. The continued preservation of existing natural areas on the site would result in positive impacts on monarch butterflies.

Most insecticides are nonspecific and broad-spectrum in nature. Furthermore, the larvae of many Lepidopterans are considered major pest species, and insecticides are specifically tested on this taxon to ensure that they will effectively kill individuals at the labeled application rates (FWS 2024-TN11177). Although insecticide use is most often associated with agricultural production, any habitat where monarchs are found may be subject to insecticide use. Studies looking specifically at the dose response of monarchs to neonicotinoids, organophosphates, and pyrethroids have demonstrated monarch toxicity (e.g., Krischik et al. 2015-TN8596; James 2019-TN8595; Krishnan et al. 2020-TN8597; Bagar et al. 2020-TN8594). Moreover, the magnitude of risk posed by insecticides may be underestimated, as research usually examines the effects of the active ingredient alone, while many of the formulated products contain more than one active insecticide.

During the proposed LR term, CEG would continue applying herbicides as needed, according to labeled uses, and with technical assistance from FWS for application in the grassland restoration project area (CEG 2024-TN10914: Attachment 62, Enclosure 1). Application would primarily be confined to industrial-use and other developed portions of the site, such as perimeters of parking lots, roads, and walkways. Continued herbicide application could directly affect monarchs in the action area by injuring or killing individuals exposed to these chemicals. Certain herbicides such as glyphosate (e.g., Round Up) can kill milkweed, which can affect the ability of female monarchs to lay eggs. CEG identified milkweed species within the grassland restoration project area (CEG 2024-TN10914: Attachment 26). Milkweed may exist in other undeveloped portions of the action area. However, given the conservation measures listed prior, there will be little to no impact to milkweed populations. Monarchs are only likely to occur in the action area seasonally during spring and fall migration when individuals are moving between areas of more suitable habitat. Because of the low likelihood of monarchs to be exposed to hazardous levels of chemicals, this potential impact is insignificant because it is unlikely to reach the scale where a take might occur.

Because the current and projected monarch population numbers are low, both the eastern and western populations are more vulnerable to catastrophic events, such as extreme storms at the overwintering habitat, and other climate change related phenomena. The FWS (FWS 2024-TN11177) anticipates that the eastern population will gain habitat in the northcentral region of

North America as the species expands northward in response to increasing ambient temperatures. The degree and rate at which this expansion occurs will depend on the simultaneous northward expansion of milkweed. In the southern region of the continent, the population will either experience no gain or some loss of habitat.

Impacts on climate change during normal operations at nuclear power plants can result from the release of GHGs from stationary combustion sources, refrigeration systems, electrical transmission and distribution systems, and mobile sources. However, such emissions are typically very minor because nuclear power plants do not normally combust fossil fuels to generate electricity. During the proposed LR term, the contribution of CPS operations to climate change-related effects on monarch butterflies would be too small to be meaningfully measured, detected, or evaluated.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on monarch butterflies that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitat for monarchs.
- Continued preservation of the existing natural areas on the site would result in positive impacts on monarchs.
- Herbicides would only be applied according to labeled uses in developed and manicured areas of the site. Herbicides would not be applied in natural areas. Monarchs would only have the potential to occur in the action area seasonally and infrequently, making the likelihood of herbicide exposure low. This represents an insignificant effect because it is unlikely to reach the scale where a take might occur.
- The contribution of CPS operations to climate-change-related effects on monarchs would be too small to be meaningfully measured, detected, or evaluated.

Conclusion for the Monarch Butterfly

All potential effects on the monarch butterfly resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the monarch butterfly. Because the monarch is proposed for Federal listing as threatened, the ESA does not require the NRC to consult with or receive concurrence from the FWS regarding this species as long as the continued existence of the species is not jeopardized.

3.8.4.1.4 *Western Regal Fritillary* (FPT)

In Section 3.8.1.2 of this SEIS, the NRC staff concludes that the non-migratory western regal fritillary may occur in the action area in nearby grassland areas to include the grassland restoration project area. If present, the western regal fritillary presents itself on the CPS site in early June to late October. Larvae overwinter in grasslands before they emerge in early spring. Though non-migratory, the regal fritillary can disperse up to 100 mi (161 km) in search for suitable habitat during its several month-long lifespan (89 FR 63888-TN10907).

The FWS identifies the primary drivers affecting the health of the western regal fritillary as (1) habitat loss and degradation, (2) other natural or human-made factors affecting its continued existence such as herbicide and pesticide application, and (3) climate change (89 FR 63888-TN10907).

The conversion of native grassland to agricultural land use is the primary factor reducing suitable habitat for this species. Other factors that may diminish suitable habitat include road construction, housing and commercial development, and energy projects (89 FR 63888-TN10907). The proposed CPS LR would not involve any habitat loss, land disturbing activities, or any activities that would degrade existing natural areas or potential habitats for the regal fritillary. The continued preservation of existing natural areas on the site would result in positive impacts on the regal fritillary.

The western regal fritillary faces similar impacts from herbicides and pesticides to that of the monarch butterfly as described in Section 3.8.4.1.3 of this SEIS. During the proposed LR term, CEG would continue applying herbicides as needed, according to labeled uses, and with technical assistance from FWS for application in the grassland restoration project area (CEG 2024-TN10914: Attachment 62, Enclosure 1). Application would primarily be confined to industrial-use and other developed portions of the site, such as perimeters of parking lots, roads, and walkways. Continued herbicide application could directly affect the regal fritillary in the action area by injuring or killing individuals exposed to these chemicals. Certain herbicides such as glyphosate (e.g., Round Up) can kill violets, which can directly affect larval food sources. CEG did not identify any violet species present onsite during its 2020 botanical survey (CEG 2024-TN10914: Attachment 26). Violets may exist in other undeveloped portions of the action area. However, given the conservation measures listed prior, there will be little to no impact to violet populations. The regal fritillary is only likely to occur in the action area seasonally from early June to late October. Because of the low likelihood of the regal fritillary to be exposed to hazardous levels of chemicals, this potential impact is insignificant because it is unlikely to reach the scale where take might occur.

Increasing temperatures as a result of climate change could have effects on the regal fritillary such as interruption of winter diapause and disruption of violet phenology and abundance. FWS notes that several populations located in Iowa experienced drought-like conditions in 2010 and have consequently never recovered (89 FR 63888-TN10907).

Impacts on climate change during normal operations at nuclear power plants can result from the release of GHGs from stationary combustion sources, refrigeration systems, electrical transmission and distribution systems, and mobile sources. However, such emissions are typically very minor because nuclear power plants do not normally combust fossil fuels to generate electricity. During the proposed LR term, the contribution of CPS operations to climate change-related effects on the regal fritillary would be too small to be meaningfully measured, detected, or evaluated.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on the western regal fritillary that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the same reasons listed for the monarch butterfly in Section 3.8.4.1.3.

Conclusion for the Western Regal Fritillary

All potential effects on the western regal fritillary resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the western regal fritillary. Because the western regal fritillary is proposed for Federal listing, the ESA does not require the NRC to consult with or receive concurrence from the FWS regarding this species as long as the continued existence of the species is not jeopardized.

3.8.4.1.5 Rusty Patched Bumble Bee (FE)

In Section 3.8.1.2 of this SEIS, the NRC staff concludes that rusty patched bumble bees may occur in the action area throughout the undeveloped portions of CPS to include the grassland restoration project area as well as in landscaped areas containing floral species. CEG reports neither mortalities nor any occurrence of rusty patched bumble bees on site (CEG 2024-TN10806).

FWS identifies the primary drivers affecting the health of the rusty patched bumble bee as (1) pesticide exposure, (2) habitat loss and degradation, and (3) climate change (FWS 2016-TN11192).

Most insecticides are nonspecific and broad-spectrum in nature. Any habitat where rusty patched bumble bees are found may be subject to insecticide use. FWS studies, with pesticide application rate data collected from 1995 to 2013 by the USGS, demonstrate neonicotinoid (imidacloprid, clothianidin, and thiamethoxam) toxicity to rusty patched bumble bees (FWS 2016-TN11192). The magnitude of risk posed by insecticides may be underestimated, as research usually examines the effects of the active ingredient alone, while many of the formulated products contain more than one active insecticide.

During the proposed LR term, CEG would continue applying herbicides as needed, according to labeled uses. Application would primarily be confined to industrial-use and other developed portions of the site, such as perimeters of parking lots, roads, and walkways. Continued herbicide application could directly affect rusty patched bumble bees in the action area by injuring or killing individuals exposed to these chemicals. CEG maintains a Pesticide Management Plan, which contains measures, precautions, and guidance on pesticide and herbicide application, safety, and maintenance (CEG 2024-TN10914: Attachment 29). Additionally, in association with the grassland restoration project, FWS will provide technical assistance on habitat management techniques to include herbicide mixing and application (CEG 2024-TN10914: Attachment 62, Enclosure 1). Because of the low likelihood of rusty patched bumble bees to be exposed to hazardous levels of chemicals, this potential impact is insignificant because it is unlikely to reach the scale where a take may occur.

Rusty patched bumble bee habitat loss and degradation has resulted primarily from the conversion of natural habitat to agricultural and urban land use. Livestock grazing and natural fire regimes have also played a role in habitat loss and degradation. Directly linked to habitat loss is the reduction of floral resources required for food and nectar (FWS 2016-TN11192). The proposed CPS LR would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitats for the rusty patched bumble bee. The continued preservation of existing natural areas and establishment of the grassland restoration project would result in positive impacts on the rusty patched bumble bee.

There are few studies that investigate the impacts of climate change on bees. Most studies that assess potential impacts of climate change on pollinators come from studies on butterflies. Associated effects from climate change may lead to a decrease in resource availability and nesting habitat for the rusty patched bumble bee (FWS 2016-TN11192). Impacts on climate change during normal operations at nuclear power plants can result from the release of GHGs from stationary combustion sources, refrigeration systems, electrical transmission and distribution systems, and mobile sources. However, such emissions are typically very minor because nuclear power plants do not normally combust fossil fuels to generate electricity. During the proposed LR term, the contribution of CPS operations to climate-change-related effects on rusty patched bumble bees would be too small to be meaningfully measured, detected, or evaluated.

Summary of Effects

The potential stressors evaluated in this section are unlikely to result in effects on rusty patched bumble bees that could be meaningfully measured, detected, or evaluated, and such stressors are otherwise unlikely to occur for the following reasons:

- The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitat for rusty patched bumble bees.
- Continued preservation of the existing natural areas on the site would result in positive impacts on bees.
- Herbicides would only be applied according to labeled uses in developed and manicured areas of the site. Additionally, rusty patched bumble bees have not been observed on site. This represents an insignificant effect because it is unlikely to reach the scale where a take might occur.
- The contribution of CPS operations to climate-change-related effects on bees would be too small to be meaningfully measured, detected, or evaluated.

Conclusion for the Rusty Patched Bumble Bee

All potential effects on the rusty patched bumble bee resulting from the proposed action would be insignificant or discountable. Therefore, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the rusty patched bumble bee. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

3.8.4.1.6 *Eastern Prairie Fringed Orchid* (FT)

In Section 3.8.1.2 of this SEIS, the NRC staff concludes that eastern prairie fringed orchids may occur in the action area near wetlands and grasslands. FWS identifies the primary driver affecting the conservation of the eastern prairie fringed orchid as habitat loss and degradation (FWS 2025-TN11271; NatureServe 2025-TN11272).

Eastern prairie fringed orchid habitat loss and degradation has resulted primarily from the conversion of natural habitat to agricultural land use for crop production as well as commercial and residential development. Increased livestock grazing has also contributed to this species decline. Additionally, much of the habitat required for the orchid is no longer under fire suppression controls which has resulted in an increase of the encroachment of woody

vegetation throughout much of the suitable habitat available for the orchid (FWS 2025-TN11271; NatureServe 2025-TN11272).

The proposed CPS LR would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitats for the eastern prairie fringed orchid. The continued preservation of existing natural areas and establishment of the grassland restoration project would result in positive impacts on the eastern prairie fringed orchid.

Summary of Effects

The proposed action would not involve any habitat loss, land-disturbing activities, or any activities that would degrade existing natural areas or potential habitats for orchids. Continued preservation of the existing natural areas onsite and the establishment of the grassland restoration area would result in positive impacts on orchids.

Conclusion for the Eastern Prairie Fringed Orchid

Because the proposed action would not have any effect on potential habitat occurring within the action area, the NRC staff concludes that the proposed action *may affect but is not likely to adversely affect* the eastern prairie fringed orchid. Following the issuance of the draft SEIS, the NRC staff will seek the FWS's concurrence with this finding.

3.8.4.2 Endangered Species Act: Federally Listed Species and Critical Habitats Under NMFS Jurisdiction

No federally listed species or critical habitats under NMFS jurisdiction occur within the action area (see Section 3.8.1.3 of this SEIS). Therefore, the NRC staff concludes that the proposed action would have no effect on federally listed species or habitats under this agency's jurisdiction.

3.8.4.3 Magnuson-Stevens Fishery Conservation and Management Act: Essential Fish Habitat

No EFH occurs within the affected area (Section 3.8.2 of this SEIS). Therefore, the NRC staff concludes that the proposed action would have no effect on EFH.

3.8.4.4 National Marine Sanctuaries Act: Sanctuary Resources

No national marine sanctuaries occur within the affected area (see Section 3.8.3 of this SEIS). Therefore, the NRC staff concludes that the proposed action would have no effect on sanctuary resources.

3.8.5 No-Action Alternative

Under the no-action alternative, the NRC would not renew the operating license and CPS would shut down on or before the expiration of the current operating license. Upon shutdown, the nuclear power plant would require substantially less cooling water and would produce little to no discernable thermal effluent. Thus, the potential for impacts on all aquatic species related to cooling system operation would be significantly less than under the proposed action. The ESA action area under the no-action alternative would most likely be the same or similar to the area

described in Section 3.8.1.1 of this SEIS. Northern long-eared bats, Indiana bats, whooping cranes, monarch butterflies, western regal fritillary, rusty patched bumble bees, and eastern prairie fringed orchids may occur within the action area (Section 3.8.1.2 of this SEIS). The NRC would consult with the FWS, as appropriate, to address potential effects to these species resulting from the shutdown and decommissioning of the plant. No EFH or national marine sanctuaries occur in the region (Sections 3.8.2 and 3.8.3 of this SEIS). Thus, shutdown would not result in impacts on EFH or sanctuary resources. Actual impacts would depend on the specific shutdown activities and whether any listed species or critical habitats are present when the no-action alternative is implemented.

3.8.6 Replacement Power Alternatives: Common Impacts

The ESA action area, for the replacement power alternatives would depend on various factors including site selection, current land uses, planned construction activities, temporary and permanent structure locations and parameters, and the timeline of the alternative. The federally listed species, critical habitats, EFH, and national marine sanctuaries potentially affected by a replacement power alternative would depend on the boundaries of that alternative's effects and the species and habitats federally protected when the alternative is implemented. For instance, if CPS continues to operate until the end of the current license term and a replacement power alternative is implemented at that time, the Services may have listed new species, delisted currently listed species whose populations have recovered, or revised EFH designations. These listing and designation activities would change the potential for the various alternatives to impact federally protected ecological resources. Additionally, the requirements for consultation under the ESA, MSA, and NMSA would depend on whether Federal permits or authorizations are required to implement each alternative.

3.8.7 Natural Gas Alternative

The natural gas alternative assumes that an NGCC plant with a design capacity of 1,241 MWe would be constructed at the CPS site with associated MDCTs. The NRC does not license natural gas facilities; therefore, the NRC would not be responsible for ESA, MSA, or NMSA consultations for this alternative. The Federal and private responsibilities for addressing impacts on federally protected ecological resources under this alternative would be similar to those described in Section 3.8.5 of this SEIS. Ultimately, the magnitude and significance of adverse impacts on federally protected ecological resources resulting from this alternative would depend on the site location and layout, plant design, plant operations, and the protected species and habitats present in the action area when the alternative is implemented.

3.8.8 Renewable and Natural Gas Combination Alternative

The renewable and natural gas combination alternative would consist of an NGCC plant constructed at the CPS site with a design capacity of 870 MWe, 652 MW onsite wind installations with battery storage, and 216 MW onsite and offsite solar installations with battery storage. The NRC does not license natural gas facilities, wind installations, or solar installations; therefore, the NRC would not be responsible for ESA, MSA, or NMSA consultations for this alternative. The Federal and private responsibilities for addressing impacts on federally protected ecological resources under this alternative would be similar to those described in Section 3.8.5 of this SEIS. Ultimately, the magnitude and significance of adverse impacts on federally protected ecological resources resulting from this alternative would depend on the site location and layout, plant design, plant operations, and the protected species and habitats present in the action area when the alternative is implemented.

3.8.9 Purchased Power Alternative

The purchased power alternative involves the establishment of a long-term contract to import replacement power into the CEG service area to replace CPS net generation. Potential environmental impact depends on the source, type and location of the energy obtained under such contract. Long-term power purchase agreements would need to comply with the Illinois Power Agency Act, which focuses on renewable power. The NRC does not license natural gas facilities, wind installations, or solar installations; therefore, the NRC would not be responsible for ESA, MSA, or NMSA consultations for this alternative. The Federal and private responsibilities for addressing impacts on federally protected ecological resources under this alternative would be similar to those described in Section 3.8.5 of this SEIS. Ultimately, the magnitude and significance of adverse impacts on federally protected ecological resources resulting from this alternative would depend on the site location and layout, plant design, plant operations, and the protected species and habitats present in the action area when the alternative is implemented.

3.9 Historic and Cultural Resources

This section describes the cultural background and the historic and cultural resources at CPS and its surrounding area. As discussed in Chapter 2, NEPA (42 U.S.C. 4321 et seq.-TN661) requires Federal agencies to consider the potential effects of their actions on the affected human environment, which includes “aesthetic, historic, and cultural resources as these terms are commonly understood, including such resources as sacred sites” (CEQ and ACHP 2013-TN4603). Section 106 of the NHPA (54 U.S.C. 306108-TN4839) requires Federal agencies to consider the effects of their undertakings on historic properties. While NHPA emphasizes impacts on historic properties, for NEPA compliance, impacts on cultural resources that are not eligible for or listed in the NRHP also need to be considered (CEQ and ACHP 2013-TN4603). In accordance with 36 CFR 800.8(c) (TN513), the NRC complies with the obligations required under NHPA Section 106 through its process under the NEPA.

Historic and cultural resources describe material culture left behind from past human activity. These resources include sites, objects, landscapes, structures, or other natural features of significance to groups of people who have traditional association with it. Historic properties are defined as resources eligible for listing in the NRHP. The NRHP is the Nation’s official list recognizing buildings, structures, objects, sites, and districts of national, State, or local historical significance which merit preservation. The criteria for eligibility are listed in the 36 CFR 60.4 (TN1682) and include (A) association with significant events in history; (B) association with the lives of persons significant in the past; (C) embodiment of distinctive characteristics of type, period, or construction; and (D) sites or places that have yielded, or are likely to yield, important information.

In the context of the NHPA, the proposed undertaking is the LR of the current operating license, which would extend the current operating term another 20 years. The area of potential effect (APE) consists of the 13,626 ac (5,514 ha) of the CPS site and the transmission lines up to the first substation that may be directly or indirectly affected by land disturbing or other operational activities associated with continued plant operations and maintenance and/or refurbishment activities. The APE may extend beyond the nuclear plant site if CEG maintenance and operational activities affect offsite historic properties. This determination is made irrespective of land ownership or control.

In accordance with the NHPA, the NRC is required to make a reasonable effort to identify historic properties within the APE. If the NRC finds that either there are no historic properties within the APE or the undertaking (LR) would have no effect on historic properties, the NRC provides documentation of this finding to the State Historic Preservation Officer (SHPO). In addition, the NRC notifies all consulting parties, including Indian Tribes, and makes this finding public through the NEPA process prior to renewing the CPS operating license. Similarly, if historic properties are present and could be affected by the undertaking, the NRC is required to assess and resolve any adverse effects in consultation with the SHPO and any Indian Tribe that attaches religious and cultural significance to identified historic properties.

In Illinois, the Historic Preservation Division of the IDNR is responsible for administering Federal and State-mandated historic preservation programs to identify, evaluate, register, and protect the State's archaeological and historic resources under the direction of the Illinois SHPO. The Historic Preservation Division maintains the Illinois Inventory of Archaeological Sites electronic database, which inventories all the registered cultural resources within the State, including those within CPS, and the Historic and Architectural Resources Geographic Information System, the State's public inventory of historic buildings, structures, sites, objects, and districts.

As part of its LRA, CEG submitted an ER, which contains information and an analysis of the environmental impacts of the proposed action, including the impacts of refurbishment activities, if any, associated with LR and the impacts of operation during the LR term. In addition to its independent review, the NRC staff uses this information to support its NHPA Section 106 consultation obligations.

3.9.1 Cultural Background

This section describes the precontact, ethnographic, and historic chronology of the proposed action's region. Illinois has several well-known archaeological sites in the southwest portion of the state that have contributed to our archaeological understanding of human populations over the course of the past 15,000 years. The Koster site near Kampsville, Illinois contributed to important discoveries on early human occupation, including some of the oldest evidence of food preparation, cemeteries for burying deceased members, and the presence of domesticated dogs (ISM 2000-TN11018). The Modoc Rockshelter in Randolph County, Illinois is one of the earliest examples of Indigenous populations using rock shelters as long-term base camp sites during the Archaic period. The site provided one of the best known opportunities for examining factors important to Archaic cultural evolution, human adaptations, and changing Holocene environments (Styles et al. 1983-TN11066; ISM 2000-TN11018). Last, the Cahokia site in southwest Illinois is the largest pre-Columbian site north of Mexico and a prime example of Mississippian era chiefdoms. Cahokia developed and influenced advanced societies by demonstrating organizational complexity, political stratification, planned community development, mound building, farming and subsistence practices, and complex mortuary practices.

The proposed action area was glaciated via the Wisconsinan glacial episode until about 15,000 years ago. Archaeological evidence demonstrates that human occupation emerged around 13,000 years ago. The chronology of the region is divided into the following periods: Paleoindian (13,000–10,000 before present [BP]), Archaic (10,000–3000 BP), Woodland (3000 BP to Anno Domini [AD] 1100), Mississippian (AD 1100–1300), the Late Prehistoric Period (1300–1673), and the Contact and Historic Period (1673 to present). The context described below helps archaeologists understand what previous research has been done in the area to inform cultural resources professionals what potential natural and cultural resources may be encountered in the proposed action area. General patterns summarizing each time period are briefly described below.

Paleoindian Period (13,000–10,000 BP)

The Paleoindian Period is considered to represent the earliest documented human occupation in the region, extending more than 12,000 years ago to the terminal Pleistocene period. This period is typically characterized by small groups of highly mobile nomadic hunters who followed large game such as mammoths, mastodons, and bison and inhabited small semi-permanent camps. Ongoing dialogue in the archaeological community has differing thoughts on what is considered the earliest documented human occupation in North America. Scholars typically associate the Clovis and Folsom cultures with the Paleoindian Period, although there are a number of well-known archaeological sites across North America that pre-date Clovis period sites. These include the Meadowcroft Rockshelter in Pennsylvania (Adovasio et al. 1990-TN10487), Paisley Caves in Oregon (Gilbert et al. 2008-TN10488), and White Sands in New Mexico (Pigati et al. 2023-TN10489). Technologies of this era are mostly associated with the Clovis and Folsom cultures. Both are known for their fluted points and large spear points made from high quality chert characterized by a groove notched out in the middle to bottom half of the point, allowing it to be attached to handles. Aside from fluted points, the Paleoindian toolkit also includes unfluted lanceolate projectile points, hammerstones, bifacial knifes, side scrapers, end scrapers, and drills (Adams and Young 2007-TN10490).

In Illinois, Clovis and Dalton sites are contemporary with the Paleoindian period. Clovis sites are typically small scatters of stone tools and chipped lithics but in some cases, may be larger camp sites such as the Mueller site in St. Clair County, Illinois (Koldehoff and Walthall 2000-TN11067). Dalton sites are smaller in comparison to Clovis sites. Archaeological evidence suggests that Dalton populations were the first groups to settle into the landscape, utilizing caves and rock shelters as habitation sites and local chert to manufacture their tools. Dalton groups not only used the landscape more intensively, but also in larger populations. Near St. Louis, Missouri, the Kimmswick site recovered Clovis points and other stone tools in the same layers as mastodon bones (Koldehoff and Walthall 2000-TN11067). Over 200 Clovis tools were retrieved during excavations at the aforementioned Mueller site in St. Clair County. Dalton component sites have been identified in St. Louis County and at the Olive Branch site in Alexander County.

Archaic Period (10,000–3000 BP)

The Archaic period is documented as starting around 10,000 years ago and marks the transition from nomadic to more sedentary settlement patterns and increased subsistence on multiple resources including smaller game and plants. The Archaic period was considered to be a period of transition; a slow, progressive trend toward exploitation of forest niches, better technologies and networks of interaction and cultural diffusion that helped spread pottery, food production and customs of politics and religion (Anderson and Sassaman 2012-TN10494). Archaic sites in Illinois include small, temporary campsites as well as larger village sites that were the locales of long-term or repeated occupation (Wiant and Berkson 2000-TN11068).

The introduction of the atlatl (a small wooden or bone stick with a hook at one end to propel darts or spears), the invention of pottery, plant cultivation, mound building, and trade began to first appear during the Archaic period in Illinois (ISM 2000-TN11019; Bense 1994-TN10495). The Archaic toolkit included polished and ground stone woodworking tools including axes, adzes and wedges, stone grinding implements, plant processing tools such as manos and metates, and fire cracked rock used in hearths and stone boiling. Specialized artifacts such as drills, awls, needles, gouges, smaller projectile points, knives, drills, and scrapers are also common in the Archaic archaeological record (USACE 2007-TN11021).

In the Illinois River Valley, the Archaic Period is divided into three subperiods: Early (10,00–8000 BP), Middle (8000–5000 BP), and Late Archaic (5000–3000 BP). They are summarized below.

Early Archaic (10,000–8000 BP)

Semi-nomadic hunting and gathering continued from the Paleoindian period into the Early Archaic period. Early Archaic sites followed settlement patterns similar to those in the Paleoindian period. Small bands of people lived at sites for a short period of time before moving to another location. Modern game species were consumed instead of megafauna, which had become extinct by that time. Most Early Archaic sites in Illinois are low density, temporary encampments in a variety of ecological settings. Early Archaic tools included end scrapers, side scrapers, gravers, adzes, and perishable items such as nets, traps, and basketry.

Early Archaic typologies and dates for the Illinois Valley are based on archaeological deposits from the Koster site in Green County, Illinois. The Koster site is a deeply stratified site containing deposits ranging from approximately 9,000 years ago through the Historic Period (TDAR 2018-TN11075). The site has been able to provide significant data on Archaic floral and faunal subsistence, settlement, stone and bone tool technologies, burial practices, and lifestyles including the presence of domesticated dogs (ISM 2000-TN11018). Projectile points recovered from Early Archaic-dated deposits at Koster include Graham Cave Side-Notched, Kirk Notched, Rice Stemmed, and LeCroy type points. Other diagnostic chipped stone tools included end scrapers, gravers, drill tips, and chert hammers. Ground stone tools included hammerstones/manos, cylindrical pestles, adzes, axes, choppers, and grinding slabs (USACE 2007-TN11021). Tools made from bone and antler included antler points, socketed bone tool-hafts, split-bone awls and bird-bone awls (Brown and Vierra 1983-TN11077).

Middle Archaic (8000–5000 BP)

During this time, Middle Archaic populations settled along river valleys, which offered abundant resources for subsistence without having to move their settlement locations. Resources such as waterfowl, fish, freshwater mussels, turtle, marsh roots, tubers and seeds from wild plants were near floodplains while upland forests provided fauna such as white-tailed deer and nuts for harvesting (Wiant and Berkson 2000-TN11068). Stemmed bifacial tool technology and the increased use of ground stones and bone mark this period. Large, side-notched points, greater variety of ground-stone and bone implements, chert tools such as rough bifaces or preforms, choppers, end and side scrapers, drills, and flake tools are common in the archaeological record for this period (Wiant and Berkson 2000-TN11068).

In the Illinois River Valley, the Helton phase represents the Middle Archaic. Based on cultural deposits from the Koster site, the Helton phase (5800–4900 BP) is characterized by small-to-medium sized side-notched Matanzas projectile points, and small quantities of Helton, Brannon and Apple Blossom projectile types. Winged T-drills, grooved axes, large scrapers and other bifaces, ground stone plummets, and other ornaments are also common in Helton phase cultural deposits.

Late Archaic (5000–3000 BP)

The Late Archaic is described as a time of increased settlement permanence, growth in population, the intensification of subsistence, and technological innovation (Adams and Young 2007-TN10490). In the Midwest, settlements were semi-permanent and populations consistently

returned to specific resource locations seasonally. Settlement along river valleys increased, as seen in areas such as the Illinois Waterway. In the Illinois River Valley, Late Archaic populations began to mix intensive exploitation of floodplain resources with plant cultivation. Late Archaic populations also consumed resources such as nuts, acorns, and squash (Anderson and Sassaman 2012-TN10494). Trade networks began to emerge during this period, which afforded the opportunity to trade resources such as copper from the Great Lakes, marine shells from the Atlantic and Gulf coasts, hematite and magnetite from the Ozarks, galena from the Upper Mississippi Valley, and high quality lithics from areas outside of Illinois (USACE 2007-TN11021; Wiant and Berkson 2000-TN11068). Stone tool assemblages from the Late Archaic included the use of large spear points and knives. Smaller dart points begin to appear as well.

In the Illinois River Valley, the Red Ochre phase dates to the Late Archaic period. The Red Ochre culture (3200–2800 BP) was first identified by Cole and Deuel (1937-TN11166) based on archaeological sites in the central Illinois River Valley. The culture is defined by flexed burials in pits on ridges of sand, gravel, or loess, the sprinkling of powdered hematite in burial contexts, "turkey tail" type points crafted from bluish gray chert sourced from southern Illinois and Indiana, large lanceolate ceremonial knives of whitish flint/chert, and caches of ovate-triangular points (Ritzenthaler and Quimby 1962-TN11085; Wiant and Berkson 2000-TN11068). Red Ochre sites in Illinois include the Banner, Morton, and Morse sites in Fulton County, the Beake, Kankakee River, Oak Grove, and Dyer sites in Lake County, the Brandwine Creek site in Hancock County and the Hasler site in Green County (Ritzenthaler and Quimby 1962-TN11085).

Closer to the project area, Sheila Lewis' (1973-TN11086) archaeological investigations for the construction of the CPS site and associated reservoir account for the extensive archaeological record in the region. The survey recorded 132 archaeological sites total, 24 of which have Archaic components (Lewis 1983-TN11078). One of the most extensively excavated sites within the APE was the Pabst site. The Pabst site was an important Late Archaic base camp most intensely occupied between 4300 and 3000 BP. The Pabst site was occupied year round, but not continuously. Midden dating to the Late Archaic contained a dense amount of fire-cracked rock, carbonized plant remains, and well-preserved faunal remains. Dominant food sources were the white tailed deer, elk, and raccoon. Plant remains were strongly dominated by hickory, followed by smaller quantities of black walnut, hazel, and acorn. Artifacts found at the site included drills, scrapers, preforms, and a stemless bifacial knife. Groundstone tools and implements included three-quarter grooved axes and axe fragments, adzes, a celt, and a rectangular banner stone. Pitted anvils, manos, metates, and multiuse cobbles were also observed in the assemblage. Middle Archaic Helton phase projectile points, like the Matanzas Cluster and Godar side-notched styles, were common at Pabst as well (Lewis 1983-TN11078).

Woodland Period (3000 BP–1100 AD)

The Woodland period is represented by settled village life, more intensive plant cultivation, more consistent use of pottery, and the emergence of earthworks and associated burial complexes. Cultigens such as squash, sunflower, marshelder (*Iva annua*) and charred goosefoot (*Chenopodium* spp.) began to be domesticated in the Late Archaic but their cultivation intensified during the Woodland period (Anderson and Sassaman 2012-TN10494). These cultigens, along with maize, were consumed during the Woodland and became more important during the subsequent Mississippian period.

The Woodland period is frequently associated with the Hopewell culture and associated Hopewell Interaction Sphere, the term to describe the vast trade network through which raw materials and finished goods were exchanged in this region. The Hopewell culture derives from

Ohio, consisting of smaller populations which expanded across eastern North America, exchanging resources via the Hopewell Interaction Sphere. In addition to exchanging resources with populations in the now-Midwest, the Ohio Hopewell also procured obsidian from as far as Yellowstone, mica from the Blue Ridge Mountains in the Carolinas, and shells from the Gulf of Mexico (NPS 2021-TN9875; National Geographic 2023-TN9878). The Ohio Hopewell were also mound builders, noted for their construction of earthen walls often built in geometric patterns and mounds of various shapes. Mounds served as burial places, but it was also believed that the earthworks represented places of ceremonial gathering (NPS 2021-TN9875).

Similar to the Archaic, the Woodland period is divided into three subperiods: the Early Woodland (3000–2200 BP), Middle Woodland (2200–1500 BP) and the Late Woodland (1500 BP–1100 AD).

Early Woodland (3000–2200 BP)

During the Early Woodland, Illinois River Valley populations remained largely hunting and gathering societies. Faunal analysis indicates that Early Woodland populations were consuming aquatic and terrestrial species, upland and bottomland plant species, as well as domesticated squash, barley, and goosefoot for subsistence (USACE 2007-TN11021). The earliest pottery in the United States developed in the southeast during the Late Archaic around 4500 BP, eventually spreading north and east during the Early Woodland (Elliott and Sassaman 1995-TN10491). The first versions of ceramics were thick and tempered with fiber materials from plants, such as Spanish moss or palmetto palms.

The Marion culture in the Illinois River Valley and the Black Sand culture in the southern portion of the State typify Early Woodland ceramics in the region. Marion pottery is thick, coarse, and flat on the bottom with markings impressed on the interior and exterior of the vessel from coarsely woven fabrics (ISM 2018-TN11087). Marion pottery has also been identified in archaeological sites in the northern part of the Illinois River Valley as well (USACE 2007-TN11021). Black Sand culture pottery is distinguished by Florence and Liverpool series pottery. Black Sand pottery has also been noted in archaeological deposits as far as northern Illinois and Wisconsin.

Middle Woodland Period (2200–1500 BP)

During this period, populations in the Illinois River Valley spread south into the lower Illinois valley, which had been abandoned by Black Sand cultures roughly 200 years earlier. Middle Woodland settlements were in a variety of environments, such as bluff bases and in floodplains. One of the most defining features of this period is the emergence of burial mounds, monumental earth or stone works serving as ceremonial centers (Bense 1994-TN10495). The complexes are mainly found in high locations, such as hilltops, and were associated with elaborate mortuary practices. Grave goods observed in cultural deposits included carved stone pipes, copper axe blades, necklaces made of river pearls, pottery vessels, spear points, copper ear ornaments and similar objects.

In the lower and central Illinois River valleys, the Middle Woodland period is associated with village sites such as the Havana, Pool, and Dickson sites from the Havana-Hopewell phase. The term “Havana” derives from a major Middle Woodland village and mound group site in the present-day town of Havana, Illinois. Havana site types consist of permanently occupied base camps, mortuary or ritual camps related to bluff-top mound groups, and ritual transaction centers marked by floodplain mound groups and habitation sites (Yerkes 1988-TN11088).

Havana subsistence was dependent on hunting, gathering, and cultivation of native domesticates. It appears that maize was not a significant part of their diets. Havana Hopewell sites have also been identified in the Upper Great Lakes region, Kankakee and Wabash River valleys. The Havana-Hopewell phase period lasted approximately 200 years (2000–1800 BP) and was then followed by the Frazier phase (1900–1650 BP).

Late Woodland Period (1500 BP–AD 1100)

Toward the end of the Middle Woodland period, there was a decline in interregional trade, complex ceremonial and mortuary practices, and elaborate pottery decoration. The Late Woodland marked changes in sociocultural development, ideology, subsistence, and technology. Increased use of ceramic vessels led to the manufacture of a variety of functional forms, such as larger storage vessels, jars, bowls, and plates but were not elaborately decorated as pottery types of previous periods. The invention of the bow and arrow about 1500 years ago is perhaps one of the more significant developments of the Late Woodland period. Bow-launched points had greater impact, which further maximized wild game harvesting (Peskin 2011-TN9872). This change in technology allowed for greater hunting success over the dart and atlatl. It also may well be responsible for the dramatic increase in warfare seen in some areas (Bense 1994-TN10495; Walthall 1980-TN10498).

Late Woodland culture continued in northern Illinois after the appearance of Mississippian culture in the southern portions of the State. Smaller, political units began to appear and the production of elaborate burial complexes ceased. Habitation sites shifted toward smaller, more numerous dispersed locales. Maize agriculture intensified, becoming more important by the end of the period. Long distance trading that was important in the Early and Middle Woodland periods reduced or disappeared during the Late Woodland (Yerkes 1988-TN11088).

Several groups are contemporary to the Late Woodland period. White Hall, Weaver, Steuben, and Rosewood cultures are distinguished primarily for their ceramic styles (Farnsworth 2000-TN11083). Cultures that emerge at the latter end of the period include the Bluff culture in southwest Illinois, Dillinger in southern Illinois, and the Maple Mills, Bauer Branch and Langford types in central and northern portions of the State (Farnsworth 2000-TN11083). The Weaver phase (1650–1500 BP) is the earliest defined Late Woodland phase in the Illinois River Valley.

The Marseton 2 site in northwest Mercer County, Illinois is a Middle-to-Late Woodland archaeological site with Weaver phase cultural deposits. The site was first recorded in 1974 as a Middle Woodland site by the University of Wisconsin-Milwaukee. Phase I investigations conducted in 2002 identified a Late Woodland component based on artifacts and ceramic sherds. In 2003, Phase III data recovery testing by the Illinois Transportation Archaeological Research Program recorded 185 prehistoric features, including 173 storage/processing pits, 11 post molds, and one fire-cracked rock concentration. About 10 nearly complete ceramic vessels were recovered from the excavations. Ceramics recovered from the site were predominantly Weaver plain, although a small number of ceramics exhibited exterior tool impressions. Ground stone tools such as manos, hammerstones, and pitted stones were identified in limited quantities. A few sandstone abraders were found, as were several lithic pipe fragments. Faunal material recovered from the site included deer, elk, fish, bird, dog, rodent, and turtle. Bone awls, and deer and elk antler batons were also found (Fishel 2004-TN11188).

Mississippian Period (AD 1100–1300)

Mississippian is the name given by archaeologists to the societies that lived in the southeast and Midwestern United States after about AD 1000. The Mississippian period began around AD 1000 and ended around the period of European contact in the 16th century. Mississippian societies were sociopolitical entities established along the floodplains of major rivers. Chiefdoms were large, fortified villages with central plazas surrounded by temple and/or mortuary mounds. Flat-topped temple mounds were constructed at these and other sites for religious practices. Surrounding settlements and farmsteads provided labor and services to the elite. Maize, along with beans and squash, was a major component of the Mississippian diets at this time (Anderson 1994-TN10499; Anderson and Sassaman 2012-TN10494). This period marked the development of chiefdoms, social and political transformations, the growth of mound centers, and increased reliance on agriculture. Shell-tempered pottery and the construction of wall trench houses were major technological innovations from the time (NPS 2016-TN11130).

One of the earliest, largest, and most influential Mississippian sites in North America is Cahokia. Located in southwest Illinois east of St. Louis, Missouri, Cahokia was the political and religious epicenter of Mississippian culture. Cahokia and its surrounding sites was the most impressive and politically centralized prehistoric society to ever emerge in terms of size, population, and organizational complexity (Anderson and Sassaman 2012-TN10494). Sites such as Cahokia demonstrated and reinforced social order and stratification of peoples by status, kin, group, and gender. Cahokia was continuously occupied for nearly 400 years. At its peak around AD 1100, the site spanned over 4,000 ac (1,618 ha), had near 120 earthen mounds, and populations up to 20,000 people (Cahokia Mounds 2025-TN11089). The leaders of Cahokia were responsible for large communal feasts and celebrations of religious and political events. They also formalized intricate religious practices that included priests, temples, and rich art forms that focused on themes such as life, fertility, and warfare (Emerson 2000-TN11081). Today, Cahokia is a State park that protects the site's 50 monumental earthworks, including Monks Mound, the largest earthen mound in the United States.

Cahokia's warfare, political, social, and economic interactions most likely influenced subsequent developments, but may have had limited reach beyond the American Bottom region. Cultural similarities to Cahokia are evident in the Illinois, Apple, Kaskaskia and Vermilion rivers. The Spoon River and central Illinois River valleys had a least seven major fortified temple towns during the Mississippian. Contemporary villages in west-central Illinois include Dickson Mounds and the Larson and Orendorf village sites in northwest Illinois. Excavations from these sites reveal that these societies were less stratified and more egalitarian than their contemporaries at Cahokia. They had similarities to the Mississippian life of the American Bottom but adapted to the differing social and political realities of their northern regions. Leaders did possess locally significant political and religious symbols such as stone animal effigy pipes, copper ornaments, and elaborate grave goods. Cahokia- influenced villages appear to be absent in the lower Illinois River valley. This may have been deliberate, suggesting potential conflict among the groups (Emerson 2000-TN11081).

