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United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437
Supplement 47, Vol.1

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 47

Regarding Columbia Generating Station

Final Report
Main Report

Office of Nuclear Reactor Regulation

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Generic Environmental Impact Statement for License Renewal of Nuclear Plants

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Regarding Columbia Generating Station

Final Report Main Report

Manuscript Completed: March 2012
Date Published: April 2012

Office of Nuclear Reactor Regulation

ABSTRACT

This final supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Energy Northwest to renew the operating license for Columbia Generating Station (CGS) for an additional 20 years.

This final SEIS includes an analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from new natural gas-fired combined-cycle generation; new nuclear generation; a combination alternative that includes some natural gas-fired capacity, energy conservation, a hydropower component, and a wind-power component; and not renewing the license (the no-action alternative).

The U.S. Nuclear Regulatory Commission's (NRC) recommendation is that the adverse environmental impacts of license renewal for CGS are not great enough to deny the option of license renewal for energy-planning decisionmakers. This recommendation is based on the following:

- the analysis and findings in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS)
- the Environmental Report submitted by Energy Northwest
- consultation with Federal, state, and local agencies
- the NRC's environmental review
- consideration of public comments received during the scoping process and draft SEIS comment period

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EXECUTIVE SUMMARY

Background

By letter dated January 19, 2010, Energy Northwest submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to issue a renewed operating license for Columbia Generating Station (CGS) for an additional 20-year period.

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

Upon acceptance of Energy Northwest's application, the NRC staff (staff) began the environmental review process, described in 10 CFR Part 51, by publishing a Notice of Intent to prepare a supplemental EIS (SEIS) and conduct scoping. In preparation of this SEIS for CGS, the staff performed the following actions:

- conducted public scoping meetings on April 6, 2010, in Richland, Washington
- conducted a tribal outreach meeting on April 27, 2010, in Richland, Washington
- conducted a site visit at the plant in June 2010
- reviewed Energy Northwest's Environmental Report (ER) and compared it to the GEIS
- consulted with other agencies
- conducted a review of the issues following the guidance set forth in NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal"
- considered public comments received during the scoping process and comment period on the draft SEIS

Proposed Action

Energy Northwest initiated the proposed Federal action—issuing a renewed power reactor operating license—by submitting an application for license renewal of CGS, for which the existing license, NPF-21, will expire on December 20, 2023. The NRC's Federal action is the decision whether to renew the license for an additional 20 years.

Purpose and Need for Action

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

If the renewed license is issued, the appropriate energy-planning decisionmakers, along with Energy Northwest, will ultimately decide if the plant will continue to operate based on factors such as the need for power. If the operating license is not renewed, then the facility must be shutdown on or before the expiration date of the current operating license—December 20, 2023.

Environmental Impacts of License Renewal

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

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

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.

For Category 1 issues, no additional site-specific analysis is required in this SEIS unless new and significant information is found. Chapter 4 of this report presents the process for finding new and significant information. Site-specific issues (Category 2 issues) are those that do not meet one or more of the criteria for Category 1 issues; therefore, an additional site-specific review for these nongeneric issues is required, and the results are documented in the SEIS. The staff has reviewed Energy Northwest’s established process for identifying and evaluating the significance of any new and significant information on the environmental impacts of license renewal of CGS. Neither Energy Northwest nor the NRC identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. This conclusion is supported by the NRC’s review of the applicant’s ER, other documentation relevant to the applicant’s activities, the public scoping process and substantive comments raised, consultations with Federal and state agencies and Native American tribes, and the findings from the environmental site visit conducted by the staff. Further, the staff did not identify any new issues applicable to CGS that have a significant environmental impact. The staff, therefore, relies upon the conclusions of the GEIS for all Category 1 issues applicable to CGS.

Table ES-1 summarizes the Category 2 issues applicable to CGS, as well as the staff’s findings related to those issues. If the staff determined that there were no Category 2 issues applicable for a particular resource area, the findings of the GEIS, as documented in Appendix B to Subpart A of 10 CFR Part 51, stand.

Table ES-1. NRC conclusions relating to site-specific impact of license renewal

Resource area	Relevant Category 2 issues	Impacts
Land use	None	SMALL
Air quality	None	SMALL
Surface water resources	None	SMALL
Groundwater resources	None	SMALL
Aquatic resources	None	SMALL
Terrestrial resources	None	SMALL
Special status species & habitats	Threatened or endangered species	SMALL
Human health	Electromagnetic fields-acute effects (electric shock)	SMALL
Socioeconomics	Housing Impacts Public services (public utilities) Offsite land use Public services (public transportation) Historic & archaeological resources	SMALL

With respect to environmental justice, the staff determined that there would be no disproportionately high and adverse impacts to these populations from the continued operation of CGS during the license renewal period. Additionally, the staff determined that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

The staff considered groundwater contamination as potentially new and significant information. Elevated concentrations of tritium have been observed in groundwater adjacent to the CGS site. However, the highest concentrations, up to 17,400 picocuries per liter (pCi/L), have been found in an upgradient well, MW-5, and have been attributed to Department of Energy Hanford Site operations. Elevated conductivity and concentrations of chloride and sulfate have also been detected adjacent to the CGS site and have been attributed to the infiltration of circulating cooling water that entered the soil through drywells. However, these elevated concentrations have not affected the groundwater used for drinking water; therefore, the staff concludes that there are no significant impacts associated with groundwater contamination at CGS.

Severe Accident Mitigation Alternatives

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

The NRC reviewed Energy Northwest's evaluation of potential SAMAs. Based on the review, the NRC concurs with Energy Northwest's identification of 16 potentially cost-beneficial SAMAs. One of them was aging-related and has already been implemented by Energy Northwest. For the other 15 potentially cost-beneficial SAMAs, the staff concludes that they do not involve aging management of passive, long-lived systems, structures, and components during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54.

Alternatives

The NRC considered the environmental impacts associated with alternatives to renewing the CGS operating license. These alternatives include other methods of power generation and not renewing the CGS operating license (the no-action alternative). Replacement power alternatives considered were natural gas combined-cycle generation; new nuclear generation; and a combination alternative that includes a portion of the natural gas combined-cycle capacity, a conservation component, a purchased power component, a hydropower component, and a wind power component. The no-action alternative and the effects it would have were also considered by the NRC. The NRC evaluated each alternative using the same impact areas that were used in evaluating impacts from license renewal. Where possible, the NRC considered the existing infrastructure at the CGS site (e.g., transmission facilities, water intakes, and discharges) and whether it could be used by new alternative power plants.

The NRC also considered many other replacement power alternatives to renewing the CGS operating license; these were later eliminated from detailed study due to technical, resource availability, or commercial limitations that currently exist and are likely to continue to exist when the existing CGS license expires. Replacement power alternatives considered but eliminated from detailed study include the following:

- offsite new nuclear and natural gas-fired capacity
- new coal-fired capacity
- energy conservation and energy efficiency as full replacement for current capacity
- purchased power
- solar power
- wind power
- biomass waste
- hydroelectric power
- wave and ocean energy
- geothermal power
- municipal solid-waste
- biofuels
- oil-fired capacity
- fuel cells
- delayed retirement of currently operating generating plants in the region

Recommendation

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

- the analysis and findings in the GEIS
- the ER submitted by Energy Northwest
- consultation with Federal, state, and local agencies
- the NRC's environmental review
- consideration of public comments received during the scoping process and draft SEIS comment period

ABBREVIATIONS AND ACRONYMS

AADT	annual average daily traffic
ac	acre
AC	alternating current
ACC	averted cleanup and decontamination costs
ACHP	Advisory Council on Historic Preservation
ACRS	Advisory Committee on Reactor Safeguards
ADAMS	Agencywide Document Access and Management System
AEA	Atomic Energy Act of 1954
AEO	annual energy outlook
ALARA	as low as is reasonably achievable
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOC	averted offsite property damage costs costs
AOE	averted occupational exposure
AOSC	averted onsite costs
AP	Associated Press
AP1000	Advanced Passive 1000
APE	averted public exposure
AQCR	air quality control region
ASME	American Society of Mechanical Engineers
ATWS	anticipated transient without scram
AWEA	American Wind Energy Association
B&W	Babcock and Wilcox Company
BA	biological assessment
BLM	Bureau of Land Management
BOP	balance of plant
BPA	Bonneville Power Administration
BRAC	Base Realignment and Closure
BTU/kWh	British thermal units per kilowatt hour
BWR	boiling-water reactor
BWROG	BWR Owners' Group
C	Celsius
C-14	carbon-14
CAA	Clean Air Act
CCF	common cause failure
CDF	core damage frequency
CDM	clean development mechanism

CEQ	Council of Environmental Quality
CERCLA	Comprehensive Environmental Resource, Compensation, and Liability Act of 1980
CETs	containment event tree
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CGS	Columbia Generating Station
CLB	current licensing basis
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
COE	cost of enhancement
COK	containment intact
COL	combined operating license
CRPP	Cultural Resources Protection Program
Cs-137	cesium-137
CsI	cesium iodide
CST	condensate storage tank
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWA	Clean Water Act
DBA	design basis accident
DC	direct current
DG	diesel generator
DHR	decay heat removal
DOE	Department of Energy
DPS	distinct population segment
DWS	drinking water standard
ECCS	emergency core cooling system
EDG	emergency diesel generator
EFH	essential fish habitat
EFSEC	Energy Facility Site Evaluation Council
EIA	Energy Information Administration
EIS	environmental impact statement
EJ	environmental justice
ELF-EMF	extremely low frequency-electromagnetic field
EMS	environmental management system
EN	Energy Northwest
EO	Executive Order
EOPs	emergency operating procedure

EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	Environmental Report
ESA	Endangered Species Act of 1973
ESU	evolutionary significant unit
Eu-152	europium-152
F	Fahrenheit
F&Os	facts and observations
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FES	final environmental statement
FFTF	fast flux test facility
FIVE	fire-induced vulnerability evaluation
FOIA	Freedom of Information Act
FP	fire protection
fps	feet per second
FR	*Federal Register*
FSAR	final safety analysis report
ft	foot
ft^2	square foot
ft^3	cubic foot
FW	feedwater
g	acceleration relative to earth's gravity
gal	gallon
gCeq/kWh	grams of carbon equivalent per kilowatt hour
GE	General Electric Company
GEIS	generic environmental impact statement
GHG	greenhouse gas
gpm	gallons per minute
GWh	gigawatt hour
H/E	high/early
H/I	high/intermediate
ha	hectare
HAP	hazardous air pollutant
HEPA	high efficiency particulate air
HEPs	human error probability

HFO	high wind, external flood, and other external events
HPCS	high-pressure core spray
HRA	human reliability analuysis
HVAC	heating, ventilation, and air conditioning
I-129	iodine-129
I-131	iodine-131
IAEA	International Atomic Energy Agency
ICM	interim compensatory measure
IDC	industrial development complex
in.	inch
IPE	internal plant examination
IPEEE	internal plant examination of external events
ISFSI	independent spent fuel storage installation
ISLOCA	interfacing systems loss-of-coolant accident
K	thousand
K-40	potassium-40
kg	kilogram
km	kilometer
km^2	square kilometer
kV	kilovolt
L	liter
L/E	low/early
L/I	low/intermediate
lb	pound
LEN	large, early, not scrubbed
LERF	large early release frequency
LES	large, early, scrubbed
LL/E	low-low/early
LL/I	low-low/intermediate
LLD	lower limit of detection
LLMW	low-level mixed waste
LLN	large, late, not-scrubbed
LLS	large, late, scrubbed
LLW	low-level radioactive waste
LOCA	loss-of-coolant accident
LOOP	loss of offsite power
LOSP	loss of offsite power
LPCI	low-pressure coolant injection

LPCS	low-pressure core spray
LRA	license renewal application
m	meter
M	million
M/E	moderate/early
M/I	moderate/intermediate
m^2	square meter
m^3	cubic meter
mA	milliampere
MAAP	Modular Accident Analysis Program
MACCS2	MELCOR Accident Consequence Code System 2
MCC	motor control center
mg	milligram
mgd	million gallons per day
mGy	milligray
mi	mile
mi^2	square mile
MIT	Massachusetts Institute of Technology
MLLW	mixed low-level radioactive waste
mm	millimeter
MMI	Modified Mercalli Intensity
MOA	Memorandum of Agreement
MOX	mixed oxide
mph	miles per hour
mrad	millirad
mrem	millirem
MS	main steam
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSIV	main steam isolation valve
MSL	mean sea level
MSOs	multiple spurious operations
MSPI	mitigating system performance indicator
mSV	millisievert
MT	metric ton
MW	megawatt
MWe	megawatt-electric
MWt	megawatt-thermal
N_2	nitrogen
NAAQS	National Ambient Air Quality Standards

NAS	National Academy of Sciences
NCI	National Cancer Institute
NDE	non-destructive evaluation
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NWPCC	Northwest Power and Conservation Council
ODCM	offsite dose calculation manual
OL	operating license
OMB	Office of Management and Budget
PA	programmatic agreement
pCi	picocurie
PDS	plant damage state
PGA	peak ground acceleration
PILOT	payments in lieu of taxes
PM_{10}	particulate matter with a diameter of 10 micrometers or less
PNNL	Pacific Northwest National Library
POST	Parliamentary Office of Science and Technology
PRA	probabilistic risk assessment
PSA	probabilistic safety assessment
PSD	prevention of significant deterioration
Pu-239/240	plutonium-239/240
PUD	public utility district
PWR	pressurized water reactor
RAI	request for additional information
RCIC	reactor core isolation cooling
RCRA	Resource Conservation and Recovery Act of 1976
RCW	Revised Code of Washington
rem	roentgen equivalent man
REMP	Radiological Environmental Monitoring Program
RFW	reactor feedwater

RG	Regulatory Guide
RHR	residual heat removal
RM	river mile
ROI	region of influence
ROW	right-of-way
RPC	replacement power cost
RPV	reactor pressure vessel
RRW	risk reduction worth
RTC	Report to Congress
SAMA	severe accident mitigation alternative
SAR	safety analysis report
SBO	station blackout
SCE&G	South Carolina Electric and Gas
SCR	selective catalytic reduction
SDS	seismic damage sequence
sec	second
SEIS	supplemental environmental impact statement
SER	safety evaluation report
SFPs	spent fuel pool
SHPO	State Historic Preservation Officer
SLC	standby liquid control
SLOCA	small loss-of-coolant accident
SO_x	sulfur oxides
SR	supporting requirement
Sr-90	strontium-90
SRV	safety relief valve
SSEL	safe shutdown equipment list
SSW	standby service water
Sv	sievert
SW	service water
SWTF	sanitary waste treatment facility
T	ton
Tc-99	technetium-99
TCP	traditional cultural property
TLD	thermoluminescent dosimeter
TSC	technical support center
TSP	total suspended particles
TSW	plant service water

USC	U.S. Code
USCB	U.S. Census Bureau
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCSNS	Virgil C. Summer Nuclear Station
WAC	Washington Administration Code
WCH	Washington Closure Hanford
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WDOE	Washington State Department of Ecology
WDOH	Washington State Department of Health
WDOR	Washington Department of Revenue
WISC	Washington Invasive Species Council
WMD	weapon of mass destruction
WNP	WPPSS Nuclear Project
WNP-2	Washington Nuclear Plant 2
WPPSS	Washington Public Power Supply System
WSDOH	Washington State Department of Health
WTP	waste treatment plant
YTC	Yakima Training Center

1.0 PURPOSE AND NEED FOR ACTION

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

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

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

1.1 Proposed Federal Action

Energy Northwest initiated the proposed Federal action by submitting an application for license renewal of Columbia Generating Station (CGS), for which the existing license, NPF-21, expires on December 20, 2023. The NRC's proposed Federal action is the decision whether to renew the license for an additional 20 years.

1.2 Purpose and Need for the Proposed Federal Action

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

If the renewed license is issued, state regulatory agencies and Energy Northwest will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the state's jurisdiction or the purview of the owners. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, December 20, 2023.

1.3 Major Environmental Review Milestones

Energy Northwest submitted an Environmental Report (ER) (EN, 2010b) as part of its license renewal application (EN, 2010a) in January 2010. After reviewing the application and the ER for sufficiency, the NRC published a Notice of Acceptance and Opportunity for Hearing in the

Federal Register (NRC, 2010a) on March 11, 2010. The NRC published another notice in the *Federal Register*, also on March 11, 2010, on its intent to conduct scoping, thus beginning the 60-day scoping period (NRC, 2010b).

The agency held two public scoping meetings on April 6, 2010, in Richland, Washington (NRC, 2010c). The NRC report entitled, "Environmental Impact Statement Scoping Process Summary Report for Columbia Generating Station," dated December 2010, presents the comments received during the scoping process (NRC, 2010d). Appendix A to this supplemental environmental impact statement (SEIS) presents the comments considered to be within the scope of the environmental license renewal review and the associated NRC responses.

In order to verify information given in the ER, NRC staff (staff) visited the CGS site in June 2010. During the site visit, the staff met with plant personnel; reviewed specific documentation; toured the facility; and met with interested Federal, state, local, and tribal agencies governments (NRC, 2010e).

Figure 1.3-1 shows the major milestones in the public review of the SEIS. Upon completion of the scoping period and site visit, the NRC prepared and issued the draft SEIS. This document was made available for public comment for 75 days. During this time, the NRC hosted two public meetings and collected public comments. Based on the information gathered, the NRC amended the draft SEIS and then published this final SEIS.

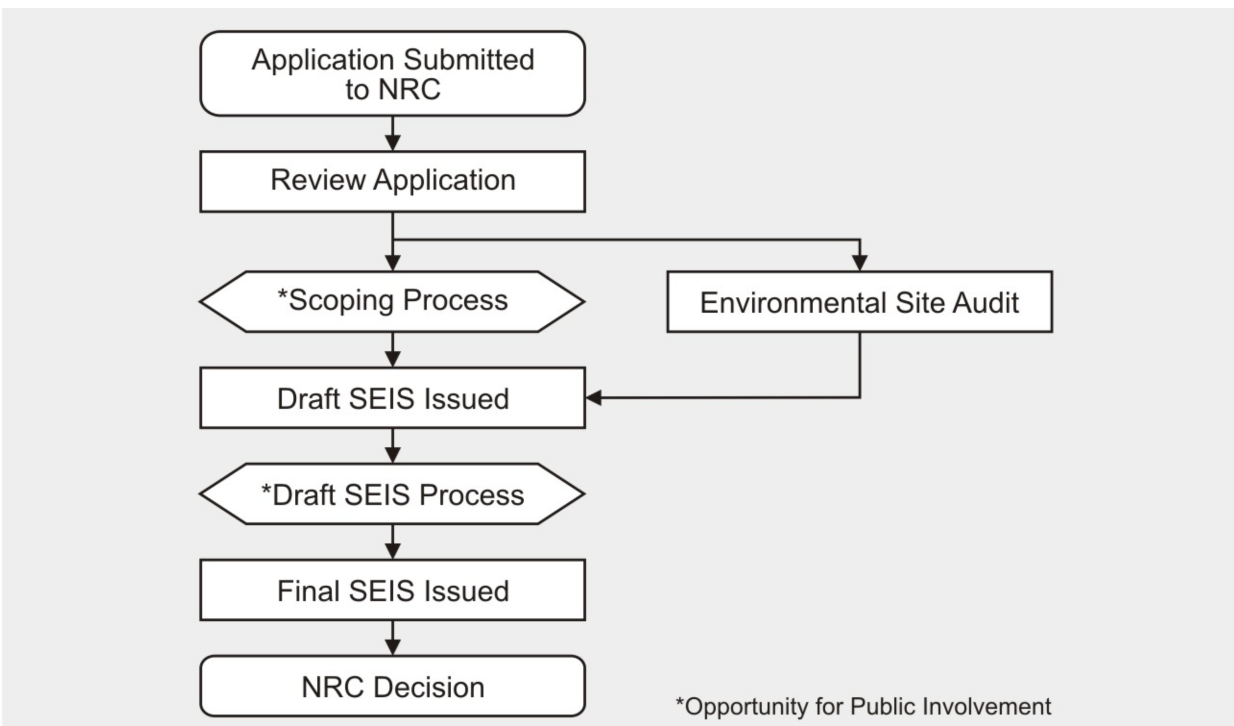

Figure 1.3-1. Environmental review process

The process gives opportunities for public involvement.

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

1.4 Generic Environmental Impact Statement

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

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

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

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

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

The NRC's standard of significance for impacts was established using the Council on Environmental Quality (CEQ) terminology for "significantly" as used in NEPA, which requires considerations of both context and intensity (see 40 CFR 1508.27). The NRC established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE—as defined below.

- **SMALL**—Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- **MODERATE**—Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

- **LARGE**—Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted (Figure 1.4-1). Issues are assigned a Category 1 or a Category 2 designation. As presented in the GEIS, Category 1 issues are those that meet of the following criteria:

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

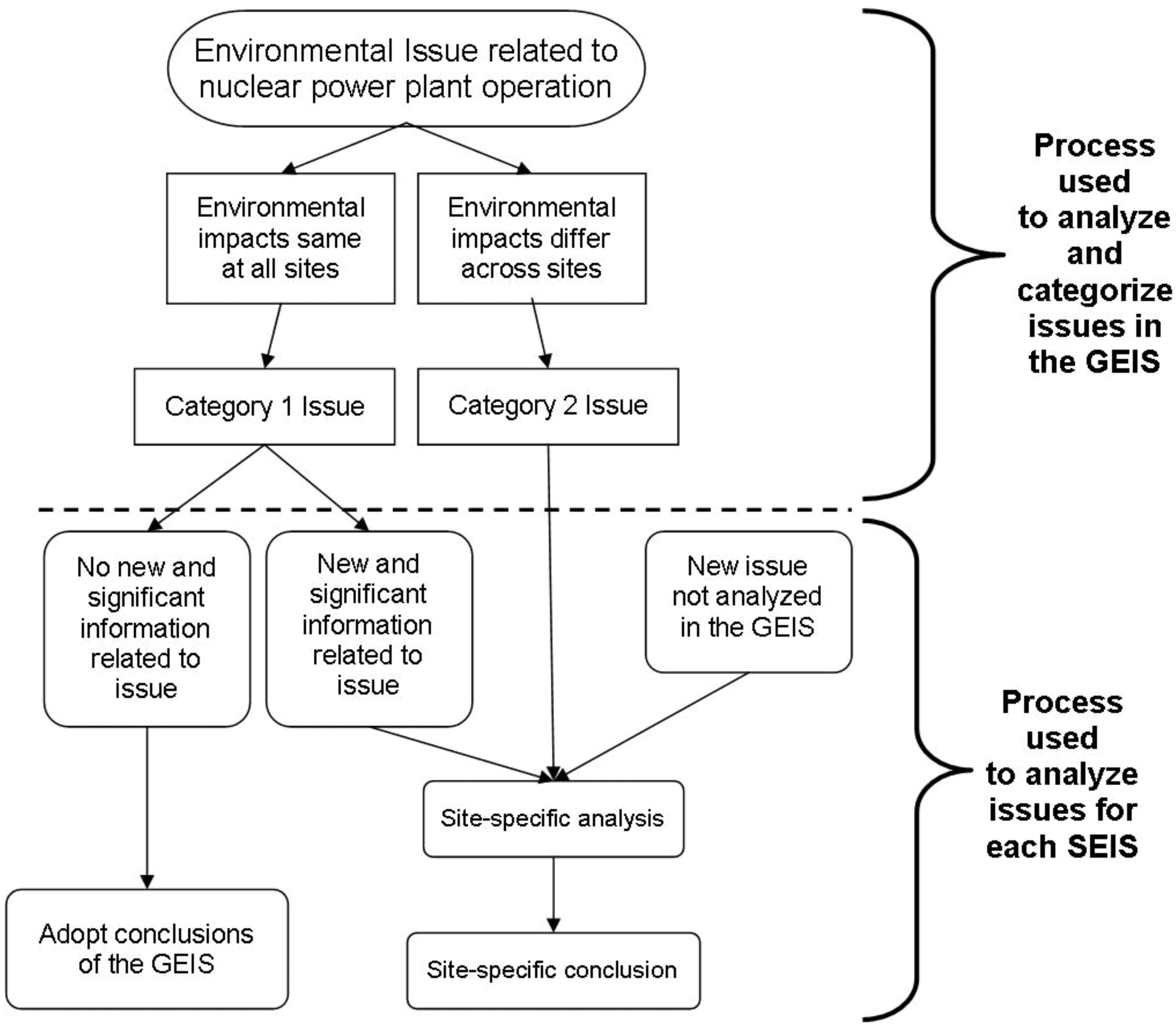

Figure 1.4-1. Environmental issues evaluated during license renewal

As previously discussed, the GEIS evaluated 92 issues. Of those 92 issues, 23 require a site-specific analysis.