Late Prehistoric Period (1300–1673)

The Late Prehistoric Period marks the decline of Mississippian culture and the beginning of European contact. During the Late Prehistoric Period, populations began to cluster into more permanent settlements around large river valleys (Redmond 2006-TN9867). Elements of the Mississippian culture were contemporary with the Late Prehistoric Period. Both had significant cultural development such as ownership of land tied to specific territories, social hierarchies,

specialization of labor, religious plazas centered around crop production, and markets for the exchange of goods (Griffin 1967-TN9876). Villages were divided by housing and related mortuary areas. Features such as open plazas with large central posts were common. Mortuary practices changed from the use of burial mounds to simple shallow graves in villages (Brose 2024-TN9880).

In the Illinois River valley, Mississippian sites became more common in the Sangamon and LaMoine rivers region. After AD 1300, Mississippian territory shifted between the mouth of Spoon River and Peoria, potentially sharing the region with a group of Oneonta people archaeologists refer to as Bold Counselor. By AD 1400, a small number of Bold Counselor Oneota were living with Mississippians at the Crable site in Fulton County, Illinois, the last Mississippian temple mound center. The site appeared to be abandoned 50 years later (Esarey 2000-TN11082). The Langford culture is also contemporary to this period. Langford groups resided in small villages with mounds but most likely had a less complex social structure. Their subsistence consisted of farmed agriculture but was also supplemented with terrestrial and wetland resources they hunted and gathered. Langford culture appears to have ended in the upper part of the Illinois valley after AD 1300, but persisted longer in northeast Illinois (Esarey 2000-TN11082).

Contact and Historic Period (1673 to present)

The Contact period is defined as the time period where Europeans initially made contact with Indigenous groups in the region. The first Europeans to explore Illinois were a small party of French explorers, including missionary Jacques Marquette and fur trader Louis Jolliet, who arrived in the summer of 1673 (Warren 2000-TN11084). The two dominant Indigenous groups during Contact were the Illinois (or Illiniwek) Indians and the Miami (ISM 2002-TN11090). The Illinois were a confederation of 12 Tribes that occupied and controlled most of central, western, and southern Illinois (later referred to as Illinois Country). The Illiniois are thought to have included the Cahokia, Chepoussa, Chinko, Coiracoetanon, Espeminkia, Kaskaskia, Michibousa, Michigamea, Moingwena, Peoria, Tamaroa, and Tapouro. The Miami occupied several villages south and west of Lake Michigan in Northern Illinois (ISM 2002-TN11090; Warren 2000-TN11084).

In the 1700s, Illinois territory shrank, and the Miami moved to present-day Indiana. Other Tribes began migrating into Illinois Country. By 1770, Tribes including the Mesquakie (Fox), Iowa, Kickapoo, Mascouten, Piankashaw, Potawatomi, and Sauk migrated into the area. The Winnebago (Ho-Chunk) came into the Rock River Valley in the 1800s. Over time, many of the Tribes disappeared or merged with others. Five Tribes survived into the 1700s: the Cahokia, Kaskaskia, Michigamea, Peoria, and the Tamaroa. Two historic sites today are former locations of occupied villages. The Zimmerman site in La Salle County was occupied intermittently by the Kaskaskia and Peoria Tribes from 1673 to 1720. Excavations from the 1940s recovered shell-tempered Danner-type pottery and French traded items (ISM 2000-TN11091). In Randolph County, the Waterman site is the location of the former Michigamea village, which was strategically located for protection from raiding war parties near the French Fort de Chartres, at the time approximately 1 mi (1.6 km) from the village. The Michigamea remained at the Waterman village until 1765, when they moved west of the Mississippi River to avoid British rule (Warren 2000-TN11084; ISM 2000-TN11092).

The Historic Period began with settlers who entered the area as part of the general westward expansion. The end of the Revolutionary War in 1783 resulted in immigrants flooding into Illinois. The earliest settlers were primarily farmers from the Carolinas, Kentucky, and

Tennessee. The Kaskaskia and the Peoria became the dominant Indigenous groups through the 1800s (ISM 2002-TN11090; Warren 2000-TN11084). Treaties and land cessions with the United States government and the Black Hawk War of 1832 forced Tribes to abandon the area by the early 1830s (Warren 2000-TN11084).

The project is within the ceded lands of the Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas, the Kickapoo Tribe of Oklahoma, the Miami Tribe of Oklahoma, and the Peoria Tribe of Indians of Oklahoma. Present-day Tribes with ancestral ties to the area include the Absentee-Shawnee Tribe of Indians of Oklahoma, Bad River Band of the Lake Superior Tribe of Chippewa Indians, Bay Mills Indian Community of Michigan, Citizen Potawatomi Nation of Oklahoma, Delaware Nation of Oklahoma, Forest County Potawatomi Community of Wisconsin, Hannahville Indian Community, Kickapoo Traditional Tribe of Texas, Kickapoo Tribe of Indians in Kansas, the Kickapoo Tribe of Oklahoma, Miami Tribe of Oklahoma, and the Peoria Tribe of Indians of Oklahoma (MIAC 2025-TN11093, MIAC 2025-TN11094).

In 2024, the U.S. Department of the Interior placed portions of lands that were originally part of the Prairie Band Potawatomi Nation's 1800s reservation, Shab-eh-nay, in present-day DeKalb County, Illinois, in trust (PBPN 2024-TN11095). The Prairie Band's reservation was in DeKalb County until 1849, when the United States government seized and auctioned off the 1,280 ac while Chief Shab-eh-nay was visiting family in Kansas. The 2020 U.S. Supreme Court case *McGirt v. Oklahoma* (2020-TN11247) determined that Tribes still had sovereignty over historic reservations if they were never disestablished by Congress. Because Congress never dissolved Shab-eh-nay, the Prairie Band still had sovereignty. Placing the land in trust affirmed the Prairie Band Potawatomi Nation's sovereignty over Shab-eh-nay, but more importantly, distinguished the lands as the only federally recognized reservation in Illinois (Armanini 2024-TN11567; PBPN 2025-TN11273).

3.9.2 Historic and Cultural Resources at Clinton Power Station

A literature review was conducted through the Illinois Inventory of Archaeological Sites and the Historic and Architectural Resources Geographic Information System, the State's public inventory of historic buildings, structures, sites, objects, and districts within the State, to gain a better understanding of the historic and cultural resources within the region. All cultural resources within a 1 mi (1.6 km) radius of the APE that could be potentially affected by the undertaking were identified. This information helps cultural resources professionals understand what resources may potentially be in the field.

A total of 197 archaeological sites are within 1 mi (1.6 km) of the APE. Of those, 176 sites are directly within the APE. These include 166 precontact sites, 3 historic sites, and 6 multicomponent sites, consisting of both precontact and historic components, and 1 precontact isolate (IIAS 2024-TN11107). No traditional cultural properties (TCPs) are known to be within the project area.

Nine buildings of historic age are located within 1 mi (1.6 km) of the APE as well. This includes a bank, school, and an unknown building in the small community of Lane, over 3 mi (4.8 km) south of CPS, the Centenary Methodist Episcopal Church and the Harp Township Hall in Birkbeck, and four standing dwellings (HARGIS 2025-TN11097). Centenary Methodist Episcopal Church and the Harp Township Hall in Birkbeck are the closest to CPS, approximately 2 mi (3.2 km) northwest. None of the nine buildings are within the APE. With the exception of the Pabst site, none of the sites or buildings are eligible for the NRHP.

The Pabst Site

The Pabst site (DW15) is a Late Archaic habitation site first recorded in 1973 as part of the survey for the proposed construction of the CPS and reservoir (Lewis 1973-TN11086). It should be noted that the Pabst site was originally documented in Lewis' report as DWv32. It appears the site was assigned DW15, the trinomial now used, when it was formally registered with the Illinois State Museum. The site was originally documented as being on a small terrace in the North Fork Creek bottom. Artifacts were scattered across 2,000 square feet (185 m^2) and consisted of material including bifacial tools, stemmed projectile points, drills and drill-like implements, cores and retouched flakes (Lewis 1973-TN11086). The site was one of 11 sites recommended for further testing due to the construction of CPS. Subsequent excavations in 1974 revealed extensive cultural deposits, including a shell midden, and was classified as a Late Archaic habitation site. Results of the 1974 excavations showed that the site was a potentially important source of information for the increased understanding of use of prairie peninsula and small forested habitats within the prairie during the Archaic period. Because the site was to be completely destroyed with the construction of CPS, it was recommended that the site be fully excavated in view of the scientific importance of the material (Lewis 1975-TN11098). Following this recommendation, Illinois Power Company proposed the site be nominated for the NRHP. The site was accepted into the Register April 30, 1975 on the basis of the inferred scientific importance of the archaeological remains preserved there (Lewis 1976-TN11099). It appears that the site was removed from the NRHP after the site was fully excavated as part of mitigation in 1975.

Previously Recorded Surveys

A total of 23 previous surveys have occurred within 1 mi (1.6 km) of the project area, 19 being within the APE. As previously stated, the earliest investigations in the region were conducted by Lewis (1973-TN11086) for the construction of the CPS and reservoir. The survey covered approximately 17,000 ac (6,880 ha) and recorded 132 archaeological sites. Most of the sites appeared to be small, seasonally occupied campsites with the exception of two sites, DW69 and DW70, which were documented as larger campsites. The report focused on the results of 18 archaeological sites as those contained diagnostic projectile points that helped assign a temporal date of use (e.g., Archaic Period, Woodland Period, historic). Of the 18 sites, 9 dated to the Archaic period, 3 were from the Early Woodland period, 1 to the Late Woodland period, and 5 to the Mississippian period. Eleven sites were recommended for further subsurface testing based on their probability of being affected by the construction of CPS: DWv23, DWv32 (the Pabst site), DWv38, DWv43, DWv44, DWv47, DWv48, DWv51, DWv60, DWv70, and DWv73.

Following the recommendations from Lewis (1973-TN11086), in 1974, R. Barry Lewis conducted excavations at the 11 sites. Excavations at all sites consisted of 6.5 ft (2 m) square units. The report provided discussions on each site excavated, site use type (habitation site, camp site, etc.), and included recommendations for or against further mitigation of each site. For brevity, only the Pabst site will be summarized here. The Pabst site was registered as being located in a small oak-hickory forested creek valley surrounded by native prairie. Three test excavation units were initially laid out for excavation—two in the field and one in the wooded portion of the site. In addition to the units, several backhoe trenches were trenched through the site to determine the extent of the site and to understand how much of it was preserved. Cultural material identified included a shell midden, drills and drill-like implements, a variety of scrapers, anvils, manos, chert hammerstones, grooved axe, oval cutting implements, flake cutting implements, bone pins, unmodified stone and fire-cracked rock, and unmodified debitage.

Diagnostic artifacts demonstrated that the site was a Middle or Late Archaic base camp where individuals and small groups left to secure resources which were brought back to the site, processed, and used. In his 1975 report, Lewis recommended that complete excavation of the site occur to understand the scientific importance of the site.

R. Barry Lewis returned later in 1975 to do full data recovery of the Pabst site. Data recovery was focused on the forested part of the site due to limited erosion and undisturbed deposits. A total of 250 units were excavated in 2–4 in. (5–10 cm) intervals. Additionally, soil samples were taken from the northeast corner of every unit for floatation samples. Cultural material was found in four distinct strata and included a range of projectile point forms, drills, several kinds of scrapers, preforms, groundstone tools such as grooved axes, adzes, celt, and banner stones. Faunal remains included whitetail deer, elk, and racoon. Plant remains were hickory, black walnut, hazel, and acorn (Lewis 1983-TN11078). Radiocarbon dates from the site determined that the site was most intensely used between 4300 ± 75 years BP and 3000 ± 75 BP (Lewis 1976-TN11099, Lewis 1983-TN11078).

The closest survey to the power plant was conducted by the Illinois State Museum Society in 2000 for the proposed construction of a wastewater treatment plant within the CPS. The Phase I survey surveyed almost 5 ac (2 ha) southeast of the facilities. Four historic artifacts were encountered on the surface. No cultural material was identified in the shovel testing. One site, DW360, was recorded. The site was recommended not eligible for the NRHP (Howe 2000-TN11100). The most recent survey within the APE was a Phase I survey conducted in 2006 by the Illinois State Museum Society (Bickel and Cobb 2006-TN11101) on a parcel of land south of Illinois Route 54 and north of Clinton Lake for a proposed alternate borrow area for wetland development at the Clinton Lake State Recreation Area. Shovel tests were excavated in 50 ft (15 m) intervals to a maximum depth of 15–20 in (40–50 cm) max. No cultural material was identified. The remainder of reports within the APE and surrounding area can be found in CEG's ER (CEG 2024-TN10806).

3.9.3 Procedures and Integrated Cultural Resources Management Plan

CEG has several administrative controls and environmental procedures that aim to identify, protect, and minimize potential impacts to historic properties within the CPS site. Procedure SA-AA-117, *Excavation, Trenching, and Shoring*, outlines work practices for excavation, trenching, and shoring. The procedure defines Cultural, Historical, and Paleontological resources and aims to protect against impacts to sites and unanticipated discoveries of historic and cultural resources. The procedure is used in conjunction with CEG's Excavation Permit. Procedure EN-AA-103-F-02, *Environmental Screening Checklist*, oversees the environmental checklist process. The "Land" section of the procedure addresses potential impacts as a result of ground-disturbing activities. Procedure EN-AA-103, *Environmental Review*, oversees the aforementioned environmental checklist process. The document provides a process for screening proposed activities to determine if an activity requires further evaluation for environmental impacts and risk. Last, EN-AA-103-0001, *Environmental Evaluations*, provides environmental personnel with direction on performing environmental evaluations to identify the environmental and regulatory impacts, if any, of proposed activities.

CEG does not have a separate Inadvertent Discovery Plan but upon discovery of human remains, CEG would engage their site security team, who would then engage the local law enforcement. If remains are over 100 years old, the Illinois SHPO would take over jurisdiction. If the remains are considered less than 100 years old, the coroner would maintain jurisdiction. In

Illinois, human remains and associated burial artifacts are protected by the State's Human Skeletal Remains Protection Act (CEG 2024-TN10914: Attachment 44).

3.9.4 Proposed Action

As documented in the LR GEIS (NRC 2024-TN10161), historic and cultural resources is a Category 2 issue and therefore must be analyzed on a plant-specific basis. Renewing the operating license of a nuclear power plant is an action that could potentially affect historic and cultural resources and historic properties. This section provides the NRC staff's assessment of impacts and effects to historic and cultural resources and historic properties.

3.9.4.1 Environmental Audit Visit

An environmental audit visit occurred September 24, 2024. The NRC staff toured various locations at the CPS site. CEG staff included one area that was surveyed in 2006 by the Illinois State Museum (Bickel and Cobb 2006-TN11101). In addition, the general location of the Pabst site was shown. After the tour, NRC staff drove around the northern and eastern sides of the APE to document the viewshed. While the area is still mostly rural, the facilities are largely not visible from surrounding vantage points due to vegetation and topography.

3.9.4.2 Consultation

In accordance with 36 CFR 800.8 (TN513), "Coordination with the National Environmental Policy Act," on April 30, 2024, the NRC staff initiated written Section 106 consultations with the Advisory Council on Historic Preservation (NRC 2024-TN11102), the Illinois SHPO (NRC 2024-TN11102), and five Tribes, including the Miami Tribe of Oklahoma, Osage Nation, Kickapoo Tribe of Oklahoma, the Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas, and the Menominee Indian Tribe of Wisconsin (NRC 2024-TN11106). In these letters, the NRC staff provided information about the proposed action, defined the APE, and notified consulting parties that the NRC would conduct its NHPA Section 106 consultation through the NEPA process in accordance with 36 CFR 800.8(c) (TN513). The NRC staff invited Tribes who might attach religious and cultural significance to historic properties in the APE the opportunity to identify their concerns, provide advice on the identification and evaluation of historic properties, including those of traditional religious, and cultural importance, and, if necessary, participate in the resolution of any adverse effects to such properties. The Advisory Council on Historic Preservation replied to the NRC on May 21, 2024 (ACHP 2024-TN11103).

Revised scoping letters were sent October 21, 2024 to the five aforementioned Tribes and to the Kickapoo Traditional Tribe of Texas, Peoria Tribe of Oklahoma, and Prairie Band Potawatomi Nation (NRC 2024-TN11104). A response was received from the Kickapoo Traditional Tribe of Texas on October 24, 2024, indicating that in addition to them not owning any land within or near the proposed project area, the LR would not affect any of the Tribe's known cultural, historical, or sacred sites (Kickapoo Traditional Tribe of Texas 2024-TN11105).

The NRC met with the Illinois SHPO in-person at IDNR's office in Springfield, Illinois on September 25, 2024 to discuss the undertaking. The NRC staff explained the LR process, the Pabst site, and received recommendations from the SHPO on what their office expected from the SEIS. The SHPO emphasized the need for an inadvertent discovery plan that would outline the process for any unanticipated discoveries that may occur in the next 20 years.

3.9.4.3 Findings

The Pabst site (DW15) is the only NRHP-eligible site within the APE. While the Pabst site was excavated in the 1970s and was impacted by construction of CPS, some remnants of the site may still exist under fill or within the lake. No new construction or modifications are anticipated for the proposed action. Plant operations and maintenance activities necessary to support the continued operation would be limited to previously disturbed areas and would be expected to be similar to current operations. For the purposes of NHPA, the proposed action will result in No Adverse Effect to historic properties, as defined in 36 CFR 800.5(b) (TN513); there would be no impact to historic and cultural resources.

3.9.5 No-Action Alternative

Under the no-action alternative, land-disturbance activities or dismantlement are not anticipated, as these would be conducted during decommissioning. Therefore, facility shutdown and adoption of the no-action alternative would have no immediate effect on historic properties or historic and cultural resources. As stated in the decommissioning GEIS (NRC 2002-TN7254), the NRC concluded that impacts on cultural resources would be SMALL at nuclear plants where decommissioning activities would only occur within existing industrial site boundaries. Impacts cannot be predicted generically if decommissioning activities would occur outside of the previously disturbed industrial site boundaries, because impacts depend on site-specific conditions. In these instances, impacts could only be determined through site-specific analysis (NRC 2002-TN665). In addition, under 10 CFR 50.82, “Termination of License,” power reactor licensees are required to submit a post shutdown decommissioning activities report to the NRC, which would describe the plant’s planned decommissioning activities (TN249). Until the post-shutdown decommissioning activities report is submitted, the NRC staff cannot determine whether historic properties or historic and cultural resources would be affected outside the existing industrial site boundary by decommissioning activities after the nuclear power plant ceases operations.

3.9.6 Replacement Power Alternatives: Common Impacts

Impacts to historic and cultural resources from construction and operation of a replacement power alternative would be dependent on the site-specific conditions. Impacts would vary depending on the site location and layout, plant design, resources present, the degree of ground disturbance (i.e., land clearing, excavations), visual intrusions on the landscape, and/or noise from the construction and operation of the alternative. The appearance of the facility and associated transmission lines could also result in alterations to the visual setting which, whether temporary or permanent, could affect other types of historic and cultural resources such as cultural landscapes, architectural resources, or TCPs. Visual impacts would vary dependent on structure heights, associated exhaust stacks, or cooling towers. Potential operational impacts could occur from activities associated with plant operations, ongoing maintenance, and modifications to the facility or transmission lines. If the project has a Federal nexus (i.e., license, permit), the Federal agency would need to make a reasonable effort to identify historic properties within the APE and consider the effects of their undertaking on historic properties, in accordance with Section 106 of the NHPA. If historic properties are present and are affected by the undertaking, adverse effects would be assessed, determined, and mitigated with the SHPO and any Tribe(s) that attach religious and cultural significance to identified historic properties through the Section 106 consultation process. Similarly, impacts to historic and cultural resources considered under NEPA would need to be assessed.

3.9.7 Natural Gas Alternative

The natural gas alternative would utilize 54 ac (22 ha) of an existing 96 ac (39 ha) parcel contained within the CPS site. A new 16 mi (26 km) pipeline extension would be necessary to support this potential alternative. The NRC does not license natural gas facilities; therefore, the NRC would not be responsible for NHPA Section 106 consultation for this alternative. Potential impacts from this alternative are similar to those described in Section 3.9.6. The site was previously analyzed for NRC's 2006 EIS for the Exelon ESP (NRC 2006-TN672) and evaluated potential impacts to existing cultural resources. The area was surveyed archaeologically prior to the construction of CPS, which registered over 100 archaeological sites (Lewis 1973-TN11086). Because of the presence of these sites, depending on where the extension is placed, there may be an increased potential for encountering cultural material during construction activities.

Updated natural and cultural resources studies should occur prior to the commencement of any ground disturbing activity to determine the presence or absence of historic and cultural resources within the project area. The SHPO database should also be reviewed to determine if any registered archaeological sites exist within the proposed 16 mi (26 km) pipeline extension and within at least a 1 mi (1.6 km) radius for the same purpose.

3.9.8 Renewable and Natural Gas Combination Alternative

This alternative considers natural gas, wind, and solar as a combination renewable energy alternative. The NRC does not license natural gas facilities, wind installations, or solar installations; therefore, the NRC would not be responsible for NHPA Section 106 consultation for this alternative. Potential impacts from this alternative are similar to those described in Section 3.9.6. Similar to the other alternatives, impacts would be dependent on the construction and operation of the combined renewable energy but may be greater under this alternative due to the physical and visual impacts associated with the construction and operation of the solar and wind components of the alternative. The natural gas component would utilize land previously considered and reviewed in the Exelon ESP EIS and would have the same impact considerations as described in Section 3.9.7 above. Access to significant acreage would be needed for the solar and wind components. CEG's ER described the potential of siting both wind and solar in the same acreage with appropriate spacing onsite. While this would limit potential impacts to known historic and cultural resources onsite, that may not be the case for any potential offsite locations considered under this alternative.

Overall, for wind as a renewable energy alternative, siting in remote/rural areas increases the chance of encountering historic and cultural resources, especially precontact types. Further impacts may occur to natural and historic and cultural resources with clearing land, vegetation, leveling, and other mechanical means if the selected location for construction/installation has not been previously disturbed. The physical footprint of a turbine may be limited to the foundation pad it may be installed on, however, ground clearing, laydown yards, and service roads are indirect impacts that would need to be taken into consideration. The visual impact may be more substantial for wind in comparison to other renewable energies. Wind turbines are large and are easily seen from miles away. The installation of any turbine would be an obstruction to the landscape, therefore, visual impacts may be greater, if not adverse, to any potential TCPs and/or historic properties within the area. While solar would require a smaller amount of acreage, there is more flexibility in siting compared to wind. Using previously disturbed industrial sites for solar installations could minimize impacts to historic properties or they could be sited in areas away from historic properties and/or TCPs.

In many cases, larger landscapes are considered TCPs and sacred areas to Tribes. Consultation with Tribes and the SHPO would be needed to understand the direct and indirect impacts under this alternative. Historic viewsheds would also need to be taken into consideration as any potential modification to the landscape may have adverse impacts. Natural and historic and cultural resources surveys should occur prior to any ground disturbing activity beginning to confirm the presence or absence of historic and cultural resources in an effort to avoid impacts as much as reasonably possible. Archaeological monitoring should also occur to avoid and/or minimize potential impacts to unknown natural and cultural resources.

3.9.9 Purchased Power Alternative

This alternative involves the establishment of a long-term contract to import replacement power into the CEG service area to replace CPS net generation. Potential impacts depend on the generation source, type, and location of energy generated. Any contract established would need to comply with the Illinois Power Agency Act, which has an emphasis on renewable power. Renewable sources may be nuclear, natural gas-fire, wind, or solar based. This alternative assumes that purchased power would be acquired from existing sources (e.g., nuclear, natural gas-fire, wind, or solar based). No new construction would occur as a result of this alternative. While the NRC does not license natural gas or renewable energy facilities, if applicable, all State and Federal laws protecting historic and cultural resources should be followed to identify and consider potential effects of the alternative.

3.10 Socioeconomics

This section describes current socioeconomic factors that have the potential to be affected by changes in power plant operations at CPS. CPS and the communities that support it can be described as a dynamic socioeconomic system. The communities supply the people, goods, and services required to operate the nuclear power plant. Nuclear power plant operations, in turn, supply wages and benefits for people and dollar expenditures for goods and services. The measure of a community's ability to support continued operation of CPS depends on its ability to respond to changing environmental, social, economic, and demographic conditions.

3.10.1 Nuclear Power Plant Employment

The socioeconomic region of influence (ROI) is defined by the areas where CPS workers and their families reside, spend their income, and use their benefits, thus affecting the economic conditions of the region. CEG employs a permanent full-time workforce of 549 workers and an additional 47 long-term contract workers for a total of 596 full-time workers (CEG 2024-TN10806). As reported in Table 3-17 below, approximately 80 percent of the CPS workforce resides across Champaign, DeWitt, Macon, and McLean counties with the rest in Illinois and several other States (CEG 2024-TN10806). Because most CPS workers reside in Champaign, DeWitt, Macon, and McLean counties, the greatest socioeconomic effects are likely to be experienced there. The focus of the impact analysis, therefore, is on the socioeconomic impacts of continued CPS operations in these four counties, which comprise the ROI.

Refueling outages occur every 24 months and last approximately 19 days. During a typical outage, an additional 1,097 workers are onsite (CEG 2024-TN10806).

Table 3-17 Residence of Permanent Employees of Clinton Power Station

State or County	Constellation Energy Generation, LLC Employees	Percentage of Total
Champaign County	54	9.9
DeWitt County	120	21.9
Macon County	112	20.4
McLean County	151	27.5
28 Other Illinois counties	97	17.7
12 Other States	15	2.7
Total	**549**	**100.0**

Source: CEG 2024-TN10806.

3.10.2 Regional Economic Characteristics

Goods and services are needed to operate CPS. Although procured from a wider region, some portion of these goods and services are purchased directly from within the ROI. These transactions sustain existing jobs and maintain income levels in the local economy. This section presents information about employment and income in the ROI.

3.10.2.1 Regional Employment and Income

According to the U.S. Bureau of Economic Analysis 2022 county-level full-time and part-time employment data, State and local government services and the healthcare and social assistance industry represented the largest employment sectors in the ROI, followed by finance and insurance, retail trade, and accommodation and food services industries (BEA 2023-TN11108). The ROI civilian labor force consisted of 257,944 individuals, and the number of employed individuals was 245,329 in 2024 (IDES 2024-TN11115). Table 3-18 below presents estimated income information for the ROI.

Table 3-18 Estimated Income Information for the Clinton Power Station Socioeconomic Region of Influence, 2018–2022, 5-Year Estimates

Metric	Champaign County	DeWitt County	Macon County	McLean County	ROI	Illinois
Median household income (dollars)	61,090	61,823	75,356	59,622	65,660	78,433
Per capita income (dollars)	35,810	35,630	40,252	34,644	37,100	43,198
Families living below the poverty level (percent)	8.0	6.0	7.5	10.6	8.3	8.2
People living below the poverty level (percent)	18.7	10.2	14.2	15.5	16.2	11.8
Unemployment rate	4.8	5.4	3.2	7.2	4.7	6.0

ROI = region of influence.
Source: USCB 2023-TN11118.

As shown in Table 3-18 above, people living in the ROI had a median household income lower than the Illinois average. Additionally, the percentage of individuals living below the poverty level in the ROI was higher than the percentage of individuals living below the poverty level in the State of Illinois.

According to the U.S. Census Bureau (USCB) 2018–2022 American Community Survey 5-year estimates, the unemployment rate in the ROI was 4.7 percent. In comparison, the unemployment rate in Illinois during this same time period was 6.0 percent (USCB 2023-TN11118). For the first half of 2024, the Illinois Department of Employment Security estimates the unemployment rate of the ROI to be 4.9 percent compared to the statewide unemployment rate of 5.3 percent (IDES 2024-TN11115).

3.10.3 Demographic Characteristics

According to the 2020 Census, an estimated 60,246 people live within 20 mi (32 km) of CPS, which equates to a population density of 48 persons per mi^2 (CEG 2024-TN10806). This amount translates to a Category 3 population density using the LR GEIS (NRC 2024-TN10161) measure of sparseness, which is defined as "60 to 120 persons per square mile…with at least one community with 25,000 or more persons within 20 mi (32 km)." An estimated 802,546 people live within a 50 mi (80 km) radius of the CPS site, which equates to a population density of 102 persons per mi^2 (CEG 2024-TN10806). This translates to a Category 3 proximity index with one or more cities having 100,000 or more persons and less than 190 persons per mi^2 within 50 mi (80 km). Therefore, CPS is a combination of "sparseness" Category 3 and "proximity" Category 3 translating to a "medium" population area based on the 1996 LR GEIS sparseness and proximity matrix (NRC 1996-TN288).

Table 3-19 below shows population projections and percent growth from 2000 to 2050 for the ROI. During the last several decades, the populations of the more rural counties (DeWitt and McLean) have been declining, while the populations of the more urban counties (Champaign and Macon) have grown. Based on population projections, the ROI population is generally expected to increase through 2050, but at a slow rate.

The 2020 Census demographic profile of the ROI population is presented in Table 3-20 below. According to the 2020 Census, minorities (race and ethnicity combined) comprise about 30 percent of the total ROI population. The largest minority population of any race in the ROI were Black or African American (12.5 percent of the total population; 41 percent of the total minority population) and Hispanic of any race (6.1 percent of total population; 20 percent of the total minority population) (USCB 2021-TN11121).

Table 3-19 Population and Percent Growth in the Clinton Power Station Socioeconomic Region of Influence in Illinois

Metric	Year	Champaign County Population	DeWitt County Population	Macon County Population	McLean County Population	ROI Population	ROI Population Percentage Change
Recorded	2000	179,669	16,798	150,433	114,706	461,606	-
Recorded	2010	201,081	16,561	169,572	110,768	497,982	+7.88
Recorded	2020	205,865	15,516	170,954	103,998	496,333	-0.33
Projected	2030	221,967	14,570	174,272	95,129	505,939	+1.94
Projected	2040	234,345	13,288	174,851	85,390	507,874	+0.38
Projected	2050	245,961	11,851	173,379	76,045	507,237	-0.13

ROI = region of influence.
"-" denotes no content in the table cell.
Sources: Hauer and CIESIN 2020-TN11123; IDPH 2024-TN11141.

Table 3-20 Demographic Profile of the Population in the Clinton Power Station Socioeconomic Region of Influence, 2020

Demographic	Champaign County	DeWitt County	McLean County	Macon County	ROI	State of Illinois
Total population	205,865	15,516	170,954	103,998	496,333	12,812,508
Percent White race alone	60.86	92.61	75.72	72.23	69.35	58.32
Percent Black or African American race alone	13.71	0.70	8.60	18.16	12.47	13.86
Percent American Indian and Alaska Native race alone	0.14	0.12	0.15	0.17	0.15	0.13
Percent Asian race alone	11.86	0.26	4.74	1.45	6.87	5.83
Percent Native Hawaiian and Other Pacific Islander race alone	0.03	0.10	0.02	0.03	0.03	0.02
Percent some other race alone	0.44	0.10	0.36	0.40	0.39	0.35
Percent two or more races	4.88	2.82	4.25	4.93	4.61	3.24
Hispanic, Latino, or Spanish Ethnicity of Any Race (Total Population)	16,666	510	10,524	2,733	30,433	2,337,410
Percent Hispanic, Latino, or Spanish Ethnicity of Any Race of total population	8.10	3.29	6.16	2.63	6.13	18.24

ROI = region of influence.
Source: USCB 2021-TN11121.

3.10.3.1 Transient Population

A transient population creates a demand for temporary housing (hotels, motels, campgrounds, etc.) and related services in the area from their typically event-driven or vacation-related visit. The ROI can experience seasonal transient population growth as a result of local tourism and recreational activities associated with multiple Federal, State, and local parks as well as camping areas in the county (CEG 2024-TN10806). The closest public use lands include the Clinton Lake State Recreation Area and Weldon Springs State Park. The University of Illinois located in Champaign-Urbana hosts Division 1 college athletic events that bring thousands of spectators into the area for football, basketball, and other college sports.

Based on the USCB 2018–2022 American Community Survey 5-year estimates (USCB 2023-TN11142), 1,210 seasonal housing units are located in the ROI.

3.10.3.2 Migrant Farm Workers

The Census of Agriculture reports the numbers of farms hiring migrant workers defined as a farm worker whose employment required travel that prevented the worker from returning to his or her permanent place of residence the same day (USDA 2024-TN11143). The Census of Agriculture is conducted every 5 years and results in a comprehensive compilation of agricultural production data for every county in the United States.

Information about both migrant and temporary farm labor (i.e., working fewer than 150 days) can be found in the 2022 Census of Agriculture. Table 3-21 below presents information about migrant and temporary farm labor in the ROI. According to the 2022 Census of Agriculture,

5,413 farm workers were hired to work for fewer than 150 days and were employed on 2,316 farms in the ROI. A total of 14 farms in the ROI reported hiring migrant workers.

Table 3-21 Migrant Farm Workers and Temporary Farm Labor in Counties Located in the Clinton Power Station Socioeconomic Region of Influence

County	Number of Farms with Hired Farm Labor	Number of Farms Hiring Workers for Fewer Than 150 Days	Number of Farm Workers Working for Fewer Than 150 Days	Number of Farms Reporting Migrant Farm Labor
Champaign	772	748	1,707	4
DeWitt	324	318	642	NA
McLean	361	268	900	4
Macon	972	982	2,164	6
ROI	2,429	2,316	5,413	14

NA = not available; ROI = region of influence.
Source: USDA Quick Stats (USDA 2024-TN11143).

3.10.4 Housing and Community Services

3.10.4.1 Housing

Table 3-22 below lists the total number of occupied and vacant housing units, vacancy rates, and median values in the ROI. Based on USCB's 2018–2022 American Community Survey 5-year estimates, there are 225,356 housing units in the ROI, of which 200,964 are occupied. The median value of owner-occupied housing units in the ROI is $173,768. The homeowner vacancy rate is approximately 1.6 percent (USCB 2023-TN11144).

Table 3-22 Housing in the Clinton Power Station Socioeconomic Region of Influence, 2018–2022, 5-Year Estimates

	Champaign County	DeWitt County	Macon County	McLean County	ROI
Total housing units	**93,444**	**7,333**	**74,822**	**49,757**	**225,356**
Occupied housing units	82,467	6,644	68,491	43,362	200,964
Total vacant housing units	10,977	689	6,331	6,395	24,392
Percent total vacant	11.7	9.4	8.5	12.9	10.8
Owner occupied units	44,154	5,075	44,512	29,890	123,631
Median value (dollars)	$192,600	$121,100	$191,300	$119,800	$173,768
Owner vacancy rate (percent)	2.0	2.8	1.3	1.1	1.6
Renter occupied units	37,498	1,473	23,218	12,727	74,916
Median rent (dollars/month)	$977	$801	$941	$774	$928
Rental vacancy rate (percent)	10.0	6.9	7.7	10.9	9.4

ROI = region of influence.
Source: USCB 2023-TN11144.

3.10.4.2 Education

The ROI has 39 public school districts comprising 169 schools with a total of 64,410 students in the 2022–2023 school year. These schools include 50 high schools, 40 middle schools,

74 elementary schools, and 5 public preschools. These public schools employed 4,631 teachers, resulting in a cumulative student-to-teacher ratio of 13.9 (NCES 2024-TN11146).

3.10.4.3 Public Water Supply

Groundwater is the primary source of public water in DeWitt County (location of CPS) and other counties in the ROI. Public water is provided by the municipalities in each ROI county (CEG 2024-TN10806). No constraints on water system capacities have been identified in these counties and water supply is projected to have sufficient capacity to meet future. Clinton Lake supplies water to CPS, which is not serviced by municipal systems in DeWitt County (CEG 2024-TN10806).

Similarly, public wastewater systems operate at the municipal level in the ROI counties. Major municipalities operate sanitary sewer services with no capacity constraints affecting these systems. CPS has a private sanitary waste treatment system (CEG 2024-TN10806).

3.10.5 Tax Revenues

CEG pays property taxes on behalf of CPS directly to DeWitt County. Table 3-23 lists total DeWitt County revenues alongside CEG's property tax payments for CPS. The percentage of DeWitt County's property tax revenue paid by CEG ranged between approximately 21 percent and 27 percent annually from 2018 to 2023. DeWitt County retains a portion of this revenue and disburses allotments to several other jurisdictions within DeWitt County (CEG 2024-TN10806) including school districts. In addition, CEG makes annual payments of $1.9 million on behalf of CPS to the Illinois Emergency Management Agency to fulfill obligations under the Illinois Nuclear Safety Preparedness Act. In addition, CEG provides minor funding to local fire departments in DeWitt County to supplement emergency planning activities.

Table 3-23 Tax Payments by Constellation Energy Generation, LLC to DeWitt County, 2018–2023

Year	DeWitt County Total General Revenue (USD)	DeWitt County Total Property Tax Paid by CEG (USD)	% of County Total Property Tax Paid by CEG	Additional Amounts Distributed to Districts and Agencies in DeWitt County by CEG (USD)
2018	6,813,000	1,776,000	26.1	10,953,000
2019	6,798,000	1,787,000	26.3	11,113,000
2020	6,770,000	1,792,000	26.5	10,960,000
2021	8,025,000	1,832,000	22.8	11,685,000
2022	9,054,000	1,855,000	20.5	12,084,000
2023	8,619,000	1,845,000	21.4	12,394,000

CEG = Constellation Energy Generation, LLC; USD = U.S. dollar(s).
Sources: CEG 2024-TN10806; CEG 2024-TN10914: Attachment 45; DC 2024-TN11147.

3.10.6 Local Transportation

The transportation network surrounding CPS comprises local roads, highways, railways, and airports. CPS is located within a triangle formed by the cities of Bloomington-Normal, Illinois, to the north; Champaign-Urbana, Illinois, to the east; and Decatur, Illinois, to the south. U.S.

Route 51 connects Bloomington and Decatur and passes through Clinton, Illinois. Interstate 72 connects Decatur and Champaign-Urbana, and Interstate 74 connects Bloomington-Normal and Champaign-Urbana. Principal vehicle access to the CPS site is via Illinois Route 54, which connects Clinton and Farmer City. Smaller local roads provide access from several small local villages and are not heavily used by employees (CEG 2024-TN10806). Table 3-24 below lists average annual daily traffic volumes and commuting routes to CPS. Based on these traffic volumes, the level-of-service ratings for existing roadway segments is estimated to range between "A" (free flow, with low volumes and high speeds) to "C" (stable flow, but speeds are restricted) (CEG 2024-TN10806; FHWA 2017-TN6585).

Table 3-24 Average Annual Daily Traffic on Commuting Routes to Clinton Power Station, 2011, 2017, and 2021

Roadway	2011 AADT	2017 AADT	2021 AADT
Illinois Route 54 North of CPS	1,550	3,200	1,750
DeWitt Road East of Wren Road	350	350	500
Wren Road East of CPS	50	50	75

AADT = Average Annual Daily Traffic; CPS = Clinton Power Station.
Source: CEG 2024-TN10806.

Amtrak provides rail passenger service to the region via routes to Bloomington-Normal and Champaign-Urbana. A private freight rail spur from the Canadian National/Illinois Central Railroad track accesses the CPS site from the north. In addition to the CPS Heliport, there are five airfields within approximately 10 mi (16 km) of CPS. Central Illinois Regional Airport (Bloomington-Normal) is the closest public, full-service airport, located approximately 22 mi (35 km) north-northwest of CPS (CEG 2024-TN10806).

3.10.7 Proposed Action

Socioeconomic effects of ongoing operations at CPS have become well established as regional socioeconomic conditions have adjusted to the presence of the nuclear power plant. Any changes in employment and tax payments caused by LR and any associated refurbishment activities could have direct and indirect impacts on community services and housing demand, as well as traffic volumes in the communities near the nuclear power plant.

As explained in the LR GEIS (NRC 2024-TN10161) and cited in Table 3-1 of this SEIS, socioeconomic impacts of LR (and the continued operation of CPS) would be SMALL. Five Category 1 socioeconomic issues were evaluated in the LR GEIS. These Category 1 issues are:

- employment and income, recreation and tourism
- tax revenue
- community services and education
- population and housing
- transportation

The LR GEIS did not identify any nuclear plant-specific Category 2 socioeconomic issues that require consideration (NRC 2024-TN10161). The NRC staff's independent review did not

identify any new and significant socioeconomic information that would change the impact findings in the LR GEIS concerning CPS LR. Additionally, the NRC staff did not identify any additional socioeconomic issues beyond those listed in Table 3-1 of this SEIS.

CEG indicated in its ER that they have no plans to add non-outage workers during the LR term and that increased maintenance and inspection activities could be managed using the current workforce (CEG 2024-TN10806). Consequently, people living near CPS would not experience any changes in socioeconomic conditions during the LR term beyond what is currently being experienced. Therefore, the impact of continued operation of CPS during the LR term would not exceed the socioeconomic impacts predicted in the LR GEIS. For these issues, the LR GEIS predicted socioeconomic impacts, including transportation, would be SMALL for all nuclear power plants.

3.10.8 No-Action Alternative

3.10.8.1 Socioeconomics

Under the no-action alternative, the NRC would not renew the operating license, and CPS would shut down on or before the expiration of the current operating license. This would have a noticeable impact on socioeconomic conditions in the counties and communities near CPS. The loss of jobs, income, and tax revenue would have an immediate socioeconomic impact. As jobs are eliminated, some, but not all, of the nearly 600 CPS workers could leave the region. Income from the buying and selling goods and services needed to maintain the nuclear power plant would also be reduced. In addition, loss of tax revenue could affect the availability of public services.

If CPS workers and their families move out of the region, increased vacancies and reduced demand for housing would likely cause property values to decrease. The greatest socioeconomic impact would be experienced in the communities located nearest to CPS in DeWitt County. However, the loss of jobs, income, and tax revenue may be less noticeable in larger communities, and the amount of time and steps required to prepare the nuclear power plant for decommissioning could diminish the impact. Therefore, depending on the jurisdiction, socioeconomic impacts from not renewing the operating license and terminating reactor operations at CPS (no-action alternative) could range from SMALL to LARGE.

3.10.8.2 Transportation

Traffic volume on roads near CPS may be noticeably reduced after the termination of reactor operations. Any reduction in traffic volume would coincide with workforce reductions at CPS. Similarly, truck deliveries and shipments would also be reduced until active decommissioning. Therefore, due to the time and steps required to prepare CPS for decommissioning, traffic-related transportation impacts would be SMALL.

3.10.9 Replacement Power Alternatives: Common Impacts

Workforce requirements for the replacement power alternatives were evaluated to measure their potential effects on current socioeconomic and transportation conditions. The following sections describe the common socioeconomic and transportation impacts during construction and operations of replacement power facilities. Table 3-25 below summarizes the socioeconomic and transportation impacts of replacement power alternatives.

Table 3-25 Socioeconomic and Transportation Impacts of Replacement Power Alternatives to the Clinton Power Station

Alternative	Resource Requirements	Impacts	Discussion
Natural gas	Large construction workforce at the CPS site; likely less operations workers than current CPS operations.	SMALL to LARGE	Construction impacts at the CPS site would be substantial in the context of the rural nature of CPS site and nearby communities. Operations impacts likely would be bounded by current CPS operations impacts.
Combination, natural gas, wind, PV	Construction at several sites would employ a noticeable number of workers over a relatively short duration of peak construction. Fewer operations workers would be required compared to current CPS operations.	SMALL to MODERATE	Facilities could be built at various locations. Workers would be scattered throughout the region and would have a minor but noticeable effect on local economy depending on the location.
Purchased Power	No new resource or worker requirements at existing, operating energy generating facilities.	SMALL	Long-term agreement would not affect existing energy generating facility operations and workforce.

CPS = Clinton Power Station; PV = photovoltaic.
Source: NRC 2024-TN10161: Appendix D.

3.10.9.1 Socioeconomics

Socioeconomic impacts are defined in terms of changes in the social and economic conditions of a region. For example, the creation of jobs and the purchase of goods and services during the construction and operation of a replacement power facility could affect regional employment, income, and tax revenue. For each replacement power generation alternative, two types of jobs would be created: (1) construction jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact, and (2) operations jobs, which have the greater potential for permanent, long-term socioeconomic impacts.

While the selection of a replacement power alternative could create opportunities for employment and income and generate tax revenue in the local economy, employment, income, and tax revenue would be greatly reduced or eliminated in communities near CPS. These impacts are described in the no-action alternative (Section 3.10.8 of this SEIS). The following describes common socioeconomic and transportation impacts that could occur in communities near replacement power facilities during construction and operations.

Construction

During construction of a replacement power facility, the relative economic effect of an influx of workers on the local economy and tax revenue would vary and depend on the size of the workforce and construction completion time. The greatest impact would occur in the communities where the majority of construction workers would reside and spend their income. As a result, some communities could experience a short-term economic expansion during construction from increased tax revenue and income generated by expenditures for goods and services and increased demand for temporary (rental) housing. After construction, local communities would likely experience a return to preconstruction economic conditions.

Operation

Before the commencement of startup and operations at a replacement power facility, local communities would see an influx of operations workers and their families and increased demand for permanent housing and public services. These communities would also experience the economic benefits from increased income and tax revenue generated by the purchase of goods and services needed to operate a new replacement power facility. Consequently, when compared to construction, power plant operations would have a greater potential for effecting permanent, long-term socioeconomic impacts on the region.

3.10.9.2 Transportation

Transportation impacts are defined in terms of changes in level of service conditions on local roads near the replacement power facility. Additional vehicles during construction and operations could lead to traffic congestion, level of service impacts, and delays at intersections.

Construction

Transportation impacts would consist of commuting workers and truck deliveries of equipment and material to the construction site. Traffic volumes would increase during shift changes. In addition, trucks would deliver equipment and material to the construction site and remove waste material, thus increasing the amount of traffic on local roads. The increase in traffic volumes could result in levels of service impacts and delays at intersections during certain hours of the day. In some instances, construction material could also be delivered and removed by rail or barge.

Operation

Traffic-related transportation impacts on local roads would be greatly reduced after construction has been completed. Transportation impacts would include daily commuting by the operations workforce and deliveries of material, and the removal of commercial waste material.

3.11 Human Health

CPS, with its single unit, is both an industrial facility and a nuclear power plant. Similar to any industrial facility or nuclear power plant, the operation of the CPS over the initial LR term will produce various human health risks for workers and members of the public. This section describes the human health risks resulting from the operation of CPS, including from radiological exposure, chemical hazards, microbiological hazards, electromagnetic fields, and other hazards. The description of these risks is followed by the NRC staff's analysis of the potential impacts on human health from the proposed action (LR) and alternatives to the proposed action are described below.

3.11.1 Radiological Exposure and Risk

Operation of a nuclear power plant involves the use of nuclear fuel to generate electricity. Through the fission process, the nuclear reactor splits uranium atoms, resulting generally in (1) the production of heat which is then used to produce steam to drive the plant's turbines and generate electricity, and (2) the creation of radioactive byproducts. As required by NRC regulations specified in 10 CFR 20.1101 (TN283), "Radiation Protection Programs," CEG designed a radiation protection program to protect onsite personnel (including employees and

contractor employees), visitors, and offsite members of the public from radiation and radioactive material at CPS. The CPS radiation protection program is extensive and includes, but is not limited to, the following:

- organization and administration (e.g., a radiation protection manager who is responsible for the program and who ensures there are trained and qualified workers for the program)
- implementing procedures
- as low as is reasonably achievable (ALARA) program to minimize dose to workers and members of the public
- dosimetry program (i.e., measure radiation dose of plant workers)
- radiological controls (e.g., protective clothing, shielding, filters, respiratory equipment, and individual work permits with specific radiological requirements)
- radiation area entry and exit controls (e.g., locked or barricaded doors, interlocks, local and remote alarms, personnel contamination monitoring stations)
- posting of radiation hazards (i.e., signs and notices alerting plant personnel of potential hazards)
- recordkeeping and reporting (e.g., documentation of worker dose and radiation survey data)
- radiation safety training (e.g., classroom training and use of mockups to simulate complex work assignments)
- radioactive effluent monitoring management (i.e., controlling and monitoring radioactive liquid and gaseous effluents released into the environment)
- radioactive environmental monitoring (e.g., sampling and analysis of environmental media, such as direct radiation, air, water, groundwater, milk, food products (corn, soybeans, and peanuts), fish, oysters, clams, crabs, silt, and shoreline sediment to measure the levels of radioactive material in the environment that may impact human health)
- radiological waste management (i.e., controlling, monitoring, processing, and disposing of radioactive solid waste)

To evaluate radiation exposure to CPS personnel, the NRC staff reviewed the data contained in NUREG-0713, Volume 44, Occupational Radiation Exposure at Commercial Nuclear Power Reactors and other Facilities 2022: Fifty-Fifth Annual Report (NRC 2024-TN11165). The 55th annual report was the most recent annual report available at the time of this environmental review. It summarizes the occupational exposure data in the NRC's Radiation Exposure Information and Reporting System database through 2022. These data are reported by nuclear power plant operators, as required by 10 CFR 20.2206 (TN283), "Reports of Individual Monitoring," which requires them to report their occupational exposure data to the NRC annually.

NUREG-0713 calculates a 3-year average collective dose per reactor for workers at all nuclear power reactors licensed by the NRC. The 3-year average collective dose is one of the metrics that the NRC uses in the Reactor Oversight Program to evaluate the applicant's ALARA program. Collective dose is the sum of the individual doses received by workers at a facility licensed to use radioactive material over a 1-year period. There are no NRC or EPA standards for collective dose. Based on the data for operating boiling-water reactors like the reactors at CPS, the average annual collective dose per reactor year was 100 person roentgen-equivalent-

man (rem) (NRC 2024-TN11165: page iv). In comparison, CPS had a reported annual collective dose per reactor year of 49.952 person-rem (NRC 2024-TN11165: Table 4-5).

Section 3.13.1 of this SEIS discusses offsite dose to members of the public.

3.11.2 Chemical Hazards

The Federal and State environmental agencies regulate the use, storage, and discharge of chemicals, biocides, and sanitary wastes. Such environmental agencies also regulate how facilities like CPS manage minor chemical spills. Chemical and hazardous wastes can potentially impact workers, members of the public, and the environment.

At CPS, chemical effects could result from discharge of waste, heavy metal leaching, the use and disposal of chemicals, and chemical spills. Workers may encounter chemicals when adjusting coolant systems, applying biocides to address the fouling of cooling system components, during maintenance activities on equipment containing hazardous chemicals, and when solvents are used for cleaning.

CEG controls the use, storage, and discharge of chemicals, biocides, and sanitary wastes at CPS in accordance with its NPDES and other permits, discussed in Section 3.5.1.3 of this SEIS, through the site's industrial safety program, waste management procedures, and hazardous waste contingency plan. These nuclear power plant procedures, plans, and processes are designed to prevent and minimize the potential for a chemical or hazardous waste release and, in the event of such a release, minimize the impact on workers, members of the public, and the environment. As stated in Section 4.5.5.4 of CEG's ER, water from station usage continues to be processed and monitored in compliance with NPDES licensing and permitting (CEG 2024-TN10806: p. 4-18).

3.11.3 Microbiological Hazards

Microbiological hazards occur when workers or members of the public come into contact with disease-causing microorganisms, also known as etiological agents. Thermal effluents associated with nuclear power plants that discharge to a river or lake, such as at the CPS, have the potential to promote the growth of certain thermophilic microorganisms linked to adverse human health effects. Microorganisms of particular concern include several types of bacteria and the free-living amoeba *Naegleria fowleri* (*N. fowleri*). There are optimum growth temperatures for the microorganisms of concern as further discussed in the LR GEIS (NRC 2024-TN10161).

The public can be exposed to the thermophilic microorganisms during swimming, boating, or other recreational uses of freshwater. If these organisms are naturally occurring and a nuclear power plant's thermal effluent enhances their growth, the public could experience an elevated risk of infection when recreating in the affected waters. Public exposure to *Legionella* spp. from nuclear power plant operation is generally not a concern because exposure risk is confined to cooling towers and related components and equipment, which are typically within the protected area of the site and, therefore, not accessible to the public.

Nuclear plant workers can be exposed to *Legionella* when performing cooling system maintenance through inhalation of cooling tower vapors because these vapors are often within the optimum temperature range for *Legionella* growth. Plant personnel most likely to come in contact with aerosolized *Legionella* are workers who clean and maintain cooling towers and

condenser tubes. Public exposure to *Legionella* from nuclear plant operation is generally not a concern because exposure risk is confined to cooling towers and related components and equipment, which are typically within the protected area of the site and, therefore, are not accessible to the public.

The free-living amoeba *N. fowleri* prefers warm freshwater habitats and is the causative agent of human primary amebic meningoencephalitis (PAM). Infections occur when *N. fowleri* penetrate the nasal tissue through direct contact with water in warm lakes, rivers, or hot springs and migrate to the brain tissues. This free-swimming amoeba species grows best at higher temperatures of up to 115°F (46°C) (NPS 2023-TN11566). It is typically not present in waters below 95°F (35°C) (Tyndall et al. 1989-TN8598). The *N. fowleri*-caused disease PAM is rare in the United States. From 1962 through 2019, the Centers for Disease Control and Prevention (CDC) reports an average of 2.5 cases of PAM annually nationwide.

Legionella is a genus of common warm water bacteria that occurs in lakes, ponds, and other surface waters, as well as some groundwater sources and soils. The bacteria thrive in aquatic environments as intracellular parasites of protozoa and are only pathogenic to humans when aerosolized and inhaled into the lungs. Approximately 2 to 5 percent of those exposed in this way develop an acute bacterial infection of the lungs known as Legionnaires' disease (AWT 2019-TN8518). *Legionella* optimally grow in stagnant surface waters containing biofilms or slimes that range in temperature from 95 to 113°F (35 to 45°C), although the bacteria can persist in waters from 68 to 122°F (20 to 50°C) (AWT 2019-TN8518). As such, human infection is often associated with complex water systems within buildings or structures, such as cooling towers (CDC 2016-TN8519).

The CPS cooling towers are operated during summer months (typically May–September). The cooling towers are maintained by a qualified contractor. The water that circulates through the cooling towers is treated with disinfectants and water treatment chemicals to prevent scaling and corrosion prior to its introduction into station systems. CEG has a comprehensive health and safety program with procedures that implement industrial hygiene practices including appropriate personal protective equipment as appropriate for hazards and entry into confined spaces to minimize the potential for station worker exposure to Legionnaires' disease (CEG 2024-TN10806: Section 3.10.1)

Thermophilic Microorganism Occurrence at Clinton Power Station

CPS uses a once-through cooling water system that withdraws water from the Clinton Lake into its condensers. After the water cools the condensers, the heated water is not cycled back to the condensers but released back into the Clinton Lake via the discharge flume. The heated water can also be pumped from the discharge flume into cooling towers installed along the discharge flume and returned back to the discharge flume. The cooling towers were installed not to recycle cooling water through the condensers but for use during warmer months to ensure compliance with the NPDES permit thermal limits for discharge into Clinton Lake. The NDPES permit limits the temperature of the water in the discharge flume at its entry to Clinton Lake to a daily average temperature which (1) does not exceed 99°F (37°C) (daily average) during more than 90 days in a calendar year, and (2) does not exceed 110.7°F (43.7°C) for any given day (daily maximum) (CEG 2024-TN10806: Attachment E). As the discharge mixes with the lake water temperatures, temperatures attenuate; however, water temperatures during summer would be within the range for thermophilic microorganism growth.

3.11.4 Electromagnetic Fields

Electromagnetic fields (EMFs) are generated by any electrical equipment. All nuclear power plants have electrical equipment and power transmission systems associated with them. Power transmission systems consist of switching stations (or substations) located on the nuclear power plant site and the transmission lines needed to connect the plant to the regional electrical distribution grid. Transmission lines operate at a frequency of 60 hertz (Hz) (60 cycles per second), which is low compared with the frequencies of 55 to 890 megahertz for television transmitters and 1,000 megahertz and greater for microwaves.

The scope of the evaluation of transmission lines includes only those transmission lines that connect the plant to the switchyard where electricity is fed into the regional power distribution system (encompassing those lines that connect the plant to the first substation of the regional electrical power grid), and power lines that feed the plant from the grid are considered within the regulatory scope of the LR environmental review. Transmission lines in-scope for CPS are shown in ER Figure 2.2-2 (CEG 2024-TN10806: page 2-20). As discussed in Section 2.1.6.5 of this SEIS, the in-scope transmission lines include the 345 kV lines between the nuclear power block and the 345 kV switchyard, which connects the generating unit to the regional grid owned and operated by Ameren and the 138 kV line owned and operated by Ameren that provides power to the emergency reserve auxiliary transformer. This 138 kV line spans a short distance onsite that generally parallels the power block and lies between the power block and Clinton Lake. The 345 kV lines and the 138 kV line are within fenced and/or barricaded areas within CPS' owner-controlled area, which were designed to meet the requirements of the National Electric Safety Code.

Based on its evaluation in the LR GEIS, the NRC has not found electric shock resulting from direct access to energized conductors or from induced charges in metallic structures to be a problem at most operating plants. Generally, the NRC staff also does not expect electric shock from such sources to be a human health hazard during the initial LR term. However, a plant-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. Transmission lines that are within the scope of the NRC's initial LR environmental review are limited to: (1) those transmission lines that connect the nuclear plant to the substation where electricity is fed into the regional distribution, and (2) those transmission lines that supply power to the nuclear plant from the grid (NRC 2024-TN10161).

3.11.5 Other Hazards

This section addresses two additional human health occupational hazards: (1) physical hazards and (2) electric shock hazards.

Nuclear power plants are industrial facilities that have many of the typical occupational hazards found at any other electric power generation utility. Nuclear power plant workers may perform electrical work, electric power line maintenance, repair work, and maintenance activities and may be exposed to potentially hazardous physical conditions (e.g., falls, excessive heat, cold, noise, electric shock, and pressure).

Under the Occupational Safety and Health Act of 1970, as amended (29 U.S.C. 651 et seq.-TN4453), the Occupational Safety and Health Administration (OSHA) is responsible for developing and enforcing workplace safety regulations. Congress created OSHA by enacting to safeguard the health of workers. With specific regard to nuclear power plants, plant conditions

that result in an occupational risk, but do not affect the safety of licensed radioactive materials, are under the statutory authority of OSHA rather than the NRC, as set forth in a memorandum of understanding (NRC 2013-TN10165) between the NRC and OSHA. Occupational hazards are reduced when workers adhere to safety standards and use appropriate protective equipment; however, fatalities and injuries from accidents may still occur. CEG maintains an occupational safety program for its workers in accordance with OSHA regulations. CEG's safety procedures are updated on as needed basis and can be updated for system or equipment changes as well as from a self-assessment process (CEG 2024-TN10914: Attachment 46). There are no proposed changes or upgrades currently being considered during the LR period.

Based on its evaluation in the LR GEIS (NRC 2024-TN10161), the NRC staff has not found electric shock resulting from direct access to energized conductors or from induced charges in metallic structures to be a problem at most operating nuclear power plants. Generally, the NRC staff also does not expect electric shock from such sources to be a human health hazard during the LR term. However, a plant-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. Transmission lines that are within the scope of the NRC's LR environmental review are limited to (1) those transmission lines that connect the nuclear power plant to the substation where electricity is fed into the regional distribution system and (2) those transmission lines that supply power to the nuclear power plant from the grid (NRC 2024-TN10161).

For occupational electric shock hazards, OSHA implemented the regulation in 29 CFR 1926.964, "Overhead Lines and Live-Line Barehand Work," in April 2014 (79 FR 20316-TN8528) for work performed on or near overhead lines and equipment and for live-line barehand work. A note to 29 CFR 1926.964(b)(4) (TN4455), "Induced Voltage," sets specific overhead line safety limits:

If the employer takes no precautions to protect employees from hazards associated with involuntary reactions from electric shock, a hazard exists if the induced voltage is sufficient to pass a current of 1 milliampere through a 500 ohm resistor. If the employer protects employees from injury due to involuntary reactions from electric shock, a hazard exists if the resultant current would be more than 6 milliamperes.

3.11.6 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for generic issues related to human health, the impacts of a nuclear power plant LR and continued operations would be SMALL. The NRC staff's review did not identify any new and significant information that would change the conclusion in the LR GEIS. Thus, as concluded in the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation of CPS on human health would be SMALL.

Table 3-2 identifies one uncategorized issue (EMFs) and two plant-specific (Category 2) issues (i.e., microbiological hazards to the public, and electric shock hazards) related to human health applicable to CPS LR. Separately, the NRC has also considered the environmental and human health impacts of the Category 1 issues, design-basis accidents and severe accidents. These issues are analyzed below.

3.11.6.1 Microbiological Hazards to the Public

In the LR GEIS (NRC 2024-TN10161), the NRC staff determined that there is a public health concern from microorganisms wherever surface waters receiving thermal effluents from nuclear power plants are accessible to the public. Specifically, members of the public could be exposed to microorganisms in thermal effluents at nuclear power plants that use cooling ponds, lakes, canals, or that discharge to publicly accessible surface waters. This is a Category 2 issue that requires plant-specific evaluation during each LR review.

The thermophilic microorganism *N. fowleri* can pose public health concerns in recreational use waters when these organisms are present in high enough concentrations to cause infection. IDPH maintains an electronic disease surveillance system with records as far back as 2004 (CEG 2024-TN10806: Attachment E). Upon review of these records for DeWitt County, where CPS is located, there have been no reported thermophilic microorganism outbreaks since 2014. That includes foodborne outbreaks, non-foodborne outbreaks, and Legionnaires' disease. Nor have there been any reported cases of primary amebic meningoencephalitis caused by *N. fowleri*. Additionally, there have been no reported cases of waterborne diseases in the vicinity of the plant since the submission of the initial LR ER, including any updates from the CDC's National Outbreak Reporting System Dashboard (now available in the CDC's Bacteria, Enterics, Amoeba, and Mycotics Dashboard) and/or subsequent local information (CEG 2024-TN10914: Attachment 47). Additionally, CEG's Cooling Tower Performance Monitoring Program procedure for CPS' two MDCTs includes processes for microbiological population control through the application of oxidizing or non-oxidizing biocides to address any potential for microorganisms such as bacteria, fungi, algae, and *Legionella pneumophila* (CEG 2024-TN10914: Attachment 48). Thus, there is no potential for microbiological exposure to members of the public from the site's two MDCTs.

During the proposed LR term, the public health risk from *N. fowleri*, Legionnaires' disease, or other microbiological hazards remains extremely low and the proposed action would not result in operational changes that would affect thermal effluent temperature or otherwise create favorable conditions. The NRC staff concludes that the impacts of thermophilic microorganisms on the public due to continued nuclear power plant operations at CPS during the LR term would be SMALL because thermal effluent discharges from CPS during the proposed LR term would not contribute to the proliferation of microorganisms of concern in Clinton Lake.

3.11.6.2 Electromagnetic Fields

The LR GEIS (NRC 2024-TN10161) and Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN10253) do not designate the health effects of EMFs as either a Category 1 or Category 2 issue, and they remain UNCERTAIN. Until a scientific consensus is reached on the health implications of EMFs, the NRC will not include them as either a Category 1 or a Category 2 issue.

As discussed in LR GEIS Sections 3.9.2.3 and 4.9.1.1.4 (NRC 2024-TN10161), electric fields and magnetic fields, collectively referred to as electromagnetic fields, or EMFs, are produced by any electrical equipment, including operating transmission lines. The information provided in these two LR GEIS sections are incorporated by reference. During the LR term, plant workers and members of the public who live, work, or pass near an associated operating transmission line may be exposed to EMFs in the same way that they are exposed during the current license term. Scientific consensus on the health implications of EMFs has not been established. The potential health effects from EMF exposure have been the subject of published studies as

described in Section 4.9.1.1.4 of the LR GEIS (NRC 2024-TN10161), but consistent evidence of harmful effects remains inconclusive.

The NRC staff considers the LR GEIS finding of "UNCERTAIN" to still be appropriate and will continue to follow developments on this issue.

3.11.6.3 Electric Shock Hazards

Based on the LR GEIS (NRC 2024-TN10161), the Commission found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been identified as a problem at most operating plants and generally is not expected to be a problem during the LR term. However, a plant-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 CPS LR review.

As discussed in Section 2.1.6.5 and Section 3.11.5 of this SEIS, the 345 kV and the 138 kV transmission corridors continue beyond the CPS site boundary, and the in-scope transmission lines are located completely within the CPS exclusion area. While Ameren is the transmission and distribution operator and owns the switchyard, CEG controls the switchyard through an interface agreement. Thus, the in-scope transmission lines are not accessible to the public (CEG 2024-TN10806: Section 2.2.5.4). Therefore, there are no potential impacts on members of the public resulting from such transmission lines.

The transmission corridors onsite shown in ER Figure 2.2-2 (CEG 2024-TN10806) containing 345 kV and 138 kV overhead transmission lines do have the potential for electric shock to workers through induced currents. To address this occupational hazard, the 345 KV lines are governed by the CPS electrical safety program which addresses proper clearances and safe work approaches and uses of mobile equipment for safe placement and operation. When working on or near the energized overhead lines under the responsibility of CEG, the work follows the guidance specified in the fleet electrical safety procedure for overhead power lines and hazardous induced voltages. The fleet electrical safety procedure was developed to comply with the National Fire Protection Association electrical safety in the workplace standards and applicable National Electrical Safety Code standards (CEG 2024-TN10914: Attachment 73). As discussed in Section 3.11.5 of this SEIS, CPS maintains an occupational safety program in accordance with OSHA regulations for its workers, which includes protection from acute electric shock. Therefore, the NRC staff concludes that the potential impacts from acute electric shock during the LR term would be SMALL.

3.11.6.4 Postulated Accidents

The LR GEIS (NRC 2024-TN10161) evaluates the following two classes of postulated accidents as they relate to LR:

- Design-basis accidents: Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.
- Severe accidents: Postulated accidents that are more severe than design-basis accidents because they could result in substantial damage to the reactor core.

As shown in Table 3-1 of this SEIS, the LR GEIS (NRC 2024-TN10161) addresses design-basis accidents as a Category 1 issue and concludes that the environmental impacts of design-basis

accidents are of SMALL significance for all nuclear power plants. No new and significant information related to design-basis accidents was identified during the review of the CPS ER (CEG 2024-TN10806), site audit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the LR GEIS.

Additionally, as shown in Table 3-1 of this SEIS, the LR GEIS (NRC 2024-TN10161) also designates severe accidents as a Category 1 issue and concludes that the environmental impacts of severe accidents are SMALL. The NRC staff identified no new and significant information related to postulated severe accidents during the review of the CPS ER (v), the site audit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the LR GEIS.

The LR GEIS also specifies the following clarification with respect to severe accidents:

> 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 and would be the functional equivalent of a Category 2 issue requiring plant-specific analysis (NRC 2024-TN10161).

Furthermore, 10 CFR 51.53(c)(3)(ii)(L) (TN10253) requires that LR applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an 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 the environmental impact of severe accidents are identified and evaluated. SAMAs have not been previously considered for CPS; therefore, the remainder of this section addresses those alternatives.

Overview of SAMA Process

This section presents a summary of the SAMA evaluation for CPS conducted by CEG and the NRC staff's review of that evaluation. The NRC staff performed its review with contract assistance from Pacific Northwest National Laboratory. The NRC staff's review is available in full in Appendix F; the SAMA evaluation is available in full in CEG's ER.

The SAMA evaluation for CPS was conducted with a four-step approach. In the first step, CEG 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, CEG 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. CEG initially identified a list of 25 potential SAMAs candidates after eliminating those candidates that (a) were not applicable to CPS, (b) had already been implemented at CPS, (c) were combined with another SAMA candidate, (d) were expected to have a very low benefit, and (e) had an excessive implementation cost.

In the third step, CEG estimated the benefits and the costs associated with each of the 25 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-TN676). 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). CEG concluded in its ER that 11 of the SAMAs evaluated are potentially cost-beneficial (CEG 2024-TN10806, CEG 2024-TN11148).

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 LR pursuant to 10 CFR Part 54 (TN4878). CEG's SAMA analyses and the NRC's review are discussed in more detail below.

Estimate of Risk

CEG submitted an assessment of SAMAs for CPS as part of the ER (CEG 2024-TN10806). This assessment was based on the most recent revision of the CPS PRA, which includes models for internal events, internal flooding, and fire, and a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System (WinMACCS) computer program, as well as insights from the CPS Individual Plant Examination (IPE) (IPC 1992-TN11153) and Individual Plant Examination of External Events (IPEEE) (IPC 1995-TN11154).

CEG combined two distinct analyses to form the basis for the risk estimates used in the SAMA analysis: (1) the CPS Level 1 and 2 PRA model, which is an updated version of the IPE (IPC 1992-TN11153), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. Other than fire events, the scope of the models does not include external events.

The CPS total core damage frequency (CDF) is approximately 3.32×10^{-5} per year. The CPS internal events CDF, including internal flooding events, is approximately 2.00×10^{-6} per year as determined from quantification of the Level 1 PRA model. The CPS CDF estimates for fire events is 3.12×10^{-5} per year, as determined from quantification of the Level 1 PRA model. The breakdown of CDF by initiating event for CPS are provided in Table 3-26 and Table 3-27 below for internal events (including internal floods) and fire events, respectively. CEG used the PRA model for CPS in determining the potential risk reduction benefits of each SAMA. CEG accounted for the potential risk reduction benefits associated with external events beyond fire events by multiplying the estimated benefits obtained from the CPS PRA by a factor of 1.193.

CEG estimated the dose to the population within 50 mi (80 km) of the CPS site to be approximately 0.284 person Sieverts (Sv) per year (28.4 person-rem per year) for internal events, internal flooding events, fire events, and seismic events combined (CEG 2024-TN11148). The breakdown of the total population dose and offsite economic cost risk by containment release mode is summarized in Table 3-28 below. High/early (H/E), high/late (H/L) and medium/early (M/E) releases are the dominant contributors to population dose risk.

Table 3-26 Clinton Power Station Core Damage Frequency for Internal Events (including Internal Flooding)

Initiating Event	CDF (per year)	% CDF Contribution
Loss of Offsite Power	7.56×10^{-7}	37.87
Major Fire Protection Rupture above MCR	4.06×10^{-7}	20.32
Open Phase Condition Occurs Upstream of RAT B	1.54×10^{-7}	7.73
Turbine Trip	1.07×10^{-7}	5.37
Major Vapor Container Rupture in CB-1i above MCR	8.84×10^{-8}	4.43
Major Service Water Rupture in AB	7.40×10^{-8}	3.71
Major Shutdown Service Water (SX) A Rupture above MCR	5.89×10^{-8}	2.95
Major SX B Rupture above MCR	5.89×10^{-8}	2.95
Manual Shutdown	4.31×10^{-8}	2.16
Major Fire Protection Water Rupture in AB	2.41×10^{-8}	1.21
Loss of Feedwater	2.29×10^{-8}	1.15
Small LOCA (below Top of Active Fuel)	1.78×10^{-8}	0.89
Other Initiating Events[(a)]	1.89×10^{-8}	9.26
Total CDF (Internal Events)	**2.00×10^{-6}**	**100[(b)]**

CDF = core damage frequency; LOCA = loss-of-coolant accident; MCR = main control room; RAT = reserve auxiliary transformer.
(a) Multiple initiating events with each contributing less than 1 percent.
(b) Sum of contributors does not add up to 100 percent due to round off error.

Table 3-27 Clinton Power Station Core Damage Frequency for Fire Events

PAU	Description	CDF (per year)	% CDF Contribution
A-2n	Division 1 Switchgear Room	9.67×10^{-6}	30.96%
A-2k	Non-Safety Switchgear Room (East)	7.50×10^{-6}	24.03%
CB-Sa	Division 3 Switchgear Room	2.24×10^{-6}	7.18%
A-3f	Division 2 Switchgear Room	1.85×10^{-6}	5.92%
CB-3a	Auxiliary Electric Equipment Room	1.60×10^{-6}	5.13%
CB-6a	Main Control Room Complex	1.57×10^{-6}	5.02%
D-4a	Division 3 Diesel-Generator Room	1.53×10^{-6}	4.91%
A-3d	Non-Safety Switchgear Room (West)	1.39×10^{-6}	4.46%
A-2o	Containment Electrical Penetration (East) Area	6.80×10^{-7}	2.18%
D-6a	Division 2 Diesel-Generator Room	5.87×10^{-7}	1.88%
TY-1a	RAT Areas	5.53×10^{-7}	1.77%
D-5a	Division 1 Diesel-Generator Room	3.74×10^{-7}	1.20%
Other[(a)]	All other PAUs	1.67×10^{-6}	5.35%
Total CDF (Fire Events)		**3.12×10^{-5}**	**100[(b)]**

CDF = core damage frequency; PAU = Physical Analysis Unit; RAT = Reserve Auxiliary Transformer.
(a) Multiple PAUs with each contributing less than 1 percent.
(b) Sum of contributors does not add up to 100 percent due to round off error.

Table 3-28 Base Case Mean Population Dose Risk and Offsite Economic Cost Risk at Clinton Power Station

Release Category: ID[(a)]	Release Category: Frequency (per yr)	Population Dose Risk: person-rem/yr[(b)]	Population Dose Risk: % Contribution	Offsite Economic Cost Risk: $/yr	Offsite Economic Cost Risk: % Contribution
BOC	4.48×10^{-10}	2.28×10^{-3}	0.01	3.30×10^{1}	0.01
H/E	8.47×10^{-7}	1.49	5.2	3.70×10^{4}	5.6
H/L	1.26×10^{-5}	21.5	75.8	5.35×10^{5}	81.4
M/E	4.46×10^{-6}	3.84	13.5	7.52×10^{4}	11.4
M/L	3.58×10^{-6}	9.80×10^{-1}	3.4	7.06×10^{3}	1.1
L/E	3.22×10^{-6}	4.81×10^{-1}	1.7	2.49×10^{3}	0.4
L/L	5.41×10^{-7}	4.14×10^{-2}	0.1	1.74×10^{2}	0.03
LL/E	1.74×10^{-7}	1.31×10^{-2}	0.05	4.69×10^{1}	0.01
LL/L	5.65×10^{-7}	2.69×10^{-2}	0.1	8.91×10^{1}	0.01
Intact	7.18×10^{-6}	1.24×10^{-2}	0.04	1.04×10^{2}	0.02
Total	**3.32×10^{-5}[(c)]**	**28.4[(c)]**	**100[(d)]**	**6.57×10^{5}[(c)]**	**100[(d)]**

BOC = break outside containment; E = early; I = intermediate; ID = identification; /L = late; H = high; M = medium/moderate; L/ = low; LL = low-low; rem = roentgen equivalent man; yr = year.

(a) Release Category descriptions provided in response to an NRC staff request for additional information (CEG 2024-TN11148).

(b) Unit Conversion Factor: 1 Sv = 100 rem.

(c) Sum of contributors may not add up to Total due to round off error.

(d) Sum of contributors may not add up to 100 percent due to round off error.

The NRC staff reviewed CEG'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, offsite doses, and offsite economic costs reported by CEG.

Potential Plant Improvements

Once the dominant contributors to plant risk were identified, CEG searched for ways to reduce that risk. In identifying potential SAMAs, CEG considered SAMAs identified in industry documents including the SAMA analyses performed for other operating plants, insights from the plant-specific PRA models, and plant improvements identified in the CPS IPE and IPEEE. CEG initially identified a list of 25 potential SAMAs candidates after eliminating those candidates that (1) were not applicable to CPS, (2) had already been implemented at CPS, (3) were combined with another SAMA candidate, (4) were expected to have a very low benefit, or (5) had an excessive implementation cost. A detailed cost-benefit analysis was performed for each of the 25 remaining SAMAs.

The staff concludes that CEG used a systematic and comprehensive process for identifying potential plant improvements for CPS, and that the set of SAMAs evaluated in the ER is reasonably comprehensive and, therefore, acceptable.

Evaluation of Risk Reduction and Costs of Improvements

CEG evaluated the risk reduction potential of the 25 candidate SAMAs. The SAMA evaluations were performed using generally conservative assumptions. CEG used PRA model re-quantification to determine the potential benefits for each SAMA. The CDF, population dose, and offsite economic cost reductions for internal events, including internal flooding, as well as fire events were estimated using the CPS PRA model (CEG 2024-TN10806). CEG accounted for the potential risk reduction benefits associated with external events beyond fire events by multiplying the estimated benefits obtained from the CPS PRA by a factor of 1.193.

The NRC staff reviewed CEG assumptions used to evaluate the benefit or risk reduction estimate for each of the plant improvements and concludes that the rationale and assumptions for estimating risk reduction are sufficient and appropriate for use in the SAMA evaluation because it is technically sufficient and meets the guidance provided in NEI 05-01A (NEI 2005-TN1978).

CEG estimated the costs of implementing each of the candidate SAMAs through the development of CPS-specific cost estimates. The cost estimates conservatively did not account for the cost of replacement power during extended outages, if required to implement the modifications, but include contingency costs associated with unforeseen implementation obstacles.

The NRC 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. The NRC staff also reviewed the basis for the cost estimates during the NRC audit of the SAMA analysis (NRC 2024-TN10876). The NRC staff concludes that the cost estimates provided by CEG are sufficient and appropriate for use in the SAMA evaluation.

Cost-Benefit Comparison

The cost-benefit analysis performed by CEG was based primarily on NUREG/BR-0184 (NRC 1997-TN676) and was executed consistent with this guidance. NEI 05-01A states that two sets of estimates should be developed—one at 3 percent and one at 7 percent (NEI 2005-TN1978). CEG provided a base set of results using a discount rate of 3 percent and a 20-year LR period and based its decisions on potentially cost-beneficial SAMAs on these values.

In CEG's analysis, if the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was determined to be not cost beneficial. If the SAMA benefit exceeded the estimated cost, the SAMA candidate was considered to be potentially cost beneficial. Considering the results from the baseline and sensitivity analyses, the full set of potentially cost-beneficial SAMAs identified in the ER and in response to NRC staff inquiries are:

- SAMA 2 — Proceduralize DC current check for extended loss of AC power load shed action.
- SAMA 4 — Enhance containment venting capability (e.g., FLEX hard pipe vent).
- SAMA 5 — Install an emergency tie line from the switchyard to an emergency bus
- SAMA 7 — Enhance procedures and operator training to include containment venting control for NPSH management.
- SAMA 10 — Install a hard piped connection between FPS and RHR.

- SAMA 12 — Modify plant procedures to direct use of FLEX generators to support containment venting.
- SAMA 14 — Install 3-hour rated fire cable wrap on offsite power cables in risk-significant areas.
- SAMA 15 — Install a battery backup to the hydrogen igniters.
- SAMA 20 — Additional diesel generator that can act as a swing diesel generator to all divisions of alternating current power.
- SAMA 26 — Include explicit steps in the loss of alternating current power procedure to address water hammer.
- SAMA 27 — Install fire wrap/barriers around critical risers in Fire Zone A-2k.

CEG indicated that the 11 potentially cost-beneficial SAMAs will be formally evaluated for potential implementation at the plant (CEG 2024-TN10806, CEG 2024-TN11148). The NRC staff reviewed CEG's cost-benefit evaluations of each SAMA and 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.

Conclusions

The NRC staff reviewed CEG'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 CEG are reasonable and sufficient for the LR submittal.

The NRC staff agrees with CEG's conclusion that the 11 candidate SAMAs discussed in this section are potentially cost beneficial, which was based on generally conservative treatment of costs, benefits, and uncertainties. This conclusion of a small number of potentially cost-beneficial SAMAs is consistent with the low residual level of risk indicated in the CPS PRA and the fact that CEG has already implemented the plant improvements identified from the IPE and IPEEE. Because the potentially cost-beneficial SAMAs do not relate to aging management during the period of extended operation, they do not need to be implemented as part of LR in accordance with 10 CFR Part 54 (TN4878). Nevertheless, CEG stated that each of these potentially cost-beneficial SAMAs will be formally evaluated for potential implementation at the plant.

3.11.7 No-Action Alternative

Under the no-action alternative, the NRC would not renew the CPS operating license and CPS would shut down on or before the expiration of the current operating license. Human health risks would be smaller following plant shutdown. The reactor unit, which currently operates within regulatory limits, would emit less radioactive gaseous, liquid, and solid 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. In Section 3.11.6 of this SEIS, the NRC staff concluded that the impacts of continued plant operation on human health would be SMALL, except for "Electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. In Section 3.11.6.4 of this SEIS, the NRC staff concluded that the impacts of accidents during operation are SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and

types of accidents decrease following shutdown, the NRC staff concludes that the risk to human health following plant shutdown would be SMALL.

3.11.8 Replacement Power Alternatives: Common Impacts

Impacts on human health from construction of a replacement power station would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker protection rules, the use of personal protective equipment, training, and placement of engineered barriers would limit those impacts on workers to acceptable levels.

The human health impacts from the operation of a power station include public risk from inhalation of gaseous emissions. Regulatory agencies, including EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits to protect human health.

3.11.9 Natural Gas Alternative

The construction impacts of the natural gas alternative would include those identified in Section 3.11.8 of this SEIS. Because the NRC staff expects that the licensee would limit access to active construction areas to only authorized individuals, consistent with NRC regulations, the impacts on human health from the construction of a natural gas facility would be SMALL.

The human health effects from the operation of the natural gas alternative would include those identified in Section 3.11.8 of this SEIS, as common to the operation of all replacement power alternatives. Health risks may be attributable to nitrogen oxide emissions that contribute to ozone formation (NRC 2024-TN10161). Given the regulatory oversight exercised by the EPA and State agencies, the NRC staff concludes that the human health impacts from the natural gas alternative would be SMALL, except for “Electromagnetic fields (EMFs),” for which the impacts are UNCERTAIN. Therefore, the NRC staff concludes that the impacts on human health from the operation of the natural gas alternative would be SMALL.

3.11.10 Renewable and Natural Gas Combination Alternative

Chapter 2 of this SEIS presents the renewable and natural gas combination alternative. Impacts to human health during the operation of a natural gas alternative would include those identified in Section 3.11.9 of this SEIS.