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

1.5 Supplemental Environmental Impact Statement

The SEIS presents an analysis that considers the environmental effects of the continued operation of CGS, alternatives to license renewal, and mitigation measures for minimizing adverse environmental impacts. Chapter 8 contains analysis and comparison of the potential environmental impacts from alternatives, and Chapter 9 presents the recommendation to the Commission as to whether or not the environmental impacts of license renewal are so great that preserving the option of license renewal would be unreasonable.

In the preparation of this SEIS for CGS, the NRC carried out the following activities:

- reviewed the information given in the Energy Northwest ER
- consulted with other Federal, state, and local agencies
- consulted with Tribal governments
- carried out an independent review of the issues during the site visit
- considered the public comments received during the scoping process and draft SEIS comment period

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

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

1.6 Cooperating Agencies

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

1.7 Consultations

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

- Advisory Council on Historic Preservation
- Confederated Tribes and Bands of the Yakama Nation
- Confederated Tribes of the Umatilla Indian Reservation
- National Marine Fisheries Service
- Nez Perce Tribe
- State of Washington Department of Archaeology and Historic Preservation
- U.S. Environmental Protection Agency, Region 10
- U.S. Fish and Wildlife Service, Pacific Region Office, Portland, OR

1.8 Correspondence

During the course of the environmental review, the NRC contacted the following Federal, state, regional, local, and tribal government agencies listed in Section 1.7.

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

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

1.9 Status of Compliance

Energy Northwest is responsible for complying with all NRC regulations and other applicable Federal, state, local, and Tribal requirements. Appendix H to the GEIS describes some of the major Federal statutes. Appendix C to this SEIS includes a list of the permits and licenses issued by Federal, state, and local authorities for activities at CGS.

1.10 References

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

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

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

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

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

Energy Northwest (EN), “License Renewal Application, Columbia Generating Station,” 2010a, Agencywide Document Access and Management System (ADAMS) Accession No. ML100250668.

EN, “License Renewal Application, Columbia Generating Station, Appendix E, Applicant's Environmental Report” 2010b, ADAMS Accession No. ML100250666

EN, "Columbia Generating Station, Docket No. 50-397, Environmental Authorizations for CGS Operation," April 20, 2011, ADAMS Accession No. ML11112A130.

U.S. Code of Federal Regulations (CFR), “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” Part 51, Chapter 1, Title 10, “Energy.”

U.S. Nuclear Regulatory Commission (NRC), “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” NUREG-1437, Washington, D.C., Volumes 1 and 2, 1996, ADAMS Accession Nos. ML040690705 and ML040690738.

NRC, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report—Final Report,” NUREG-1437, Washington, D.C., Section 6.3, Table 9.1, 1999, ADAMS Accession No. ML040690720.

NRC, “Notice of Acceptance for Docketing of the Application, Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. NPF-21 for an Additional 20-Year Period; Energy Northwest; Columbia Generating Station,” *Federal Register*, Volume 75, No. 47, March 11, 2010 (2010a), pp. 11572–11574.

NRC, “Energy Northwest; Notice of Intent to Prepare an Environmental Impact Statement and Conduct the Scoping Process for Columbia Generating Station,” *Federal Register*, Volume 75, No. 47, March 11, 2010 (2010b), pp. 11576–11578.

NRC, “Summary of Public License Renewal Overview and Environmental Scoping Meetings Related to the Review of the Columbia Generating Station License Renewal Application (TAC Nos. ME3058 and ME3121),” 2010c, ADAMS Accession No. ML101250540.

NRC, “Environmental Impact Statement, Scoping Process, Summary Report, Columbia Generating Station,” Richland, WA, 2010d, ADAMS Accession No. ML102770232.

NRC, “Summary of Site Visit in Support of the Environmental Review of the License Renewal Application for Columbia Generating Station (TAC No. ME3121),” 2010e, ADAMS Accession No. ML103400163.

2.0 AFFECTED ENVIRONMENT

Columbia Generating Station (CGS) is located in Benton County, Washington, 12 miles (mi) (19 kilometers (km)) northwest of Richland and approximately 160 mi (257 km) southeast of Seattle. The CGS site is located on land leased from the U.S. Department of Energy (DOE) within the Hanford Site. The leased area is bounded on the east by the Columbia River. Figure 2.1-1 and Figure 2.1-2 present the 50-mi (80-km) and 6-mi (10-km) vicinity maps, respectively. For purposes of the evaluation in this supplemental environmental impact statement (SEIS), the “affected environment” is the environment that currently exists at and around CGS. Because existing conditions are at least partially the result of past construction and operation at the plant, the impacts of these past and ongoing actions and how they have shaped the environment are presented here. Section 2.1 of this SEIS describes the facility and its operation, and Section 2.2 discusses the affected environment.

Energy Northwest, formerly known as the Washington Public Power Supply System (WPPSS), is the owner and licensee of CGS. CGS was formerly known as Hanford No. 2 and WPPSS Nuclear Project No. 2 (WNP-2). Energy Northwest is a municipal corporation and joint operating agency of the State of Washington. It is comprised of 28 public member utilities from across the state. All electrical energy produced at CGS is delivered to electrical distribution facilities owned and operated by Bonneville Power Administration (BPA) as part of the Federal Columbia River Power System (FCRPS) (EN, 2010).

2.1 Facility Description

CGS is a single unit nuclear power plant that began commercial operation in December 1984. The CGS site boundary encloses approximately 1,089 acres (ac) (441 hectares (ha)) leased to Energy Northwest by the DOE. The most conspicuous structures on the CGS site include the reactor containment building, the turbine building, six cooling towers, and various buildings auxiliary to the reactor (EN, 2010). Figure 2.1-3 provides a general layout of the CGS site.

2.1.1 Reactor and Containment Systems

CGS is a single unit nuclear power plant with a boiling water reactor (BWR). General Electric Company supplied the nuclear steam supply system, and Westinghouse Electric Company supplied the turbine generator. The nuclear steam supply system uses a single-cycle, forced-circulation system and is designated a BWR/5 reactor. The reactor core produces heat that boils water, producing steam for direct use in a turbine-generator to produce electricity.

The containment consists of primary and secondary containment systems. The primary containment structure is a free-standing steel pressure vessel containing a drywell and a suppression chamber. The secondary containment structure consists of the reactor building, which completely encloses the primary containment. The reactor building has reinforced-concrete exterior walls up to the refueling floor. Above this level, the reactor building is a steel framed structure with insulated metal siding with sealed joints.

CGS fuel for the reactor core consists of enriched (less than 5 percent by weight) uranium dioxide pellets sealed in Zircaloy-2 tubes. Fuel design is such that individual rod average burnup (burnup averaged over the length of the fuel rod) will not exceed 62,000 megawatt-days per metric ton uranium. The maximum rated power level limit of the reactor planned for the extended period of operation is 3,486 megawatts-thermal (MWt). The net and gross electrical power outputs are 1,190 and 1,230 megawatts-electric (MWe), respectively (EN, 2010).

In February 2011, the NRC staff (staff), through newspaper articles, became aware that Energy Northwest is considering the potential use of mixed oxide (MOX) fuel at CGS. MOX fuel is produced by taking nuclear weapons plutonium oxide at about 10–15 percent concentration levels and blending it with uranium oxide to enrichment levels suitable for commercial nuclear reactors.

Energy Northwest is interested in advanced fuel technologies, including MOX fuel, said a spokesperson for Energy Northwest. The spokesperson also stated that Energy Northwest has no plans to use MOX fuel without more research and cannot predict the viability of the fuel for use at CGS. Energy Northwest is talking with Pacific Northwest National Laboratory about a study to evaluate the feasibility of using the fuel at CGS (Cary, 2011).

At this time, the NRC has not received notification from Energy Northwest on its plans to use MOX fuel in the future. The staff notes that a change in the type of fuel used at CGS will require a thorough evaluation by the NRC on the safety and environmental impacts associated with the new fuel prior to receiving approval for its use.

Figure 2.1-1. Location of CGS, 50-mi (80-km) Region

(Source: EN, 2010)

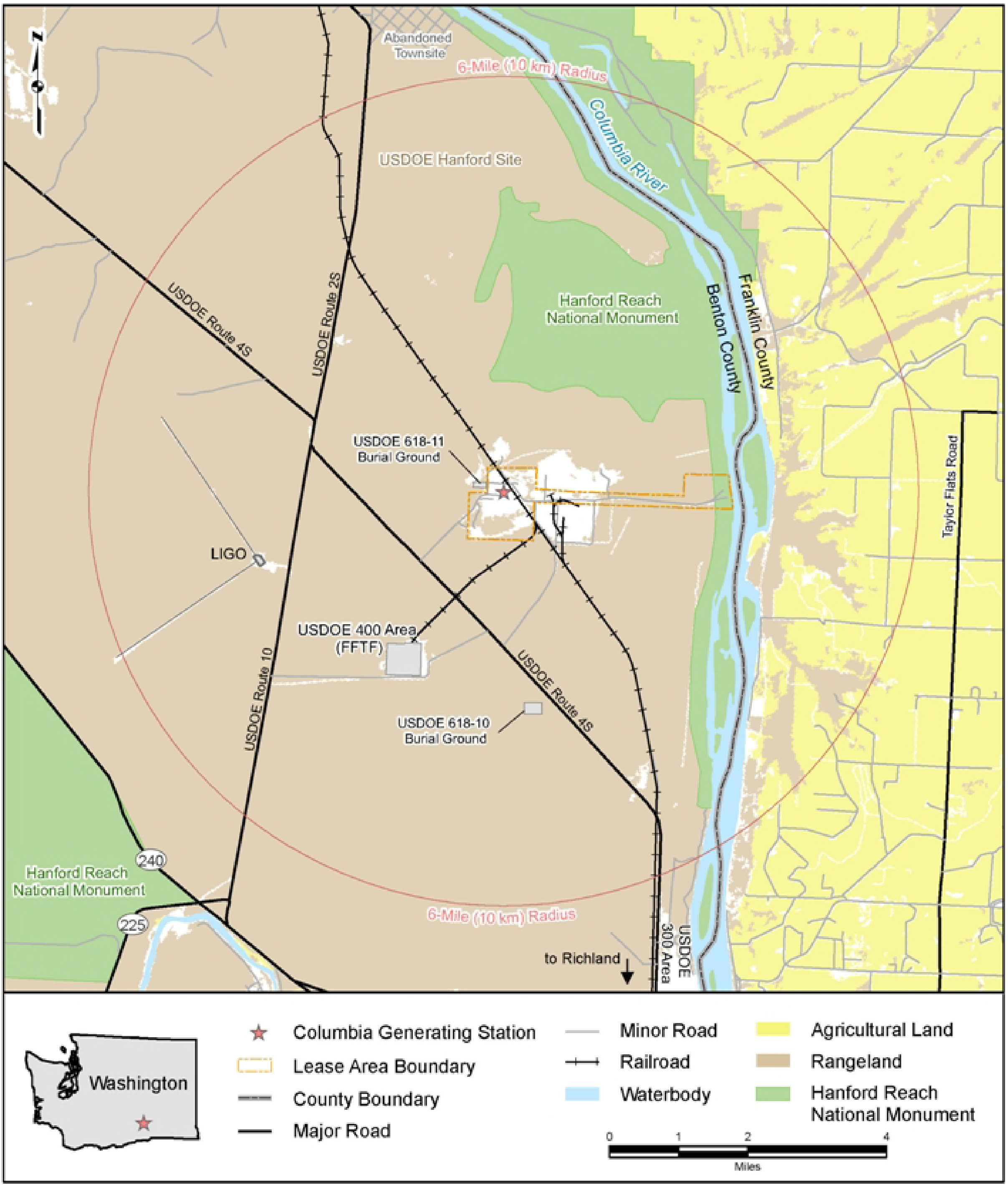

Figure 2.1-2. Location of CGS, 6-mi (10-km) Region

(Source: EN, 2010)