Human health hazards for the workforce during operation at a wind facility include working at heights, working near rotating mechanical or electrically energized equipment, and working in extreme weather. Adherence to safety standards and the use of appropriate protective equipment through implementation of an OSHA-approved worker safety program would minimize occupational hazards. Potential impacts on workers and the public include ice thrown from rotor blades and broken blades thrown as a result of mechanical failure. Adherence to proper worker safety procedures and limiting public access to wind turbine sites would minimize the impacts from ice thrown and broken rotor blades. Potential impacts also include EMF exposure, aviation safety hazards, and exposure to noise and vibration from the rotating blades. Impacts from EMF exposure would be minimized by adherence to proper worker safety procedures and limiting public access to any components that could create an EMF. Aviation safety hazards would be minimized by proper siting of the wind turbine facilities and maintaining all proper safety warning devices, such as indicator lights, for pilot visibility. Furthermore, the NRC staff has identified no epidemiologic studies on noise and vibration from wind turbines that would suggest any direct human health impact. Based on this information, the human health impacts from the operation of the wind component for the combination alternative would be SMALL.

Solar PV panels are encased in heavy-duty glass or plastic. Therefore, there is little risk that the small amounts of hazardous semiconductor material that they contain would be released into the environment. In the event of a fire, hazardous particulate matter could be released to the atmosphere. Given the short duration of fires and the high melting points of the materials found in the solar PV panels, the impacts from inhalation are minimal. Also, the risk of fire at ground-mounted solar installations is minimal due to precautions taken during site preparation, such as the removal of fuels and the lack of burnable materials contained in the solar PV panels. Another potential risk associated with PV systems and fire is the potential for shock or electrocution from contact with a high-voltage conductor. Proper procedures and clear marking of system components should be used to provide emergency responders with appropriate warnings to diminish the risk of shock or electrocution (Good Company 2011-TN8599).

Solar PV panels do not produce EMFs at levels considered harmful to human health, as established by the International Commission on Non-Ionizing Radiation Protection. These small EMFs diminish significantly with distance and are indistinguishable from normal background levels within several yards (Good Company 2011-TN8599).

Regarding wind and solar power storage, lithium-ion batteries can be used for utility-scale storage and would fall under industrial safety plans, environmental protection rules, and OSHA regulations. Lithium-ion batteries have the potential to catch fire due to an effect called thermal runaway; although an uncommon occurrence, thermal runaway is one of the most recognized safety issues for lithium-ion batteries. The self-perpetuating process can end in battery destruction, release of toxic gases, and has a high risk of fire or explosion (Łukasz et al. 2023-TN9618). Although thermal runaway is a concern, industrial safety practices would limit the impacts on human health and, therefore, overall impacts would be SMALL as part of the solar alternative.

Therefore, given the expected compliance with worker and environmental protection rules and the use of personal protective equipment, training, and engineered barriers, the NRC staff concludes that the potential human health impacts for the combination alternative would be SMALL.

3.11.11 Purchased Power Alternative

Purchased power would come from existing energy generating facilities. These facilities would likely have BMPs and other procedures in place to ensure that any human health effects from operational changes are minimized. Therefore, based on this information, the impact of this alternative on human health would be SMALL.

3.12 Reserved

10 CFR Part 51 (TN10253), Subpart A, Appendix B, Table B-1, “Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants,” requires an environmental impact statement for license renewal to include an analysis for the Category 2 issue of “Environmental Justice—Impacts on minority populations, low-income populations, and Indian Tribes.” Executive Order 14173 (90 FR 8633-TN11607), “Ending Illegal Discrimination and Restoring Merit-Based Opportunity,” issued January 21, 2025, revoked Executive Order 12898 (59 FR 7629-TN1450), “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” issued February 11, 1994, among other things. Based on Executive Order 14173, and pursuant to 10 CFR 51.6 (TN10253), “Specific exemptions,” the NRC staff has, upon its own initiative, determined that an exemption from the requirement to address

environmental justice in this SEIS is authorized by law and otherwise in the public interest. Accordingly, this SEIS does not address that issue.

3.13 Waste Management and Pollution Prevention

Like any operating nuclear power plant, CPS would produce both radioactive and nonradioactive waste during the proposed LR term. This section of the SEIS describes waste management and pollution prevention at CPS. The description of these waste management activities is followed by the NRC staff's analysis of the potential impacts of waste management from the proposed action of CPS LR and alternatives to the proposed action.

3.13.1 Radioactive Waste

The NRC licenses nuclear power plants with the expectation that they will release a limited amount of radioactive material to both the air and water during normal operations. However, NRC regulations require that gaseous and liquid radioactive releases from nuclear power plants meet radiation dose based limits specified in 10 CFR Part 20 (TN283), "Standards for Protection Against Radiation," and the ALARA criteria in 10 CFR Part 50 (TN249), Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents." In other words, the NRC places regulatory limits on the radiation dose that members of the public can receive from radioactive effluents of a nuclear power plant. For this reason, all nuclear power plants use radioactive waste management systems to control and monitor radioactive wastes.

CPS uses liquid, gaseous, and solid waste processing systems to collect and treat, as needed, radioactive materials produced as a byproduct of nuclear power plant operations. Radioactive materials in liquid, gaseous, and solid effluents are reduced before being released into the environment so that the resultant dose to members of the public from these effluents is well within the NRC and EPA dose standards. Radionuclides that can be efficiently removed from the liquid and gaseous effluents before release are converted to a solid waste form for disposal in a licensed disposal facility.

CEG maintains a REMP to assess the radiological impact, if any, to the public and the environment from radioactive effluents released during operations at CPS (CEG 2024-TN10806).

CEG has an Offsite Dose Calculation Manual (ODCM) that contains the methods and parameters for calculating offsite doses resulting from liquid and gaseous radioactive effluents. These methods ensure that radioactive material discharges from CPS meet NRC and EPA dose standards. The ODCM also contains the requirements for the REMP (CEG 2023-TN11113). As discussed during the audit, there are no proposed changes or upgrades to the effluent control program planned for the LR term (CEG 2024-TN10914; NRC 2024-TN10876).

3.13.1.1 Radioactive Liquid Waste Management

The LRS collects, monitors, and treats liquid radioactive wastes for return to the station for reuse insofar as is practicable. The LRS is designed so that if liquid radwaste is discharged from the site it will have radioactive nuclide concentrations well within the limits specified in 10 CFR Part 20 (TN283) and Appendix I to 10 CFR Part 50 (TN249). However, the station has not discharged through the LRS since 1992. All potentially radioactive liquid wastes are collected in

sumps or drain tanks at various locations in the station. These wastes are transferred to collection tanks in the radwaste facility (CEG 2024-TN10806).

Section 2.2.6.2 of CEG's ER describes the radioactive liquid waste management systems at CPS. The LRS consists of four major subsystems: (1) the equipment drain subsystem, (2) the floor drain subsystem, (3) the chemical waste subsystem, and (4) the laundry waste subsystem (CEG 2024-TN10806).

As discussed during the audit, liquid effluents may originate from two sources at CPS. The use of these radioactive waste systems and the procedural requirements in the ODCM ensure that the dose from radioactive liquid effluents, if released, complies with NRC and EPA dose standards.

The first is effluent from the Radioactive Waste Treatment System. The station is licensed to discharge liquid radwaste effluent should it need to do so, but as a matter of station management decisions it has not discharged through the LRS since 1992. If a processed liquid waste batch from the radwaste system meets the quality standards required for recycling, it is sent to the cycled condensate storage tank for reuse. If the condensate tank does not have the capacity to hold additional processed wastewater, this water can be either sent back through the Radioactive Waste Treatment System for re-processing or sent to one of both excess water tanks. In the case that storage capacity is not available in the cycle condensate storage system within a reasonable period, as determined by the liquid waste accumulation rate, the site may schedule a discharge of liquid waste. If effluents were to be released through this system, sampling is conducted to ensure the releases would be within regulatory limits (CEG 2024-TN10914; NRC 2024-TN10876).

The second source of liquid effluents is from potential heat exchanger leaks found in closed cooling water systems that service radioactively contaminated systems. This second source would be considered an abnormal release if it were to occur. The licensee has procedures for the monthly grab sampling and analysis of the plant service water and shutdown service water effluents for gamma emitting radionuclides and tritium (H-3) as specified in Sections 2.2 and 2.3 of the ODCM (CEG 2023-TN11113). The site revised the procedures in 2022 such that if the results are below the Lower Limit of Detection for tritium and gamma emitting nuclides, no further action is needed. If quarterly grab sample analysis indicates the presence of contamination, a quarterly composite sample will be obtained and analyzed in compliance with ODCM Sections 2.2, 2.3, 2.4 and 2.5. Leakage into this system from the potentially radioactive systems would be detected by a radiation monitor (CEG 2024-TN10914).

Dose estimates for members of the public are calculated based on radioactive liquid effluent release data and aquatic transport models. CEG's annual radiological effluent release report contains a detailed presentation of the radioactive liquid effluents released from CPS and the resultant calculated doses. These reports are publicly available on the NRC's website (https://www.nrc.gov/). The NRC staff reviewed 5 years of radioactive effluent release data: 2019 through 2023 (Exelon 2020-TN11109, Exelon 2021-TN11110; CEG 2022-TN11111, CEG 2023-TN11113, CEG 2024-TN11114). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance activities that can affect the generation of radioactive effluents. The NRC staff compared the data against NRC dose limits and looked for indications of adverse trends (i.e., increasing dose levels or increasing radioactivity levels) over the period of 2019 through 2023.

The doses calculated for radioactive liquid effluents released from CPS during 2023 are summarized below (CEG 2024-TN10806).

Clinton Power Station Liquid Effluents in 2023

There were no liquid effluent releases in 2023. As such, there was no dose received by the public from the liquid radioactive effluent pathway.

The NRC staff's review of CEG's radioactive liquid effluent control program shows that the applicant maintained radiation doses to members of the public were well within NRC and EPA radiation protection standards, as contained in Appendix I to 10 CFR Part 50-TN249, 10 CFR Part 20-TN283, and 40 CFR Part 190-TN739, "Protection of Environment, Environmental Radiation Protection Standards for Nuclear Power Operations." The NRC staff observed no adverse trends in the dose levels.

As documented in the effluent reports, there were no abnormal liquid releases in the period from 2019 through 2023 (Exelon 2020-TN11109, Exelon 2021-TN11110; CEG 2022-TN11111, CEG 2023-TN11113, CEG 2024-TN11114). As confirmed during the audit, there have been no reportable unplanned liquid releases of radioactive materials since the ER was written (CEG 2024-TN10914).

During the LR term, CEG would continue to perform routine plant refueling and maintenance activities. Based on CEG's past performance in operating a radioactive waste system at CPS that maintains ALARA doses from radioactive liquid effluents, the NRC staff expects that CPS would maintain similar performance during the LR term.

3.13.1.2 Radioactive Gaseous Waste Management

Section 2.2.6.1 of the ER discusses radioactive gaseous waste management. The NRC staff summarizes that information below and incorporates the information in the CEG ER, Section 2.2.6.1 (CEG 2024-TN10806: p. 2-13), herein by reference. The Gaseous Radwaste System used at CPS is designed to remove fission product gases from the reactor coolant and minimize the amount of radioactive material released into the environment. The gases are stored for an appropriate time to allow for radioactive decay of the material to levels that comply with plant procedures to ensure that the radiation doses to members of the public are within regulatory limits (CEG 2024-TN10806). The radioactive gaseous waste sampling and analysis program specifications provided in the ODCM address the gaseous release type, sampling frequency, minimum analysis frequency, type of activity analysis, and lower limit of detection (i.e., sensitivity) for the radiation monitor (CEG 2023-TN11113).

The treatment of gases includes volume reduction through a catalytic hydrogen-oxygen recombiner, water vapor removal through a condenser, decay of short-lived radioisotopes through a holdup line, further condensation and cooling, adsorption of isotopes on activated charcoal beds, further filtration through high efficiency filters, and final releases. Airborne radioactive releases to the environs are from a single common station vent above the containment building dome which is the tallest structure in the power block. Continuous radiation monitors are provided which indicate radioactive release from the reactor and from the charcoal adsorbers and the system prevents releasing gases of unacceptably high activity (CEG 2024-TN10806).

CEG calculates dose estimates for members of the public based on radioactive gaseous effluent release data and atmospheric transport models. CEG annual radioactive effluent release reports present in detail the radiological gaseous effluents released from CPS and the resultant calculated doses. As described in Section 3.13.1.1 of this SEIS, the NRC staff reviewed 5 years of radioactive effluent release data from the 2019 through 2023 reports (Exelon 2020-TN11109, Exelon 2021-TN11110; CEG 2022-TN11111, CEG 2023-TN11113, CEG 2024-TN11114). The NRC staff compared the data against NRC dose limits and looked for indications of adverse trends (i.e., increasing dose levels or increasing radioactivity levels) over the period of 2019 through 2023.

The calculated doses from radioactive gaseous effluents released from CPS during 2023 (CEG 2024-TN10806) are summarized below.

Clinton Power Station Gaseous Effluents in 2023

- The air dose due to noble gases with resulting gamma radiation in gaseous effluents was 2.02×10^{-3} millirad (mrad) (2.02×10^{-5} milligray), which is well below the 10 mrad (0.1 milligray) dose criterion specified in Appendix I of 10 CFR Part 50-TN249.
- The air dose from beta radiation in gaseous effluents was 7.11×10^{-4} mrad (7.11×10^{-6} milligray), which is well below the 20 mrad (0.2 milligray) dose criterion specified in Appendix I of 10 CFR Part 50-TN249.
- The critical organ dose (bone) to an offsite member of the public from radiation in gaseous effluents as a result of iodine-131, iodine-133, hydrogen-3, and particulates with greater than 8-day half-lives was 2.42×10^{-1} millirem (mrem) (2.42×10^{-3} millisieverts [mSv]), which is below the 15 mrem (0.15 mSv) dose criterion in Appendix I of 10 CFR Part 50-TN249.

The NRC staff's review of CPS' radioactive gaseous effluent control program showed radiation doses to members of the public that were well below NRC and EPA radiation protection standards contained in Appendix I of 10 CFR Part 50-TN249, 10 CFR Part 20-TN283, and 40 CFR Part 190-TN739. The NRC staff observed no adverse trends in the dose levels over the 5 years reviewed.

As documented in the effluent reports, there were no abnormal gaseous releases in the period from 2019 through 2023 (Exelon 2020-TN11109, Exelon 2021-TN11110; CEG 2022-TN11111, CEG 2023-TN11113, CEG 2024-TN11114). As confirmed during the audit, there have been no reportable unplanned releases of gaseous radioactive materials since the ER was written (CEG 2024-TN10914).

During the LR term, CEG would continue to perform routine plant refueling and maintenance activities. Based on CEG's past performance in operating a radioactive waste system at CPS that maintains ALARA doses from radioactive gaseous effluents, the NRC staff expects that CPS would maintain similar performance during the LR term.

3.13.1.3 Radioactive Solid Waste Management

CPS' radioactive solid waste management system provides for packaging and/or solidification of radioactive waste that will subsequently be shipped offsite to an approved burial facility, in accordance with NRC regulations in 10 CFR Parts 61 (TN252) and 71 (TN301). Transportation of the radioactive solid waste is governed by the U.S. Department of Transportation regulations in 49 CFR Part 171 to 49 CFR Part 178 (TN10307).

Section 2.2.6.3 of the ER discusses radioactive solid waste management. The NRC staff summarizes that information below and incorporates the information in the CEG ER, Section 2.2.6.3 (CEG 2024-TN10806: pp. 2-13 to 2-14), herein by reference. Solid radioactive wastes are logged, processed, packaged, and stored for subsequent shipment and offsite burial. Solid radioactive wastes and potentially radioactive wastes include reactor components, equipment, and tools removed from service; chemical laboratory samples; spent resins; used filter cartridges; and radioactively contaminated hardware, as well as compacted wastes such as contaminated protective clothing, paper, rags, and other trash generated from plant design modifications and operations and routine maintenance activities. In addition, nonfuel radioactive solid wastes result from treating and separating radionuclides from gases and liquids and from removing contaminated material from various reactor areas. The waste is divided into two categories: (1) dry active waste and (2) wet active waste. Low-Level Radioactive Waste (LLRW) is classified as Class A, Class B, Class C, or greater than Class C. Class A includes both dry active waste and processed waste (e.g., dewatered resins). Classes B and C normally include processed waste and irradiated hardware. The majority of LLRW generated at CPS is Class A waste. Classes B and C wastes constitute a low percentage by volume of the total LLRW generated. Radioactive waste that is greater than Class C waste is the responsibility of the Federal government. Low-level mixed waste is managed and transported to the facility with which CEG has contracts.

CEG has contracts with Energy Solutions and Waste Control Specialists for the processing and disposal of all radiologically contaminated material from CPS. CEG has previously, within the last 5 years, held a contract with Perma-Fix (CEG 2024-TN10806). Routine plant operation, refueling outages, and maintenance activities that generate radioactive solid waste would continue during the LR term. Radioactive solid waste is expected to be generated and shipped off site for disposal during the LR term. As discussed during the audit, there are no plans to change the radioactive solid waste disposal program during the LR term (CEG 2024-TN10806).

3.13.1.4 Radioactive Waste Storage

As indicated in CEG's ER and discussed with the NRC staff at the virtual audit, CPS has sufficient existing capability to store all generated LLRW onsite (CEG 2024-TN10806, CEG 2024-TN10914). CPS does not currently generate or store mixed waste on site. No additional construction of onsite storage facilities would be necessary for LLRW or mixed waste storage during the proposed LR term. As CEG confirmed during the audit, there are no proposed changes to the solid waste storage program during the LR term (CEG 2024-TN10914).

CEG stores spent fuel in the spent fuel pool and in an onsite ISFSI. The ISFSI safely stores spent fuel onsite in licensed and approved dry cask storage containers. Spent fuel is stored in the ISFSI under a general license. Section 2.2.6.4 of the ER anticipates that the ISFSI may need to be expanded during the LR period of extended operation if the DOE has not taken ownership of the spent nuclear fuel prior to the ISFSI reaching capacity (CEG 2024-TN10806). As confirmed during the audit, it is expected that there is enough previously disturbed land area available for this expansion within the site boundary on previously disturbed land adjacent or almost adjacent to the ISFSI (e.g., to the southeast of the current ISFSI) (CEG 2024-TN10914). The NRC staff understands that CEG is allowed under a 10 CFR Part 72 (TN4884) general license as part of its 10 CFR Part 50 (TN249) licenses to build ISFSI capacity as necessary (see 10 CFR Part 72-TN4884).

CEG confirms that it will ensure that there will be adequate spent fuel storage to safely accommodate spent fuel onsite for the current license term and during the proposed LR term.

The impacts of onsite storage of spent nuclear fuel during the LR term is a Category 1 issue and has been determined to be SMALL at all plants, as stated in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN10253). For the period after the licensed life for reactor operations, the impacts of onsite storage of spent nuclear fuel during the continued storage period are discussed in NUREG-2157 (NRC 2014-TN4117) and as stated in 10 CFR 51.23(b), shall be deemed incorporated into this issue.

As confirmed during the audit, there are no proposed changes or upgrades to the solid waste processing system program being considered for the LR term. Also as confirmed during the audit, there is no greater-than-Class C waste currently stored onsite and there is adequate storage between the ISFSI, LLRW storage capacity, and spent fuel pools to safely store the greater-than-Class C waste likely to be generated during the LR term, accounting for the needed capacity for the spent nuclear fuel generated through the LR term (CEG 2024-TN10914).

3.13.1.5 Radiological Environmental Monitoring Program

CEG maintains a REMP to assess the radiological impact, if any, to the public and the environment from CPS operations. The REMP measures the aquatic, terrestrial, and atmospheric environment for ambient radiation and radioactivity. Monitoring is conducted for the following: direct radiation, air, precipitation, well water, river water, surface water, milk, food products and vegetation (such as edible broad leaf vegetation), fish, silt, and shoreline sediment. The REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). As part of the REMP, CEG conducts analyses of selected wells for the presence of gamma emitters and tritium in groundwater on a quarterly basis (CEG 2024-TN10806).

The NRC staff reviewed 5 years of annual radiological environmental monitoring data from 2019 through 2023 (Exelon 2020-TN10997, Exelon 2021-TN10999; CEG 2022-TN11000, CEG 2023-TN11001, CEG 2024-TN11002). A 5-year period provides a dataset that covers a broad range of activities that occur at a nuclear power plant, such as refueling outages, routine operation, and maintenance that can affect the generation and release of radioactive effluents into the environment. The NRC staff reviewed the data for indications of adverse trends (i.e., increasing dose levels or increasing radioactivity levels) over the period of 2019 through 2023.

In addition to the REMP, CEG established an onsite groundwater protection initiative program in accordance with NEI 07-07, “Industry Groundwater Protection Initiative” (NEI 2007-TN1913). This program monitors the onsite nuclear power plant environment to detect leaks from nuclear power plant systems and pipes containing radioactive liquid. Section 3.5.2.2.1 of this SEIS contains information on CPS’ onsite groundwater protection initiative program. CEG performs groundwater monitoring from a network of groundwater monitoring wells, indoor and outdoor piezometers, and manholes to monitor for potential radioactive releases to groundwater, environmental conditions, and groundwater elevation in accordance with site procedures as described in Section 3.6.2.4 of CEG’s ER (CEG 2024-TN10806).

Based on its review of the REMP and inadvertent release data, the NRC staff finds no apparent increasing trend in concentration or pattern indicating persistently high tritium or other radionuclide concentrations that might indicate an ongoing inadvertent release from CPS. The groundwater monitoring program data at CPS show that CEG monitors, characterizes, and actively remediates spills, and that there were no significant radiological impacts to the environment from operations at CPS.

3.13.2 Nonradioactive Waste

CPS generates nonradioactive waste from nuclear power plant maintenance, cleaning, and operational processes. CPS manages nonradioactive wastes in accordance with applicable Federal and State regulations, as implemented through its corporate procedures. CPS generates and manages hazardous wastes, nonhazardous wastes, and universal wastes. CEG maintains a list of waste vendors that it has approved for use across the entire company to remove and dispose of the nonradioactive wastes offsite. CEG maintains a list of approved waste vendors used to manage and dispose of hazardous, nonhazardous, and recyclable waste (CEG 2024-TN10806).

Waste minimization and pollution prevention are important elements of operations at all nuclear power plants. Licensees are required to consider pollution prevention measures as dictated by the Pollution Prevention Act (Public Law 101 5084-TN6607) and the Resource Conservation and Recovery Act of 1976, as amended (Public Law 94 580-TN1281).

The Resource Conservation and Recovery Act governs the disposal of solid waste. The IEPA Bureau of Land Permit Section is authorized by the EPA to implement the Resource Conservation and Recovery Act and regulate solid and hazardous waste in Illinois (CEG 2024-TN10806). Clinton has a nonradioactive waste management program to handle nonradioactive waste in accordance with Federal, State, and corporate regulations and procedures. CPS maintains a waste minimization program that uses material control, process control, waste management, recycling, and feedback to reduce waste.

CPS' SWPPP identifies potential sources of pollution that may affect the quality of stormwater discharges from permitted outfalls. The SWPPP also describes BMPs for reducing pollutants in stormwater discharges and assuring compliance with the site's NPDES permit (CEG 2024-TN10806).

CPS also has an environmental management system (CEG 2024-TN10806). Procedures are in place to monitor areas within the site that have the potential to discharge oil into or on navigable waters, in accordance with the regulations in 40 CFR Part 112, "Oil Pollution Prevention" (TN1041). The Pollution Incident/Hazardous Substance Spill Procedure identifies and describes the procedures, materials, equipment, and facilities that CEG uses to minimize the frequency and severity of oil spills at CPS.

CPS is subject to the EPA reporting requirements in 40 CFR Part 110, "Discharge of Oil," under CWA Section 311(b)(4) (TN8485). Under these regulations, CPS must report to the EPA's National Response Center any discharges of oil if the quantity may be harmful to the public health or welfare or to the environment. Based on the NRC staff's review of Section 9.5.3.6 of the CEG's ER (CEG 2024-TN10806) and a review of records from 2018 to 2022, there have been no releases at CPS that have triggered this notification requirement (CEG 2024-TN10806) during that time period. In addition, CEG confirmed that there have been no reportable spills under the provisions of 40 CFR Part 110 in from 2018 through when the NRC staff's audit took place in August 2024 (CEG 2024-TN10914).

CPS is subject to the reporting provisions of 40 CFR 262.34(d)(5)(iv)(C) (TN5492) as it relates to a fire, explosion, or other release of hazardous waste that could threaten human health outside the facility boundary or when the facility has knowledge that a spill has reached a surface water. Any such event must be reported to the EPA's National Response Center. Based on the NRC staff's review of Section 9.5.13.2 of CEG's ER and of records from 2019–2023,

there have been no releases at CPS during that time that triggered this notification requirement (CEG 2024-TN10806). In addition, the applicant confirmed that there have been no inadvertent releases or spills at CPS that would trigger the notification requirement from when the ER was developed through the NRC staff audit in August 2024 (CEG 2024-TN10914).

There has been one spill of nonradioactive material since the ER was written (40 percent sodium bisulfite) which was discovered on September 18, 2023. The cause of the spill was traced to a burst pipe and approximately 1,450 to 3,390 gallons of material were released. The spill occurred in the flume detox building, on a concrete pad; however, the nonradioactive material flowed to the surrounding area which included a dirt surface and the discharge flume. The Illinois Emergency Management Agency and Office Homeland Security was notified of the spill 11 minutes after discovery (IEMA 2023-TN11155). The immediate response included: confirmation that associated pumps were no longer active, removal of non-essential personnel from the area, ventilation of the area, and use of absorbent to contain the material. Subsequently, the top layer of affected soil was removed, and the area was rinsed. All soil and wash water were collected for proper disposal. Five soil samples were collected in the affected area to confirm no remaining soil intrusion. The secondary response included a repair of pipe/connections, replacement pumps (as needed), and a leak check to ensure the issue was corrected. On September 22, 2023, a 5 day follow up report concerning this incident was delivered to the Illinois Emergency Management Agency detailing the status of the recommended actions, which were followed. The event is documented and actions to eliminate or prevent reoccurrence are tracked in CEG's Corrective Action Program. As discussed during the audit, the site took corrective actions in response to this event. These actions include repairing the piping connections and replacing pumps as necessary. A Post Maintenance Test leak check of piping will be performed prior to use to ensure the leak has been corrected (CEG 2024-TN10914). This spill is discussed further in Section 3.5.1.3.1 of this SEIS on surface water quality.

3.13.3 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, for generic issues related to waste management, the impacts of nuclear power plant LR and continued operations would be SMALL during the LR term for the issues of LLRW storage and disposal, onsite storage of spent nuclear fuel, mixed waste storage and disposal, and nonradioactive waste storage and disposal. For the period after the licensed life for reactor operations, the impacts of onsite storage of spent nuclear fuel during the continued storage period are discussed in NUREG-2157 (NRC 2014-TN4117) and as stated in 10 CFR 51.23(b) (TN10253), shall be deemed incorporated into this SEIS. The NRC staff's review did not identify any new and significant information that would change the conclusions in the LR GEIS. Thus, as concluded in the LR GEIS, for these Category 1 (generic) issues, the impacts of continued operation on waste management during the LR term would be SMALL. The ultimate disposal of spent fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this review. Per Appendix B to Subpart A of 10 CFR Part 51 (TN10253), the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants. There are no plant-specific (Category 2) waste management issues applicable to CPS (Table 3-2 of this SEIS).

3.13.4 No-Action Alternative

Under the no-action alternative, CPS would cease operation at the end of the term of the current license or sooner and enter decommissioning. After entering decommissioning, the plant would generate less spent nuclear fuel, emit fewer gaseous and liquid radioactive effluents into the environment, and generate less low-level radioactive and nonradioactive waste. In addition, after shutdown, the variety of potential accidents at the plant (radiological and industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. Therefore, as radioactive emissions to the environment decrease, and the likelihood and variety of accidents decrease after shutdown and decommissioning, the NRC staff concludes that impacts resulting from waste management for the no-action alternative would be SMALL.

3.13.5 Replacement Power Alternatives: Common Impacts

The LR GEIS in Appendix D, Section D.4.10 provides types of wastes routinely associated with the construction and operation of replacement power alternatives (NRC 2024-TN10161). The NRC staff summarizes that information below and incorporates the information in NUREG-1437, Revision 2, Appendix D, Section D.4.10 (NRC 2024-TN10161: p. D-38 and p. D-40), herein by reference.

Construction

Impacts would be from construction-related nonradiological debris. Materials and wastes would be accumulated onsite and disposed of or recycled through licensed offsite disposal and treatment facilities (NRC 2024-TN10161).

Operations

Solid wastes would be generated throughout the period of plant operations. Most facilities produce small amounts of industrial solid wastes associated with onsite maintenance of equipment and infrastructure. Such wastes could include used oils, used glycol-based antifreeze, waste lead-acid storage batteries, spent cleaning solvents, and excess corrosion control coatings, requiring proper characterization and disposal. The LR GEIS in Appendix D, Section D.4.10 provides types of wastes routinely associated with the maintenance of mechanical and electrical equipment (NRC 2024-TN10161).

3.13.6 Natural Gas Alternative

As discussed in Section 2.3.2.1 of this SEIS, the natural gas alternative would consist of construction of a new natural gas combined cycle plant with a design capacity of 1,241 Mwe (gross)/1,080 MWe (assuming an 87 percent capacity factor) constructed at the CPS site.

Impacts from the waste generated during the construction of the NGCC plant would include those identified in Section 3.13.5 of this SEIS as common to all replacement power alternatives.

Waste generation from operation of the natural gas technology would be minimal. The only significant waste generated at a NGCC plant would be spent selective catalytic reduction catalyst (plants use selective catalytic reduction catalyst to control nitrogen oxide emissions). This spent catalyst is considered hazardous and would be disposed of at a facility that handles hazardous materials. Other than the spent selective catalytic reduction catalyst, waste generation at an operating natural gas-fired plant would be limited largely to typical operations

and maintenance of nonhazardous waste. Based on this information, the NRC staff concludes that the waste impacts for the natural gas alternative would be SMALL.

3.13.7 Renewable and Natural Gas Combination Alternative

As discussed in Section 2.3.2.2 of this SEIS, the renewable and natural gas combination alternative would consist of an NGCC plant, wind energy installations, and solar panel installations.

Impacts from the waste generated during the construction and operation of the renewables combination alternative would include those identified in Section 3.13.5 of this SEIS as being common to all replacement power alternatives.

The construction and operation of the solar PV facilities would create sanitary and industrial waste. This waste could be recycled or shipped to an offsite waste disposal facility. All the waste would be handled in accordance with appropriate Illinois regulations. Therefore, the NRC staff concludes that the waste management impacts resulting from the construction and operation of the PV facilities would be SMALL.

During construction of onshore wind facilities as part of the combination alternative, waste materials or the accidental release of fuels are expected to be negligible because of the very limited amount of traffic and construction activity that might occur with construction, installation, operation, and decommissioning of onshore turbine generators. Therefore, the waste management impacts resulting from the construction and operation of the onshore wind portion would be SMALL.

3.13.8 Purchased Power Alternative

Purchased power would come from existing energy generating facilities. Waste material generated at these facilities would be managed in accordance with existing contracts, permits, approvals, and/or disposal agreements. Therefore, based on this information and depending on the types of energy sources used to provide the purchased electricity, waste management impacts would likely be SMALL.

3.14 Evaluation of New and Significant Information

As stated in Section 1.4 of this SEIS, for Category 1 (generic) issues, the NRC staff can rely on the analysis in the LR GEIS (NRC 2024-TN10161) unless otherwise noted. Table 3-1 of this SEIS lists the Category 1 issues that apply to CPS during the proposed LR term. For these issues, the NRC staff did not identify any new and significant information based on its review of the applicant's ER (CEG 2024-TN10806), the environmental site audits, the review of available information as cited in this SEIS, or arising through the environmental scoping process, that would change the conclusions presented in the LR GEIS.

New and significant information must be new, based on a review of the LR GEIS (NRC 2024-TN10161), as codified in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN10253). Such information must also bear on the proposed action or its impacts, presenting a seriously different picture of the impacts from those envisioned in the LR GEIS (i.e., impacts of greater severity than impacts considered in the LR GEIS, considering their intensity and context).

The NRC defines new and significant information in Regulatory Guide 4.2, Supplement 1, Revision 2 "*Preparation of Environmental Reports for Nuclear Power Plant License Renewal*

Applications" (NRC 2024-TN10280), as (1) information that identifies a significant environmental issue that was not considered or addressed in the LR GEIS and, consequently, not codified in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN10253), or (2) information not considered in the assessment of impacts evaluated in the LR GEIS leading to a seriously different picture of the environmental consequences of the action than previously considered, such as an environmental impact finding different from that codified in Table B-1. Further, a significant environmental issue includes, but is not limited to, any new activity or aspect associated with the nuclear power plant that can act upon the environment in a manner or an intensity not previously recognized or quantified.

In accordance with 10 CFR 51.53(c) (TN10253), the applicant's ER must analyze the Category 2 (plant-specific) issues in Table B-1 in 10 CFR Part 51, Subpart A, Appendix B. Additionally, the applicant's ER must discuss actions to mitigate any adverse impacts associated with the proposed action and environmental impacts of alternatives to the proposed action. In accordance with 10 CFR 51.53(c)(3), the applicant's ER does not need to analyze any Category 1 issue unless there is new and significant information about a specific issue.

NUREG-1555, Supplement 1, Revision 2, "*Standard Review Plans for Environmental Reviews for Nuclear Power Plants for Operating License Renewal*," describes the NRC process for identifying new and significant information (NRC 2024-TN10251). The search for new information includes, but is not limited to:

- review of an applicant's ER (CEG 2024-TN10806) and the process for discovering and evaluating the significance of new information
- review of public comments
- review of environmental quality standards and regulations
- coordination with Federal, State, Tribal, and local environmental protection and resource agencies
- review of technical literature as documented through this SEIS

New information that the NRC staff discovers is evaluated for significance using the criteria set forth in the LR GEIS. For Category 1 issues for which new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to assessment of the relevant new and significant information; the scope of the assessment does not include other facets of an issue that the new information does not affect.

The NRC staff reviewed the discussion of environmental impacts associated with operation during the renewal term in the LR GEIS and conducted its own independent review, including a public involvement process (e.g., public meetings and public comments) to identify new and significant issues for the CPS LRA environmental review. The assessment of new and significant information for each resource is addressed within each resource area discussion.

3.15 Impacts Common to All Alternatives

This section describes the impacts that the NRC staff considers common to all alternatives discussed in this SEIS, including the proposed action and replacement power alternatives. In addition, the following sections discuss the fuel cycles of the proposed action and replacement power alternatives, the termination and decommissioning of nuclear power plant operations and potential replacement power facilities, and GHG emissions and climate change.

3.15.1 Fuel Cycle

This section describes the environmental impacts associated with the fuel cycles of both the proposed action (uranium fuel cycle) and all replacement power alternatives that are analyzed in detail in this SEIS.

3.15.1.1 Uranium Fuel Cycle

The uranium fuel cycle consists of 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. Impacts to the uranium fuel cycle are evaluated in the LR GEIS (NRC 2024-TN10161) and are considered to be generic (the same or similar at all plants), or Category 1. Section 4.14.1 of the LR GEIS describes in detail the generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes (NRC 2024-TN10161). The NRC staff incorporates the information in the LR GEIS Section 4.14.1 (NRC 2024-TN10161: pp. 4-150 through 4-164) herein by reference. The LR GEIS does not identify any plant-specific (Category 2) uranium fuel cycle issues.

As explained in the LR GEIS (NRC 2024-TN10161) and indicated in Table 3-1 of this SEIS, the generic issues related to the uranium fuel cycle would not be affected by continued operations associated with LR. The NRC staff identified no new and significant information for these issues. Thus, as concluded in the LR GEIS, the impacts of generic issues related to the uranium fuel cycle would be SMALL for the proposed CPS LR.

3.15.1.2 Replacement Power Alternatives Fuel Cycles

3.15.1.2.1 Natural Gas Alternative

Fuel cycle impacts for an NGCC power plant result from the transport of fuel to the facility, and management and ultimate disposal of any wastes from fuel combustion. These impacts are discussed in more detail in Appendix D, Section D.4.12.1 of the LR GEIS (NRC 2024-TN10161) and can generally include the following: significant changes to land use and visual resources; impacts on air quality, including release of criteria pollutants, volatile organic compounds, and methane into the atmosphere; noise impacts; ecological impacts, and historic and cultural resource impacts within the pipeline footprint associated with the supply of the fuel; socioeconomic impacts from employment of workforce and service and support industries; health impacts on workers from exposure to airborne emissions such as methane gases; and generation of other industrial wastes.

3.15.1.2.2 Renewable and Natural Gas Combination Alternative

As stated in Appendix D, Section D.4.12.3 of the LR GEIS (NRC 2024-TN10161) (under “Renewable Alternatives”), the fuel cycles for renewable technologies such as wind and solar are difficult to define. This is because the associated natural resources exist regardless of any effort to harvest them for electricity production. Impacts from the presence or absence of these renewable energy technologies are often difficult to determine (NRC 2024-TN10161).

3.15.1.2.3 Purchased Power Alternative

The environmental impacts from fuel cycles for the purchased power alternative are dependent on the type of power purchased. The preceding sections describe impacts from fuel cycles for power generated from nuclear, fossil fuel power, and renewable sources. Potential environmental impacts associated with purchased power would include those associated with the source of the generation and the transmission of the power into the regional grid. The impacts of a purchased power alternative are further described in Appendix D, Section D.3.4.3 of the LR GEIS (NRC 2024-TN10161)

3.15.2 Terminating Power Plant Operations and Decommissioning

This section describes the environmental impacts of the CPS LR associated with the termination of operations and the decommissioning of a nuclear power plant and replacement power alternatives. All operating nuclear power plants will terminate operations and be decommissioned at some point after the end of their operating life or after a decision is made to cease operations. The proposed action would delay this eventuality for an additional 20 years beyond the current license term.

3.15.2.1 Existing Nuclear Power Plant

The decommissioning process begins when a licensee informs the NRC that it has permanently ceased reactor operations, defueled, and intends to decommission the nuclear plant. The licensee may also notify the NRC of the permanent cessation of reactor operations prior to the end of the license term. Consequently, most nuclear plant activities and systems dedicated to reactor operations would cease after reactor shutdown. The environmental impacts of decommissioning a nuclear power plant are evaluated in NUREG-0586, *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (NRC 2002-TN665). Additionally, Section 4.14.2.1 of the LR GEIS (NRC 2024-TN10161) summarizes the incremental environmental impacts associated with nuclear power plant decommissioning activities. As listed in Table 3-1, there is one Category 1 issue for the “Termination of power plant operations and decommissioning,” applicable to CPS decommissioning. The LR GEIS (NRC 2024-TN10161) did not identify any plant-specific (Category 2) decommissioning issue.

3.15.2.2 Replacement Power Facilities

3.15.2.2.1 Natural Gas Alternative

The environmental impacts from the termination of power plant operations and the decommissioning of a power generating facility are dependent on the facility’s decommissioning plan. Decommissioning plans generally outline the actions needed to restore the site to a condition equivalent in character and value to the site on which the facility was first constructed. General elements and requirements for a thermoelectric power plant decommissioning plan can include the removal of structures below grade, the removal of all accumulated waste materials, the removal of intake and discharge structures, and the cleanup and remediation of incidental spills and leaks at the facility.

The environmental consequences of decommissioning can generally include the following:

- short-term impacts on air quality and noise from the deconstruction of facility structures
- short-term impacts on land use and visual resources
- long-term reestablishment of vegetation and wildlife communities
- socioeconomic impacts caused by decommissioning the workforce and the long-term loss of jobs
- elimination of health and safety impacts on operating personnel and the public

These impacts are representative of those associated with decommissioning any thermoelectric power generating facility. Activities that are unique to the termination of operations and the decommissioning of a power generating facility include the safe removal of the facility from service, the reduction of residual fuel and wastes to a level that permits the release of the property under restricted conditions or unrestricted use, and the termination of the license.

3.15.2.2.2 Renewable and Natural Gas Combination Alternative

The environmental impacts from termination of power plant operations and decommissioning for the natural gas component of the combination alternative are described in Section 3.15.2.2.1 above. The decommissioning of renewable energy facilities would generally result in similar types of activities and environmental impacts. Decommissioning would involve the removal of facility components and any operational wastes and residues, if present, to restore sites to a condition equivalent in character and value to the site on which the facility was first constructed. In other circumstances, supporting infrastructure (e.g., buried utilities and pipelines) could be abandoned in place (NRC 2024-TN10161). The range of possible decommissioning considerations and impacts, depending on the renewable energy alternative considered, are discussed in Appendix D, Section D.4.13.3 of the LR GEIS (NRC 2024-TN10161). The NRC staff incorporates the information in the LR GEIS, Appendix D, Section D.4.13.3 (NRC 2024-TN10161: pp. D-45 and D-46), herein by reference.

Purchased Power Alternative

The termination of power plant operation and decommissioning for purchased power would generally be similar to the activities and impacts discussed above for the replacement power plants.

3.15.3 Greenhouse Gas Emissions and Climate Change

The following sections discuss GHG emissions and climate change impacts. Section 3.15.3.1 below evaluates the GHG emissions associated with operation of CPS and replacement power alternatives. Section 3.15.3.2 below discusses the observed changes in climate, potential future climate change during the LR term based on climate model simulations under future global GHG emissions scenarios, and the potential impacts of climate change on environmental resources.

3.15.3.1 Greenhouse Gas Emissions from the Proposed Action and Alternatives

Gases found in the Earth's atmosphere that trap heat and play a role in the Earth's climate are collectively termed greenhouse gases, or GHGs. These GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor, and fluorinated gases, such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The Earth's climate responds to changes in concentrations of GHGs in the atmosphere because these gases affect the amount of energy absorbed and heat trapped by the atmosphere. Increasing concentrations of GHGs in the atmosphere generally increase the Earth's surface temperature. Atmospheric concentrations of CO_2, CH_4, and N_2O have significantly increased since 1750 (IPCC 2013-TN7434, IPCC 2021-TN7435).

Long-lived GHGs—CO_2, CH_4, N_2O, and fluorinated gases—are well mixed throughout the Earth's atmosphere, and their impact on climate is long-lasting and cumulative in nature as a result of their long atmospheric lifetimes (EPA 2016-TN7561). Therefore, the extent and nature of climate change is not specific to where GHGs are emitted. CO_2 is of primary concern for global climate change because it is the primary gas emitted as a result of human activities. In 2019, global net GHG emissions were estimated to be 59 ± 6.6 gigatons of CO_2 equivalent (CO_2eq), with the largest share in gross GHG emissions being CO_2 from fossil fuels combustion and industrial processes (IPCC 2023-TN8557). In 2019, atmospheric concentrations of CO_2 (measured at 410 parts per million) were higher than any time in at least 2 million years (IPCC 2023-TN8557).

The sixth assessment synthesis report from the Intergovernmental Panel on Climate Change (IPCC) states that "[i]t is unequivocal that human influence has warmed the atmosphere, ocean, and land" (IPCC 2023-TN8557).

The operation of CPS results in direct and indirect GHG emissions. CEG provided calculated direct (i.e., stationary and portable combustion sources) and indirect (i.e., workforce commuting and purchased electricity) GHG emissions, which are provided in Table 3-29 below. CEG does not maintain an inventory of GHG emissions resulting from visitors and delivery vehicles. Fluorinated gas emissions from refrigerant sources and from electrical transmission and distribution systems can result from leakage, servicing, repair, or disposal of sources. In addition to being GHGs, chlorofluorocarbons and hydrochlorofluorocarbons are ozone-depleting substances that are regulated by the CAA under Title VI, "Stratospheric Ozone Protection." Direct emission sources at CPS include: (1) onsite combustion sources (e.g., diesel generators); (2) sulfur hexafluoride used for main condenser tube testing, main control room tracer testing, and circuit breakers; (3) process carbon dioxide used in the emergency diesel generator fire suppression system, main generator hydrogen displacement during outages to remove hydrogen, and for hydrogen and water chemistry piping repairs; and (4) fugitive hydrofluorocarbon and perfluorocarbons refrigerants and ozone depleting chemical refrigerants. CEG has procedures and training for performing sulfur hexafluoride leak testing and the pressure in the breakers is monitored. CEG has a program in place at CPS to manage the station refrigeration appliances for the management of ozone depleting substances. CPS is in compliance with the requirements established in Sections 608 of the CAA and 40 CFR, Part 82, Subpart F and Subpart H. Section 608 of the CAA (40 CFR Part 82-TN10849) prohibits the intentional venting of ozone-depleting substances while maintaining, servicing, repairing or disposing of air conditioning or refrigeration equipment.

Table 3-29 Annual Greenhouse Gas Emissions from Operations at Clinton Power Station[a]

Emission Source	2019	2020	2021	2022	2023
Direct Emissions[b]	4,785[c]	6,170[c]	1,375	1,820	1,300
Purchased Electricity	50	55	50	65	NA
Workforce Commuting[d]	2,730	2,730	2,730	2,730	2,730
Total	**7,565**	**8,955**	**4,155**	**4,620**	**4,030**

CO_2 = carbon dioxide; CO_2eg = carbon dioxide equivalent(s); CPS = Clinton Power Station; EPA = U.S. Environmental Protection Agency; GHG = greenhouse gas; GWP = global warming potential; NA = not available; USCB = U.S. Census Bureau.

(a) GHG emissions were reported in metric tons and converted to tons. All reported values are rounded. Expressed in CO_2eq, a metric used to compare the emissions of GHGs based on their GWP. The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs over a period of time compared to CO_2. CO_2eq is obtained by multiplying the amount of the GHG by the associated GWP.

(b) Includes all emissions from CPS including stationary combustion sources, sulfur hexafluoride, process CO_2, and refrigerants.

(c) Elevated direct emissions in 2019 and 2020 were due to fugitive emissions of R-134a, a synthetic hydrofluorocarbon refrigerant, resulting from a problem with the plant chilled water system. This problem was resolved and documented as part of the CPS corrective action program.

(d) Workforce commuting calculations are based on:

i. Statistical information for carpooling rates from the USCB for workers in the Transportation and Warehouse and Utilities Industry were used for the State of Illinois, and Champaign, DeWitt, Macon, and McClean counties to compute a weighted average carpool rate for the Clinton workforce of 6.5% (USCB 2020-TN11070). The number of CPS employees as of September 2022 was 596.

ii. Based on the EPA's Greenhouse Gas Equivalencies Calculator, the CO_2e/year to be 2,474 metric tons (2,730 tons) for 577 vehicles (EPA 2024-TN11096).

3.15.3.1.1 Proposed Action

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-1 of this SEIS, the GHG impacts on climate change continued operations would be SMALL. The NRC staff did not identify any new and significant information that would change the conclusion in the LR GEIS. GHG emissions from routine operations at CPS include diesel engines, refrigeration systems, leak testing, as well as mobile sources and are minor. CEG does not anticipate future upgrades or replacement activities of emission sources during the LR term to support plant operation that could result in a significant increase in GHG emissions. Thus, as concluded in the LR GEIS, for the "Greenhouse Gas Impacts on Climate Change" generic issue, the impacts of continued operation of CPS on climate change would be SMALL.

3.15.3.1.2 No-Action Alternative

Under the no-action alternative, the NRC would not renew the CPS operating license and CPS would permanently shut down on or before the expiration of the current license. At some point, all nuclear plants will terminate operations and undergo decommissioning. The decommissioning GEIS (NRC 2002-TN7254) considers the environmental impacts of decommissioning. Therefore, the scope of impacts considered under the no-action alternative includes the immediate impacts resulting from activities at CPS that would occur between plant shutdown and the beginning of decommissioning (i.e., activities and actions necessary to cease operation of CPS). When the facility stops operating, a reduction in GHG emissions from activities related to plant operation, such as the use of diesel engines and employee vehicles would occur. The NRC staff anticipates that GHG emissions for the no-action alternative would be less than those presented in Table 3-29 above, which shows the estimated direct GHG

emissions from operation of CPS. Therefore, the NRC staff concludes that the impacts of the no-action alternative on climate change would be SMALL.

3.15.3.1.3 Natural Gas Alternative

The natural gas alternative would have a design capacity of 1,241 MWe and 87 percent capacity factor. The 2013 LR GEIS (NRC 2013-TN2654) presents life-cycle (e.g., material production, system and plant component manufacturing, installation) GHG emissions associated with natural gas power generation. Life-cycle GHG emissions from natural gas power generation can range from 120 to 930 grams of carbon equivalent per kilowatt hour. The GHG emission sources during construction would be similar to construction of an industrial facility and include construction equipment, engine exhaust, and workforce commuting. Applying emission factors developed by the DOE's NETL (NETL 2022-TN10530), the NRC staff estimates that operation of the natural gas alternative with a design capacity of 1,241 MWe would emit 4.0 million tons (3.7 million metric tons) of CO_2eq.

As can be seen in Table 3-30 of this SEIS, if CPS' generating capacity were to be replaced by a natural gas alternative, there would be a significant increase in GHG emissions. Therefore, given the potential for a significant increase in GHG emissions, the NRC staff concludes that the impacts of the natural gas alternative on climate change would be MODERATE.

3.15.3.1.4 Renewable and Natural Gas Combination Alternative

The renewable and natural gas combination alternative would consist of a natural gas combined cycle plant, solar with battery storage, and wind with battery storage. The 2013 LR GEIS (NRC 2013-TN2654) discusses life-cycle GHG emissions associated with natural gas power generation, solar power generation, and wind power generation. Life-cycle GHG emissions from natural gas power generation can range from 120 to 930 grams of carbon equivalent per kilowatt hour, from solar power can range from 5 to 217 grams of carbon equivalent per kilowatt hour, and from wind 2 to 81 grams of carbon equivalent per kilowatt hour. The GHG emission sources during construction of the renewables combination alternative would be similar to the construction of an industrial facility and include construction equipment, engine exhaust, and workforce commuting. The GHG emissions from construction of the renewables combination alternative would depend on the construction duration and equipment usage of each component (i.e., wind, solar, natural gas). For instance, facility construction is responsible for 24 percent of wind life-cycle emissions and 19 percent of solar PV life-cycle emission (Nugent and Sovacool 2014-TN10630). The GHG emissions associated with operation of the combination alternative would primarily be from the natural gas portion. Direct GHG emissions associated with operation of the solar with battery storage and wind with battery storage portions of this alternative are negligible because no fossil fuel is burned to generate electricity. Applying emission factors developed by the DOE's NETL (NETL 2022-TN10530), the NRC staff estimates that emissions from the operation of a 1,000 MWe NGCC plant would emit 3.2 million tons (2.9 million metric tons) of CO_2eq per year. As can be seen from Table 3-30 in this SEIS, if CPS' generating capacity were to be replaced by the combination alternative, there would be a significant increase in GHG emissions. Therefore, given the potential for a significant increase in GHG emissions, the NRC staff concludes that the impacts of natural alternative on climate change would be MODERATE.

3.15.3.1.5 Purchased Power Alternative

The purchased power alternative involves importing power into the CPS service area from multiple existing, operating energy generating sources (e.g., nuclear, natural gas-fire, solar, and wind energy). Since purchased power would be from existing sources, there would be no GHG emissions associated with construction of new facilities. Using the 2023 EIA State of Illinois (EIA 2023-TN11156) electricity mix profile emission factors and CPS' 2023 generation (8,101,628 megawatt-hours), the NRC staff estimates that the purchased power alternative would emit up to 2.2 million tons (1.9 million MT) of CO_2eq (see Table 3-30). However, this estimate is bounding in that it considers a mix of energy sources. Illinois' Public Act 102-0062 (PA 102-0662) commits to reduce GHG emissions to zero from electricity generating units by 2045. As power generation from renewable energy sources increases and technology to achieve zero emissions is implemented to existing units, GHG emissions would decrease over time to zero. If CPS' generating capacity were to be replaced by the purchased power alternative, there initially could be a significant increase in GHG emissions. However, over time GHG emissions from the purchased power alternative would be zero. Therefore, the NRC staff concludes that the impacts from the purchased power alternative would be SMALL to MODERATE.

Table 3-30 Direct Greenhouse Gas Emissions from Facility Operations Under the Proposed Action and Alternatives

Technology/Alternative	CO_2eq (tons per year)[(a)]
Proposed Action[(b)]	6,170
No-Action Alternative[(c)]	<6,170
Natural Gas Alternative[(d)]	3.5 million
Renewable and Natural Gas Combination Alternative[(d)]	2.8 million
Purchased Power Alternative[(e)]	0–2.2 million

CO_2 = carbon dioxide; CO_2eq = carbon dioxide equivalent; EIA = Energy Information Administration; GHG = greenhouse gas; GWP = global warming potential; NETL = National Energy Technology Laboratory.

(a) CO_2eq is a metric used to compare the emissions of GHGs based on their GWP. The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs over a period of time compared to CO_2. CO_2eq is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane emission is equivalent to 21 tons of CO_2 emissions.

(b) The GHG emissions include direct emissions from onsite combustion sources at CPS. This is conservatively based on 2020 emissions.

(c) Emissions resulting from activities at CPS that would occur between plant shutdown and the beginning of decommissioning are assumed to be less than GHG emissions from CPS operations.

(d) Natural gas estimates based on emission factor from NETL (2022-TN10530). For the Renewable and Natural Gas Combination Alternative, emissions from the solar and wind with battery portions assumed to be negligible.

(e) Bounding value of 2.2 million tons of CO_2eq based on EIA State of Illinois electricity mix profile emission factors and CPS' 2023 generation (EIA 2023-TN11156). Illinois' Public Act 102-0062 (PA 102-0662) commits to reduce GHG emissions to zero from electricity generating units by 2045. As power generation from renewable energy sources increases and technology to achieve zero emissions is implemented to existing units is implemented, GHG emissions would decrease over time to zero.

3.15.3.2 Climate Change

Climate change is the decades or longer change in climate measurements (e.g., temperature and precipitation) that has been observed on a global, national, and regional level (IPCC 2007-TN7421; EPA 2016-TN7561; USGCRP 2014-TN3472). Globally, the year 2024 was the warmest year on record and the 10 warmest years since 1850 have occurred in the past decade (NOAA 2025-TN11287). Climate change research indicates that the cause of the Earth's

warming over the last 50 to 100 years is due to the buildup of GHGs in the atmosphere resulting from human activities (IPCC 2013-TN7434, IPCC 2021-TN7435, IPCC 2023-TN8557; USGCRP 2014-TN3472, USGCRP 2017-TN5848, USGCRP 2018-TN5847). Climate change can vary regionally, spatially, and seasonally, depending on local, regional, and global factors. Just as regional climate differs throughout the world, the impacts of climate change can vary among locations.

3.15.3.2.1 Observed Trends in Climate Change Indicators

Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2,000 years (IPCC 2023-TN8557). From 2011 through 2020, the global surface temperature was 2°F (1.1°C) warmer than that in the preindustrial period (1850–1900) (IPCC 2023-TN8557). From 1901 to 2023, global precipitation has increased at an average rate of 0.03 in. (0.08 cm) per decade (EPA 2024-TN10205). From 1901 to 2023, average surface temperature across the contiguous United States has increased by 0.17°F (0.09°C) per decade (EPA 2024-TN10205). From 1901 to 2023, total annual precipitation in the contiguous United States has increased at a rate of 0.18 in. (0.4 cm) per decade (EPA 2024-TN10205).

The United States Global Change Research Program (USGCRP) reports that since 1970 the contiguous United States is warming faster than the global average. Since 1970, global temperature has increased by 1.7°F (0.9°C), while average surface temperature in the contiguous United States has increased by 2.5°F (1.4°C) (USGCRP 2023-TN9762). Observed climate change indicators across the United States include increases in the frequency and intensity of heavy precipitation, earlier onset of spring snowmelt and runoff, rise of sea level and increased tidal flooding in coastal areas, an increased occurrence of heat waves, and a decrease in the occurrence of cold waves.

Climate change and its impacts can vary regionally, spatially, and seasonally, depending on local, regional, and global factors. Observed climate changes and impacts have not been uniform across the United States. Annual average temperature data for a greater part of the Midwest region (where CPS is located) between 2002 and 2021 (relative to 1901–1960) exhibit an increase of 0.5°F to 2.0°F (0.28°C to 1.1°C) (USGCRP 2023-TN9762: Figure 2.4). The number of hot days (days at or above 95°F [35°C]) has decreased by 5.6 days, the number of cold days (days at or below 32°F [0°C]) has decreased by 4.9 days, and the number of warm nights (nights at or above 70°F [21°C]) has increased by 0.6 days in the Midwest region from 2002 to 2021 relative to 1901–1960 (USGCRP 2023-TN9762: Figure 2.7). Average annual precipitation from 2002 to 2021 (relative to the 1901–1960 average) for a greater part of the Midwest region has increased by 5–15 percent (USGCRP 2023-TN9762: Figure 2.4). The Midwest region has experienced a 45 percent increase in the number of extreme precipitation days (defined as the top 1 percent of heaviest precipitation events) from 1958 to 2021 (USGCRP 2023-TN9762: Figure 2.8). Long term data (from 1900 to 2022) exhibits wetter conditions for Illinois, with the State having a standardized precipitation evapotranspiration index (SPEI) ranging between +1.5 and +2.5 (USGCRP 2023-TN9762: Figure A4.9). SPEI measures the combination of precipitation and evapotranspiration to determine if an area is experiencing extreme drought (negative SPEI) or extreme moisture (positive SPEI).

The NRC staff used the NOAA “Climate at a Glance” tool to analyze temperature and precipitation trends for the 1895–2024 period in Illinois’ Central Climate Division. A trend analysis shows that the average annual temperature has increased at a rate of 0.2°F (0.1°C) per decade, and average precipitation increased at a rate of 0.37 in. (9.4 mm) per decade (NOAA 2024-TN11157).

3.15.3.2.2 Climate Change Projections

Future global GHG emission concentrations (emission scenarios) and climate models are commonly used to project possible climate change. Climate model simulations often use GHG emission scenarios to represent possible future social, economic, technological, and demographic development that, in turn, drives future emissions. Climate models indicate that over the next decade, warming is very similar across all emission scenarios (USGCRP 2023-TN9762). However, by mid-century (2040–2070), differences between projected temperatures under higher and lower emission scenarios become observable. The impacts of climate change increase with warming, and warming is certain to continue if emissions of CO_2 do not reach net zero (USGCRP 2023-TN9762).

The IPCC has generated various representative concentration pathway (RCP) scenarios commonly used by climate modeling groups to project future climate conditions (IPCC 2000-TN7652, IPCC 2013-TN7434; USGCRP 2017-TN5848, USGCRP 2018-TN5847). In the IPCC Fifth Assessment Report, four RCPs were developed and are based on the predicted changes in radiative forcing (a measure of the influence that a factor, such as GHG emissions, has in changing the global balance of incoming and outgoing energy) in the year 2100, relative to preindustrial conditions. The four RCP scenarios are numbered in accordance with the change in radiative forcing measured in watts per m^2 (i.e., +2.6 [very low], +4.5 [lower], +6.0 [mid-high], and +8.5 [higher]) (USGCRP 2018-TN5847). For example, RCP 2.6 is representative of a mitigation scenario aimed at limiting the increase of global mean temperature to 1.1°F (0.7°C) (IPCC 2014-TN7651). RCP 8.5 reflects a continued increase in global emissions resulting in increased warming by 2100. In the IPCC Working Group contribution to the Sixth Assessment Report, five shared socioeconomic pathways were used along with associated modeling results as the basis for the climate change assessments (IPCC 2021-TN7435). These five socioeconomic pathway scenarios cover a range of GHG pathways and climate change mitigation.

The NRC staff considered the best available climate change studies performed by USGCRP as part of the staff's assessment of potential climate change projections during the Clinton LR term (2025–2045). The Fourth National Climate Assessment relies on the four RCPs in the IPCC Fifth Assessment Report and presents projected climate change categorized by geographic region in the United States (USGCRP 2018-TN5847: Figure 1.1). The Fifth National Climate Assessment (USGCRP 2023-TN9762) uses shared socioeconomic pathways, RCPs, and global warming levels when presenting projected climate change. Global warming levels are used to describe the level of global temperature increase (e.g., 2.7°F or 1.5°C) relative to preindustrial temperature conditions (USGCRP 2023-TN9762). Climate model projections indicate that changes in climate will not be uniform across the United States. The results of these reports are summarized in the following paragraphs.

Regional projections for annual mean temperature are available from the Fourth National Climate Assessment based on the RCP 4.5 and RCP 8.5 scenarios for the midcentury (2036–2065) as compared to the annual mean temperature for 1975–2005. The modeling predicts increases of 4.21–5.29°F (2.3–2.9°C) across the Midwest by midcentury, with higher GHG emission scenarios leading to greater and faster temperature increases (USGCRP 2017-TN5848: Table 6.4). Under the RCP 8.5 scenario, the coldest and warmest extreme temperatures of the year are expected to increase by 9.44 and 6.71°F (5.2 and 3.7°C), respectively, in the Midwest by midcentury (USGCRP 2017-TN5848: Table 6.5).

As for precipitation, climate model simulations suggest small changes in average annual precipitation, with overall increases in average rainfall every season (USGCRP 2017-TN5848: Figure 7.1; EPA 2023-TN8803). Under an intermediate scenario (RCP 4.5), projected changes in annual precipitation by midcentury (2036–2065, relative to 1991–2020) for Illinois indicate primarily an increase ranging from 0.5–2 in. (1.27–5.07 cm) (USGCRP 2023-TN9762: Figure 4.3). USGCRP, however, predicts continued increases in the frequency and intensity of heavy precipitation events across the United States, including across the Midwest. Generally, extreme precipitation events are observed to increase by 6–7 percent for each degree Celsius of temperature increase (USGCRP 2017-TN5848).

3.15.3.2.3 Climate Change Impacts on Environmental Resources

As described in the LR GEIS (NRC 2024-TN10161) and as cited in Table 3-2 of this SEIS, there is a Category 2 issue "Climate change impacts on environmental resources" applicable to CPS. According to the LR GEIS, the impacts of climate change on environmental resources during the LR term are location-specific and cannot be evaluated generically. Changes in climate can have broad implications for certain resource areas. Climate change may impact the affected environment in a way that alters the environmental resources that are impacted by the proposed action (LR). In order for there to be a climate change impact on an environmental resource, the proposed action must have an incremental new, additive, or increased physical effect or impact on the resource or environmental condition beyond what is already occurring. Below, the NRC considers the effects of climate change on environmental resource areas that may also be directly affected by continued operation of CPS during the LR term.

The effects of climate change on CPS structures, systems, and components are outside the scope of this Category 2 issue. The NRC staff's environmental review documents the potential effects of continued nuclear power plant operation on the environment. Site-specific environmental conditions are considered when siting nuclear power plants. This includes the consideration of meteorological and hydrologic siting criteria as set forth in 10 CFR Part 100-TN282. The NRC regulations require that plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions. Further, nuclear power plants are required to operate within technical specifications in accordance with their NRC operating licenses, including coping with natural phenomena hazards. The NRC conducts safety reviews prior to allowing licensees to make operational changes due to changing environmental conditions. Additionally, the NRC evaluates nuclear power plant operating conditions and physical infrastructure to ensure ongoing safe operations under the plant's operating licenses through the NRC's Reactor Oversight Program. If new information about changing environmental conditions (such as rising sea levels that threaten safe operating conditions or challenge compliance with the plant's technical specifications) becomes available, the NRC will evaluate the new information to determine whether any safety-related changes are needed at licensed nuclear power plants. This is a separate and distinct process from the NRC staff's LR environmental review that it conducts in accordance with NEPA.

Air Quality: Climate change can impact air quality as a result of changes in meteorological conditions. Air pollutant concentrations are sensitive to winds, temperature, humidity, and precipitation. Ozone levels and particulate matter have been found to be particularly sensitive to climate change influences. Ozone is formed by the chemical reaction of nitrogen oxides and volatile organic compounds in the presence of heat and sunlight. The emission of ozone precursors also depends on the temperature, wind, and solar radiation (IPCC 2007-TN7421). Warmer temperatures, air stagnation, droughts, and wildfires are favorable conditions for higher

levels of ozone and $PM_{2.5}$ (USGCRP 2023-TN9762 USGCRP reports that there is medium confidence that climate change is projected to worsen air quality in many regions of the United States (USGCRP 2023-TN9762). This is due to the uncertainty in how meteorology will respond to climate change and how these meteorological conditions will in turn change air pollutant concentrations. For instance, while warmer average temperatures are projected to increase seasonal mean daily maximum 8 hour average ozone and $PM_{2.5}$ concentrations, increases in annual average precipitation could decrease $PM_{2.5}$ concentrations (USGCRP 2023-TN9762). Nolte et al. (2018-TN8571) examined the impact of climate change on ozone and $PM_{2.5}$ under RCP 4.5, RCP 6.0, and RCP 8.5 scenarios for 2025–2035 relative to 1995–2005. For the Ohio Valley region (which includes Illinois), increases in spring, autumn, and summer mean maximum daily 8 hour ozone was projected by 2030 under the RCP 4.5 and RCP 8.5, with summer increases under the RCP 8.5 scenario being the most statistically significant. Under the RCP 6.0 scenario, however, a decrease in the spring mean maximum daily 8-hour ozone was projected by 2030. With respect to $PM_{2.5}$, however, concentrations exhibited increases and decreases depending on the scenario considered. Under the RCP 4.5 and RCP 8.5 scenario, Nolte et al. (2018-TN8571) found statistically significant decreases in annual mean concentrations of total $PM_{2.5}$ for the Ohio Valley. Under the RCP 6.0 scenario, however, an increase in annual mean concentrations of total $PM_{2.5}$ was exhibited in the Ohio Valley.

Surface Water Resources: Climatic changes, such as changes in air temperature and precipitation patterns, can affect the availability of water resources (NRC 2024-TN10161). Observational data and climate model projections for Illinois and the broader Midwest region indicate recent and potential future changes to precipitation, runoff, and air temperature that could influence surface water availability and water quality.

Observations of precipitation and air temperature in Illinois over the last 2 decades (2002–2021) compared to the 1901–1960 period show warmer and wetter average conditions with an increase in average annual temperature of 0.5–2°F (0.28–1.11°C) and an increase in annual average precipitation from 5 to greater than 15 percent compared to the historical baseline (USGCRP 2023-TN9762: Figure 2.4). Increases in precipitation have occurred for both winter and summer seasons. Another relevant trend across the broader Midwest region has been a 45 percent increase in extreme precipitation events (top 1 percent of heaviest precipitation events) during the period 1958–2021 (USGCRP 2023-TN9762: Figure 2.8). The frequency and severity of extreme precipitation events are projected to continue across the Midwest region, including Illinois (USGCRP 2023-TN9762: Figure 2.12). Precipitation projections for mid-century (2036–2065) under the intermediate emission scenarios (RCP 4.5) on average show a 0.5–2 in. (1.27–5.08 cm) increase in annual precipitation across Illinois compared to 1991–2020, while the driest 20 percent of RCP 4.5 projections show a 0–2 in. (0–5.08 cm) decrease in precipitation (USGCRP 2023-TN9762: Figure 4.3). Compared to precipitation, averaged projections for runoff show a smaller (0–0.5 in. or 0–1.27 cm) increase over the mid-century period for the RCP 4.5 scenarios, (USGCRP 2023-TN9762: Figure 4.7). Increases in annual precipitation and heavy precipitation can increase runoff and the potential for riverine flooding. Increased runoff and high-flow events can result in the transport of a higher sediment load and other contaminants to surface waters with potential degradation of ambient water quality. The USGRP climate projections suggest an increase in conditions that could temporarily influence water quality (temperature and pollutants) and hazards posed to CPS by flooding, but water availability is less of a concern as annual average precipitation and runoff are projected to increase and excess runoff can be stored in Clinton Lake for use during dry periods, which the USGRP notes could increase in frequency and intensity (USGCRP 2023-TN9762).

Decreases in average precipitation coupled with increases in extreme precipitation, temperatures, and evapotranspiration can result in increased aridity, more frequent droughts, and reduction in the average flow of rivers and streams (USGCRP 2023-TN9762; EPA 2023-TN8803). The USGCRP does not identify aridification as a concern for the Midwest region, however, changes in the amount and timing of precipitation and evapotranspiration could alter the seasonal balance of surface water supply and demand (USGCRP 2023-TN9762: Chapter 2). The Midwest is projected to experience an increase the in number of hot days (≥ 95°F or 35°C) and the number of warm nights (≥70°F or 21.1°C) (USGCRP 2023-TN9762: Figure 2.11), both of which could increase surface water temperature and evaporation. However, recent observations of hot days show a 5.6 day reduction for 2002–2021 compared to 1901–1960 (USGCRP 2023-TN9762: Figure 2.7). Observed monthly cooling water intake temperatures at CPS from 2000 to 2023 (see Figure 3-5 in this SEIS), which are reflective of trends in water temperature of Clinton Lake, display some interannual variability, but do not show any significant trend of increasing intake temperatures over the last two decades.

Regulatory agencies would need to account for changes in water availability in their water resources allocation and environmental permitting programs. Regardless of water use permitting constraints, nuclear power plant operators would have to account for any changes in water temperature in operational practices and procedures.

Aquatic Resources: Changes in water temperature can alter the balance of aquatic ecosystems. Water temperature is an essential physical property of all lakes to which aquatic resources rely on. An increase in annual mean air temperature of 4.21–5.29°F (2.3–2.9°C) across the Midwest by midcentury and an increase in the in number of hot days (≥ 95°F or 35°C) and the number of warm nights (≥70°F or 21.1°C) is projected for the Midwest (USGCRP 2017-TN5848and USGCRP 2023-TN9762). Higher ambient air temperatures can increase surface water temperatures (USGCRP 2023-TN9762). Temperature directly affects water quality. Increased water temperature extends the duration of thermal stratification in lakes, separating them into density layers each year (USGCRP 2014-TN3472). Extending thermal stratification in lakes can eliminate or reduce lake circulation and mixing patterns, resulting in reduced dissolved oxygen which leads to nutrient, heavy metals, and toxin enrichment of the aquatic environment (USGCRP 2014-TN3472). In turn, creating impacts to biodiversity and changes in biological productivity. Nutrient enrichment and warming water temperatures can lead to harmful algal blooms which further reduce dissolved oxygen levels within lakes (EPA 2025-TN11131, EPA 2025-TN11132). Warming water temperatures may also influence the abundance and distribution of both native and invasive species, as well as result in earlier spawning times. Species may migrate or shift their ranges to cooler waters in response to habitat loss from warming waters (Phillips et al. 2018-TN10290). Additionally, warmer water temperatures can increase the time a lake remains ice-free, promoting an increase in evaporation and reduction in water levels further effecting the aquatic environment (EPA 2025-TN11131, EPA 2025-TN11132). CEG's adherence to permit requirements, such as temperature-related criteria established in the NPDES permit and applicable regulations, would minimize the impacts of continued operation of CPS such that continued operations would not further exacerbate climate change-related impacts on the aquatic environment.

3.16 Cumulative Effects of the Proposed Action

Cumulative effects are effects on the environment that result from the incremental effects of an action when added to the effects of other past, present, and reasonably foreseeable future actions. The goal of the cumulative effects analysis is to identify any potentially significant environmental effects that may be apparent when the proposed action (i.e., CPS LR) is

considered in the context of other actions affecting the same environmental resources. The analysis considers all actions including minor ones, because the effects of individually minor actions may be significant when considered collectively over a period of time.

For the purposes of analysis, past and present actions include all actions that have occurred since the commencement of reactor operations up to the submittal of the LRA. Older actions are accounted for in baseline assessments presented in the affected environment discussions in Sections 3.2 through 3.13 of this EIS. The time frame for the consideration of reasonably foreseeable future actions is the 20 year LR term. Reasonably foreseeable future actions include current and ongoing planned activities through the end of the LR term. Information from CEG's ER; responses to requests for additional information; information from other Federal, State, and local agencies; scoping comments; and information gathered during the environmental site audit at CPS were used to identify past, present, and reasonably foreseeable future actions in the cumulative effects analysis.

For there to be a cumulative effect, the proposed action (i.e., CPS LR) must have an incremental new, additive, or increased physical effect or impact on the resource or environmental condition beyond what is already occurring. Therefore, the cumulative effects analysis only considers resources and environmental conditions that could be affected by the proposed action. A qualitative cumulative effects analysis is conducted in instances where the incremental effects of the proposed action and past, present, and reasonably foreseeable future actions are uncertain or not well known.

At the CPS facility itself, operations would continue during the LR term as described in Section 2.2.1 and result in those incremental effects identified for the proposed action in Sections 3.2 through 3.13 of this SEIS. CEG has not proposed any refurbishment activities and does not anticipate a need to expand the ISFSI for additional spent fuel storage during the LR term. However, if the expansion of the ISFSI becomes necessary during the LR term, CEG indicated that the existing ISFSI pad could be expanded onto the adjacent, previously disturbed land. The effects from this expansion, if needed during the LR term, are expected to be minor due to its location within the highly industrialized CPS protected area.

The Alta Farms Wind Project II is a 200 MW, 66 turbine project currently under construction in DeWitt County, approximately 9 mi (14 km) west of CPS (FG 2025-TN11064). The project covers approximately 12,000 ac (5,000 ha).

In 2024, DeWitt County entered into a purchase agreement to sell Clinton Lake Marina (located south of the CPS facility) to private owners (WANDTV 2024-TN11061). Plans for the marina include construction of a campground, new marina docks, and renovation of onsite buildings to include boat sales/service, retail, and a restaurant.

Illinois Route 54, the primary access to the CPS facility, is currently undergoing construction for road improvements, which is scheduled to be finished in December 2024 (IDOT 2025-TN11060).

3.16.1 Air Quality

The region of influence for the cumulative air quality analysis consists of DeWitt County, where CPS is located. CEG has not proposed any refurbishment activities or additional air emission sources during the LR term. As a result, air emission from the nuclear power plant during the LR term would be similar to those presented in Section 3.3 of this SEIS. Consequently,

cumulative changes to air quality in DeWitt County would be the result of future projects and actions that change present day emissions within DeWitt County, as well as from environmental trends as discussed in Section 3.15.3.2.3 of this SEIS. Construction activities (e.g., road improvements, new campground) could increase air emissions during their respective construction period, but those air emissions would be temporary and localized.

3.16.2 Water Resources

3.16.2.1 Surface Water Resources

The description of the affected environment in Section 3.5.1 of this SEIS, serves as the baseline for the cumulative impacts assessment for surface water resources. Clinton Lake was constructed to provide water required to operate CPS (CEG 2024-TN10806). CPS operations represent the only significant user of Clinton Lake water (CEG 2024-TN10806). CPS withdraws cooling water from the North Fork arm of Clinton Lake and discharges return flows and comingled effluents back to the Salt Creek arm through an unlined, earthen canal. Per the State of Illinois Water Use Act of 1983, CPS does not have an explicit annual withdrawal limit from Clinton Lake (CEG 2024-TN10914). CPS maintains a minimum 5 cfs discharge from the Clinton Lake Dam and as shown in Figure 3-2 of this SEIS, no adverse trend in the monthly average Clinton Lake level is apparent over the 2009–2023 period. The nearest downstream user of surface water for drinking purposes is approximately 240 river miles from CPS (CEG 2024-TN10806). The primary source of irrigation for farming in the vicinity of CPS is groundwater (Exelon 2020-TN10993).

CEG has no plans to conduct LR-related refurbishment or replacement activities and no major changes to CPS operations or plans for future expansion of station infrastructure during the LR term are anticipated. Additionally, while preparing this assessment, the NRC staff did not identify any new or proposed industrial, commercial, or public projects in the vicinity of CPS that require substantial surface water withdrawals.

CPS has not discharged from its LRS since 1992 and there are no plans for future discharges (CEG 2024-TN10806). The NRC staff review of the radiological environmental monitoring results for the last 5 years did not identify any adverse trend in radioactivity levels in surface water (Exelon 2020-TN10997, Exelon 2021-TN10999; CEG 2022-TN11000, CEG 2023-TN11001, CEG 2024-TN11002). Clinton Lake and several streams near CPS are listed as impaired by IEPA due to not meeting water quality standards for dissolved oxygen, total phosphorus, and oil concentrations; however, CPS operations do not contribute to these impairments.

Under the CWA, the NRC cannot issue a Federal permit or license unless the CWA Section 401 water quality certification has been issued or the water quality certification requirement has been waived by a State or another authorized agency. The IEPA approved a Section 401 waiver request for CPS on February 3, 2023 (CEG 2024-TN10806). Wastewater discharges from CPS are regulated under current IEPA NPDES Permit No. IL0036919 and CEG has not received any notices of violation associated with these discharges over the past 5 years (CEG 2024-TN10806, CEG 2024-TN10914). IEPA would be expected to alter NPDES discharge conditions, as necessary, to protect the water quality of the Clinton Lake. CPS will continue operating under the current and future renewed IEPA permits during the LR term and will also continue to implement BMPs and well as its SWPPP and SPCC plan. Moreover, any offsite projects would similarly have to comply with IEPA regulations such that cumulative water-quality objectives are served. In summary, a substantial regulatory framework exists to address current and future

water quality and water use considerations. Therefore, the proposed action would have no cumulative effect beyond what is already being experienced.

3.16.2.2 Groundwater Resources

The description of the affected environment in Section 3.5.2 of this SEIS, serves as the baseline for the cumulative impacts assessment for groundwater resources. CPS does not withdraw groundwater for nuclear power plant use (e.g., operational needs, drinking water, sanitation, or irrigation/grounds maintenance). As described in Section 3.5.2.1, the Unit 2 Pit serves as a collection point for shallow groundwater within the core reactor buildings area. The rate of discharge is not known, but groundwater elevation data and historical stormwater discharge data indicate the radius of influence of the system is likely to be within the plant site boundary. Groundwater withdrawal at the site is not anticipated to significantly increase during the proposed LR term due to abundant surface water resources and potentially low-quality groundwater in the vicinity of the site. In addition, the major aquifer in the region is absent beneath the main CPS site, and the proposed and projected future projects listed above would not have significant effects on groundwater in the CPS site vicinity. CPS will continue to implement its groundwater protection program and SPCC plan to reduce impacts to groundwater quality. Based on this information, the proposed action would have no cumulative impacts beyond those identified in Section 3.5.3.2.

3.16.3 Aquatic Resources

The description of the affected environment in Section 3.7.1 of this SEIS provides the baseline for the cumulative-impact assessment for aquatic resources. The impacts of LR on aquatic resources are described in Section 3.7.2 of this SEIS and have been determined by the NRC staff to be SMALL. CPS would continue operating under the current and future renewed IEPA permits during the LR term and would also continue to implement BMPs as well as its SWPPP and SPCC plan.

Ongoing and future projects that have or could affect aquatic resources include construction work at the Alta Farms Wind Project, construction of new marina docks, and construction on Illinois Route 54. Any offsite projects would similarly have to comply with IEPA regulations, including stormwater and erosion control, to minimize impacts to water quality and aquatic resources. A substantial regulatory framework exists to address current and future water quality and water use issues that could impact aquatic resources. Therefore, the proposed action would have no cumulative effect on aquatic resources beyond what is already being experienced.

3.16.4 Socioeconomics

As discussed in Section 3.10.7, continued operation of CPS during the LR term would have no impact on socioeconomic conditions in the region beyond what is already being experienced. CEG has no planned activities at CPS beyond continued reactor operations and maintenance.

Because CEG has no plans to hire additional workers during the LR term, overall expenditures and employment levels at CPS would remain unchanged and there would be no new or increased demand for housing and public services. Therefore, the only contributory effects would come from reasonably foreseeable future operational activities at CPS and other planned offsite activities, unrelated to the proposed action. When combined with past, present, and reasonably foreseeable future activities, the proposed action would have no new or increased effect on socioeconomic conditions beyond what is currently being experienced.

3.16.5 Human Health

The NRC and EPA have established radiological dose limits to protect the public and workers from both acute and long-term exposure to radiation and radioactive materials. These dose limits are specified in 10 CFR Part 20 (TN283) and 40 CFR Part 190 (TN739), "Environmental Radiation Protection Standards for Nuclear Power Operations." As discussed in Section 3.11.6 of this SEIS, the impacts on human health from continued plant operations during the LR term would be SMALL.

3.16.6 Waste Management and Pollution Prevention

This section of the SEIS considers the incremental waste management impacts of the proposed CPS LR term when added to the contributory effects of other past, present, and reasonably foreseeable future actions. In Section 3.13.3, the potential waste management impacts from continued operations at CPS during the LR term were determined to be SMALL.

As discussed in Sections 3.13.1 and 3.13.2 of this SEIS, CEG maintains waste management programs for radioactive and nonradioactive waste generated at CPS and is required to comply with Federal and State permits and other regulatory waste management requirements. All industrial facilities, including nuclear power plants and other facilities within a 50 mi (80 km) radius of CPS, are also required to comply with appropriate NRC, EPA, and State requirements for the management of radioactive and nonradioactive waste. Current waste management activities at CPS would likely remain unchanged during the LR term. Furthermore, the NRC staff expects that CPS would continue to comply with Federal and State requirements for radioactive and nonradioactive waste.

Therefore, the proposed action, including continued radioactive and nonradioactive waste generation during the LR term, would have no cumulative effect beyond what is already being experienced. This is based on CPS' expected continued compliance with Federal and State of Illinois requirements for radioactive and nonradioactive waste management, as applicable, and the expected regulatory compliance of other waste producers in the area.

3.17 Resource Commitments Associated with the Proposed Action

This section describes the NRC staff's consideration of potentially unavoidable adverse environmental impacts that could result from implementation of the proposed action and alternatives; the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity; and the irreversible and irretrievable commitments of resources.

3.17.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out the proposed action or any of the replacement power alternatives considered in this SEIS would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to the emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with Federal EPA and State emissions standards. Chemical and radiological emissions would not 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 low levels of radiation as well as 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 are not expected to exceed regulatory 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, for workers and the public.

The generation of spent nuclear fuel and waste material, including LLRW, hazardous waste, and nonhazardous waste, would be unavoidable. Hazardous and nonhazardous wastes would be generated at some non-nuclear power generating facilities. Wastes generated during nuclear 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, the NRC staff expects that power plant operators would optimize all waste management activities and operations in a way that generates the smallest possible amount of waste.