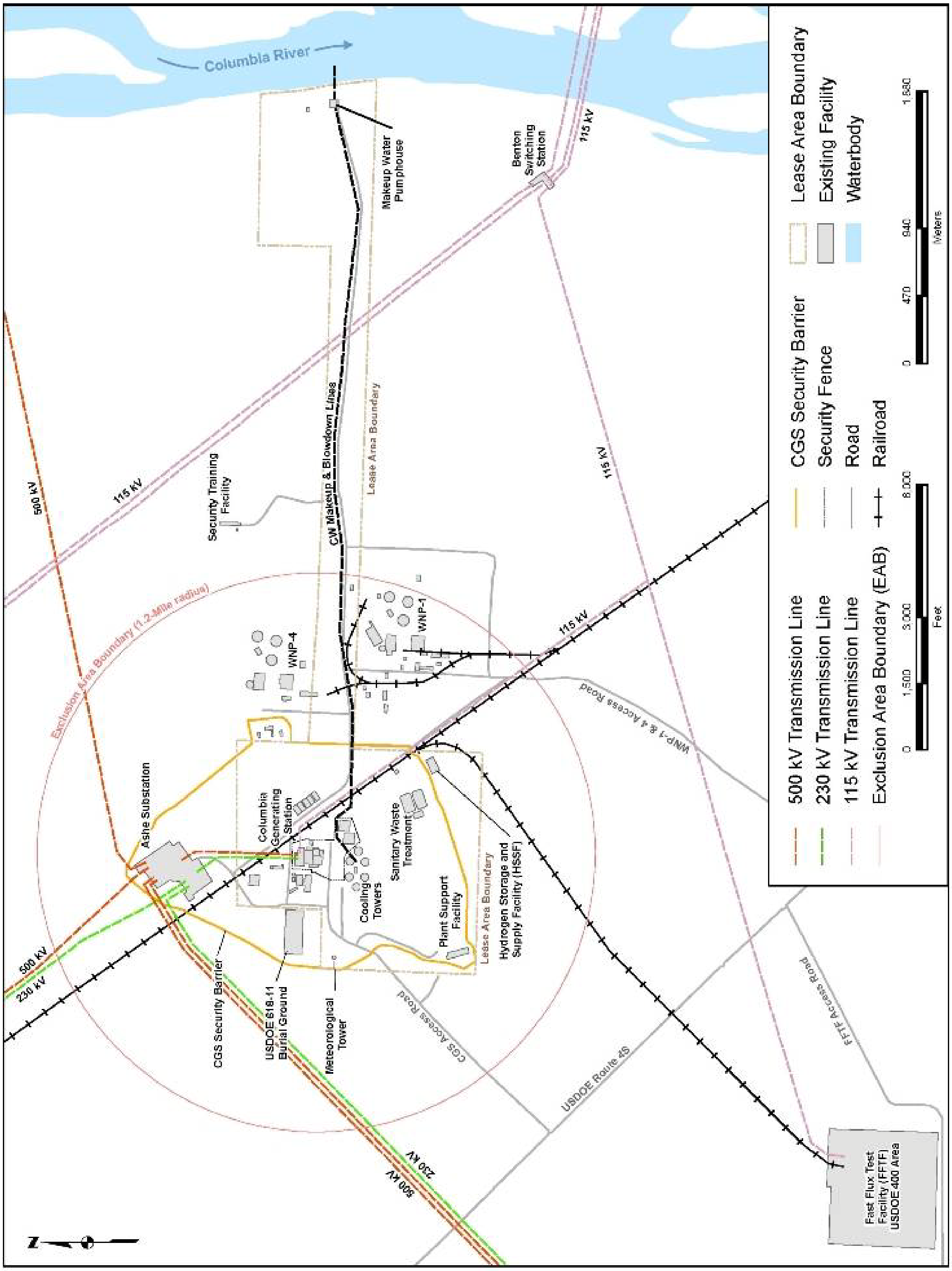

Figure 2.1-3. CGS, general site layout

(Source: EN, 2010)

2.1.2 Radioactive Waste Management

The radioactive waste systems collect, treat, and dispose of radioactive and potentially radioactive wastes that are byproducts of CGS operations. The byproducts are activation products resulting from the irradiation of reactor water and impurities within the reactor water (principally metallic corrosion products) and fission products resulting from defective fuel cladding or uranium contamination within the reactor coolant system. Operating procedures for the radioactive waste system ensure that radioactive wastes are safely processed and discharged from CGS. The systems are designed and operated to assure that the quantities of radioactive materials released from CGS are as low as is reasonably achievable (ALARA) and within the dose standards set forth in 10 CFR Part 20, “Standards for Protection against Radiation,” and Appendix I to 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities.” The CGS Offsite Dose Calculation Manual (ODCM) contains the methods and parameters used to calculate offsite doses resulting from radioactive effluents. These methods are used to ensure that radioactive material discharged from CGS meets regulatory dose standards.

Radioactive wastes resulting from CGS operations are classified as liquid, gaseous, and solid. Radioactive wastes generated by CGS operations are collected and processed to meet applicable regulations. The design and operational objectives of the radioactive waste management systems are to limit the release of radioactive effluents from CGS during normal operation and anticipated operational occurrences (EN, 2010).

Reactor fuel that has exhausted a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages. Spent nuclear fuel from the reactor is stored onsite in a spent fuel pool and an independent spent fuel storage installation (ISFSI) located about 1,200 feet (ft) northwest of the reactor building. The ISFSI is comprised of dry casks on concrete pads surrounded by a security fence. The ISFSI is licensed in accordance with 10 CFR Part 72 (EN, 2010).

2.1.2.1 Radioactive Liquid Waste

The liquid waste management system collects, segregates, stores, and disposes of radioactive liquid waste. The system is designed to reduce radioactive materials in liquid effluents to levels that are ALARA and reduce the volume of waste through recycling. Liquid wastes that accumulate in radwaste tanks or in sumps throughout CGS are transferred to collection tanks in the radwaste building and segregated into three categories: high purity waste, low purity waste, and chemical waste. High purity wastes collect in the waste collector tank and are treated in the equipment drain subsystem. Radioactive material is removed from high purity liquid wastes using filtration and ion exchange. Low purity wastes collect in the floor drain collector tank and are treated in the floor drain subsystem. Similar to high purity wastes, treatment of low purity wastes consists of filtration and ion exchange. The chemical waste subsystem is used to treat liquid chemical wastes that collect in the chemical waste tank. Chemical wastes may be treated using a neutralizing agent, and they are processed by routing to a backwash tank or phase separator and then to the floor drain subsystem for further processing.

All liquid radwaste process streams end in either a sample or distillate tank. Liquid wastes are processed on a batch basis so that each treated batch can be sampled. Depending on sample results, the waste is either reprocessed or returned to the condensate storage tanks for reuse in CGS. Excess processed water, within 10 CFR Part 20 release limits and 10 CFR Part 50 dose criteria, is discharged—per the procedures and methods described in the ODCM—to the circulating water system blowdown and into the Columbia River. CGS limits, to the extent possible, the amount of liquid radioactive wastes discharged to the Columbia River. Although allowed by U.S. Nuclear Regulatory Commission (NRC) regulation, CGS water management practices are such that no discharge of liquid radwaste has occurred in over 10 years. Protection against accidental discharge of liquid radioactive waste is supplied by design redundancy, detection instrumentation and alarms for abnormal conditions, and procedural control (EN, 2010).

2.1.2.2 Radioactive Gaseous Waste

Gaseous waste management systems process and control the release of gaseous radioactive effluents to the atmosphere. Offgases from the main condenser are the major source of gaseous radioactive waste. Other radioactive gas sources collected by the system include leakage from steam piping and equipment in the reactor building, turbine generator building, and radwaste building.

Before release into the environment through the reactor building elevated release duct, treatment of the gases includes the following:

- volume reduction through a catalytic recombiner to recombine hydrogen and oxygen
- water vapor removal through a condenser
- decay of short-lived radioisotopes through a holdup line
- high efficiency particulate air (HEPA) filtration
- adsorption of isotopes on activated charcoal beds
- further HEPA filtration

CGS discharges gaseous waste in accordance with the procedures and methods described in the ODCM so that exposure to persons offsite are ALARA and do not exceed limits specified in 10 CFR Part 20 and Appendix I to 10 CFR Part 50 (EN, 2010).

2.1.2.3 Radioactive Solid Waste

The solid waste management system collects, processes, and packages solid radioactive wastes for storage and offsite shipment and burial. The system is located in the radwaste building. The system is designed to process waste while maintaining occupational exposure ALARA. To ensure compliance with applicable regulations in 10 CFR Parts 20, 61, and 71, characterization, classification, processing, waste storage, handling, and transportation of solid wastes are controlled by the process control program.

CGS uses a portable dewatering and drying system to remove freestanding liquids from wet solid wastes (e.g., filter residue, concentrated wastes, and spent resins). Dry solid wastes (e.g., rags, paper, and air filters) are also processed in the radwaste building. Dry solid wastes are segregated and monitored to reduce volumes where practicable and may be compressed and packaged into steel containers. Non-compressible solid wastes are packaged in container vans or other containers suitable for shipment. Mixed (radioactive and hazardous) wastes generated at CGS are shipped to permitted offsite facilities.

Periodic cleaning of the cooling tower basins and the standby service water ponds results in sediment that contains low levels of radioactivity. The sediment is disposed of onsite in a dedicated area south of the cooling towers. The State of Washington Energy Facility Site Evaluation Council allows the onsite disposal of the contaminated sediment as long as the material meets specific concentration limits and monitoring requirements.

Solid radioactive wastes are packaged and shipped from CGS in containers that meet the requirements established by the U.S. Department of Transportation and by the NRC. Radioactive waste is transported to a commercial low-level radioactive waste disposal facility located near the center of the Hanford Site, approximately 12 mi west-northwest of CGS. Low activity waste may also be transported from CGS to a vendor for volume reduction before disposal (EN, 2010).

2.1.3 Nonradiological Waste Management

CGS generates nonradioactive wastes as part of routine plant maintenance, cleaning activities, and plant operations. The Resource Conservation and Recovery Act (RCRA) governs the disposal of solid and hazardous waste. RCRA waste regulations are contained in 40 CFR Parts 239–299. In addition, 40 CFR Parts 239–259 contain regulations for solid (nonhazardous) waste, and 40 CFR Parts 260–279 contain regulations for hazardous waste. RCRA Subtitle C establishes a system for controlling hazardous waste from "cradle to grave," and RCRA Subtitle D encourages states to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills. Washington State RCRA regulations are administered by the Washington State Department of Ecology (WDOE) and address the identification, generation, minimization, transportation, and final treatment, storage, or disposal of hazardous and nonhazardous waste.

2.1.3.1 Nonradioactive Waste Streams

CGS generates solid waste, defined by RCRA, as part of routine plant maintenance, cleaning activities, and plant operations. Washington is a part of Environmental Protection Agency (EPA) Region 10 and its solid waste program. In 1986, the EPA authorized WDOE to administer portions of the RCRA program in the State of Washington that are incorporated in Chapter 173-303 (Dangerous Waste Regulations) of the Washington Administrative Code (WAC).

The EPA classifies certain nonradioactive wastes as hazardous based on characteristics including ignitability, corrosivity, reactivity, or toxicity (hazardous wastes are listed in 40 CFR Part 261). State-level regulators may add wastes to the EPA's list of hazardous wastes. RCRA supplies standards for the treatment, storage, and disposal of hazardous waste for hazardous waste generators (regulations are available in 40 CFR Part 262).

The EPA recognizes the following main types of the hazardous waste generators (40 CFR 260.10) based on the quantity of the hazardous waste produced:

- large quantity generators that generate 2,200 pounds (lb) (1,000 kilograms (kg)) per month or more of hazardous waste, more than 2.2 lb (1 kg) per month of acutely hazardous waste, or more than 220 lb (100 kg) per month of acute spill residue or soil
- small quantity generators that generate more than 220 lb (100 kg) but less than 2,200 lb (1,000 kg) of hazardous waste per month
- conditionally exempt small quantity generators that generate 220 lb (100 kg) or less per month of hazardous waste, 2.2 lb (1 kg) or less per month of acutely hazardous waste, or less than 220 lb (100 kg) per month of acute spill residue or soil

The State of Washington has incorporated the EPA's regulations regarding hazardous wastes and recognizes CGS as a large quantity generator of hazardous wastes under WAC Chapter 173-303-070. CGS hazardous wastes include spent and expired chemicals, laboratory chemical wastes, and occasional project-specific wastes. CGS produced 9,614 lb (4,361 kg) waste in 2005; 2,598 lb (1,178 kg) in 2006; 6,797 lb (3,083 kg) in 2007; 23,946 lb (10,862 kg) in 2008; and 12,638 lb (5,733 kg) in 2009 (Gambhir, 2010b).

The EPA classifies several hazardous wastes as universal wastes; these include batteries, pesticides, mercury-containing items, and fluorescent lamps. WDOE has incorporated the EPA's regulations (40 CFR Part 273) regarding universal wastes in WAC Chapter 173-303-573. WDOE defines mercury-containing equipment, used batteries, and lamps (e.g., fluorescent, mercury vapor, metal halide, high-pressure sodium, and neon) as universal waste; these items make up the majority of the hazardous wastes produced by the CGS and are disposed of or recycled in accordance with WDOE regulations.

Conditions and limitations for wastewater discharge by the CGS are specified in National Pollutant Discharge Elimination System (NPDES) Permit No. WA-002515-1 (EN, 2010). Radioactive liquid waste is addressed in Section 2.1.2 of this SEIS. Section 2.1.7.3 gives more information about the CGS NPDES permit and permitted discharges.

The Emergency Planning and Community Right-to-Know Act (EPCRA) requires applicable facilities to supply information about hazardous and toxic chemicals to local emergency planning authorities and the EPA (42 USC 11001). On October 17, 2008, the EPA finalized several changes to the Emergency Planning (Section 302), Emergency Release Notification (Section 304), and Hazardous Chemical Reporting (Sections 311 and 312) regulations that were proposed on June 8, 1998 (63 FR 31268). The CGS is subject to Federal EPCRA reporting requirements; thus, CGS submits an annual Section 312 (Tier II) report on hazardous substances to local emergency agencies.

Low-level mixed wastes (LLMW) are wastes that contain both low-level waste and RCRA hazardous waste (40 CFR 266.210). The State of Washington regulates the hazardous component of the mixed waste through RCRA, and the NRC regulates radioactive waste subject to the Atomic Energy Act (AEA). CGS periodically produces small amounts of LLMW, mainly from the use of wiping cloths and liquid cleaners, and sends it offsite for disposal in an approved disposal facility.

2.1.3.2 Pollution Prevention and Waste Minimization

Pollution-prevention and waste-minimization opportunities carried out by CGS are summarized in annual reports submitted to WDOE. CGS performs pollution prevention assessments, which are used to identify and carry out programs that reduce waste. These assessments have resulted in a several waste-minimization programs, including a comprehensive recycling program and a program that replaces the use of hazardous materials with non-hazardous substitutes.

In support of nonradiological waste-minimization efforts, the EPA's Office of Prevention and Toxics has established a clearinghouse that supplies information about waste management and technical and operational approaches to pollution prevention (EPA, 2010b). The EPA clearinghouse can be used as a source for additional opportunities for waste minimization and pollution prevention at CGS, as appropriate.

The EPA also encourages the use of environmental management systems (EMSs) for organizations to assess and manage the environmental impacts associated with their activities, products, and services in an efficient and cost-effective manner. The EPA defines an EMS as "a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency." EMSs help organizations fully integrate a wide range of environmental initiatives, establish environmental goals, and create a continuous monitoring process to help meet those goals. The EPA Office of Solid Waste especially advocates the use of EMSs at RCRA-regulated facilities to improve environmental performance, compliance, and pollution prevention (EPA, 2010d). Energy Northwest has implemented an EMS (EN, 2010).

2.1.4 Plant Operation and Maintenance

Maintenance activities carried out at CGS include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. Various programs and activities currently exist at CGS to maintain, inspect, test, and monitor the performance of facility equipment. These maintenance activities include inspection requirements for reactor vessel materials, boiler and pressure vessel inservice inspection and testing, maintenance structures monitoring program, and maintenance of water chemistry.

Additional programs include those carried out to meet technical specification surveillance requirements; those carried out in response to the NRC generic communications; and various periodic maintenance, testing, and inspection procedures (EN, 2010). Certain program activities are carried out during the operation of the unit, while others are carried out during scheduled refueling outages. Nuclear power plants must periodically discontinue the production of electricity for refueling, periodic inservice inspection, and scheduled maintenance. CGS refuels on a 24-month interval (EN, 2010).

2.1.5 Power Transmission System

CGS is connected to the BPA transmission grid via the H.J. Ashe Substation, which is located 0.5 mi (0.8 km) north of CGS. Electricity output is transmitted from the plant to the Ashe Substation via a 500-kilovolt (kV) transmission line, which extends 2,900 ft (884 meters (m)) from CGS. CGS has four main power transformers, with one as a backup, which increase the generator output from 25 kV to 500 kV. An additional 230-kV line connects the plant start-up transformer to the Ashe Substation. This transformer is able to supply power for plant start-up, normal operating auxiliary loads, and engineered safety feature shutdown loads. The 230-kV transmission line and the 500-kV transmission line run parallel in a 280-ft wide (85 m) transmission corridor (Figure 2.1-3) (EN, 2010).

Originally, CGS was intended to connect to the BPA transmission grid via an 18-mi (29 km) long 500-kV transmission line running from CGS to the existing Hanford Substation (AEC, 1972). Instead, BPA constructed the nearby Ashe Substation, which then tied into the transmission network via four 500-kV lines to the Hanford (18 mi (29 km)), Lower Monumental (41 mi (66 km)), Slatt (72 mi (116 km)), and Marion (224 mi (360 km)) Substations. These transmission lines are operated and maintained by BPA and will remain in service past CGS decommissioning (EN, 2010). These lines connecting the Ashe Substation to the four previously discussed substations are not considered in-scope for this review.

A third transmission line supported CGS operations as a power source during construction and is now used as back-up power for safe shutdown under accident conditions. This 115-kV line has a right-of-way (ROW)-width of about 90 ft (27 m), and it connects the CGS switchyard to the 115-kV line at the Benton switchyard, about 1.8 mi (2.9 km) southeast of CGS.

The transmission lines considered in-scope for license renewal are those that connect the facility to the transmission system; therefore, the 500-kV and 230-kV lines connecting CGS to the Ashe Substation, and the 115-kV back-up powerline, are the only transmission lines considered in-scope for this review. All ROW maintenance of the in-scope transmission lines is performed by BPA; however, because the vegetation underneath the overhead lines are mainly low-lying plants and shrubs, very little maintenance is necessary (EN, 2010).

2.1.6 Cooling and Auxiliary Water Systems

The circulating-water system supplies cooling water for the condenser at CGS. The plant service-water system removes the rejected heat from the auxiliary equipment during normal operation. The standby service-water system is a separate cooling water system that removes heat during a loss-of-coolant accident and removes residual reactor heat during a normal shutdown. Unless otherwise cited, the staff drew information about CGS's cooling and auxiliary water systems from Energy Northwest's ER (EN, 2010).

Circulating-Water System. The CGS circulating-water system is a closed-cycle cooling system that removes heat from the condenser and transfers it to the atmosphere through evaporation using six mechanical draft cooling towers (EN, 2010). The circulating-water pumphouse circulates the water from the condenser through the cooling towers and back again at a rate of about 550,000 gallons per minute (gpm) (35 cubic meters (m^3 per second (sec)). The temperature of the cooling water in the circulating-water system increases about 30 degrees Fahrenheit (F) (17 degrees Celsius (C)) as the water flows through the condenser. The cooling towers rise 60 ft (18 m) above the basin and are approximately 200 ft (61 m) in diameter at the base of the towers.

The circulating-water system uses water from the Columbia River to replenish the water lost from evaporation, drift, and blowdown. The makeup water pumphouse is located 3 mi (5 km) east of the plant and houses three 800-horsepower makeup water pumps (Figure 2.1-3). The pumps are designed to each supply 12,500 gpm (0.79 m^3/sec), or half the system capacity, at the design head. Two pumps normally supply makeup water to the plant with a withdrawal capacity of 25,000 gpm (1.58 m^3/sec).

The intake system for the makeup water pumps consists of two 36-inch (in.) (91-centimeter (cm)) diameter buried pipes that extend 900 ft (274 m) from the pumphouse into the river, about 300 ft (91 m) from the shoreline at Columbia River Mile (RM) 352 (Figure 2.1-4 and Figure 2.1-5) (WPPSS, 1980). An intake structure is located at the end of each of the pipes. The pipes make a 90-degree bend and extend slightly above the surface of the riverbed. Each of the pipes ends with an intake structure (20 ft (6 m) in length) mounted above the riverbed and approximately parallel to the river flow, as shown in Figure 2.1-6. Each intake structure is composed of two intake screens that are each 6.5 ft (2 m) in length (Figure 2.1-7) and mounted end to end. The remaining length of the intake structure consists of two solid cones at either end of the structure. The intake screens consist of an outer and inner perforated pipe sleeve (WPPSS, 1986). The outer sleeve has a 42-in. (107-cm) diameter sleeve with 3/8-in. (9.5 millimeter (mm)) diameter holes (composing 40 percent of the surface area). The inner sleeve has a 36-in. (91-cm) diameter sleeve with 3/4-in. (19-mm) diameter holes (composing 7 percent of the surface area). The intake screens are designed to distribute the water flow evenly along its surface. During normal operating periods, the average makeup water withdrawal is about 17,000 gpm (1.1 m^3/sec).

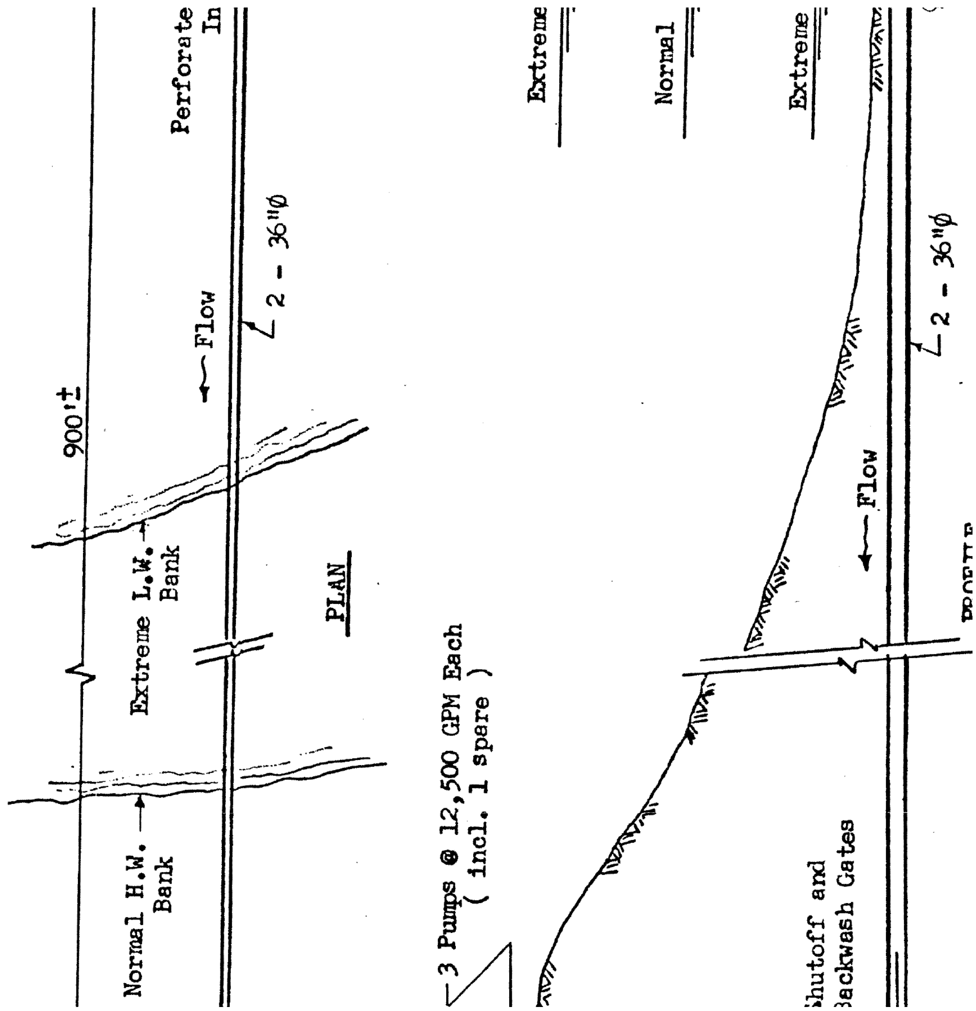

Figure 2.1-4. Intake system plan and profile

(WPPSS, 1980)