3.17.2 Relationship Between Short-Term Use of the Environment and Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment, as described in Sections 3.2 through 3.13 of this SEIS. 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 (e.g., land and energy), indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including LR, 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 entail similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from nuclear power plant operations introduce small amounts of radiological and nonradiological emissions to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but the NRC staff does not expect that these emissions would impact air quality or radiation exposure to the extent that they would impair public health and long-term productivity of the environment.

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 require an increase in energy and consume 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 these facilities are decommissioned and the area restored, the land could be available for other future productive uses.

3.17.3 Irreversible and Irretrievable Commitment of Resources

Resource commitments are irreversible when primary or secondary impacts limit the future options for a resource. For example, the consumption or loss of nonrenewable resources is irreversible. An irretrievable commitment refers to the use or consumption of resources for a period of time (e.g., for the duration of the action under consideration) that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitments of resources for electrical power generation include the commitment of land, water, energy, raw materials, and other natural and man-made resources required for power plant operations. In general, the commitments of capital, energy, labor, and material resources are also irreversible.

The implementation of any of the replacement power alternatives considered in this SEIS would entail the irreversible and irretrievable commitments of energy, water, chemicals, and—in some cases—fossil fuels. These resources would be committed during the LR term and over the entire life cycle of the power plant, and they would be unrecoverable.

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 or withdrawn from surface water or groundwater. These resources are readily available, and the NRC staff does not expect that the amounts required would deplete available supplies or exceed available system capacities.

NEPA Section 102(2)(C)(v), as amended by the Fiscal Responsibility Act of 2023, requires Federal agencies to describe any irreversible and irretrievable commitment of Federal resources which would be involved in the proposed agency action. The CEQ has stated that “federal resources” mean resources owned by the Federal Government or held in trust for Tribal Nations (89 FR 35442-TN10163).

This section discusses the irreversible and irretrievable commitment of resources such as land, water, raw materials, and other natural resources. However, this section also notes the use of resources such as the commitment of capital, energy, labor, and material resources, which are also irreversible. As some of these types of resources are expended by the NRC during its review of the CPS LRA, the NRC staff considers that these could be considered Federal resources under the Fiscal Responsibility Act of 2023.

It is important to note that the NRC staff and applicant have no way at this time of identifying the specific origins of all future resources that might be consumed. Some of the committed resources may ultimately be derived from Federally controlled lands, waters, funds, or other origins and some from non-Federal origins. By addressing the entirety of the resources in this SEIS, the staff has ensured consideration of any possible Federal subcomponent.

4 CONCLUSIONS

4.1 Environmental Impacts of License Renewal

This SEIS contains the environmental review of the LRA for CPS. After reviewing the plant-specific (Category 2) environmental issues in this SEIS, the NRC staff concluded that renewing the operating license for CPS would have SMALL impacts for the Category 2 issues applicable to LR at CPS. The NRC staff considered mitigation measures for each Category 2 issue, as applicable. The NRC staff concluded that no additional mitigation measure is warranted.

4.2 Comparison of Alternatives

In Chapter 3 of this SEIS, the NRC staff considered the following alternatives to renewing the operating license for CPS:

- no-action
- natural gas
- renewable and natural gas combination
- purchased power

Based on the review presented in this draft SEIS, the NRC staff concludes that the environmentally preferred alternative is the proposed action. The NRC staff preliminarily recommends renewal of the CPS operating license. As shown in Table 2-1 of this SEIS, all other replacement power alternatives have impacts in more than one resource area that are greater than LR, in addition to the environmental impacts inherent to new construction projects. To make up the lost power generation if the NRC does not renew the CPS operating license (i.e., the no-action alternative), energy decision-makers may implement one of the replacement power alternatives discussed in Chapter 3, or a comparable alternative capable of replacing the power generated by CPS.

4.3 Recommendation

The NRC staff's preliminary recommendation is that the adverse environmental impacts of LR for CPS are not so great that preserving the option of LR for energy-planning decision-makers would be unreasonable. This preliminary recommendation is based on the following:

- the analysis and findings in the LR GEIS
- the ER submitted by the applicant
- the NRC staff's consultation with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- the NRC staff's consideration of public comments received during the scoping process

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AM or MA = Master of Arts; BA = Bachelor of Arts; BS = Bachelor of Science; DoD = U.S. Department of Defense; DOE = U.S. Department of Energy; DOI = U.S. Department of Interior; CEG = Certified Engineering Geologist; GradCert = Graduate Certificate; MBA = Master of Business Administration; MRP = Master of Regional Planning; MS = Master of Science; NEPA = National Environmental Policy Act of 1969; NNSA = National Nuclear Security Administration; NRC = U.S. Nuclear Regulatory Commission; PG = Professional Geologist; PhD = Doctor of Philosophy; PNNL = Pacific Northwest National Laboratory; PSM = Professional Science Masters; SAMA = Severe Accident Mitigation Alternative.

7 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THIS SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT ARE SENT

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APPENDIX A

COMMENTS RECEIVED ON THE CLINTON POWER STATION UNIT 1 ENVIRONMENTAL REVIEW

A.1 Comments Received During the Scoping Period

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a scoping process for the environmental review of the Clinton Power Station, Unit 1, license renewal application in accordance with the National Environmental Policy Act of 1969 (42 *United States Code* [U.S.C.] 4321 et seq.-TN661) (NEPA). The scoping process began on April 29, 2024, with publication of the NRC's notice of intent in the *Federal Register* (89 FR 33400-TN10841). In its notice of intent, the NRC requested that members of the public and stakeholders submit comments on the scope of the environmental review for the proposed Clinton Power Station, Unit 1 license renewal.

The scoping process included two virtual public scoping meetings on May 7 and May 9, 2024. Attendees made oral statements that were recorded and transcribed by a certified court reporter. A summary and transcripts of the public scoping meetings are available in the NRC's Agencywide Documents Access and Management System (ADAMS) under ADAMS Package No. ML24135A363 (NRC 2024-TN11191). The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams.html. In addition to the comments received during the public meetings, comments were also received electronically via Regulations.gov and email.

At the conclusion of the scoping process, the NRC staff issued a scoping summary report (NRC 2024-TN10870). The report contains comments received during the public meetings and electronically during the scoping period as well as the NRC staff's consideration of these comments.

A.2 References

89 FR 33400. April 29, 2024. "Notice of Intent To Conduct Scoping Process and Prepare Environmental Impact Statement; Constellation Energy Generation, LLC; Clinton Power Station, Unit 1." *Federal Register*, Nuclear Regulatory Commission. TN10841.

National Environmental Policy Act of 1969 (NEPA), as amended. 42 U.S.C. § 4321 *et seq.* TN661.

NRC (U.S. Nuclear Regulatory Commission). 2024. Letter from S.S. Koenick, Chief, Environmental Project Manager Branch 1, to C.D. Wilson, Director, License Renewal, Constellation Energy Generation, LLC, dated September 27, 2024, regarding "Issuance of Environmental Scoping Summary Report Associated with the U.S. Nuclear Regulatory Commission Staff's Review of Clinton Power Station, Unit 1, License Renewal Application (EPID Number: L-2024-LNE-0000) (Docket Number: 50-461)." Washington, D.C. ADAMS Accession No. ML24215A280. TN10870.

NRC (U.S. Nuclear Regulatory Commission). 2024. Memorandum from A. Waldron, Project Manager, Environmental Project Management Branch 1, to S.S. Koenick, Chief, Environmental Project Management Branch 1, dated May 21, 2024, regarding "Meeting Summary: Public

1 Scoping Meetings for the Environmental Review of the License Renewal Application for Clinton
2 Power Station, Unit 1 (EPID Number: L-2024-LNE-0000) (Docket Number: 50-461)".
3 Washington, D.C. ADAMS Accession No. ML24135A363. TN11191.

APPENDIX B

APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

There are several Federal laws and regulations that affect environmental protection, health, safety, compliance, and consultation at every U.S. Nuclear Regulatory Commission (NRC)-licensed nuclear power plant. Some of these laws and regulations require permits by or consultations with other Federal agencies or State, Tribal, or local governments. Certain Federal environmental requirements have been delegated to State authorities for enforcement and implementation. Furthermore, States have also enacted laws to protect public health and safety and the environment. It is the NRC's policy to make sure nuclear power plants are operated in a manner that provides adequate protection of public health and safety and protection of the environment through compliance with applicable Federal and State laws, regulations, and other requirements, as appropriate.

The Atomic Energy Act of 1954, as amended (AEA) (42 United States Code [U.S.C.] 2011 et seq.-TN663) and the Energy Reorganization Act of 1974, as amended (42 U.S.C. 5801 et seq.-TN4466), give the NRC the licensing and regulatory authority for commercial nuclear energy use. They allow the NRC to establish dose and concentration limits for protection of workers and the public for activities under NRC jurisdiction. The NRC implements its responsibilities under the AEA through regulations set forth in Title 10, "Energy," of the *Code of Federal Regulations* (CFR). The AEA also authorizes the NRC to enter into an agreement with any State that allows the State to assume regulatory authority for certain activities (see 42 U.S.C. 2021-TN10029). A State that enters into such an agreement with the NRC is called an Agreement State, which assumes regulatory responsibility over certain byproducts, sources, and quantities of special nuclear materials not sufficient to form a critical mass. The Illinois Emergency Management Agency and Office of Homeland Security administers the Illinois State Program.

In addition to carrying out some Federal programs, State legislatures develop their own laws. State statutes can supplement, as well as implement, Federal laws for protection of air, surface water, and groundwater. State legislation may address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

The U.S. Environmental Protection Agency (EPA) has the primary responsibility to administer the Clean Water Act, as amended (CWA; 33 U.S.C. 1251-1387-TN662). The National Pollutant Discharge Elimination System (NPDES) program addresses water pollution by regulating the discharge of potential pollutants to waters of the United States. The CWA allows for primary enforcement and administration through State or Tribal agencies, as long as the State program is at least as stringent as the Federal program. EPA has delegated the authority to issue NPDES permits to the Illinois Environmental Protection Agency.

B.1 Federal and State Requirements

Clinton Power Station (CPS) is subject to various Federal and State requirements. Table B-1 lists the principal Federal and State regulations and laws that are used or mentioned in this supplemental environmental impact statement for CPS.

1 **Table B-1 Federal and State Requirements**

Category Law or Regulation	Requirements
Current Operating License and License Renewal Atomic Energy Act, 42 U.S.C. 2011 et seq.	The AEA of 1954, as amended, and the Energy Reorganization Act of 1974 (42 U.S.C. 5801 et seq.) give the NRC the licensing and regulatory authority for nuclear energy uses within the commercial sector. They give the NRC responsibility for licensing and regulating commercial uses of atomic energy and allows the NRC to establish dose and concentration limits for protection of workers and the public for activities under NRC jurisdiction. The NRC implements its responsibilities under the AEA through regulations set forth in Title 10 of the CFR.
Current Operating License and License Renewal National Environmental Policy Act of 1969, 42 U.S.C. 4321 et seq.	NEPA, as amended, requires Federal agencies to integrate environmental values into their decision-making process by considering the environmental impacts of proposed Federal actions and reasonable alternatives to those actions. NEPA establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. NEPA Section 102(2) contains action-forcing provisions to ensure that Federal agencies follow the letter and spirit of the Act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the proposed action and other specified information.
Current Operating License and License Renewal 10 CFR Part 20	Regulations in 10 CFR Part 20, “Standards for Protection Against Radiation,” establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the NRC. These regulations are issued under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. The purpose of these regulations is to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards for protection against radiation prescribed in the regulations in this part.
Current Operating License and License Renewal 10 CFR Part 50	Regulations in 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” are NRC regulations issued under the Atomic Energy Act, as amended, and Title II of the Energy Reorganization Act of 1974, to provide for the licensing of production and utilization facilities, including power reactors.
Current Operating License and License Renewal 10 CFR Part 51	Regulations in 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” contain the NRC’s regulations that implement NEPA.
Current Operating License and License Renewal 10 CFR Part 54	NRC regulations in 10 CFR Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants,” govern the issuance of renewed operating licenses and renewed combined licenses for nuclear power plants licensed under Sections 103 or 104b of the AEA, as amended, and Title II of the Energy Reorganization Act of 1974. The regulations focus on managing adverse effects of aging. The rule is intended to ensure that important systems, structures, and components will continue to perform their intended functions during the period of extended operation.

Table B-1 Federal and State Requirements (Continued)

Category Law or Regulation	Requirements
Air Quality Protection Clean Air Act, 42 U.S.C. 7401 et seq.	The CAA is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." The CAA establishes regulations to ensure maintenance of air quality standards and authorizes individual States to manage permits. Section 118 of the CAA requires each Federal agency, with jurisdiction over properties or facilities engaged in any activity that might result in the discharge of air pollutants, to comply with all Federal, State, inter-State, and local requirements with regard to the control and abatement of air pollution. Section 109 of the CAA directs the EPA to set NAAQS for criteria pollutants. The EPA has identified and set NAAQS for the following criteria pollutants: particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. Section 111 of the CAA requires the establishment of national performance standards for new or modified stationary sources of atmospheric pollutants. Section 160 of the CAA requires that specific emission increases must be evaluated before permit approval to prevent significant deterioration of air quality. Section 112 requires specific standards for release of hazardous air pollutants (including radionuclides). These standards are implemented through plans developed by each State and approved by the EPA. The CAA requires sources to meet standards and obtain permits to satisfy those standards. Nuclear power plants may be required to comply with the CAA Title V, Sections 501–507, for sources subject to new source performance standards or sources subject to National Emission Standards for Hazardous Air Pollutants. EPA regulates the emissions of air pollutants using 40 CFR Parts 50 to 99.
Water Resources Protection Clean Water Act, 33 U.S.C. 1251 et seq., and the NPDES (40 CFR Part 122)	The CWA was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The Act requires all branches of the Federal government with jurisdiction over properties or facilities engaged in any activity that might result in a discharge or runoff of pollutants to surface waters, to comply with Federal, State, inter-State, and local requirements. As authorized by the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NPDES program requires all facilities that discharge pollutants from any point source into waters of the United States to obtain an NPDES permit. A nuclear power plant may also participate in the NPDES General Permit for Industrial Stormwater due to stormwater runoff from industrial or commercial facilities to waters of the United States. EPA is authorized under the CWA to directly implement the NPDES program; however, EPA has authorized many States to implement all or parts of the national program. Section 401 of the CWA requires States to certify that the permitted discharge would comply with all limitations necessary to meet established State water quality standards, treatment standards, or schedules of compliance. The USACE is the lead agency for enforcement of CWA wetland requirements (33 CFR Part 320, "General Regulatory Policies"). Under Section 401 of the CWA, EPA or a delegated

Table B-1 Federal and State Requirements (Continued)

Category Law or Regulation	Requirements
	State agency has the authority to review and approve, condition, or deny all permits or licenses that might result in a discharge to waters of the State, including wetlands.
Water Resources Protection Coastal Zone Management Act of 1972, as amended (16 U.S.C. 1451 et seq.)	Congress enacted the CZMA in 1972 to address the increasing pressures of over-development upon the Nation's coastal resources. The National Oceanic and Atmospheric Administration administers the Act. The CZMA encourages States to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. Participation by States is voluntary. To encourage States to participate, the CZMA makes Federal financial assistance available to any coastal State or territory, including those on the Great Lakes, as long as the State or territory is willing to develop and implement a comprehensive coastal management program.
Water Resources Protection Wild and Scenic Rivers Act, 16 U.S.C. 1271 et seq.	The Wild and Scenic Rivers Act created the National Wild and Scenic Rivers System, which was established to protect the environmental values of free-flowing streams from degradation by impacting activities, including water resources projects.
Waste Management and Pollution Prevention Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq.	The RCRA requires EPA to define and identify hazardous waste; establish standards for its transportation, treatment, storage, and disposal; and require permits for persons engaged in hazardous waste activities. Section 3006, "Authorized State Hazardous Waste Programs" (42 U.S.C. 6926), allows States to establish and administer these permit programs with EPA approval. EPA regulations implementing RCRA are found in 40 CFR Parts 260 through 283. Regulations imposed on a generator or on a treatment, storage, and/or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, and/or disposed. The method of treatment, storage, and/or disposal also impacts the extent and complexity of the requirements.
Waste Management and Pollution Prevention Pollution Prevention Act, 42 U.S.C. 13101 et seq.	The Pollution Prevention Act establishes a national policy for waste management and pollution control that focuses first on source reduction, then on environmental issues, safe recycling, treatment, and disposal.
Protected Species Endangered Species Act, 16 U.S.C. 1531 et seq.	The ESA was enacted to prevent the further decline of endangered and threatened species and to restore those species and their critical habitats. Section 7, "Interagency Cooperation," of the Act requires Federal agencies to consult with the FWS or the NMFS on Federal actions that may affect listed species or designated critical habitats.
Protected Species Magnuson–Stevens Fishery Conservation and Management Act, 16 U.S.C. 1801 et seq.	The Magnuson–Stevens Fishery Conservation and Management Act, as amended, governs marine fisheries management in U.S. Federal waters. The Act created eight regional fishery management councils and includes measures to rebuild overfished fisheries, protect essential fish habitat, and reduce bycatch. Under Section 305 of the Act, Federal agencies are required to consult with the National Marine Fisheries Service for any Federal actions that may adversely affect essential fish habitat.

Table B-1 Federal and State Requirements (Continued)

Category Law or Regulation	Requirements
Historic Properties National Historic Preservation Act, 54 U.S.C. 100101 et seq. (formerly 16 U.S.C. 470 et seq.)	The National Historic Preservation Act was enacted to create a national historic preservation program, including the National Register of Historic Places and the ACHP. Section 106 of the Act requires Federal agencies to take into account the effects of their undertakings on historic properties. The Advisory Council on Historic Preservation regulations implementing Section 106 of the Act are found in 36 CFR Part 800, "Protection of Historic Properties." The regulations call for public involvement in the Section 106 consultation process, including involvement from Indian Tribes and other interested members of the public, as applicable.

ACHP = Advisory Council on Historic Preservation; AEA = Atomic Energy Act; CAA = Clean Air Act; CFR = *Code of Federal Regulations*; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; EPA = U.S. Environmental Protection Agency; ESA = Endangered Species Act of 1973, as amended; FWS = U.S. Fish and Wildlife Service; IAC = Illinois Administrative Code; NAAQS = National Ambient Air Quality Standards; NEPA = National Environmental Policy Act; NMFS = National Marine Fisheries Service; NPDES = National Pollutant Discharge Elimination System; NRC = U.S. Nuclear Regulatory Commission; RCRA = Resource Conservation and Recovery Act; U.S.C. = *United States Code*; USACE = U.S. Army Corps of Engineers.

B.2 Operating Permits and Other Requirements

Table B-2 below lists the permits and licenses issued by Federal, State, and local authorities for operational activities at CPS, as identified in Constellation Energy Generation, LLC's environmental report (CEG 2024-TN10806) and updated in response to the NRC staff's request for additional information (CEG 2024-TN10914).

Table B-2 Operating Permits and Other Requirements for Clinton Power Station

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
AEA (10 CFR Part 50)	NRC	NPF-62	4/17/2027	Operation of CPS Unit 1
CWA Section 401 (33 U.S.C. 1341)	EPA/IEPA	N/A	N/A	Discharge into waters of the United States, permitted under the Illinois NPDES permit
49 U.S.C. 5180 (49 CFR Part 107, Subpart G)	USDOT	051022550113EG	6/30/2025	Hazardous material shipments
TDEC Rule 0400-20-10-.32	TDEC	T-IL004-L23	12/31/2024	Shipment of radioactive material to a licensed disposal/processing facility in Tennessee
Utah Administrative Code R313-26	UDEQ	0110000033	7/28/2025	Delivery of radioactive waste to a land disposal facility located in Utah

Table B-2 Operating Permits and Other Requirements (Continued)

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
RCRA (42 U.S.C. 6912) and IEPA Title 35 Ill. Adm. Code, Parts 700-739	IEPA	ILD000806075	8/31/2025	Authorizes facility to operate as a hazardous waste generator
IEPA Title 35 Ill. Adm. Code, Subtitle C and/or D, Chapter 1, and the CWA	IEPA	IL0036919	3/31/2025	Discharges of stormwater, wastewater and treated water to waters of the State
IEPA, Title 35 III. Adm. Code, Subtitle C, Chapter 1, and the CWA	IEPA	1LG870019	9/30/2027	Pesticide Application Point Source Discharges
IEPA Title 35 Ill. Adm. Code, Subtitle B, Chapter 1, and the CAA	IEPA	039804AAC	4/18/2024 Administratively Extended	Operate emission sources and/or air pollution control equipment as listed in permit
IEPA Title 35 Part 380	IEPA	311999999	7/1/2028	Class K (Industrial) Wastewater Treatment Works Operator
IDPH, Title 77 Ill. Adm. Code, Chapter 1, Subchapter r, Part 900, and Safe Drinking Water Act	IDPH and SDWA	Water System No. IL3111153 (CPS Personnel Beach Rec Area Well)	N/A	Transient, non-community water system
IDPH, Title 77 Ill. Adm. Code, Chapter 1, Part 900 Drinking Water System Code, and Part 930 Surface Source Water Treatment Code, Ill. Pollution Control Board 35 Ill. Adm. Code Part 611 Primary Drinking Water Standards and Safe Drinking Water Act	IDPH and SDWA	Water System No. IL3112201	N/A	Non-transient, non-community public water system

Table B-2 Operating Permits and Other Requirements (Continued)

Permit	Responsible Agency	Number	Expiration Date	Authorized Activity
IDPH, Title 77 Ill. Adm. Code, Chapter 1, Subchapter r, Part 900.45	IDPH	Operator ID: 24661	12/31/2026	Operate Non-Transient, Non-Community Public Water System
IDPH, Title 77 Ill. Adm. Code 820	IDPH	134-08208	5/1/2025	Beach Facility License
Ch 19, par. 5.2 IDNR IDOT/Division of Water Resources	IDOT/Division of Water Resources Permit IDOT	18199	N/A	Operating and Maintenance Permit for Clinton Lake Dam

AEA = Atomic Energy Act; CAA = Clean Air Act; CPS = Clinton Power Station, Unit 1; CWA = Clean Water Act; IDNR = Illinois Department of Natural Resources; IDOT = Illinois Department of Transportation; IDPH = Illinois Department of Public Health; IEPA = Illinois Environmental Protection Agency; N/A = not available; NPDES = National Pollutant Discharge Elimination System; NRC = U.S. Nuclear Regulatory Commission; RCRA = Resource Conservation and Recovery Act; SDWA = Safe Drinking Water Act; TDEC = Tennessee Department of Environment and Conservation; U.S.C. = *United States Code*; UDEQ = Utah Department of Environmental Quality.
Source: CEG 2024-TN10914.

B.3 References

42 U.S.C. § 2021 et seq. U.S. Code Title 42, Public Health and Welfare, Section 2021, "Cooperation with States." TN10029.

Atomic Energy Act of 1954. 42 U.S.C. § 2011 et seq. Public Law 112-239, as amended. TN663.

CEG (Constellation Energy Generation, LLC). 2024. Letter from C.D. Wilson, License Renewal Director, to NRC Document Control Desk, dated February 14, 2024, regarding "Clinton Power Station, Unit 1, Facility Operating License No. NPF-62, NRC Docket No. 50-461, Application for Renewed Operating License." RS-24-012, Kennett Square, Pennsylvania. ADAMS Accession Package No. ML24045A023. TN10806.

CEG (Constellation Energy Generation, LLC). 2024. Letter from C.D. Wilson, License Renewal Director, to NRC Document Control Desk, dated November 21, 2024, regarding "Clinton Power Station, Unit 1, Facility Operating License No. NPF-62, NRC Docket No. 50-461, Response to NRC Request for Additional Information, dated October 23, 2024, Regarding the Clinton Power Station, Unit 1, License Renewal Application, Environmental Requests for Additional Information – Environmental Review." RS-24-012, Kennett Square, Pennsylvania. ADAMS Accession Package No. ML24326A273. TN10914.

Energy Reorganization Act of 1974, as amended. 42 U.S.C. § 5801 et seq. TN4466.

Federal Water Pollution Control Act of 1972 (commonly referred to as the Clean Water Act). 33 U.S.C. § 1251 et seq. TN662.

APPENDIX C

CONSULTATION CORRESPONDENCE

C.1 Endangered Species Act Section 7 Consultation

As a Federal agency, the U.S. Nuclear Regulatory Commission (NRC) must comply with the Endangered Species Act of 1973, as amended (ESA) (16 *United States Code* [U.S.C.] 1531 et seq.-TN1010), as part of any action authorized, funded, or carried out by the agency. In this case, the proposed agency action is whether to renew the facility operating license for the continued operation of Clinton Power Station, Unit 1 (CPS). The proposed action would authorize Constellation Energy Generation, LLC (CEG) to operate CPS for an additional 20 years beyond the terms of the current operating license. Under Section 7 of the ESA, the NRC must consult with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) ("the Services" [collectively] or "Service" [individually]), as appropriate, to ensure that the proposed action is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat.

C.1.1 Federal Agency Obligations under Section 7 of the Endangered Species Act

The ESA and the regulations that implement ESA Section 7 at Title 50 of the *Code of Federal Regulations* (CFR) Part 402 (50 CFR Part 402-TN4312) describe the consultation process that Federal agencies must follow in support of agency actions. As part of this process, the Federal agency shall either request that the Services (1) provide a list of any listed or proposed species or designated or proposed critical habitats that may be present in the action area or (2) request that the Services concur with a list of species and critical habitats that the Federal agency has created (50 CFR 402.12(c)). If any such species or critical habitats may be present, the Federal agency prepares a biological assessment to evaluate the potential effects of the agency action and determine whether the species or critical habitats are likely to be adversely affected by the action (50 CFR 402.12(a); 16 U.S.C. 1536(c)-TN4459).

Biological assessments are required for any agency action that is a "major construction activity" (50 CFR 402.12(b)) (TN4312). A major construction activity is a construction project or other undertaking having construction-type impacts that is a major Federal action significantly affecting the quality of the human environment under the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.-TN661) (NEPA) (51 FR 19926-TN7600). Federal agencies may fulfill their obligations to consult with the Services under ESA Section 7 and to prepare a biological assessment, if required, in conjunction with the interagency cooperation procedures required by other statutes, including NEPA (50 CFR 402.06(a)) (TN4312). In such cases, the Federal agency should include the results of ESA Section 7 consultation(s) in the NEPA document (50 CFR 402.06(b)).

C.1.2 Biological Evaluation

The proposed action of CPS license renewal (LR) does not require the preparation of a biological assessment because it is not a major construction activity. Nonetheless, the NRC staff must consider the impacts of this action on federally listed species and designated critical habitats. In cases where the staff finds that LR "may affect" ESA-protected species or habitats, ESA Section 7 requires the NRC to consult with the relevant Service(s).

To support such consultations, the NRC staff has incorporated its analysis of the potential impacts of the proposed LR into Section 3.8 of this supplemental environmental impact statement (SEIS). The NRC staff refers to its ESA analysis as a "biological evaluation."

The NRC staff structured its biological evaluation in accordance with the Services' suggested biological assessment contents described at 50 CFR 402.12(f) (TN4312). Section 3.8.1 of this SEIS describes the action area as well as the ESA-protected species and critical habitats potentially present in the action area. Section 3.8.4 assesses the potential effects of the proposed action of CPS LR on the ESA-protected species and critical habitats present in the action area and contains the NRC's effect determination for each of those species and habitats. Finally, Sections 3.8.5 through 3.8.9 address the potential effects of the no-action alternative and the replacement power alternatives. The results of the NRC staff's analysis are summarized below in Table C-1.

Table C-1 Effect Determinations for Federally Listed Species under U.S. Fish and Wildlife Service Jurisdiction

Species	Federal Status[(a)]	Potentially Present in the Action Area?	Effect Determination[(b)]	FWS Concurrence Date[(c)]
northern long-eared bat	FE	Yes	NLAA	TBD
Indiana bat	FE	Yes	NLAA	TBD
whooping crane	EXPN	Yes	NLAA	TBD
salamander mussel	FPE	No	NE	N/A
monarch butterfly	FPT	Yes	NLAA	TBD
western regal fritillary	FPT	Yes	NLAA	TBD
rusty patched bumble bee	FE	Yes	NLAA	TBD
eastern prairie fringed orchid	FT	Yes	NLAA	TBD

(a) Indicates protection status under the Endangered Species Act of 1973, as amended (ESA). FC = candidate for Federal listing; FE = federally endangered; FPE = proposed for Federal listing as endangered; FPT = proposed for Federal listing as threatened; FT = federally threatened; EXPN = experimental population, non-essential.

(b) The NRC staff makes its effect determinations for federally listed species in accordance with the language and definitions specified in the FWS and NMFS Endangered Species Consultation Handbook (FWS and NMFS 1998-TN1031). LAA = may affect and is likely to adversely affect; NE = no effect; NLAA = may affect but is not likely to adversely affect.

(c) The ESA does not require Federal agencies to seek FWS concurrence for "no effect" determinations or for NLAA determinations for candidate and proposed species. N/A = not applicable; TBD = to be determined; the NRC will seek the FWS's concurrence following the issuance of this draft SEIS.

C.1.3 Chronology of Endangered Species Act Section 7 Consultation

Endangered Species Act Section 7 Consultation with the U.S. Fish and Wildlife Service

Following issuance of this draft SEIS, the NRC staff will seek the FWS's concurrence for the species for which the NRC determined that the proposed action of CPS LR may affect but is not likely to adversely affect (see Table C-1) in accordance with 50 CFR 402.13(c) (TN4312). Table C-2 lists the correspondence between the NRC and the FWS pursuant to ESA Section 7 that has transpired to date.

Table C-2 Endangered Species Act Section 7 Consultation Correspondence with the U.S. Fish and Wildlife Service

Date	Description	ADAMS Accession No.[(a)]
December 5, 2024	Iowa-Illinois Ecological Services Field Office (FWS) to M. Dehmer (NRC), List of threatened and endangered species for proposed Clinton LR	ML24341A080
December 5, 2024	Iowa-Illinois Ecological Services Field Office (FWS) to M. Dehmer (NRC), Federal agency coordination under ESA Section 7 and concurrence that the proposed Clinton LR is not likely to adversely affect the northern long-eared bat	ML24341A081

ADAMS = Agencywide Documents Access and Management System; ESA = Endangered Species Act; FWS = U.S. Fish and Wildlife Service; LR = license renewal; NRC = U.S. Nuclear Regulatory Commission.
(a) Access these documents through the NRC's ADAMS at http://adams.nrc.gov/wba/.

Endangered Species Act Section 7 Consultation with the National Marine Fisheries Service

As discussed in Section 3.8.1.3 and 3.8.4.2 of this SEIS, no federally listed species or critical habitats under NMFS's jurisdiction occur within the action area. Therefore, the NRC staff did not engage the NMFS pursuant to ESA Section 7 for the proposed CPS LR.

C.2 Magnuson–Stevens Act Essential Fish Habitat Consultation

The NRC must comply with the Magnuson–Stevens Fishery Conservation and Management Act of 1976, as amended (MSA) (16 U.S.C. 1801 et seq.-TN9966), for any actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect any essential fish habitat (EFH) identified under the MSA. In Sections 3.8.2 and 3.8.4.3 of this SEIS, the NRC staff concludes that the NMFS has not designated any EFH under the MSA within the affected area and that the proposed Clinton LR would have no effect on EFH. Thus, the MSA does not require the NRC to consult with the NMFS for the proposed action.

C.3 National Marine Sanctuaries Act Consultation

The National Marine Sanctuaries Act of 1966, as amended (NMSA) (16 U.S.C. § 1431 et seq.-TN4482), authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or aesthetic qualities as national marine sanctuaries. Under Section 304(d) of the act, Federal agencies must consult with the National Oceanic and Atmospheric Administration's Office of National Marine Sanctuaries if a Federal action is likely to destroy, cause the loss of, or injure any sanctuary resources.

In Sections 3.8.3 and 3.8.4.4 of this SEIS, the NRC staff concludes that no coastal or marine waters or Great Lakes occur near CPS and that the CPS LR would have no effect on sanctuary resources. Thus, the NMSA does not require the NRC to consult with the National Oceanic and Atmospheric Administration for the proposed action.

C.4 National Historic Preservation Act and Section 106 Consultation

The National Historic Preservation Act of 1966, as amended (NHPA) (54 U.S.C. 306108 et seq.-TN4839), requires Federal agencies to consider the effects of their undertakings on historic properties and consult with applicable State and Federal agencies, Indian Tribes, individuals,

and organizations with a demonstrated interest in the undertaking before taking action. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places. The NHPA Section 106 review process is outlined in regulations issued by the Advisory Council on Historic Preservation in 36 CFR Part 800, "Protection of Historic Properties" (TN513). In accordance with 36 CFR 800.8(c), "Use of the NEPA Process for Section 106 Purposes," the NRC has elected to use the NEPA process to comply with its obligations under Section 106 of the NHPA.

Table C-3 lists the chronology of consultation and consultation documents related to the NRC's NHPA Section 106 review of the proposed action of CPS LR.

Table C-3 National Historic Preservation Act Section 106 Consultation Correspondence for Clinton Power Station License Renewal

Date	Description	ADAMS Accession No.[(a)]
April 30, 2024	NRC letter to Jeff Krutchen, Illinois State Historic Preservation Office (SHPO) – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24103A103
April 30, 2024	NRC letter to Reid Nelson, Advisory Council on Historic Preservation (ACHP) – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24103A099
April 30, 2024	NRC letter to Chairman Lester Randall, Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24120A345
April 30, 2024	NRC letter to Chairman Darwin Kaskaske, Kickapoo Tribe of Oklahoma – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24120A343
April 30, 2024	NRC letter to Chairwoman Gena Kakkak, Menominee Indian Tribe of Wisconsin – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24120A344
April 30, 2024	NRC letter to Chief Douglas G. Lankford, Miami Tribe of Oklahoma – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24120A346

Table C-3 National Historic Preservation Act Section 106 Consultation Correspondence for Clinton Power Station License Renewal (Continued)

Date	Description	ADAMS Accession No.[(a)]
April 30, 2024	NRC letter to Principal Chief Geoffrey M. Standing Bear, Osage Nation – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24103A115
May 21, 2024	Letter from Rachael Mangum, ACHP, Regarding Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24290A094
October 21, 2024	NRC letter to Chairman Estavio Elizondo, Sr., Kickapoo Traditional Tribe of Texas – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A144
October 21, 2024	NRC letter to Chairwoman Gail Cheatham, Kickapoo Tribe of Indians of the Kickapoo Reservation in Kansas – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A145
October 21, 2024	NRC letter to Chairman Darwin Kaskaske, Kickapoo Tribe of Oklahoma – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A142
October 21, 2024	NRC letter to Chairwoman Gena Kakkak, Menominee Indian Tribe of Wisconsin – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A146
October 21, 2024	NRC letter to Chief Douglas G. Lankford, Miami Tribe of Oklahoma – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A143
October 21, 2024	NRC Letter to Chief Craig Harper Peoria Tribe of Oklahoma – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A141
October 21, 2024	NRC letter to Chairman Joseph Rupnick, Prairie Band Potawatomi Nation – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A148
October 24, 2024	NRC letter to Principal Chief Geoffrey M. Standing Bear, Osage Nation – Request to Initiate Section 106 Consultation and Scoping Process for the Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	ML24285A147
October 24, 2024	Letter from Jason C. Nelson, General Counsel, Kickapoo Traditional Tribe of Texas Regarding Request to Initiate Section 106 Consultation and Scoping Process for the	ML24340A125

Table C-3 National Historic Preservation Act Section 106 Consultation Correspondence for Clinton Power Station License Renewal (Continued)

Date	Description	ADAMS Accession No.[(a)]
	Environmental Review of Clinton Power Station, Unit 1 License Renewal Application	

ADAMS = Agencywide Documents Access and Management System; ACHP = Advisory Council on Historic Preservation; SHPO = State Historic Preservation Office; NRC = U.S. Nuclear Regulatory Commission
(a) Access these documents through the NRC's ADAMS at http://adams.nrc.gov/wba/.

C.5 References

36 CFR Part 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties." TN513.

50 CFR Part 402. *Code of Federal Regulations,* Title 50, *Wildlife and Fisheries*, Part 402, "Interagency Cooperation—Endangered Species Act of 1973, as amended." TN4312.

51 FR 19926. 1986. "Interagency Cooperation - Endangered Species Act of 1973, as amended." Final Rule, *Federal Register*, Fish and Wildlife Service, Interior; National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Commerce. TN7600.

16 U.S.C. § 1536. Endangered Species Act, Section 7, "Interagency Cooperation." TN4459.

16 U.S.C. § 1801 et seq. U.S. Code Title 16, Conservation, Chapter 38, "Fishery Conservation and Management." TN9966.

54 U.S.C. § 306108. National Historic Preservation Act Section 106, "Effect of Undertaking on Historic Property." TN4839.

Endangered Species Act of 1973. 16 U.S.C. § 1531 et seq. TN1010.

FWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 1998. *Endangered Species Act Consultation Handbook, Procedures for Conducting Section 7 Consultation and Conference*. Washington, DC. ADAMS Accession No. ML14171A801. TN1031.

National Environmental Policy Act of 1969 (NEPA), as amended. 42 U.S.C. § 4321 et seq. TN661.

National Marine Sanctuaries Act, as amended. 16 U.S.C. § 1431 et seq. TN4482.

APPENDIX D

CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

Date	Correspondence Description	ADAMS Accession No. or FR Citing
02/14/2024	Clinton Power Station - License Renewal Application	ML24045A279 (ER)
02/29/2024	Letter to Christopher D. Wilson - Clinton Power Station, Unit 1 - Receipt and Availability of the License Renewal Application	ML24045A142
03/07/2024	Clinton Power Station Availability Federal Register Notice	89 FR 16591
04/11/2024	Clinton LRA - Acceptance and Opportunity for Hearing - Letter	ML24089A222
04/18/2024	Clinton LRA - Acceptance and Opportunity for Hearing - FRN	89 FR 27805
04/29/2024	Clinton LRA Notice of Intent EIS and Scoping Federal Register Notice	89 FR 33400
04/29/2024	Letter to C. Wilson - Clinton Power Station, Unit 1 - Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process	ML24107B031
04/30/2024	Clinton LRA ACHP-SHPO Scoping Consultation Letter	ML24103A097
04/30/2024	Clinton LRA Tribal Consultation Letters	ML24103A114
05/06/2024	Clinton Power Station Unit 1 License Renewal Public Scoping Meeting May 2024 (Meeting Slides)	ML24127A095
05/21/2024	May 2024 Environmental Scoping Meetings Related to the Clinton Power Station License Renewal	ML24135A363
09/27/2024	Environmental Impact Statement Scoping Summary Report for Clinton Power Station Unit 1	ML24215A280
10/23/2024	Clinton Environmental Audit Summary- Request for Additional Information	ML24283A161
10/24/2024	NHPA Section 106 Letters to Consulting Tribes for Clinton Power Station LR	ML24285A138
11/21/2024	Clinton, Unit 1, Response to NRC Request for Additional Information, dated October 23, 2024, regarding the License Renewal Application, Environmental Requests for Additional Information – Environmental Review	ML24326A273
11/25/2024	Clinton, Unit 1, Response to NRC Request for Additional Information, dated October 23, 2024, regarding the License Renewal Application, Environmental Requests for Additional Information – Severe Accident Mitigation Alternative Analysis	ML24330A171

ACHP = Advisory Council on Historic Preservation; ADAMS = Agencywide Documents Access and Management System; EIS = environmental impact statement; ER = environmental report; FR = Federal Regulation; FRN = Federal Register Notice; LR = license renewal; LRA = license renewal application; NHPA = National Historic Preservation Act; SHPO = State Historic Preservation Officer.

APPENDIX E

PROJECTS AND ACTIONS CONSIDERED IN THE CUMULATIVE IMPACTS ANALYSIS

All information previously provided in Appendix E has been incorporated into Section 3.16 of this environmental impact statement (see Section 3.16, “Cumulative Effects of the Proposed Action”).

APPENDIX F

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

F.1 Introduction

Constellation Energy Generation, LLC (CEG, or the applicant) submitted an assessment of severe accident mitigation alternatives (SAMAs) for Clinton Power Station, Unit 1 (CPS), in Section 4.15 and Attachment G of the environmental report (ER) (CEG 2024-TN10806). This assessment was based on the most recent revision to the CPS probabilistic risk assessment (PRA), including an internal events model, internal flooding model, a fire model, and a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System (WinMACCS) computer code, as well as insights from the CPS individual plant examination (IPE) (IPC 1992-TN11153) and the CPS individual plant examination of external events (IPEEE) (IPC 1995-TN11154). In identifying and evaluating potential SAMAs, CEG considered SAMAs that addressed the major contributors to core damage frequency (CDF), population dose at CPS, and offsite economic cost, as well as insights and SAMA candidates found to be potentially cost-beneficial from the analysis of other boiling water reactor (BWR) nuclear power generating stations. CEG identified a list of 25 potential SAMA candidates after eliminating those candidates that (a) were not applicable to CPS, (b) had already been implemented at CPS, (c) were combined with another SAMA candidate, (d) were expected to have a very low benefit, or (e) had an excessive implementation cost. Of these 25 unique SAMA candidates, CPS concluded in the ER that 11 candidate SAMAs are potentially cost beneficial.