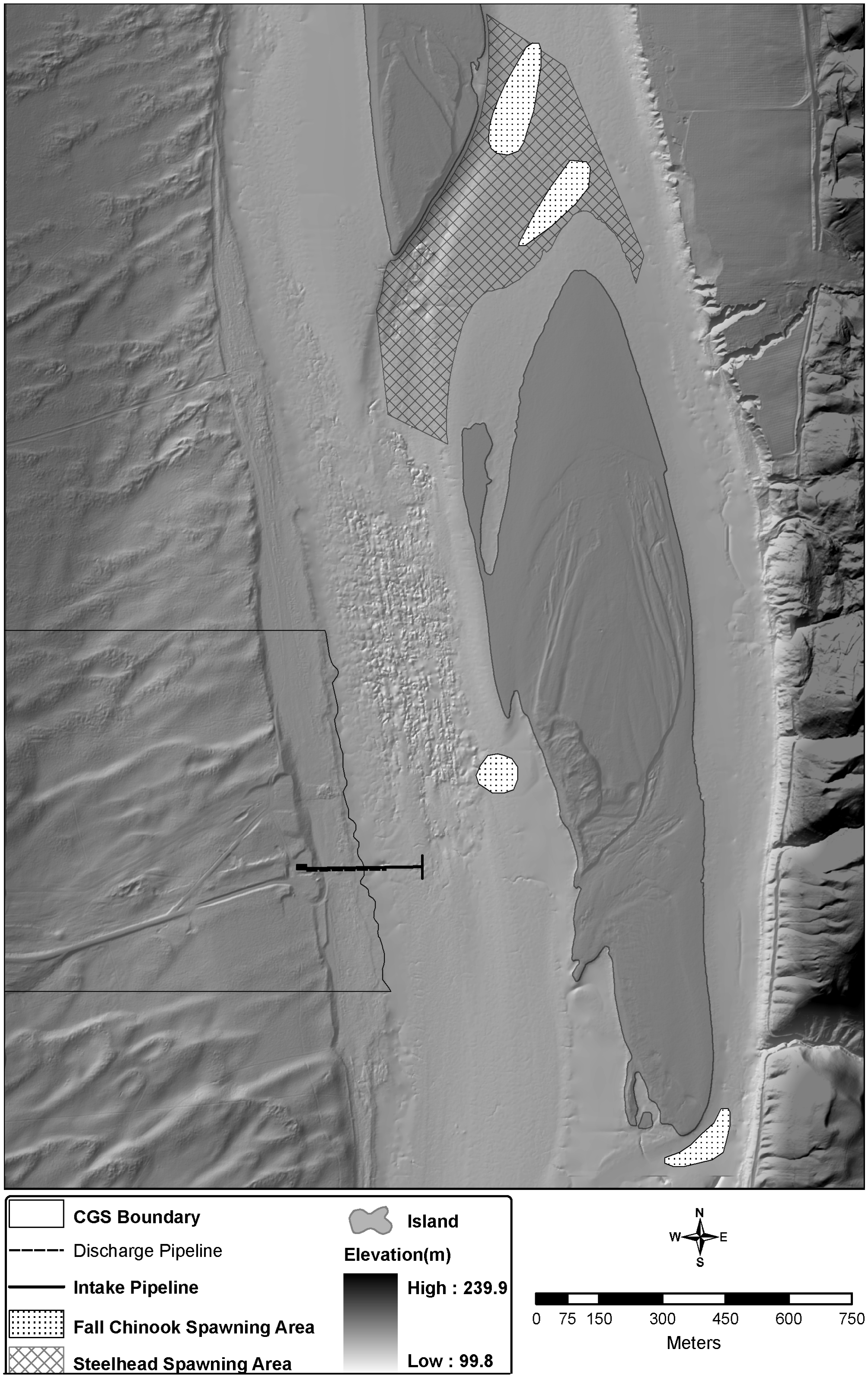

Figure 2.1-5. Location of pumphouse, pipelines, intakes, and outfalls

(Gambhir, 2010a), (Poston, et al., 2008)

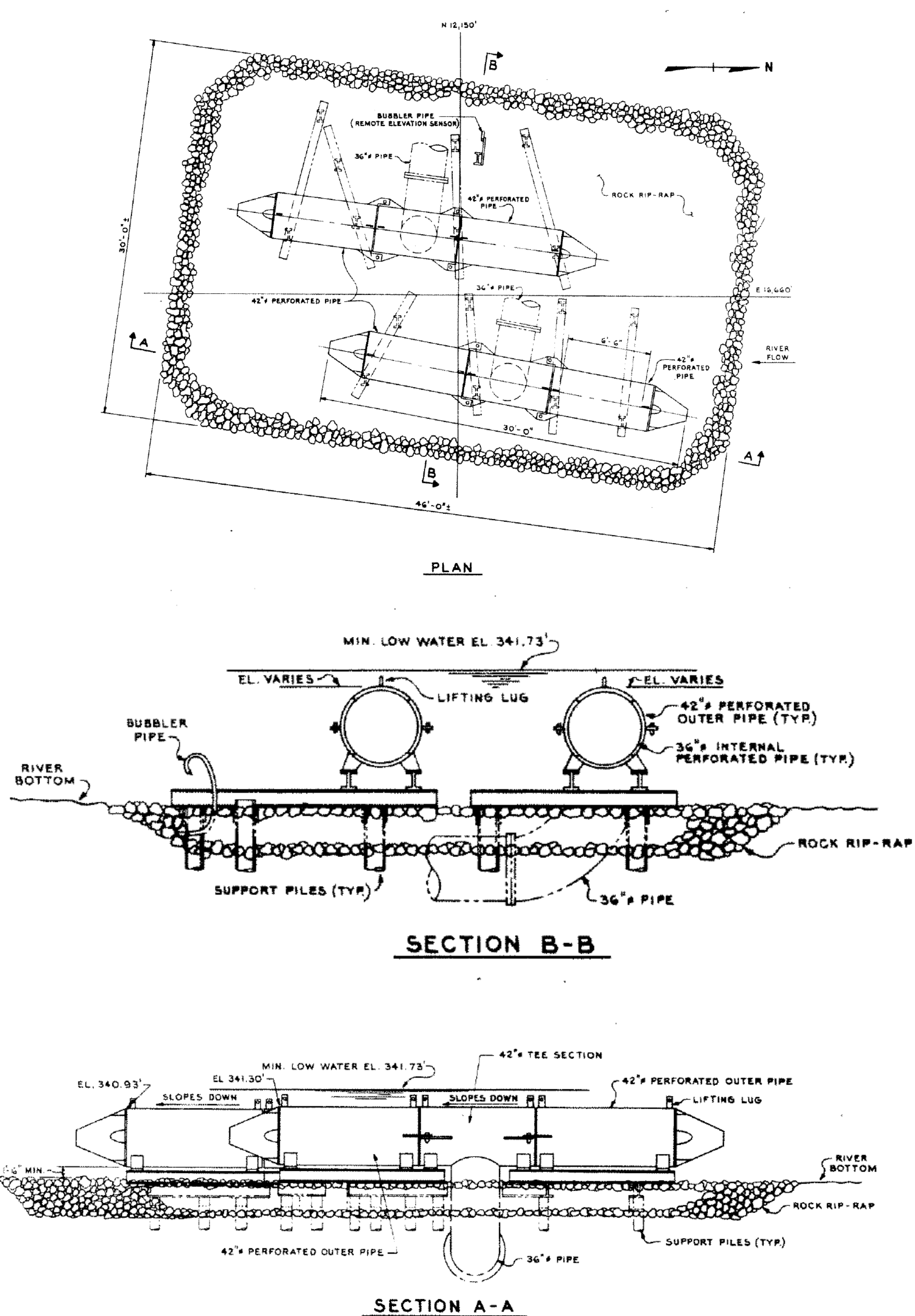

Figure 2.1-6. Perforated intake plan and section

(WPPSS, 1980)

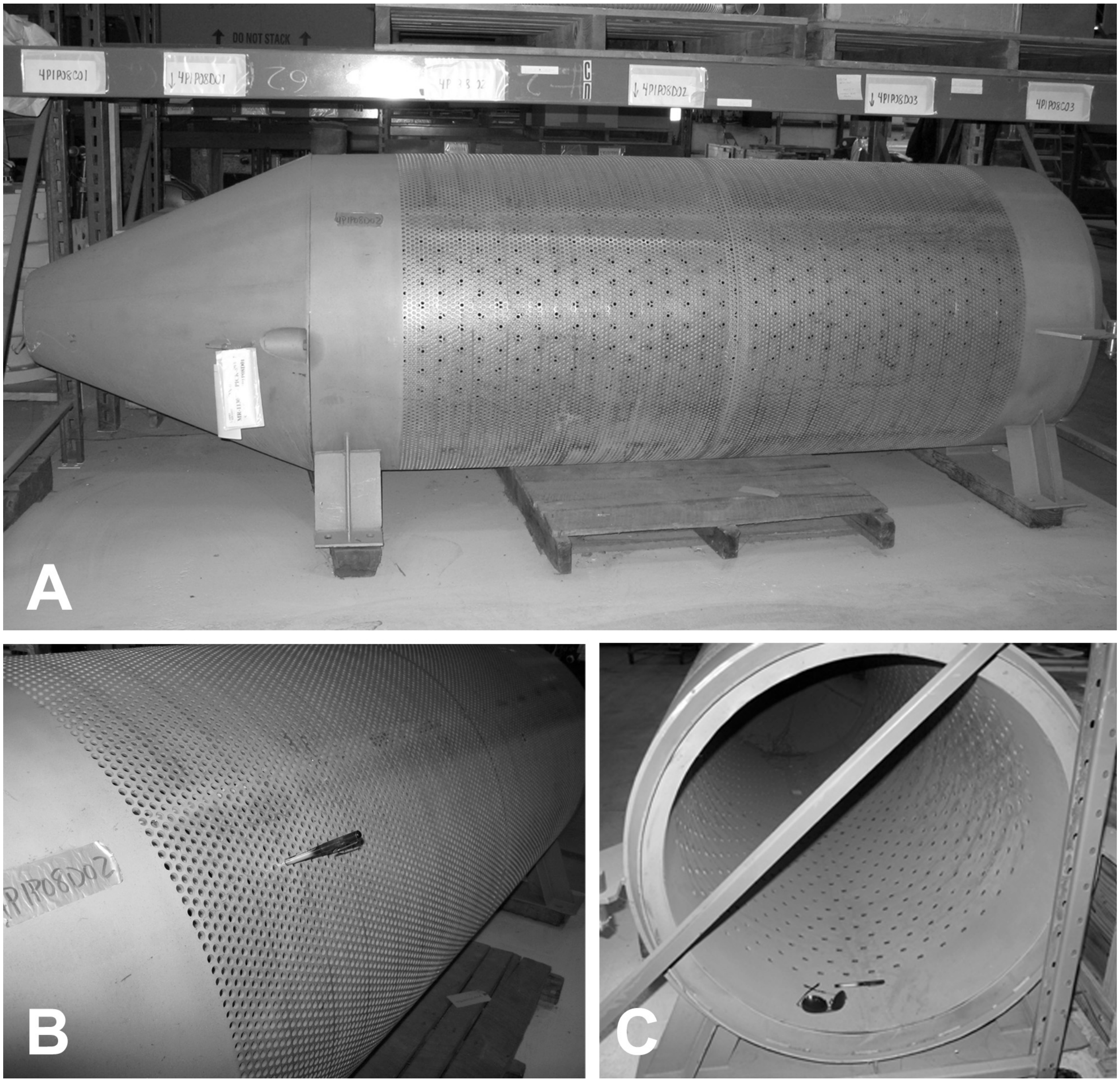

Figure 2.1-7. Spare perforated pipe for the intake screen at CGS.

"A" side view; "B" close up of outer sleeve; and "C" end view showing inner sleeve of perforated pipe

The water in the circulating-water system is supplemented with biocides (sodium hypochlorite and sodium bromide) to retard biological growth. Other chemical additives are used to control corrosion (orthophosphates and a halogen-resistant azole), scale (polyacrylate dispersant), and pH control (sulfuric acid) (EN, 2011). The circulating-water system discharges a portion of the cooled water back into the river as blowdown. On an annual basis, blowdown into the river averages about 2,000 gpm (0.1 m^3/sec) (NRC, 1981).

Blowdown water returns to the river from the cooling towers through a line that extends out into the river next to the makeup water pumphouse. The 18-in. (46-cm) diameter, buried blowdown pipe extends about 175 ft (53 m) from the shoreline at low river stage. The pipe ends above the riverbed at a 15-degree angle in a rectangular slot outfall port that measures 8-in. by 32-in. (20-cm by 81-cm) and is perpendicular to the river flow (Figure 2.1-8).

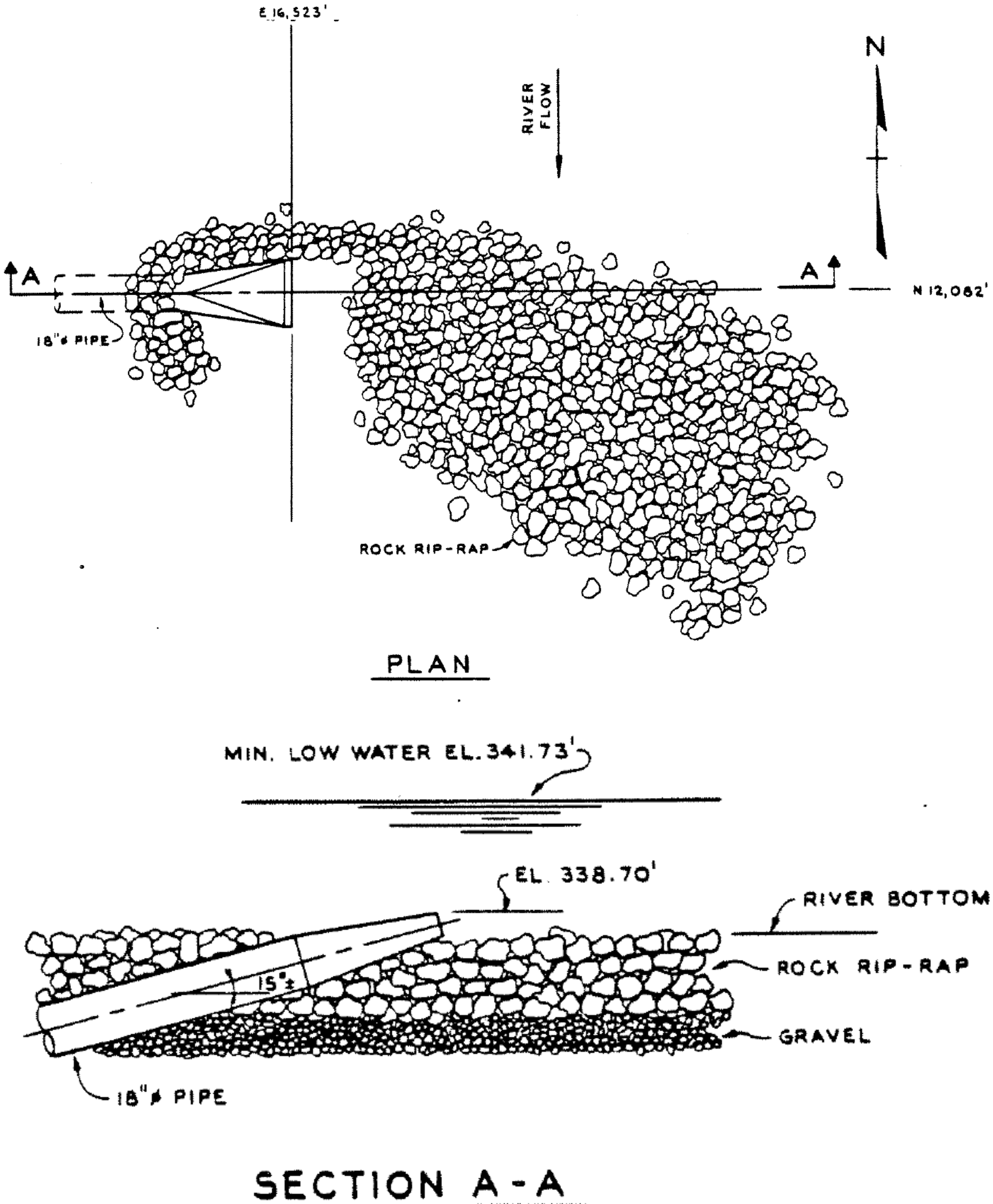

Figure 2.1-8. Rectangular slot discharge

(WPPSS, 1980)

The flow of the Columbia River below Priest Rapids Dam for water years 1960–2009 has an average mean annual discharge of 117,823 cubic feet per second (cfs) (3,336 m^3/sec) and a minimum mean annual discharge of 80,650 cfs (2,283 m^3/sec) (USGS, 2010). Thus, the makeup water withdrawal of 17,000 gpm (1.1 m^3/sec) is about 0.03 percent of the average mean annual discharge and 0.05 percent of the minimum mean annual discharge of the river. The annual average blowdown of 2,000 gpm (0.1 m^3/sec) is about 0.004 percent of the averaged mean annual discharge and 0.006 percent of the minimum mean annual discharge of the river.

Plant Service-Water System. The plant service-water system functions continuously to supply cooling water for removal of heat rejected from auxiliary (nonessential) equipment, including the turbine generator (EN, 2003a). Two 100-percent capacity pumps draw water from the circulating-water system to supply cooling water to equipment located throughout the plant. The circulating water in the system mechanical draft cooling towers also cools the service-water return. In addition to the biocide-treated circulating-water supply used by the plant service-water system, the plant service-water system is equipped with systems to add biocides and other chemicals. The biocide retards biological growth, and the chemicals are added to minimize silt deposition, scale formation, corrosion, and consequent fouling of heat-transfer surfaces (EN, 2003a).

Standby Service-Water System. In the event of a loss-of-coolant accident, the standby service-water system supplies emergency cooling water. The standby service-water system functions as the ultimate heat sink. The system has two concrete spray ponds. Each spray pond measures 250 ft (76 m) by 250 ft (76 m) and 15 ft (4.6 m) deep, consisting of 14 ft (4.2 m) of water and 1 ft (0.3 m) of free board (WPPSS, 1980). The combined water inventory of the ponds can supply cooling water for 30 days without makeup. The cooling tower makeup water system or the potable water system can supply water to the standby service-water system lost through evaporation, drift, and occasional blowdown (needed to maintain the water chemistry of the system). The spray ponds supply suction and discharge points for the redundant pumping and spray facilities of the service-water system. Two independent, 100-percent capacity service-water pumps supply water to the emergency core cooling system, essential plant equipment, and reactor shutdown cooling equipment. Separate pumphouses accommodate each pump. In one of the pumphouses, a third pump provides supply water to high-pressure core spray system cooling equipment. Chemicals are added to the water in the standby service-water system to control biological growth (e.g., hydrogen peroxide) and to minimize corrosion (e.g., sodium metasilicate) (EN, 2011).

2.1.7 Facility Water Use and Quality

A portion of the cooling water is lost through evaporation and drift. The evaporative losses lead to concentration of dissolved solids in the cooling water. Thus, a portion of the cooling water, so-called blowdown water, is routinely discharged back to the Columbia River and replenished with freshwater, thus controlling the buildup of dissolved solids.

In addition to the normal water supply from the Columbia River, CGS maintains one groundwater-supply well (Well 699-13-1C) as a backup source of water for plant operations. Two other water-supply wells are maintained to support ongoing activities on the Industrial Development Complex (IDC) site. The IDC water system is cross-tied to the CGS site potable water system and can be used to supply water to the CGS site during infrequent maintenance and repair activities that make the CGS river water supply unavailable (EN, 2010).

2.1.7.1 Groundwater Use and Quality

Where undisturbed, the CGS site is underlain by a thin (less than 15 ft thick) sequence of Holocene-age eolian sand and loess (EN, 2005), (HGI, 2008) overlying an approximate 45–50-ft-thick sequence of Pleistocene-age glaciofluvial sands and gravels (EN, 2005). These glaciofluvial sediments, informally referred to as the Hanford formation, were deposited by numerous cycles of cataclysmic Ice Age flooding (DOE, 2002a). Sediments of the Cold Creek Unit (DOE, 2002a) are not believed to be present beneath the CGS site (Thorne, 2007). However, the Cold Creek gravels are often difficult to differentiate from Hanford formation gravels and the underlying Ringold Formation. They have been noted approximately 1 mi (1.6 km) northwest of the site and may exist in the area immediately north of the site (Vermeul, et al., 2005).

Beneath the Hanford formation lies a thick (approximately 480 ft thick) sequence of dense silt, sand, and gravel conglomerates of the Ringold Formation—member of Wooded Island (EN, 2005), (EN, 2010), (Lindsey, 1996). The upper 200 ft of the Ringold Formation, beneath the CGS site, consists of very dense sandy gravel (EN, 2005) equivalent to Units E and C (HGI, 2008), (Lindsey, 1996). The lower portion of the Ringold Formation consists of very compact, interbedded gravel, sand, silt, and clay extending to a depth of about 500–525 ft (EN, 2005). Finer-grained overbank deposits separate gravel and sand dominated sediments of the combine Units B/D from the overlying Units E/C, while the lower mud unit separates Units B/D from unit A, directly overlying the basalt bedrock (HGI, 2008). Bedrock beneath the site consists of Miocene age tholeitic basalt of the Columbia River Basalt Group, at a depth of approximately 550 ft (EN, 2005).

The uppermost aquifer is located within the Ringold Formation, at a depth of about 60 ft beneath the ground surface (EN, 2005), (EN, 2010). The upper portion of this aquifer is unconfined, while deeper portions of the Ringold Formation may be locally confined (semi-confined) by lower permeability silts and clays. The effective bottom of the unconfined aquifer is assumed to be at about 220–260 ft above mean sea level (MSL) at the top of the finer-grain overbank deposits separating Units E/C from Units B/D. Groundwater potentials from the lower portion of the Ringold Formation (Units B/D and A) and from the basalt aquifers are about 25 ft higher than those of the unconfined aquifer (EN, 2005).

The groundwater in the unconfined aquifer generally moves in an easterly direction towards its primary points of discharge to the Columbia River approximately 3 mi away. This aquifer is in direct hydraulic communication with the Columbia River. However, because of the distance from the river, and the permeability characteristics and enormous volume of the Ringold Formation, the water table beneath the site fluctuates very little (EN, 2005), (EN, 2010).

Three water-supply wells were installed during construction of the CGS plant to supply construction support (EN, 2010) (Figure 2.1-9). Two of the wells, 699-13-1A and 699-13-1B, were constructed in the unconfined aquifer to depths of about 244 and 234 ft, respectively (EN, 2005), but they were removed from service in 1979 when the pumps were removed (EN, 2010). The third well, Well 699-13-1C, was completed at a depth of approximately 695 ft (EN, 2005) in a confined aquifer within the basalt bedrock. This well has a pumping capacity of about 250 gpm and is maintained in the standby mode to supply supplemental makeup water for the potable and demineralized water system as needed (EN, 2005). It is typically only pumped to support quarterly sample collections, with an estimated run time per year of 2 hours or less at an approximate rate of 200 gpm (EN, 2010).

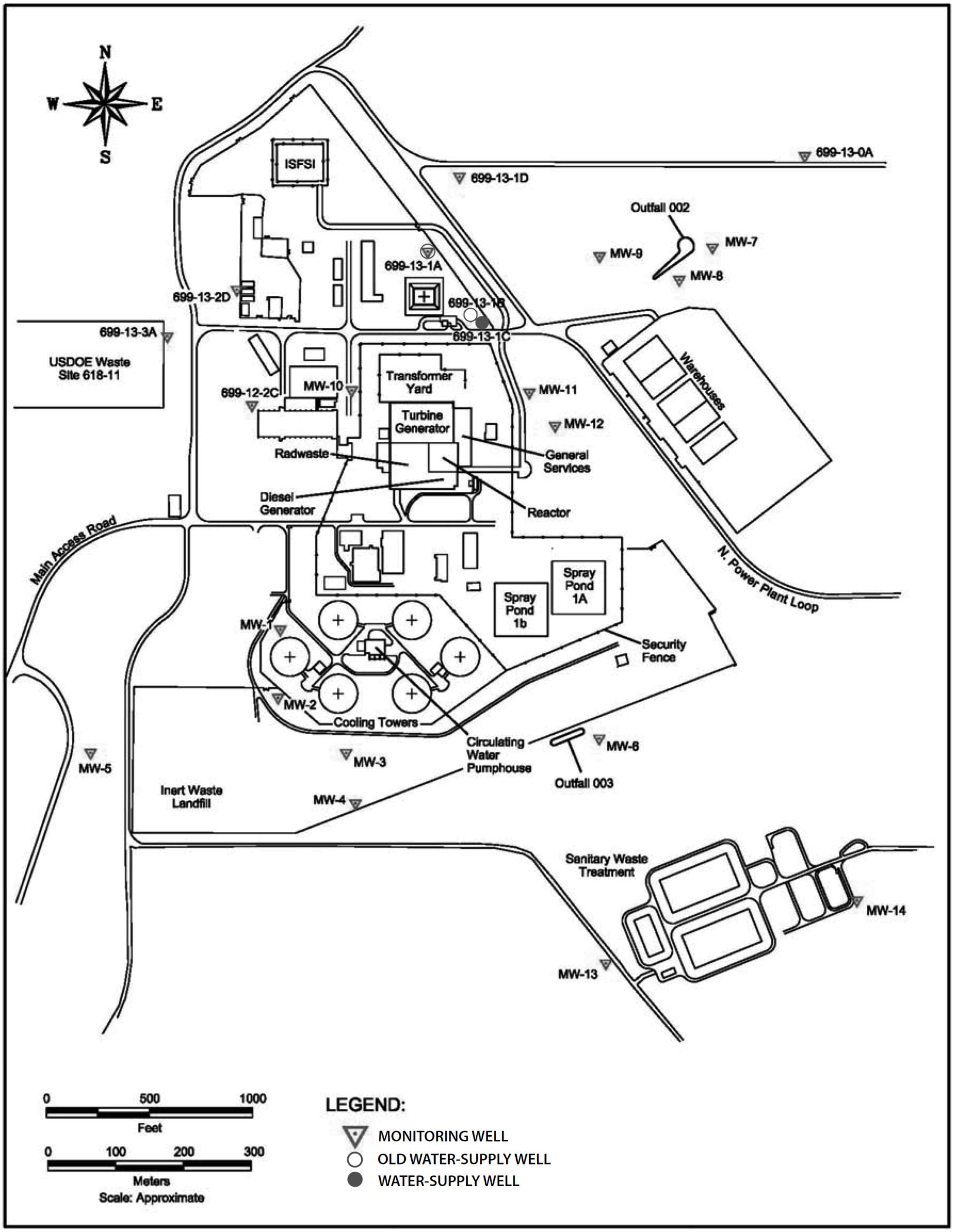

Figure 2.1-9. Well location map

(After ER Figure 2.3-1 (EN, 2010))