As a result of the review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) staff issued a request for additional information (RAI) to CEG by email dated October 23, 2024 (NRC 2024-TN10876). Key questions involved:

- the status of the Level 1 PRA model relative to the closure process of peer review facts and observations (F&Os), current and planned future design and operating features, and modeling of Diverse and Flexible Mitigation Capabilities (FLEX)
- the grouping and quantification of sequences in the Level 2 analysis, selection of representative sequences for each Source Term Category (STC) in the Level 2 analysis, and determination of the magnitude of release for each STC
- clarifications of the adequacy of the treatment of external events in the SAMA analysis, including seismic events and consideration of other external event hazards since the IPEEE
- selection of input parameters to the Level 3 analysis
- the PRA importance analysis used to identify CEG-specific SAMA candidates as well as the estimated implementation costs for screening SAMAs
- further information on the cost-benefit analysis of specific candidate SAMAs and low-cost alternatives

CEG submitted additional information by a letter dated November 25, 2024 (CEG 2024-TN11148). In response to the staff RAIs, CEG provided further information on:

- the closure process of peer review F&Os for the CPS PRA
- FLEX modeling

- the development of the Level 2 containment release model
- the treatment of external events
- the basis for inputs to the Level 3 analysis
- the identification and screening of SAMA candidates
- the cost-benefit analysis of specific candidate SAMAs
- the cost of various SAMAs and potential low-cost alternatives

CEG's responses addressed the staff's concerns and resulted in the identification of one additional potentially cost-beneficial SAMA.

An assessment of the SAMAs for CPS is presented below. Guidance for the SAMA analysis submittal is provided in NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Guidance Document" (NEI 2005-TN1978), which is endorsed in Regulatory Guide 4.2, Supplement 1 (NRC 2013-TN4791). The NRC staff notes that the licensee for CPS has changed multiple times since it was granted an operating license by the NRC. Licensee's previous to CEG have included Illinois Power and Exelon Generation Company. In this assessment of the SAMA analysis, regardless of which of the licensee's submitted the information referenced in this assessment, CEG or the applicant is used to represent all current and prior licensees.

F.2 Estimate of Risk for CPS

Section F.2.1 summarizes CEG's estimates of offsite risk at CPS. The summary is followed by the staff's review of CEG's risk estimates in Section F.2.2.

F.2.1 CEG's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the CPS SAMA analysis: (1) the CPS Level 1 and 2 PRA model, which is an updated version of the CPS IPE (IPC 1992-TN11153), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the CPS SAMA analysis. The scope of the CPS PRA used for the SAMA analysis addresses internal events, including internal flooding (model CL122A) and fire events (model CL122AF0), but does not include seismic and other external events.

The CPS internal events, including internal flooding, CDF is approximately 2.00×10^{-6} per year as determined from quantification of the Level 1 PRA model. The CPS fire CDF is approximately 3.12×10^{-5} per year as determined from quantification of the Level 1 PRA model. These values were used to form the baseline CDF of 3.32×10^{-5} (i.e., 2.00×10^{-6} per year + 3.12×10^{-5} per year) for the SAMA evaluations (CEG 2024-TN10806). CEG did not explicitly include the contribution from external events, including seismic events, within the CPS 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 1.193. This is discussed further in Sections F.2.2 and F.6.2.

In response to an RAI (CEG 2024-TN11148), CEG clarified that to perform accurate SAMA quantifications, the SAMA analysis makes use of higher truncation limits for Level 2 quantification (i.e., 1×10^{-12} per year for the internal events PRA and a 5×10^{-11} per year for the

fire PRA) than those used for large early release frequency (LERF) quantification in the internal events and fire PRA models of record (MORs) (i.e., 1×10^{-13} per year for the internal events PRA and a 5×10^{-12} per year for the fire PRA). However, the applicant demonstrated through a series of sensitivity studies that application of the lower MOR truncation limit would not alter the Phase 1 screening results, the conclusions of the Phase 2 analysis results, or the conclusions of the overall SAMA evaluation.

In the response, the applicant demonstrated through the use of a sensitivity study that the higher universal truncation limit has an insignificant impact on the results of the SAMA analysis when compared to those results obtained using risk models that employ truncation limits achieving convergence consistent with the American Society of Mechanical Engineers (ASME)/American Nuclear Society (ANS) PRA Standard RA-Sa-2009 (ASME/ANS 2009-TN6220). As such, risk results making use of the higher universal truncation limit were used as the baseline CDFs in the SAMA evaluations (CEG 2024-TN10806).

CEG provided the breakdown of CDF by initiating internal events, including internal flooding, which is provided in Table F-1 and by initiating fire events, which is provided in Table F-2. As shown in the former table, loss of offsite power and internal flooding are the dominant contributors to the internal events CDF, whereas in the latter table, fires within switchgear rooms dominate the fire CDF.

Table F-1 Clinton Power Station Core Damage Frequency for Internal Events (including Internal Flooding)

Initiating Event	CDF (per year)	% CDF Contribution
Loss of Offsite Power	7.56×10^{-7}	37.87
Major Fire Protection Rupture above MCR	4.06×10^{-7}	20.32
Open Phase Condition Occurs Upstream of RAT B	1.54×10^{-7}	7.73
Turbine Trip	1.07×10^{-7}	5.37
Major Vapor Container Rupture in CB-1i above MCR	8.84×10^{-8}	4.43
Major Service Water Rupture in AB	7.40×10^{-8}	3.71
Major Shutdown Service Water (SX) A Rupture above MCR	5.89×10^{-8}	2.95
Major SX B Rupture above MCR	5.89×10^{-8}	2.95
Manual Shutdown	4.31×10^{-8}	2.16
Major Fire Protection Water Rupture in AB	2.41×10^{-8}	1.21
Loss of Feedwater	2.29×10^{-8}	1.15
Small LOCA (below Top of Active Fuel)	1.78×10^{-8}	0.89
Other Initiating Events[(a)]	1.89×10^{-8}	9.26
Total CDF (Internal Events)	**2.00×10^{-6}**	**100[(b)]**

AB = auxiliary building; CDF = core damage frequency; LOCA = loss-of-coolant accident; MCR = main control room; RAT = reserve auxiliary transformer; SX = shutdown service water system.
(a) Multiple initiating events with each contributing less than 1 percent
(b) Sum of contributors may not add up to 100 percent due to round off error.

Table F-2 Clinton Power Station Core Damage Frequency for Fire Events

PAU[a]	Description	CDF (per year)	% CDF Contribution
A-2n	Division 1 Switchgear Room	9.67×10^{-6}	30.96%
A-2k	Non-Safety Switchgear Room (East)	7.50×10^{-6}	24.03%
CB-Sa	Division 3 Switchgear Room	2.24×10^{-6}	7.18%
A-3f	Division 2 Switchgear Room	1.85×10^{-6}	5.92%
CB-3a	Auxiliary Electric Equipment Room	1.60×10^{-6}	5.13%
CB-6a	Main Control Room Complex	1.57×10^{-6}	5.02%
D-4a	Division 3 Diesel-Generator Room	1.53×10^{-6}	4.91%
A-3d	Non-Safety Switchgear Room (West)	1.39×10^{-6}	4.46%
A-2o	Containment Electrical Penetration (East) Area	6.80×10^{-7}	2.18%
D-6a	Division 2 Diesel-Generator Room	5.87×10^{-7}	1.88%
TY-1a	RAT Areas	5.53×10^{-7}	1.77%
D-5a	Division 1 Diesel-Generator Room	3.74×10^{-7}	1.20%
Other[b]	All other PAUs	1.67×10^{-6}	5.35%
Total CDF (Fire Events)		**3.12×10^{-5}**	**100[c]**

CDF = core damage frequency; RAT = reserve auxiliary transformer.
(a) Physical Analysis Unit (PAU)
(b) Multiple PAUs with each contributing less than 1 percent
(c) Sum of contributors may not add up to 100 percent due to round off error.

Within the ER and in response to an RAI (CEG 2024-TN11148), CEG explained that the full Level 2 CPS PRA model that forms the basis for the SAMA evaluation includes two types of considerations: (1) a deterministic analysis of the physical processes for a spectrum of severe accident progressions and (2) a probabilistic analysis component in which the likelihood of the various outcomes are assessed. The Level 2 model uses containment event trees (CETs) containing both phenomenological and systemic events. Each of the Level 1 core damage sequences is then evaluated by a CET to assess the frequency of various containment release modes, based on the operational configurations of the CPS containment protection systems.

The CETs consider the influence of physical and chemical processes on the integrity of the containment and on the release of fission products once core damage has occurred. The quantified CET sequences are binned into one of 10 end states or source term categories (STCs). The frequency of each STC was obtained by summing the frequency of the Level 1 sequences binned into the STC. Source terms were developed for each of the STCs using the results of Modular Accident Analysis Program (MAAP) Version 4.0.5 computer code calculations. The results of this analysis for CPS are provided in Table F.3-17 of ER Attachment F and serve as input to the Level 3 consequence analysis (CEG 2024-TN10806).

CEG computed offsite consequences for potential releases of radiological material using the MACCS, Version 3.10.0, code and analyzed exposure and economic impacts from its determination of offsite and onsite risks. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution and growth within a 50-mile (mi) (80-kilometer [km]) radius, emergency response evacuation modeling, and local economic data. Radionuclide inventory in the reactor core is based on a plant-specific evaluation and corresponds to 3,473 megawatts thermal (MWt) (CEG 2024-

TN10806: Attachment F). The estimation of onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on guidance in NUREG/BR–0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997-TN676). Additional details on the input parameter assumptions are discussed below.

In response to an RAI (CEG 2024-TN11148), the applicant estimated the dose risk to the population within 50 mi (80 km) of the CPS site to be 0.284 person-Sieverts (Sv) per year (28.4 person-rem per year) for internal events, including internal flooding and fire events. The population dose risk (PDR) and offsite economic cost risk (OECR) contributions by containment release mode are summarized in Table F-3 below. High/early (H/E), high/late (H/L) and medium/early (M/E) releases provide the greatest contribution, totaling approximately 94 percent of the PDR and 98 percent of the OECR.

Table F-3 Base Case Mean Population Dose Risk and Offsite Economic Cost Risk at Clinton Power Station

Release Category: ID[(a)]	Release Category: Frequency (per yr)	Population Dose Risk: person-rem/yr[(b)]	Population Dose Risk: % Contribution	Offsite Economic Cost Risk: $/yr	Offsite Economic Cost Risk: % Contribution
BOC	4.48×10^{-10}	2.28×10^{-3}	0.01	3.30×10^{1}	0.01
H/E	8.47×10^{-7}	1.49	5.2	3.70×10^{4}	5.6
H/L	1.26×10^{-5}	21.5	75.8	5.35×10^{5}	81.4
M/E	4.46×10^{-6}	3.84	13.5	7.52×10^{4}	11.4
M/L	3.58×10^{-6}	9.80×10^{-1}	3.4	7.06×10^{3}	1.1
L/E	3.22×10^{-6}	4.81×10^{-1}	1.7	2.49×10^{3}	0.4
L/L	5.41×10^{-7}	4.14×10^{-2}	0.1	1.74×10^{2}	0.03
LL/E	1.74×10^{-7}	1.31×10^{-2}	0.05	4.69×10^{1}	0.01
LL/L	5.65×10^{-7}	2.69×10^{-2}	0.1	8.91×10^{1}	0.01
Intact	7.18×10^{-6}	1.24×10^{-2}	0.04	1.04×10^{2}	0.02
Total	**3.32×10^{-5} [(c)]**	**28.4[(c)]**	**100[(d)]**	**6.57×10^{5} [(c)]**	**100[(d)]**

BOC = break outside containment, E = early, I = intermediate, ID = identification; L/ = late, H = high, M = medium/moderate, /L = low, LL = low-low; rem = roentgen equivalent man; yr = year.
(a) Release Category descriptions provided in response to an NRC staff request for additional information (CEG 2024-TN11148).
(b) Unit Conversion Factor: 1 Sv = 100 rem.
(c) Sum of contributors may not add up to Total due to round off error.
(d) Sum of contributors may not add up to 100 percent due to round off error.

F.2.2 Review of CEG's Risk Estimates

CEG's determination of offsite risk at CPS is based on three major elements of analysis:

- the Level 1 risk models that form the bases for the 1992 IPE submittal (IPC 1992-TN11153) and the external event analyses of the 1995 IPEEE submittal (IPC 1995-TN11154);
- the major modifications and upgrades to the IPE and IPEEE models that have been incorporated in the CPS PRA, as well as updates to the analysis of other external events; and
- the combination of offsite consequence measures from MACCS analyses with release frequencies and radionuclide source terms from the Level 2 PRA model.

Each analysis element was reviewed to determine the acceptability of CEG's risk estimates for the SAMA analysis, as summarized further in this section.

F.2.2.1 Internal Events CDF Model

Section 11.2.3.1 of NUREG-1560, Volume 2, *Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance Parts 2–5*, Final Report (NRC 1997-TN7812) shows that the IPE-based total internal events CDF for BWR 5/6 plants ranges from 1×10^{-5} per year to 4×10^{-5} per year, with an average CDF for the group of 2×10^{-5} per year. The internal events, including internal flooding, CDF value from the 1992 CPS IPE (2.6×10^{-5} per reactor-year) are consistent with the values reported at that time for other BWR 5 and BWR 6 units. Other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes, which in many cases has resulted in substantially reduced CDFs compared to those reported in the IPE. The internal events, including internal flooding, CDF result for CPS used for the SAMA analysis (2.00×10^{-6} per year) are in the range reported in previous SAMA analyses for other similar plants.

As provided in Section F.5.1.4 of the ER, CPS IPE Plant Improvement Review, the CPS IPE submittal includes several proposed plant improvements, most of which of which have been implemented. The exception is the enhancement to provide a bypass line around a check valve that is in the flow path use to provide fire protection system injection to the RPV; however, a SAMA has been generated for CPS that is functionally equivalent to this enhancement and the SAMA analysis addresses the issue.

There have been numerous revisions to the CPS IPE Level 1 model since the 1992 IPE submittal leading up to the CPS PRA model (CL122A) utilized for the SAMA analysis. The NRC staff reviewed a listing of the changes made to the CPS PRA since the original IPE submittal, with corresponding CDF and LERF results, during the September 2024 audit. A comparison of internal events, including internal flooding, CDF between the 1992 IPE and the 2022 CPS PRA model (CL122A) indicates a significant decrease in the total CDF (from 2.6×10^{-5} per reactor-year to 2.0×10^{-6} per reactor-year).

The ER indicates that the PRA model used for the SAMA analysis (CL122A) reflects the CPS as-built, as-operated configuration as of December 31, 2021. In an NRC staff RAI (NRC 2024-TN10876), CEG was asked to discuss if there have been any major plant modifications or plant changes since the release of this PRA model, or if there are any planned major plant modifications or changes that could adversely impact the SAMA analysis, and assess the impact of these completed/planned modifications/changes on the SAMA analysis. In response to the RAI (CEG 2024-TN11148), CEG explained that the only major plant modification performed since the release of the CPS PRA used to support the SAMA analysis is the replacement of static var compensators with the implementation of mechanically switched capacitors and on-load tap changers (OLTCs) to regulate voltage on Class 1E busses. The applicant further clarified that the static var compensators are not risk significant and their modification would not impact the overall SAMA evaluation. Lastly, the applicant stated that there are no planned major plant modifications or changes that could adversely impact the SAMA analysis.

The NRC staff considered the peer reviews, F&O closure reviews, and other assessments performed to provide assurance of the quality of the CPS PRA and the potential impact of the review findings on the SAMA evaluation. The following summarizes the most relevant PRA peer reviews and other assessments:

- In October 2009, a full-scope peer review was performed on the Level 1 and Level 2/LERF models addressing internal events as well as on the internal flooding model. The ER indicates that this peer review was conducted using the ASME/ ANS PRA Standard RA-Sa-2009 (ASME/ANS 2009-TN6220) and NRC Regulatory Guide 1.200, Revision 2 (NRC 2009-TN6211) in accordance with the NEI 05-04 process (NEI 2008-TN10638).
- In December 2018 and November 2019, an F&O closure review was conducted using Nuclear Energy Institute (NEI) Appendix X guidance for closeout of F&Os (NEI 2017-TN10358). In response to an RAI (CEG 2024-TN11148), CEG confirmed that this review included all finding-level F&Os. Additionally, CEG acknowledged that the closure review was conducted using NEI Appendix X guidance for closeout of F&Os (NEI 2017) and in accordance with NRC expectations and conditions of its use (NRC 2017-TN10368, NRC 2017-TN10369).

The ER explains that all but two F&Os from the October 2009 peer review were formally closed using the F&O closure review process. In response to an NRC staff RAI (CEG 2024-TN11148), CEG clarified that the PRA model of record used in the SAMA analysis (CL122A) incorporates the dispositions to all the formally closed F&Os. Additionally, the two F&Os that remain open are concerned with the need to demonstrate that risk-significant combinations of human failure events (HFEs) were adequately captured by the internal events human reliability analysis dependency analysis. CEG addressed this concern for the SAMA analysis by (1) reviewing the importance measures from the baseline PRA results to confirm that all risk-significant HFE-dependent combinations were reviewed for proper dependence level assignments and order of HFEs and (2) identifying unanalyzed HFE-dependent combinations and evaluating the impact on the SAMA evaluation. Upon doing so, the applicant stated that the exclusion of the unanalyzed HFE-dependent combinations in the internal events PRA does not alter the conclusions of the SAMA evaluation.

Within the ER, CEG does indicate that the SAMA analysis utilizes a full-scope Level 2 analysis instead of the limited Level 2 analysis contemplated by peer review supporting requirements to evaluate LERF. This is discussed further in Section F.2.2.3.

The ER indicates that FLEX strategies are credited in the PRA. In an NRC staff RAI (NRC 2024-TN10876), challenges and strategies were identified for incorporating FLEX equipment into a PRA model in support of risk-informed decision-making and so CEG was asked to describe and justify that the PRA modeling of FLEX strategies addresses the NRC concerns. In response to the RAI (CEG 2024-TN11148), CEG clarified that FLEX strategies are credited in the PRA utilizing guidance from NEI 16-06 (NEI 2016-TN10640) and further explained that this modeling was done consistent with NRC guidance (NRC 2022-TN10641) except for the FLEX human reliability analysis. CEG performed a sensitivity analysis removing credit for FLEX strategies, reviewed the impact on each of the Phase 2 SAMAs, and confirmed that there is no adverse impact to the results of the SAMA evaluation. Given that no new cost-beneficial SAMAs would be identified, the NRC staff concludes that use of the existing PRA model is reasonable for the purposes of the SAMA evaluation.

The ER provides a brief discussion of the CPS maintenance process that ensures the applicable PRA model is an accurate reflection of the as-built and as-operated plant. This process includes procedures for the PRA maintenance and update process, activities related to PRA quality, and routine PRA model updates to reflect the current plant configuration and additional plant operating history and component data.

Given that the CPS internal events, including internal flooding, the Level 1 PRA model has been peer-reviewed, and the peer review findings were either all closed using a process acceptable to the NRC or were addressed, that CEG has in place procedures to assure the technical quality of the PRA, and that CEG has satisfactorily addressed NRC staff questions regarding the PRA. The NRC staff concludes that the internal events Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

F.2.2.2 External Events

NEI 05-01A allows the use of an external events multiplier on the maximum benefit and on the upper bound estimated benefits for individual SAMA candidates during the Phase II screening if external events are not included in the PRA utilized for SAMA analysis (NEI 2005-TN1978). As stated above, the CPS PRA utilized for the SAMA analysis only includes fire events and thus excludes seismic and other external events. In the ER, as clarified by the response to RCIs and RAIs (CEG 2024-TN11148), CEG explained that a CPS-specific seismic CDF estimate was developed by CEG. Additionally, the applicant performed an updated analysis, used in place of the CPS IPEEE and accounting for current plant configuration, to assess the impact of other (high winds, flooding, and other) external events.

The final CPS IPEEE was submitted in 1995 (IPC 1995-TN11154), in response to Supplement 4 of Generic Letter 88–20 (NRC 1991-TN10360). No fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events were identified in the CPS IPEEE, and additionally, no plant enhancements or improvements were identified. In the NRC staff's safety evaluation of the CPS IPEEE (NRC 2000-TN11334), the staff stated “[o]n the basis of the IPEEE review, the staff concludes that the licensee’s IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities and, therefore, that CPS has met the intent of Supplement 4 to Generic Letter 88-20.”

<u>Seismic Events</u>

As discussed in the ER, the CPS IPEEE seismic analysis was a reduced-scope seismic margins assessment (SMA) following the NRC IPEEE guidance (i.e., NRC 1991-TN10360, NRC 1991-TN10361). The SMA approach is deterministic in nature and does not result in probabilistic risk information. CEG estimated the plant’s high confidence low probability of failure (HCLPF) for all components, structures, and systems reviewed to be at least 0.3 g, which is equivalent to the review level earthquake (RLE).

Following the accident at the Fukushima Dai-ichi Nuclear Power Plant, CEG conducted additional seismic walkdowns at CPS. The NRC staff concluded that the licensee had, through the implementation of the walkdown guidance activities and in accordance with plant processes and procedures, verified the plant configuration with the current seismic licensing basis; addressed degraded, nonconforming, or unanalyzed seismic conditions; and verified the adequacy of monitoring and maintenance programs for protective features. Furthermore, the NRC staff confirmed that no immediate safety concerns were identified (NRC 2014-TN11248, NRC 2015-TN11251).

The NRC staff notes that CEG’s response to the Fukushima Near Term Task Force Recommendation 2.1 for a Seismic Hazard and Screening Report was found acceptable, confirming the licensee's conclusion that the Ground Motion Response Spectrum for the CPS site is bounded by the Safe Shutdown Earthquake in the 1 to 10 Hz range but exceeds the Safe Shutdown Earthquake above 10 Hz. As such, a high-frequency confirmation was merited (NRC

2015-TN11253). The high-frequency exceedance confirmation was subsequently resolved, and the NRC staff concluded that no further response or regulatory actions were required related to the seismic hazard reevaluation activities requested by Enclosure 1 of the 50.54(f) letter (NRC 2016-TN11255).

The NRC staff also notes that CEG submitted in June 2016 its *Seismic Mitigating Strategies Assessment (MSA) Report* concluding that FLEX for CPS can be implemented as designed and that no further seismic evaluations were necessary (Exelon 2016-TN11256). In its review, the NRC staff concluded that sufficient information has been provided to demonstrate that the applicant's plans for the development and implementation of guidance and strategies under Order EA-12-049 appropriately address the reevaluated seismic hazard information stemming from the 50.54(f) letter (NRC 2016-TN11330).

Since CPS was a focused-scope SMA plant, the method to address seismic risk for the IPEEE focused on walkdowns of success path equipment and systems and evaluation of equipment capacities against a RLE defined by a ground motion with a peak ground acceleration (PGA) of 0.3 g. Thus, no seismic CDF estimate was developed. However, a CPS-specific seismic CDF estimate has since been developed by CEG and is used to assess the impact of SAMAs on seismic risk. As clarified in response to an NRC staff RCI (CEG 2024-TN11148), the applicant's estimate is based on using the plant-specific seismic hazard curves developed in response to the Near-Term Task Force Recommendation 2.1 dated March 31, 2014 (Exelon 2014-TN11288) and supplemented on August 21, 2014 (Exelon 2014-TN11318) as well as a plant-level HCLPF capacity of 0.30 g (gravity) referenced to PGA. The uncertainty parameter for seismic capacity was represented by a combined beta factor of 0.4. The HCLPF parameters used for the CPS seismic CDF estimate are those cited for CPS in Tables B-2 and C-2 of "Results of Safety/Risk Assessment of Generic Issue 199 (GI-199), 'Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants,'" dated September 2, 2010 (NRC 2010-TN11319), which develops approximate seismic CDF estimates using a method that includes integrating the mean seismic hazard curve and the mean plant-level fragility curve for each nuclear power plant. This method is discussed in Section 10.8.9 of AMSE/ANS RA-Sa-2009 (ASME/ANS 2009-TN6220) and has previously been used by the staff in the resolution of GI-194, "Implications of Updated Probabilistic Seismic Hazard Estimates," and during reviews of various risk-informed license amendments. The 0.30 g PGA value is consistent with the CPS IPEEE RLE. The applicant's estimation of the seismic CDF is performed by convolving the PGA-based seismic hazard curve for the CPS site using the geometric mean of the 19 seismic hazard intervals with the CPS PGA-based HCLPF. The NRC staff review finds that the method used to estimate the seismic core damage frequency is acceptable because it is consistent with the approach used by the NRC staff to assess the implications of updated seismic hazard estimates (NRC 2010-TN11319).

Considering that the seismic CDF estimate of 6.40×10^{-6} per year is based on the most current site-specific seismic hazard information and an acceptably low plant HCLPF value of 0.3 g consistent with the information for the CPS in the GI-199 evaluation, the NRC staff concludes that the seismic CDF, as discussed above, is acceptable for use in the development of the external events multiplier.

Fire Events

The CPS IPEEE (IPC 1995-TN11154) included an internal fire analysis in which a fire probabilistic safety assessment was performed based on the methodology of the Electric Power Research Institute Fire-Induced Vulnerability Evaluation methodology (EPRI 1992-TN10380).

Since the IPEEE submittal, a fire PRA has been developed for CPS. In response to an NRC staff RAI (CEG 2024-TN11148), CEG confirmed that the fire PRA model (CL122AF0) used for the SAMA analysis reflects the CPS as-built, as-operated configuration as of December 31, 2021. Additionally, as discussed in Section F.2.2.1, there have been no major plant modifications performed since the release of the CPS PRA and no planned major plant modifications or changes that could adversely impact the SAMA analysis.

Similar to Section F.2.2.1, the NRC staff considered the peer reviews, F&Os closure reviews, and other assessments performed to provide assurance of the quality of the CPS fire PRA and the potential impact of the review findings on the SAMA evaluation. The following summarizes the most relevant PRA peer reviews and other assessments related to those aspects of the model that address fire events:

- In April 2018, a full-scope peer review was performed on the fire PRA model. As clarified in Section 2.5.2 of Addendum 2 to Attachment F of the ER, this peer review was conducted using the ASME/ANS PRA Standard RA-Sa-2009 (ASME/ANS 2009-TN6220) and NRC Regulatory Guide 1.200, Revision 2 (NRC 2009-TN6211) in accordance with the NEI 07-12 process (NEI 2010-TN10652).
- In December 2018 and November 2019, an F&O closure review was conducted using NEI Appendix X guidance for closeout of F&Os (NEI 2017-TN10358). In response to an RCI (CEG 2024-TN11148), CEG confirmed that this review included all finding-level F&Os. Additionally, CEG acknowledged that the closure review was conducted using NEI Appendix X guidance for closeout of F&Os (NEI 2017-TN10358) and in accordance with NRC expectations and conditions of its use (NRC 2017-TN10368, NRC 2017-TN10369).
- In 2022, a focused-scope peer review was performed on the Fire Scenario Selection technical element. In response to an NRC staff RAI (CEG 2024-TN11148), CEG clarified that the peer review was conducted using the ASME/ANS) PRA Standard RA-Sa-2009 (ASME/ANS 2009) and NRC Regulatory Guide 1.200, Revision 2 (NRC 2009-TN6211) in accordance with the NEI 17-07 process (NEI 2019-TN10639).

The ER explains that all F&Os from the April 2018 peer review were formally closed using the F&O closure review process, but that one F&O remains open from the 2022 focused-scope peer review. In response to an NRC staff RAI (CEG 2024-TN11148), CEG clarified that the fire PRA model of record used in the SAMA analysis (CL122AF0) incorporates the dispositions to all the formally closed F&Os. Additionally, the one F&O that remains open is concerned with the need to demonstrate that risk-significant combinations of human failure events (HFEs) were adequately captured by the fire human reliability analysis dependency analysis. CEG addressed this concern for the SAMA analysis by (1) reviewing the importance measures from the baseline PRA results to confirm that all risk-significant HFE-dependent combinations were reviewed for proper dependence level assignments and order of HFEs and (2) identifying unanalyzed HFE-dependent combinations and evaluating the impact on the SAMA evaluation. Upon doing so, the applicant stated that the exclusion of the unanalyzed HFE-dependent combinations within the fire PRA does not alter the conclusions of the SAMA evaluation.

Considering that a CPS fire PRA has been significantly upgraded since the IPEEE, that the fire PRA was used to directly assess the impact of SAMAs, and that the fire PRA has been peer-reviewed with peer review findings either addressed or closed using a process acceptable to the NRC, the NRC staff concludes that the fire PRA, as discussed above, is acceptable for use in the assessment of SAMAs.

High Winds, Floods, and Other External Events

In response to an RAI (CEG 2024-TN11148), CEG explained that other external events, such as high winds, floods, aircraft accidents, hazardous materials, and turbine-generated missiles were assessed in the CPS IPEEE and that the conclusion from the IPEEE assessment is that there are no significant events of concern. CEG further explained that an updated assessment of other external hazards, which supersedes the IPEEE, was performed using a progressive screening approach consistent with ASME/ANS RA-Sa-2009 (ASME/ANS 2009-TN6220), concluding that CPS meets the applicable NRC Standard Review Plan requirements for high winds, floods, and other external events, that the contribution to CDF from other external hazards is less than 1×10^{-6} per reactor-year, and that, therefore, these events are not significant contributors to external event risk.

The NRC staff noted in an RAI (NRC 2024-TN10876) that NRC Regulatory Issue Summary (RIS) 2015-06 identified several instances in which nuclear power plants were determined to not conform with their tornado-generated missile licensing basis and asked CEG to discuss any changes to the CPS site or surrounding environment or to CPS that would change the conclusions of the IPEEE regarding tornado-generated missiles and which could impact the SAMA analysis. CEG responded that the basis for the CPS extreme winds and tornado hazard has been updated since the submittal of the IPEEE, that evaluation accounts for the current configuration of the CPS site, and that the risk from extreme winds and tornado missiles can be characterized as negligible for the CPS SAMA analysis (CEG 2024-TN11148).

Following the accident at the Fukushima Dai-ichi Nuclear Power Plant, CEG conducted additional external flood walkdowns as requested by NRC's Title 10 CFR 50.54(f) letter request for information (NRC 2012-TN2198). Based on its review of CEG's submittal, the NRC staff concluded that the licensee's implementation of the flooding walkdown methodology meets the intent of the walkdown guidance and that the licensee, through the implementation of the walkdown guidance activities and, in accordance with plant processes and procedures, verified the plant configuration with the current flooding licensing basis; addressed degraded, nonconforming, or unanalyzed flooding conditions; and verified the adequacy of monitoring and maintenance. Furthermore, the NRC staff noted that the licensee's walkdown results, which were verified by the staff's inspection, identified no immediate safety concerns (NRC 2014-TN11320).

As part of implementing lessons learned from the accident at the Fukushima Dai-ichi Nuclear Power Plant, the NRC issued a Title 10 CFR 50.54(f) letter request for information (NRC 2012-TN2198). Enclosure 2 to the letter requested licensees to re-evaluate flood-causing mechanisms using present-day methodologies and guidance. Concurrently with the re-evaluation of flooding hazards, licensees were required to develop and implement mitigating strategies in accordance with NRC Order EA-12-049, "Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" (NRC 2012-TN3237).

CEG submitted the CPS reevaluated flood hazard assessment on March 12, 2014 (Exelon 2014-TN11321), and the NRC staff provided its assessment of the reevaluation on October 27, 2015 (NRC 2015c). In its assessment, the NRC staff confirmed the licensee's determination that (a) the reevaluated flood hazard results for each re-evaluated flood-causing mechanism are bounded by the current design basis flood hazard and (b) an integrated assessment or focused evaluation as outlined in COMSECY-15-0019 (NRC 2015-TN11322) is not necessary.

CEG submitted the flooding mitigating strategies assessment for CPS on March 24, 2016 (Exelon 2016-TN11323), and the NRC staff provided its assessment of the CEG submittal on June 29, 2016 (NRC 2016-TN11324). The NRC staff assessment confirmed that the licensee's flood hazard mitigating strategies assessment was performed consistent with applicable guidance. Further, based on the licensee's appropriate hazard characterization, the methodology used in the mitigating strategies assessment evaluation, and the description of its strategies (i.e., existing FLEX strategies and changes and modifications to the site), the staff concluded that the licensee has demonstrated that the mitigation strategies, if appropriately implemented, are reasonably protected from reevaluated flood hazard conditions for beyond-design-basis external events.

Considering that the NRC staff concluded that the flooding protection measures implemented at CPS provide effective measures for protection against beyond-design-basis external flooding events, that the NRC staff has concluded that flooding mitigation strategies implemented at CPS are reasonably protected from reevaluated flood hazard conditions, that the reevaluated flood hazard conditions were conservatively assessed, and that the contribution to CDF from high winds and other external events is negligible. The NRC staff concludes that not including a CDF contribution for these hazards in the development of the external events multiplier is acceptable. Furthermore, the NRC staff concludes that no additional external flooding SAMAs need to be considered because CEG has implemented the NRC-mandated safety enhancements from the lessons learned from the Fukushima Dai-ichi accident and that has completed its response to the 50.54(f) letter for CPS (NRC 2017-TN11325, NRC 2019-TN11326).

<u>External Events Multiplier</u>

As stated in Addendum 2 to Attachment F of the CPS ER, a multiplier of 1.193 was used to adjust the risk benefit associated with a SAMA to account for seismic events. This multiplier was based on a total CDF of 3.96E-5, which is the sum of the CDF for internal events, internal flooding, and fire contributors of 3.32×10^{-5} per year and the CDF for seismic events of 6.40×10^{-6} per year. The external events multiplier was therefore calculated by CEG to be 1.193 (3.96×10^{-5} per year / 3.32×10^{-5} per year).

The sources of these CDF values are discussed in the previous sections above. Considering the assumptions and uncertainties associated with this analysis and noting that non-seismic external events are not significant contributors to external event risk, the NRC staff considers the external events multiplier of 1.193 reasonable for the SAMA analysis.

F.2.2.3 Level 2 Fission Product Release Analysis

The NRC staff reviewed the general process used by CEG to translate the results of the Level 1 PRA into containment releases as well as the results of the Level 2 analysis, as described in the ER and in responses to staff RAIs (CEG 2024-TN11148). CEG indicated that both the internal events model (CL122A) and the fire PRA model (CL122AF0) used to support the SAMA analysis can quantify a full range of Level 2 release categories, including LERF.

Within the response to an NRC staff RAI (CEG 2024-TN11148), CEG explained that the Level 2 analysis is linked to the Level 1 model by extending the model to include CETs, which characterize the post-core-melt accident response. The CETs consider the influence of physical and chemical processes on the integrity of the containment and on the release of fission products. Level 1 CDF accident sequences are assigned to accident classes and grouped under accident class gates in the fault tree. Those accident class gates are the entry conditions for the

Level 2 CETs to ensure that the Level 1 failures propagate through the CETs. Each accident class has a corresponding CET Level 2 sequence for evaluation.

The top events of the CET represent events that may have a significant impact on the ability of the containment to remain intact and contain the fission products released from the core by the core damage accident. The top events describe either phenomenological events or processes of severe accident response, potential recovery or mitigating actions, or containment system responses that impact the severe accident progression. The CET events and their respective nodal equations are related to additional fault tree logic to ensure complete linking of all system-related interactions. A list of the CET functional events and their descriptions used for the Level 2 analysis is provided within CEG's RAI response (CEG 2024-TN11148). The NRC staff notes that the CET nodes or functional events are relatively complex and may involve more than simple success or failure. A single CET is used with nodes evaluated by fault tree logic, which, in some cases, are representations of decomposition event trees.

The CET end points, or STCs, represent the outcomes of possible containment accident progression sequences with each end point representing a complete sequence from initiator to release to the environment. Associated with each STC is an atmospheric radionuclide source term, including the timing, magnitude, and other conditions associated with the release. Because of the large number of STCs, they are grouped into release categories. CEG defined 10 release categories. One release category is for no containment failure or containment intact; two represent large releases (early and late), two represent medium releases (early and late), two represent low releases (early and late), two represent low-low releases (early and late), and one represents a break outside of containment.

The release categories and their frequencies are provided within CEG's response to an NRC staff RAI (CEG 2024-TN11148). The frequency of each release category is the sum of the frequencies of the various STCs assigned to that release category.

As stated in the ER (CEG 2024-TN10806), MAAP 4.0.5 was used to determine the progression of the various Level 2 sequences and the resulting timing and magnitude of fission product releases. CEG indicated that many different accident sequences were analyzed using MAAP, primarily focused on the dominant core damage sequences of the internal events and fire PRA models, and that a representative MAAP case was then chosen for each STC based on MAAP case release magnitudes and release timing. Table F.3-15 of the ER summarizes the selection process of representative MAAP cases for each release category (CEG 2024-TN10806). In response to an NRC staff RAI (CEG 2024-TN11148), the applicant further explained that where multiple MAAP cases could be reasonably selected, the more conservative case was chosen such that the SAMA analysis did not underestimate the estimated benefits of SAMA candidates.

In response to an RAI (CEG 2024-TN11148), CEG states, with regard to the Level 2 PRA, that although the focus of documented peer reviews was LERF, they included a review of the Level 2 and CET modeling. Additionally, CEG clarified that Level 2 analyses have been prepared, reviewed, and approved using CEG procedures, which require an independent review by knowledgeable risk management engineers.

Based on its review of the Level 2 methodology that is in accordance with the NEI 05-01A guidance, CEG's responses to NRC staff RAIs, and the bases for determining that the resolution to internal CEG and independent peer reviews of the Level 2 model would not impact the SAMA results, the NRC staff concludes that the Level 2 PRA, as used in the SAMA analysis, provides an acceptable basis for evaluating the benefits associated with various SAMAs.

F.2.2.4 Level 3 Consequence Analysis

CEG used the WinMACCS code, Version 3.10.0, and a core inventory from a plant-specific calculation to determine- the offsite consequences from potential releases of radioactive material (CEG 2024-TN10806). CEG calculated the core inventory for 3,473 MWt, which is the licensed power level for CPS (CEG 2024-TN10806).

The staff reviewed the process used by CEG to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (Level 3 PRA model). 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 were considered. In ER Section F.3.5, CEG clarified that the core inventory used in the SAMA radiological dose calculations bounds the current and anticipated CPS fuel management and burnup approach during the period of extended operation.

Additional plant-specific input to the Level 3 assessment includes the core release fractions and source terms for each release category, site-specific meteorological data, projected population distribution, and expected growth out to the year 2047 within a 50-mi (80-km) radius, emergency evacuation modeling, and economic data. This information is provided in Section F.3 of Attachment F to the ER (CEG 2024-TN10806).

According to the ER, CEG considered site-specific meteorological data for the calendar years 2019 through 2021. CEG explained that the 2020 data set was used to support the SAMA analysis based on the combination of low data voids and generally higher PDR and OECR. Within the ER, CEG performed a sensitivity analysis and demonstrated that the population dose and offsite economic cost varied less than 1.0 percent for years 2019 and 2021. Within Section F.3.7 of the ER, CEG explained that all meteorological data except mixing layer height was obtained from onsite meteorological stations.

Missing meteorological data was obtained by interpolation (if the data gap was less than 6 hours) or by substitution (that is, using data from the same hour and a nearby day if the data gap was 6 or more consecutive hours). After reviewing the meteorological data for reasonableness, CEG determined that about 0.3 percent of data was revised via interpolation or substitution. Over the period of collection, less than one percent of temperature data were missing, with the hours of missing data filled by substitution.

For atmospheric mixing height data, the NRC staff noted in an RAI that values are based on 1972 U.S. Environmental Protection Agency data (NRC 2024-TN10876). In response (CEG 2024-TN11148), CEG clarified that atmospheric mixing height data for CPS is limited and determined that the only other data applicable to CPS was from U.S. Environmental Protection Agency sources for the eight-year period between 1984 and 1991. The applicant performed two sensitivity studies applying the minimum and maximum mixing layer heights obtained over the eight-year period. With the maximum mixing layer heights, the offsite economic cost was reported to increase by 7.4 percent, and with the minimum heights, the offsite economic cost was reported to increase by 5.5 percent. With the maximum mixing layer heights, the total population dose risk was reported to increase by 4.3 percent, and with the minimum heights, the total population dose risk was reported to increase by 3.2 percent. Given the small or negligible change in the population dose and offsite economic cost, the NRC staff concludes that the assumption related to mixing layer heights is reasonable and acceptable for the purposes of the SAMA evaluation.

The sources of data and models for atmospheric dispersion used by the applicant are consistent with standard industry practice and acceptable for calculating consequences from potential airborne releases of radioactive material. Because multiple years of meteorological data were considered by the applicant and the annual data set that resulted in the largest total population dose and offsite economic cost was selected for the SAMA analysis, the NRC staff finds that the data selection was performed in accordance with NRC guidance (NEI 2005-TN1978), and thus, the meteorological data are appropriate for use in the SAMA analysis.

CEG projected population distribution and expected growth within a radius of 50 mi (80 km) out to the year 2047 to account for the time remaining on the original operating license plus a 20-year period of extended operation (CEG 2024-TN10806). The CEG assessment used U.S. Census 2020 data and scaled the population data to 2047 using county-level projection estimates for Illinois. For any counties having projections of declining populations, CEG used 2023 population estimates given that it is early in the extended license period, which would begin in 2027. Transient populations were included in the projections. The total projected population of the 50 mi (80 km) zone of analysis is 841,744, and the distribution of the 2047 total population is summarized in Table F.3-6 of the ER. The NRC staff considers the methods and assumptions for estimating population to be reasonable and acceptable for purposes of the SAMA evaluation because its review of CEG's assessment determined that CEG considered appropriate data sources, used a reasonable approach for applying data, and followed NRC guidance (NEI 2005-TN1978).

CEG assumed that 99 percent of the population within the emergency planning zone would evacuate (CEG 2024-TN10806). This assumption is more conservative relative to the NUREG-1150 study (NRC 1990-TN525), which assumed evacuation of 99.5 percent of the population within the 10-mile emergency planning zone. While CEG did not perform a sensitivity analysis on the time to declaration of an emergency, CEG conservatively used a minimum time of 30 minutes for declaration of a general emergency, as discussed in ER Section F.3.6, for release categories with core damage projected to occur in less than 30 minutes.

CEG assumed that based on a 2014 evacuation time estimate (ETE) study, the delay time for the population to evacuate following a declaration of an emergency is 57 minutes for the first cohort and 105 minutes for the second cohort (CEG 2024-TN10806). CEG performed a sensitivity analysis assuming the delay time was doubled for the first cohort and increased by 50 percent for the second. The population dose was reported to increase by 0.1 percent, and the offsite economic cost was reported to be unchanged. Additionally, as stated in Section 7.3.1.2 of Addendum 2 to Appendix F of the CPS ER, a 2022 update to the 2014 ETE study demonstrated that the delay times informed by the 2014 study bound those developed in the 2022 update. Given that the change in the population dose and offsite economic cost is small or negligible, the 2014 ETE study used to inform the base case is bounding in nature, and the sensitivity analysis results are bounded by the uncertainty analysis results discussed in Section F.6.2, the NRC staff concludes that the assumption related to the delay time to evacuate is reasonable and acceptable for the purposes of the SAMA evaluation.

CEG also considered a sensitivity analysis on evacuation speed, which was assumed to be 4.0 meters per second for the first cohort and 2.4 meters per second for the second cohort in the base case used to support the SAMA evaluations (CEG 2024-TN10806). CEG performed sensitivity analyses that both increased and reduced the evacuation speeds for each cohort by a factor of 2. When the evacuation speed was increased, the population dose was reported to decrease by 0.1 percent, and when it was decreased, the population dose was reported to increase by 0.2 percent. For both cases, the offsite economic cost was reported to be

unchanged. Additionally, as stated in Section 7.3.1.2 of Addendum 2 to Appendix F of the CPS ER, a 2022 update to the 2014 ETE study demonstrated that the evacuation speeds informed by the 2014 study bound those developed in the 2022 update. Given that the change in the population dose and offsite economic cost is small or negligible, the 2014 ETE study used to inform the base case is bounding in nature, and the sensitivity analysis results are bounded by the uncertainty analysis results discussed in Section F.6.2, the NRC staff concludes that the assumption related to the evacuation speed is reasonable and acceptable for the purposes of the SAMA evaluation.

CEG assumed that the height of the release of the plumes was at mid-containment or 29.1 m (95.5 f) (CEG 2024-TN10806). CEG performed sensitivity analyses assuming the height of the release of the plumes was at the ground surface (ground release) and at the top of containment or 58.2 m (190.9 ft). The population dose increased by 0.2 percent for the ground release and decreased by 0.2 percent for the top of the containment release. The offsite economic cost decreased by 1.4 percent for the ground release and increased by 1.5 percent for the top of the containment release. Given that the change in the population dose and offsite economic cost is small or negligible and that the sensitivity analysis results are bounded by the uncertainty analysis results discussed in Section F.6.2, the NRC staff concludes that the plume release height assumption is reasonable and acceptable for the purposes of the SAMA evaluation.

CEG assumed that the rate of release of sensible heat in each plume segment was in the range of 1×10^6 to 1×10^7 watts (CEG 2024-TN10806). CEG performed sensitivity analyses assuming the rate of release of sensible heat in each plume segment was zero watts, or in other words, that there was no buoyant plume rise. The population dose was increased by 0.3 percent, and the offsite economic cost was decreased by 1.9 percent. Given that the change in the population dose and offsite economic cost is small or negligible and that the sensitivity analysis results are bounded by the uncertainty analysis results discussed in Section F.6.2, the NRC staff concludes that the assumption regarding the rate of release of sensible heat in plume segments is reasonable and acceptable for the purposes of the SAMA evaluation.

CEG assumed 10 particle size groups with a different dry deposition velocity for each group (CEG 2024-TN10806). CEG performed sensitivity analyses assuming a single dry deposition velocity of 0.3 centimeters per second. The population dose was increased by 6.6 percent, and the offsite economic cost was increased by 16 percent. Given that the change in the population dose and offsite economic cost is small and that the sensitivity analysis results are bounded by the uncertainty analysis results discussed in Section F.6.2, the NRC staff concludes that the assumption regarding the dry deposition velocity is reasonable and acceptable for the purposes of the SAMA evaluation.

The site-specific regional economic and agricultural data was provided from the 2012 U.S. Census of Agriculture, SECPOP (Version 4), and the U.S. Bureau of Labor Statistics. Data was obtained for all of the counties that are all or in part within 50 mi (80 km) of the CPS site. ER Table F.3-7 summarizes economic parameter inputs used in the Level 3 analysis in support of SAMA evaluations. In the ER (CEG 2024-TN10806), as clarified by the response to an NRC staff RAI (CEG 2024-TN11148), the applicant scaled economic costs for evacuation, relocation, and decontamination to year 2022 costs from values in or based on NUREG/CR-7270 (SNL 2022) using the ratio of the associated yearly consumer price index (CPI) values. The average cost of decontamination labor was scaled to 2022 costs from the 2012 value obtained from NUREG/CR-7270 using the ratio of the 2022 and 2012 CPI values. The staff considers the MACCS2 values, adjusted to 2022 costs using the CPI, used by the applicant to be reasonable for the SAMA analysis.

As indicated in Table 7.3-1 of Addendum 2 to Attachment F of the applicant's ER (CEG 2024-TN10806) and as clarified by the response to an NRC staff RAI (CEG 2024-TN11148), CEG applied values of 365 days for the decontamination time and $100,000 per person for the non-farmland decontamination costs. Given these values, the sensitivity analysis values recommended in U.S. NRC order CLI-16-06 (NRC 2016-TN4631), the NRC staff concludes that the decontamination time and the decontamination costs values are reasonable and acceptable for the purposes of the SAMA evaluation.

In summary, the NRC staff reviewed CEG's assessments of the source term, radionuclide releases, meteorological data, projected population distribution, emergency response, and regional economic and agricultural data and evaluated CEG's responses to NRC staff RAIs, as previously described in this subsection. Based on the NRC staff's review, the NRC staff concludes that CEG's consequence analysis is acceptable and that CEG's methodology to estimate offsite consequences for CPS and consideration of parameter sensitivities provide an acceptable basis to assess the risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDFs, population doses, and offsite economic costs reported by CEG.

F.3 Potential Plant Improvements

The process for identifying potential plant improvements (SAMAs), an evaluation of that process, and the improvements evaluated by CEG are discussed in this section.

F.3.1 Process for Identifying Potential Plant Improvements

CEG's process for identifying potential plant improvements consisted of the following elements (CEG 2024-TN10806):

- review of SAMAs identified in industry documents, specifically NEI 05-01A (NEI 2005-TN1978),
- review of SAMA analyses for other BWR plants,
- review of potential plant improvements identified in the CPS IPE and IPEEE, and
- review of the risk-significant events in the current CPS PRA Levels 1 and 2 models.

Based on this process, CEG identified a number of potential plant improvements, subjecting them to qualitative and bounding quantitative screening and eliminating those from further consideration using the following criteria:

- the SAMA-modified features not applicable to CPS,
- the SAMA has already been implemented at CPS,
- the SAMA is similar in nature and could be combined with another SAMA candidate, and
- the SAMA is expected to have a very low benefit (small or no contribution to risk).

Based on this screening, CEG identified an initial set of 25 candidate SAMAs, referred to as Phase I SAMAs, within Addendum 2 to Attachment F of the applicant's ER (CEG 2024-TN10806). This set of Phase I SAMAs was not reduced further as none had an excessive implementation cost (in excess of the maximum averted cost-risk). These remaining 25 SAMAs, referred to as Phase II SAMAs within the applicant's ER, are evaluated in Section 6 of Addendum 2 to Attachment F of the ER. As discussed in Section F.6.2, CEG also considered possible increases in benefits from analysis uncertainties on the results of the SAMA

assessment, leading to the retention of an additional Phase I SAMA candidate that underwent Phase II evaluations in Section 7.2 of Addendum 2 to Attachment F to the applicant's ER. In Phase II, a detailed evaluation was performed for each of the 25 remaining SAMA candidates, as discussed in Sections F.4 and F.6 below.

F.3.2 Review of CEG's Process

The initial SAMA list was developed primarily from a review of the cost-beneficial SAMAs from past BWR license renewal applications and from CPS-specific assessments of the CPS PRA Level 1 and Level 2 results. CEG provided a listing and description of equipment failures, human actions, and phenomenological assumptions (including probability and Fussell-Vesely [F-V] value for each) from the Level 1 PRA and Level 2 analysis that have the greatest potential for reducing risk at CPS based on importance analysis (CEG 2024-TN10806). For each item in this listing, CEG identified Phase I SAMA candidate(s) that could mitigate the failures, and as a result, 23 Phase I SAMA candidates were identified from the review of these importance lists. At least one Phase I SAMA candidate was identified for all the dominant risk contributors.

In its review of the cost-beneficial SAMAs from six previous BWR license renewal applications, CEG identified two additional unique Phase I SAMA candidates. Within Section F.5.1 of Attachment F to the CPS ER, CEG also explained that the industry generic list of SAMA candidates in NEI 05-01A (NEI 2005-TN1978) was not explicitly identified as Phase I SAMA candidates, but this list was used to inform the generation of SAMAs for dominant contributors to CPS risk.

Additionally, while the CPS IPE and IPEEE did not identify any vulnerabilities requiring enhancements, all the plant enhancements identified in these documents have been implemented except one (CEG 2024-TN10806). CEG determined that a functional equivalent of the one unimplemented enhancement is already captured as a Phase I SAMA candidate (specifically, SAMA 10).

In Table 5-1 of Addendum 2 to Attachment F of the ER (CEG 2024-TN10806), CEG provided a tabular listing of the Level 1 PRA basic event CDF importance down to an F-V value of 0.05. This listing included consideration of internal events, including internal flooding, as well as fire events. In response to RAI (CEG 2024-TN11148), CEG clarified the process used to review risk contributors and ensure that SAMAs are evaluated for each dominant risk contributor, as defined by NEI 05-01A. This process included a robust review of associated accident sequences as well as systems, structures, and components and operator actions, including those far lower than the 0.05 F-V threshold. CEG further explained that the results of the review also provided validation for the cutoff value used to determine what a dominant risk contributor is in the context of the SAMA analysis, as no new contributors were being identified near the review threshold.

In Table 5-2 of Addendum 2 to Attachment F of the ER (CEG 2024-TN10806), CEG also provided and reviewed the basic events associated with the high (H/E and H/L), medium (M/E and M/L), and BOC release categories down to an F-V value of 0.05. These release category groups combine to represent over 98 percent of the PDR and 99 percent of the OECR for approximately 33 percent of the Level 2 frequency. Exclusion of the other results from the Level 2 review allows the contributors that are most important to PDR and OECR to rise to the top of the importance list. As discussed above, CEG, in response to a staff RAI (CEG 2024-TN11148), clarified that the same process as that used for the Level 1 PRA analysis was employed to review the risk contributors associated with the high (H/E and H/L), medium (M/E and M/L), and

BOC release categories and ensure that SAMAs are evaluated for each dominant risk contributor, as defined by NEI 05-01.

As discussed above in Section F.2.2.2, the CPS external flooding-focused evaluation demonstrated that the flood hazard results for each re-evaluated flood-causing mechanism are bounded by the CLB. Additionally, the NRC staff concluded that the applicant has demonstrated that the mitigation strategies appropriately address the reevaluated hazard conditions at CPS. Lastly, the NRC staff notes that no additional external flooding SAMAs need to be considered because CEG has implemented the NRC-mandated safety enhancements from the lessons learned from the Fukushima Dai-ichi accident and has completed its response to the 50.54(f) letter for CPS (NRC 2017-TN11325).

The CPS IPEEE used a limited-scope seismic margins assessment, which provided neither quantitative risk information nor deterministic seismic capacities for specific CPS systems, structures, or components. As discussed above in Section F.2.2.2, the IPEEE did not identify any seismic vulnerabilities. Additional reviews of the impact of seismic events on CPS were also undertaken following the accident at the Fukushima Dai-ichi Nuclear Power Plant. Furthermore, the NRC staff concluded that no further response or regulatory actions were required related to the seismic hazard reevaluation activities requested by Enclosure 1 of the 50.54(f) letter and that sufficient information has been provided to demonstrate that the applicant's plans for the development and implementation of guidance and strategies under Order EA-12-049 appropriately address the reevaluated seismic hazard information stemming from the 50.54(f) letter (NRC 2016-TN11330). Lastly, the NRC staff notes that seismic risk is addressed within the SAMA analysis through the external events multiplier.

The NRC staff questioned the applicant about additional potentially lower-cost alternatives to a number of the SAMAs as follows (NRC 2024-TN10876):

- In an RAI (NRC 2024-TN10876), the staff noted that SAMA 5, which addresses the installation of an emergency tie line from the switchyard to an emergency bus, is based on an estimate developed for a potentially cost-beneficial SAMA at Wolf Creek Generating Station (WCGS); however, given the difference between the scope of the WCGS SAMA and that of CEG's SAMA 5, the basis for applying the WCGS estimate was not clear. In response (CEG 2024-TN11148), the applicant clarified the differences and stated that while some differences exist, any significant differences make the $400,000 WCGS cost estimate a low-end cost for the scope of changes required by CEG's SAMA 5.
- The staff notes that the set of SAMAs submitted is not all-inclusive because additional, possibly even less expensive, alternatives can always be proposed. 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 likely would not cost less than the least expensive alternatives evaluated when the subsidiary costs associated with maintenance, procedures, and training are considered.
- The staff concludes that CEG used a systematic and comprehensive process for identifying potential plant improvements for CPS, which included reviewing a list of generic industry SAMAs (NEI 2005-TN1978), reviewing insights from the CPS plant-specific risk studies, including internal initiating events as well as fire, seismic, and other externally initiated events, considering cost-beneficial plant improvements from previous SAMA analyses, and satisfactorily addressing the NRC staff's questions regarding the SAMA identification process. The staff further concludes that the set of SAMAs evaluated in the ER, together with those evaluated in response to staff inquiries, is reasonably comprehensive and acceptable.

F.4 Risk Reduction Potential of Plant Improvements

In the ER, and in response to RAIs, the applicant evaluated the risk-reduction potential of the 24 SAMAs that were not screened out in the Phase I analysis and retained for the Phase II evaluation. Beyond these SAMAs, one additional SAMA underwent Phase II evaluations as a means to address possible increases in benefits from analysis uncertainties on the results of the SAMA assessment, as discussed in Section F.6.2. The SAMA evaluations were performed using generally conservative assumptions (e.g., the SAMA is assumed to completely eliminate the associated risk).

Table F-4 below 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, PDR, and OECR; the estimated total benefit (present value) of the averted risk, and the estimated implementation cost. The estimated benefits reported in Table F–4 reflect the combined benefit in both internal and external events. The determination of the implementation costs and benefits for the various SAMAs is further discussed in Sections F.5 and F.6, respectively. The SAMAs identified in **bold** in Table F–4 were found to be potentially cost beneficial; the other listed SAMAs were determined not to be potentially cost beneficial, which is further discussed in Section F.6.

CEG used model re-quantification to determine the potential benefits for each SAMA. The CDF, PDR, and OECR were estimated using the CPS PRA model (CL122A/CL122AF0). The changes made to the model to quantify the impact of SAMAs are detailed in Sections 6.0 and 7.2 of Addendum 2 to Attachment F to the CPS ER (CEG 2024-TN10806). Bounding evaluations were performed to address each of the Phase II SAMA candidates.

The NRC staff review of the assumptions and risk reduction potential for the SAMAs leads to an additional RAI as discussed below.

In an RAI (NRC 2024-TN10876), the NRC staff noted that Section 6.2 of Addendum 2 to Attachment F of the CPS ER indicates that the benefit of SAMA 3 is at least partially derived from the reactor core isolation cooling (RCIC) storage tank being protected but that the protection entailed is not clear. In response to the RAI (CEG 2024-TN11148), CEG clarified that the existing CPS RCIC storage tank is not designed to withstand some of the external events hazards (e.g., tornado missiles) that are postulated to lead to extended loss of AC power (ELAP) scenarios at CPS; therefore, the CPS FLEX strategies assume the RCIC storage tank is not available to support long-term RCIC injection for any ELAP scenario. For CPS SAMA 3, CEG conservatively assumes that if the RCIC storage tank could be protected from tornado missiles, it would be available for use in all ELAP scenarios. The NRC staff finds the assumption used by CEG to evaluate this SAMA reasonable.

In an RAI (NRC 2024-TN10876), the NRC staff noted that Section 6.4 of Addendum 2 to Attachment F of the CPS ER indicates that SAMA 5 is modeled by reducing the human error probability associated with bus realignment, by reducing the execution time for bus realignment from 60 to 30 minutes, but that it was not clear how this captured the risk reduction potential for the SAMA in question. In response to the RAI (CEG 2024-TN11148), CEG clarified that the assumption of a 30-minute execution time did not impact the results of the SAMA analysis, as the time would need to be reduced to less than one minute, which is not realistic given the operational steps involved, to have any further significant impact. The NRC staff finds the assumption used by CEG to evaluate this SAMA reasonable.

In an RAI (NRC 2024-TN10876), the NRC staff noted that Section 6.25 of Addendum 2 to Attachment F of the CPS ER indicates that for SAMA 28, risk-significant conduits are re-routed from Fire Zone CB-5A to Fire Zone CB-1G but that these conduits are then assumed to be failed for all fires originating in Fire Zone CB-1G. In response to the RAI (CEG 2024-TN11148), CEG performed a sensitivity study, assuming that contributions from Fire Zone CB-1G are also eliminated. The averted cost-risk was shown to increase by a factor of 3.08, but the results of the SAMA evaluation did not change (i.e., the SAMA was not found to be cost beneficial). The NRC staff finds that the assumption used by CEG does not adversely impact the results of the evaluation for SAMA 28.

The staff concludes that, with the above clarifications, the consideration of risk reduction potential of plant improvements by CEG is sufficient and appropriate for use in the SAMA evaluation because it is technically sufficient and meets the guidance provided in NEI 05-01A.

Table F-4 SAMAs Cost/Benefit Analysis for Clinton Power Station, Unit 1. Percentage Risk Reductions are Presented for Core Damage Frequency, Population Dose Risk, and Offsite Economic Cost Risk (OECR)[a]

SAMAs	Analysis Assumptions	% Risk Reduction			Internal and External Benefit[b]	Internal and External Benefit with Uncertainty[b]	Implementation Cost
		CDF	PDR	OECR			
2 – Proceduralize DC current check for ELAP load shed action	**Revise associated HEP to represent a procedure-based check.**	**4.6%**	**2.7%**	**2.4%**	**$428,739**	**$1,320,516**	**$50,000**
3[c] – Protect the RCIC storage tank and provide long term makeup	Ensure that a viable source of water and containment heat removal is available for any ELAP scenarios.	1.0%	2.8%	3.1%	$483,826	$1,490,184	$8,915,554
4 – Enhance containment venting capability (e.g., FLEX hard pipe vent)	**Apply failure probability of 0.5 to represent this capability.**	**29.2%**	**39.5%**	**41.1%**	**$6,537,049**	**$20,134,111**	**$12,940,000**
5[c] – Install an emergency tie line from the switchyard to an emergency bus	**Reduce the HEP associated with bus realignment.**	**0.8%**	**0.9%**	**0.9%**	**$148,298**	**$456,758**	**$400,000**
6 – Provide flood protection for MCR HVAC ducts	Reduce frequency of flooding event by a factor of 5.	1.4%	0.0%	0.1%	$25,159	$77,490	$475,000
7 – Enhance procedures and operator training to include containment venting control for NPSH management	**Reduce HEP by an order of magnitude.**	**1.1%**	**1.0%**	**0.9%**	**$155,574**	**$479,168**	**$250,000**
8 – Replace the inboard containment vent AOV with an environmentally qualified valve	Reduce failure probability of valve to operate due to adverse environmental conditions by an order of magnitude.	1.5%	1.1%	1.0%	$172,813	$532,264	$1,828,302

Table F-4 SAMAs Cost/Benefit Analysis for Clinton Power Station, Unit 1. Percentage Risk Reductions are Presented for Core Damage Frequency, Population Dose Risk, and Offsite Economic Cost Risk (OECR)[a] (Continued)

SAMAs	Analysis Assumptions	% Risk Reduction			Internal and External Benefit[b]	Internal and External Benefit with Uncertainty[b]	Implementation Cost
		CDF	PDR	OECR			
9 – Install keylock switch to override MSIV low RPV level isolation logic	Reduce HEP to reflect use of keylock switch.	0.1%	0.1%	0.1%	$20,823	$64,135	$635,242
10 – Install a hard piped connection between FPS and RHR	**Apply failure probability to align FPS for RPV makeup of 0.5.**	**7.9%**	**3.8%**	**3.7%**	**$641,717**	**$1,976,488**	**$649,194**
11 – Replace valves with versions designed to close against high flow and differential pressure	Model failure of valve of capable of isolation with a failure probability of 1E-02.	0.0%	0.0%	0.0%	$1,211	$3,730	$600,000
12 – Modify plant procedures to direct use of FLEX generators to support containment venting	**Apply current FLEX modeling to add support for containment venting.**	**0.5%**	**0.8%**	**0.9%**	**$134,977**	**$415,729**	**$100,000**
14 – Install 3-hour-rated fire cable wrap on offsite power cables in risk-significant areas	**Assume cable wrap that prevents failure of protected cables for all fire scenarios.**	**37.7%**	**49.9%**	**50.7%**	**$8,120,783**	**$25,012,012**	**$5,629,397**
15 – Install a battery backup to the hydrogen igniters	**Apply a failure probability of 0.1 for the battery system.**	**0.0%**	**3.2%**	**3.3%**	**$495,734**	**$1,526,861**	**$352,000**
17 – Protect the equipment required for SRV operation in the auxiliary building	Eliminate all environmentally induced failures of the SRVs.	0.0%	0.4%	0.5%	$71,094	$218,970	$701,000
18 – Install an emergency RCIC storage tank makeup capability from service water operable from the MCR	Model this capability using a lumped failure probability of 0.25.	0.4%	0.1%	0.1%	$19,003	$58,529	$2,900,000
19 – Modify FLEX procedure for FPS makeup to the RCIC storage tank to allow use in non-ELAP scenarios	Model this capability using a lumped failure probability of 0.25.	0.4%	0.1%	0.1%	$17,251	$53,133	$100,000

Table F-4 SAMAs Cost/Benefit Analysis for Clinton Power Station, Unit 1. Percentage Risk Reductions are Presented for Core Damage Frequency, Population Dose Risk, and Offsite Economic Cost Risk (OECR)[a] (Continued)

SAMAs	Analysis Assumptions	% Risk Reduction			Internal and External Benefit[b]	Internal and External Benefit with Uncertainty[b]	Implementation Cost
		CDF	PDR	OECR			
20 – Additional diesel generator that can act as a swing diesel generator to all divisions of AC power	**Model this capability using a lumped failure probability of 0.25.**	**26.3%**	**33.8%**	**33.5%**	**$5,419,888**	**$16,693,255**	**$8,000,000**
21 – Address flow FW diversion in the loss of instrument air procedure	Loss of instrument air is no longer assumed to lead to loss of FW or to a flow diversion that fails FW.	0.0%	0.0%	0.0%	-$942	-$2,901	$30,000
22 – Upgrade the alternate shutdown panel to include additional system control for the opposite division	Reduce failure probability of the lumped event that represents safe shutdown after MCR abandonment by 50%.	1.0%	0.1%	0.1%	$21,569	$66,433	$790,000
23 – Automatic ATWS level control system	Incorporate an automatic ATWS level control system with a total failure probability of 5E-02.	0.2%	0.4%	0.4%	$64,007	$197,142	$1,481,002
24 – Proceduralize use of Blackstartech DC in non-ELAP situations	Incorporate of the portable system during non-ELAP conditions with a failure probability of 5E-02.	0.7%	0.1%	0.1%	$17,539	$54,020	$100,000
25 – Develop flood area-specific response procedures	Modify detailed HEP calculations to reduce delay times and cognitive failure.	0.0%	0.0%	0.0%	$1,170	$3,604	$115,000
26 – Include explicit steps in the loss of AC power procedure to address water hammer	**Credit an operator action with an HEP of 5E-02.**	**7.3%**	**3.1%**	**3.0%**	**$541,589**	**$1,668,094**	**$250,000**
27 – Install fire wrap/barriers around critical risers in Fire Zone A-2k	**Assume fire wrap/barriers prevent failure of protected cables for all fire scenarios.**	**18.1%**	**28.2%**	**30.1%**	**$4,740,802**	**$14,601,670**	**$1,121,838**

Table F-4 SAMAs Cost/Benefit Analysis for Clinton Power Station, Unit 1. Percentage Risk Reductions are Presented for Core Damage Frequency, Population Dose Risk, and Offsite Economic Cost Risk (OECR)[a] (Continued)

SAMAs	Analysis Assumptions	% Risk Reduction			Internal and External Benefit[b]	Internal and External Benefit with Uncertainty[b]	Implementation Cost
		CDF	PDR	OECR			
28[c] – Reroute risk-significant conduits in Fire Zone CB-5a to Fire Zone CB-1g	Assume risk-significant conduits are re-routed to avoid fire damage.	5.7%	4.3%	3.7%	$649,080	$1,999,166	$3,250,000

AC = alternate current; AOV = air-operated valve; ATWS = anticipated transient without scram; CDF = core damage frequency; DC = direct current; ELAP = extended loss of AC power; FLEX = Diverse and Flexible Mitigation Capabilities; FPS = fire protection system; FW = feedwater; HEP = human error probability; HVAC = heating ventilating air conditioning; MCR = main control room; MSIV = main steam isolation valve; n/a – not applicable or not available; NPSH = net positive suction head; OECR = offsite economic cost risk; PDR = population dose risk; RCIC = reactor core isolation cooling; RHR = residual heat removal; RPV = reactor pressure vessel; SAMA = severe accident mitigation alternative; SRV = safety relief valve.

(a) SAMAs in bold are potentially cost-beneficial.

(b) Benefit values were provided in response to an NRC staff RAI (CEG 2024-TN11148).

(c) Analysis assumptions were provided in response to an NRC staff RAI (CEG 2024-TN11148).

F.5 Cost Impacts of Candidate Plant Improvements

As enumerated in Table F–4, CEG estimated the costs of implementing the 25 SAMAs for which a Phase II evaluation was performed using a site-specific cost estimating process, industry estimates, or, in some cases, a combination of these two sources. CEG provided cost estimates for the implementation of the CPS SAMAs in Table 5-3 of Addendum 2 to Attachment F to the CPS ER (CEG 2024-TN10806).

In response to an NRC staff RAI (CEG 2024-TN11148), CEG clarified that plant-specific estimates were based on conceptual designs, informed by industry examples, available design information, walkdowns, and other relevant data, and reviewed by the CPS SAMA team. The cost estimates included engineering, procurement, and construction costs as well as functional testing costs, when appropriate. However, long-term maintenance, testing, calibration, and training costs were not included. For industry estimates, considerations included the type, capacity, and scope of hardware included in the SAMA; operating conditions and qualifications; and the type of local interface. Industry-sourced implementation costs that conservatively underestimated those associated with SAMA were considered acceptable. Lastly, none of the industry cost estimates were escalated from their original values.

The staff reviewed the applicant's cost estimates, presented in Table 5-3 of Addendum 2 to Attachment F to the CPS ER (CEG 2024-TN10806) and provided in response to RAIs (CEG 2024-TN11148). 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. The NRC staff also reviewed the basis for the cost estimate during the NRC audit of the SAMA analysis (NRC 2024-TN10876).

The staff concludes that the cost estimates provided by CEG are sufficient for use in the SAMA evaluation because the economic viability of the proposed modification could be adequately gauged, and the process meets the guidance provided in NEI 05-01A.

F.6 Cost-Benefit Comparison

CEG's cost-benefit analysis and the staff's review are described in the following sections.

F.6.1 CEG's Evaluation

The methodology used by CEG was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR–0184 (NRC 1997-TN676), which is referenced in the guidance provided in NEI 05-01A. As described in Section F.4 of the ER (CEG 2024-TN10806), the net value was determined for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) – COE

where

APE (averted public exposure) = present value of APE costs ($)

AOC (averted offsite property damage costs) = present value of AOC costs ($)

AOE (averted occupational exposure) = present value of AOE costs ($)

AOSC (averted onsite costs) = present value of AOSC ($)

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, and it is not considered to be cost beneficial. CEG's derivation of each of the associated costs is summarized next.

NEI 05-01A states that two sets of estimates should be developed for discount rates of 7 percent and 3 percent (NEI 2005-TN1978). CEG provided a base set of results using a discount rate of 3 percent and a 20-year license renewal period.

F.6.1.1 Averted Public Exposure Costs

CEG defined annual off-site exposure risk, or averted public exposure, as the monetary value of accident risk avoided from population doses after discounting (CEG 2024-TN10806). The averted public exposure costs were calculated using the following formula:

Averted public exposure = Annual reduction in public exposure (Δ person-rem per year)
× monetary equivalent of unit dose ($5,200 per person-rem)
× present value conversion (NRC 1997-TN676)

The monetary equivalent of a dose of $6,700 per person-rem was determined using the methodology in NUREG-1530, Rev. 1 (NRC 2022-TN7859). The annual reduction in public exposure was calculated according to the following formula:

Annual reduction in public exposure = (Accident frequency without modification × accident population dose without modification) – (Accident frequency with modification × accident population dose with modification)

As stated in NUREG/BR–0184 (NRC 1997-TN676), it is important to note that 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 20-year 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 a discount rate of 3 percent and a 20-year analysis period with a CDF of 3.32×10^{-5} per year and a monetary equivalent of unit dose of $6,700 per person-rem, the applicant calculated an APE cost of approximately $2,863,753 (CEG 2024-TN10806, CEG 2024-TN11148).

F.6.1.2 Averted Offsite Property Damage Costs (AOC)

CEG defined annual offsite economic cost risk, or AOC, as the monetary value of risk avoided from offsite property damage after discounting (CEG 2024-TN10806). The AOC values were calculated using the following formula:

AOC = Annual reduction in offsite property damage × present value conversion

The annual reduction in offsite property damage was calculated according to the following formula:

Annual reduction in offsite property damage = (Accident frequency without modification × accident property damage without modification) – (Accident frequency with modification × accident property damage with modification)

For a discount rate of 3 percent and a 20-year analysis period with a CDF of 3.32×10^{-5} per year, the applicant calculated an AOC of approximately $9,880,303 (CEG 2024-TN10806, CEG 2024-TN11148).

F.6.1.3 Averted Occupational Exposure Costs

CEG defined annual onsite or occupational exposure risk, or AOE, as the avoided onsite exposure (CEG 2024-TN10806). Similar to the APE calculations, the applicant calculated costs for immediate onsite exposure. Long-term onsite exposure costs were calculated consistent with guidance in NUREG/BR–0184 (NRC 1997-TN676).

CEG derived the values for averted occupational exposure from information provided in Section 5.7.3 of NUREG/BR–0184 (NRC 1997-TN676). 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 clean-up period) were used. The present value of these doses was calculated using the equations provided in the NUREG/BR–0184 handbook with a monetary equivalent of unit dose of $6,700 per person-rem, a real discount rate of 3 percent, and an analysis period of 20 years to represent the remaining life of CPS. Immediate and long-term onsite exposure costs were summed to determine AOE cost. For a CDF of 3.32×10^{-5} per year, the applicant calculated an AOE cost of approximately $68,845 (CEG 2024-TN10806, CEG 2024-TN11148).

F.6.1.4 Averted Onsite Costs

AOSC includes 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. The applicant derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR–0184 (NRC 1997-TN676). This cost element was divided into two parts: the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs, and the replacement power cost (RPC).

Averted cleanup and decontamination costs (ACC) were calculated using the following formula:

ACC = Annual CDF reduction
× present value of clean-up costs per core damage event
× 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 spread over a 10-year clean-up period and integrated over the term of the proposed license extension. For a discount rate of 3 percent and an analysis period of 20 years with a CDF of 3.32×10^{-5} per year, CEG calculated an ACC of approximately $647,067 (CEG 2024-TN10806, CEG 2024-TN11148).

Long-term RPCs were calculated using the following formula:

RPC = Annual CDF reduction
× present value of replacement power for a single event
× factor to account for remaining service years for which replacement power is required
× reactor power scaling factor

The applicant based its calculations on a net electric output of 1180 megawatts-electric (MWe) and scaled up from the 1062 MWe reference plant in NUREG/BR-0184 (NRC 1997-TN676). Therefore, the applicant applied a power-scaling factor of 1.17 (1062 / 910) to determine the RPC. For a discount rate of 3 percent and a 20-year analysis period with a CDF of 3.32×10^{-5} per year, CEG calculated an RPC of $214,088 (CEG 2024-TN10806, CEG 2024-TN11148). AOSC, the summation of ACC and RPC, is therefore approximately $861,155 for the 20-year analysis period and a discount rate of 3 percent.

Using the above equations, CEG estimated the total present dollar value equivalent associated with completely eliminating severe accidents due to internal events, including internal flooding and fire events at CPS to be approximately $13,675,000 (CEG 2024-TN10806, CEG 2024-TN11148).

CEG multiplied the estimated benefit for internal events, including internal flooding and fire contributors by a factor of 1.193 to account for the risk contributions from external events to yield the internal and external benefit or maximum attainable risk benefit (CEG 2024-TN11148). Additionally, the internal and external benefits were multiplied by a factor of 3.08 to account for uncertainties in the CDF calculation (CEG 2024-TN10806, CEG 2024-TN11148).

F.6.1.5 CEG's Results

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was determined not cost beneficial. If the benefit exceeded the estimated cost, the SAMA candidate was considered cost beneficial. In the baseline analysis, without consideration of uncertainty, six SAMA candidates (i.e., SAMAs 2, 12, 14, 15, 26, and 27) were found to be potentially cost beneficial (CEG 2024-TN11148). Based on consideration of uncertainty analysis, CEG identified five additional SAMA (i.e., SAMA 4, 5, 7, 10, and 20) as potentially cost beneficial. The results of the cost-benefit evaluation are presented in Table F-4.

The potentially cost-beneficial SAMAs are:

- SAMA 2 – Proceduralize direct current check for ELAP load shed action.
- SAMA 4 – Enhance containment venting capability (e.g., FLEX hard pipe vent).
- SAMA 5 – Install an emergency tie line from the switchyard to an emergency bus.
- SAMA 7 – Enhance procedures and operator training to include containment venting control for NPSH management.
- SAMA 10 – Install a hard-piped connection between FPS and RHR.
- SAMA 12 – Modify plant procedures to direct the use of FLEX generators to support containment venting.
- SAMA 14 – Install 3-hour-rated fire cable wrap on offsite power cables in risk-significant areas.
- SAMA 15 – Install a battery backup to the hydrogen igniters.
- SAMA 20 – Additional diesel generator that can act as a swing diesel generator to all divisions of alternating current (AC) power.
- SAMA 26 – Include explicit steps in the loss of AC power procedure to address water hammer.

- SAMA 27 – Install fire wrap/barriers around critical risers in Fire Zone A-2k.

CEG stated in Section 8.0 of Addendum 2 to Attachment F of the CPS ER that none of the SAMAs identified as potentially cost beneficial are aging related. In response to an NRC Staff RAI (CEG 2024-TN11148), CEG stated that these SAMA candidates will be formally evaluated for potential implementation at the plant.

F.6.2 Review of CEG's Cost-Benefit Evaluation

Based primarily on NUREG/BR–0184 (NRC 1997-TN676) and NUREG-1530 guidelines on discount rates (NRC 2022-TN7859), the staff determined the cost-benefit analysis performed by CEG was consistent with the guidance. Four SAMA candidates were found to be potentially cost beneficial based on the benefit from internal and external events, assuming an external events multiplier of 1.193 (CEG 2024-TN10806, CEG 2024-TN11148).

The applicant considered possible increases in benefits from analysis uncertainties on the results of the SAMA assessment. CEG stated that the 95th percentile value of the CPS Level 1 CDF was a factor of 3.08 greater than the mean CDF. A multiplication factor of 3.08 was selected by the applicant to account for uncertainty in internal events, including internal flooding, as well as fire events. As indicated in Section F.6.1.5, one additional SAMA candidate (i.e., SAMA 8) was determined to be potentially cost-beneficial as a result of the uncertainty analysis (CEG 2024-TN10806, CEG 2024-TN11148).

The NRC staff considers that the multiplier of 3.08 used to account for uncertainty in internal events, including internal flooding, as well as fire events, provides adequate margin and is acceptable for the SAMA analysis.

As discussed in Section F.2.2.4, CEG performed additional sensitivity analyses on MACCS input parameters for the delay time for the population to evacuate, evacuation speed, the rate of release of sensible heat in each plume segment, plume release height, the length of the intermediate phase, and atmospheric mixing heights. No additional cost-beneficial SAMAs were identified as a result of these sensitivity analyses (CEG 2024-TN10806, CEG 2024-TN11148).

The staff concludes that the cost-benefit results provided by CEG are sufficient for use in the SAMA evaluation because the process and methodology for estimating the MB, and for performing uncertainty and sensitivity analyses meet the guidance provided in NEI 05-01A (NEI 2005-TN1978), NUREG/BR–0184 (NRC 1997-TN676), and NUREG-1530 (NRC 2022-TN7859).

F.7 Conclusions

Based on NRC and industry documentation of potential plant improvements, its review of SAMA analyses for other BWR plants, CPS IPE and IPEEE assessments, and risk significant contributors at CPS from plant-specific probabilistic safety assessment models, CEG identified 25 candidate SAMAs after eliminating those candidates that were not applicable to CPS, had already been implemented at CPS, were combined with another SAMA candidate, were expected to have a very low benefit, or had an excessive implementation cost.

For these 25 remaining SAMA candidates, CEG performed a cost-benefit analysis. Results from the cost-benefit analysis of these SAMA candidates are shown in Table F-4.

The cost-benefit analysis identified 11 potentially cost-beneficial SAMAs (i.e., 2, 4, 5, 7, 10, 12, 14, 15, 20, 26, and 27). Sensitivity cases were analyzed for the MACCS input parameters, but no additional potentially cost-beneficial SAMAs were identified.

The staff reviewed the CEG SAMA analysis and concludes that, subject to the discussion in this appendix, the methods used and implementation of these methods were sound. Based on the applicant's treatment of SAMA benefits and costs, the staff finds that the SAMA evaluations performed by CEG are reasonable and sufficient for the license renewal submittal.

The staff agrees with CEG's conclusion that the 11 candidate SAMAs discussed in this section are potentially cost beneficial, which was based on generally conservative treatment of costs, benefits, and uncertainties. This conclusion of a small number of potentially cost-beneficial SAMAs is consistent with the low residual level of risk indicated in the CPS PRA and the fact that CEG has already implemented the plant improvements identified from the IPE and IPEEE. Because the potentially cost-beneficial SAMAs do not relate to aging management during the period of extended operation, they do not need to be implemented as part of license renewal in accordance with Title 10 of the Code of Federal Regulations, Part 54. Nevertheless, as stated in response to an NRC staff RAI (CEG 2024-TN11148), CEG will formally evaluate these SAMA candidates for potential implementation at the plant.

F.8 References

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11. ABSTRACT (200 words or less)

The U.S. Nuclear Regulatory Commission (NRC) staff prepared this supplemental environmental impact statement (SEIS) as part of its environmental review of Constellation Energy Generation, LLC’s (CEG) application to renew the operating license for Clinton Power Station, Unit 1 (CPS) for an additional 20 years. This SEIS evaluates the environmental impacts of the license renewal and alternatives to license renewal. The alternatives evaluated in detail were the replacement power alternatives of natural gas, a combination of renewable and natural gas, and purchased power, which were determined to be commercially viable, and the no-action alternative. The NRC staff’s preliminary recommendation is that the adverse environmental impacts of license renewal for CPS are not so great that preserving the option of license renewal for energy-planning decision-makers would be unreasonable. The NRC staff based its preliminary recommendation on the following: (1) the analysis and findings in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (LR GEIS), (2) the environmental report submitted by CEG, (3) the NRC staff’s consultation with Federal, State, Tribal, and local agencies, (4) the NRC staff’s independent environmental review, and (5) the NRC staff’s consideration of public comments received during the scoping process.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

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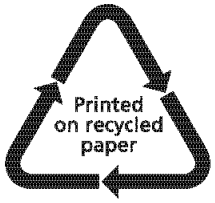

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Regarding License Renewal for Clinton Power Station, Unit 1

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