Two other water-supply wells were constructed in 1975 to support construction of Nuclear Projects Nos. 1 and 4 (WNP-1/4), about 1 mi east of the CGS site. These wells, ENW-31 (C3080) and ENW-32 (C3081), are screened from 247–341.5 ft and 244.25–366 ft, respectively (Dresel, et al., 2000). These wells are used to fill a water-storage tank to supply water for ongoing activities on the IDC site. The IDC water supply system is cross-tied to the CGS site potable water system to supply the CGS site during infrequent maintenance and repair activities that make the CGS river water supply unavailable. The estimated pumping capacity of each of these wells is estimated at 250–270 gpm (Gambhir, 2010b). Typically, the crosstie is open less than 50 hours per year, although in 2008 it was used for 1,655 hours to supply water to portions of the CGS site (EN, 2010). The water is not metered, but the average annual usage rate for 2005–2008 was estimated at about 1 gpm (EN, 2010). From October 2009–April 2010, these water-supply wells each operated for an estimated 120 hours, at pumping rates of approximately 270 gpm, for a total average pumping rate estimated at about 30 gpm, or 15 gpm per well (Gambhir, 2010b).

Recharge to the unconfined aquifer is primarily from precipitation and runoff in elevated areas along the western margin of the Pasco Basin (i.e., Rattlesnake Hills, Yakima Ridge, and Umtanum Ridge), leakage from the underlying basalt-confined aquifers, influx from the Yakima River, and recharge from precipitation across the Hanford Site (EN, 2005), (HGI, 2008). Artificial recharge from large wastewater discharges during Hanford Site operations created groundwater mounds that affected groundwater characteristics across the Hanford Site. Significant reduction in wastewater discharges in the 1990s has allowed these groundwater mounds to dissipate over most of the Hanford Site (Duncan, et al., 2007), (DOE, 2008).

Some artificial recharge from wastewater and stormwater discharges also occurs locally on the CGS site. One of these recharge sources is an unlined pond located 1,500 ft northeast of the CGS reactor building. This pond receives stormwater from plant roofs, backwashes of the potable water-treatment filter, and a reject stream from a process water reverse osmosis unit. It also receives infrequent batch-type discharges from flushes of emergency diesel engine cooling water and flushes of the fire-protection system. The outfall to this pond is designated as Outfall 002 in the CGS NPDES permit. Annual discharges are estimated at about 15 million gallons (gal.) (EN, 2010).

The percolation beds at the site sanitary waste-treatment facility supply another point of artificial recharge. This site is located 2,500 ft southeast of the reactor building where, once or twice per year, 1–2 million gal. of treated effluent are released to the soil over a 3–5 day period (EN, 2010).

A third point of artificial recharge is an old soil borrow pit, or swale, located about 1,500 ft south-southeast of the reactor building. This pit is designated as Outfall 003 in the NPDES permit (EN, 2010). This site was used for the disposal of about 500,000 gal. per year of backwash water from a sidestream sand filter on the standby service-water system from 1997–2003. Regular discharges to this site ceased in October 2003 when the filter was removed from service. However, the outfall is still available for discharge of water if the spray ponds need to be drawn down for cleaning or maintenance.

The CGS site also has numerous drywells for the collection of stormwater. These wells also supply a groundwater recharge pathway (EN, 2010). Drywells around the cooling towers also catch the drift and spray of condenser cooling water from the towers during windy conditions.

Groundwater monitoring on the CGS site is done by sampling 14 monitoring wells (MWs). Five of these MWs (MW-1–MW-5, Figure 2.1-9) were installed in 1995 as part of an investigation of a construction debris landfill in use from 1976–1993, located just southwest of the cooling towers. Sampling showed low-level concentrations of contaminants in the groundwater (EN, 2010), (Golder, 1995) and, subsequently, led to capping of the landfill with a synthetic membrane and soil cover in 1999. Groundwater sampling specific to the landfill continued until April 2002, when the data showed that the landfill contaminants were not causing degradation of the groundwater (EN, 2010). Instead, the elevated conductivity and concentrations of chloride and sulfate were attributed to the infiltration of circulating cooling water that entered the soil through drywells (EN, 2002), (EN, 2010).

Four more wells (MW-6–MW-9, Figure 2.1-9) were installed in 1997 to support groundwater monitoring of Outfalls 002 and 003 (EN, 2010). MW-6 was installed downgradient of the borrow pit receiving backwash from the service-water filter (Outfall 003), with well MW-3 serving as the upgradient and background well for this site. Wells MW-7, MW-8, and MW-9 were installed at the unlined stormwater pond (Outfall 002). One year (four quarters) of monitoring data showed no adverse effect on groundwater quality at the two points of discharge (WPPSS, 1999). Groundwater monitoring is being carried out under the terms of the current NPDES permit (EN, 2010).

In response to the Nuclear Energy Institute Groundwater Protection Initiative (NEI, 2007), the CGS carried out a groundwater monitoring program to routinely sample the unconfined aquifer. As part of this program, five additional MWs (MW-10–MW-14) were installed in late 2008 (EN, 2009). Wells MW-10, MW-11, and MW-12 were installed close to the CGS turbine building to help detect potential leakage from the condensate storage tanks and underground piping. Wells MW-13 and MW-14 were installed at the onsite Sanitary Waste Treatment Facility (SWTF) to help assess the effect of discharges to the facility.

Groundwater monitoring in 2008 failed to note any gamma-emitting radionuclides of interest (EN, 2009). Tritium concentrations ranged from less than detectable limits to 17,400 picocuries (pCi) per liter (L). However, the highest concentrations were from an upgradient well, MW-5, and have been attributed to DOE Hanford Site operations (EN, 2009), (EN, 2010).

2.1.7.2 Surface-Water Use and Quality

The primary water supply for the CGS is the Columbia River. Water-quality parameters measured by the U.S. Geological Survey (USGS) from 1996–2003 at Vernita Bridge (USGS Station No. 12472900 at RM 388), 35 mi upstream of the CGS site, showed that water temperature ranged between 3–20.5 degrees C with a median of 12 degrees C (EN, 2010), (USGS, 2006). Dissolved oxygen ranged between 9.2–14.0 milligrams (mg) per L with a median of 12.4 mg/L. The pH fluctuated between 7.4–8.2 standard units (EN, 2010), (USGS, 2006).

As part of its operational monitoring programs, Energy Northwest collected river water samples at four or more stations near the plant discharge at RM 352. This water-quality component of the environmental monitoring program was discontinued after 1995, when years of data showed no discernable changes in river water quality at monitoring locations 150–1,900 ft downstream of the outfall (EN, 2010).

Comparison of water-quality parameters measured 36 mi upstream of CGS, near Vernita Bridge, and 12 mi downstream of CGS, near Richland (USGS Station No. 12473520 at RM 340), found no indication of any deterioration of Columbia River water quality along the Hanford Reach (Poston, et al., 2009). Poston, et al., did report that small amounts of radioactive materials were detected downriver from the Hanford Site. However, the amounts were far below Federal and state limits. Further, there was no indication of any deterioration of Columbia River water or sediment quality resulting from operations at the Hanford Site (Poston, et al., 2009).

The 2008 assessment of water quality by the State of Washington found no quality impairments based on water samples in the river reach below Vernita Bridge. However, it did find organic elements in fish tissue and pH and temperature in irrigation return flows as an indicator of water-quality impairment at upstream locations (EN, 2010), (WDOE, 2008).

2.1.7.3 National Pollutant Discharge Elimination System

The State of Washington authorizes discharge of treated wastewater via three outfalls at the CGS, in accordance with the special and general conditions of NPDES Permit No. WA-002515-1 under authority delegated by EPA.

Outfall 001—the main discharge outfall for condenser cleaning effluent, radioactive waste-treatment system effluent, cooling water blowdown from the circulating water system, and discharge from the standby service-water system—is located in the Columbia River (RM 351.75). The discharge pipe is buried in the riverbed and ends in an outfall port, about 175 ft from the shoreline at low river flow (EN, 2010). This outfall consists of an 8-in. by 32-in. rectangular orifice oriented at a 15-degree angle to the riverbed and perpendicular to the river flow (EN, 2010).

Outfall 002 discharges stormwater from plant roofs, backwashes of the potable water-treatment filter, and a reject stream from a process water reverse osmosis unit to an unlined pond located 1,500 ft northeast of the CGS reactor building. In addition, infrequent batch-type discharges include flushes of emergency diesel engine cooling water and flushes of the fire-protection system.

Outfall 003 is available for water discharges from the spray ponds if they need to be drawn down for cleaning or maintenance. This outfall discharges to an old soil borrow pit or swale located about 1,500 ft south-southeast of the reactor building (EN, 2010). The location was used for the disposal of about 500,000 gal. per year of backwash water from a sidestream sand filter on the standby service-water system from 1997–2003. Regular discharges at this location ended in October 2003 when the filter was removed from service (EN, 2010).

2.2 Surrounding Environment

CGS is in south-central Washington State along the Columbia River on the Hanford Site on land leased from DOE. The nearest population center is the Tri-Cities of Richland, Kennewick, and Pasco, approximately 15 mi southeast of the site. The estimated population within 20 mi (32 km) of CGS in 2000 was 171,371.

The topography around CGS is generally flat with gentle hills and an elevation ranging from about 350 ft above MSL near the river to about 460 ft MSL on the hills.

There is one Native American reservation within a 50-mi (80-km) radius of CGS—the Yakama Reservation, located approximately 45 mi (72 km) to the west.

2.2.1 Land Use

CGS is located 3 mi (4.8 km) west of the Columbia River in Benton County, Washington. The site is comprised of 1,089 ac (441 ha) leased to Energy Northwest by DOE. The leased land is in two parcels—a nearly square section containing the power block and associated structures and an elongated area running east from the station to the river. In addition, the lease from DOE grants Energy Northwest authority to control activities within a 1.2 mi (1.9 km) exclusion area (per 10 CFR 100.3) including land outside of the lease boundary (see Figure 2.1-3).

The immediate area surrounding CGS is enclosed by a security barrier shown in Figure 2.1-3. Access to CGS is through a security gate via a three lane road off DOE-owned Route 4S, west of the plant. A DOE-owned railroad track runs through the CGS site and passes within about 500 ft (152 m) east of the plant. The track is used infrequently by DOE, and it is blocked by security barriers located north and south of the plant.

Notable manmade features within a 6-mi (10-km) radius of CGS (see Figure 2.1-2) include two abandoned power plant construction projects (WNP-1 and WNP-4), located about 1 mi (1.6 km) east-southeast and east-northeast of the plant. BPA's H.J. Ashe Substation is 0.5 mi (0.8 km) north of the plant, while the Laser Interferometer Gravitational-Wave Observatory is 3.5 mi (5.6 km) from the plant. The following DOE facilities are also within a 3.5 mi (5.6 km) radius of CGS:

- Fast Flux Test Facility (FFTF), located 2.75 mi (4.4 km) south-southwest in the Hanford 400 Area
- two radioactive waste burial grounds—618-10 located 3.5 mi (5.6 km) south and 618-11 immediately west of CGS

Nearby communities include Richland, approximately 10 mi (17 km) south; Pasco, 18 mi (29 km) southeast; and Kennewick, 21 mi (34 km) southeast. The nearest residence is 4.25 mi (6.8 km) from CGS in an east-southeasterly direction across the Columbia River. Prominent features of the surrounding area, out to 50 mi (80 km), are shown in Figure 2.1-1.

2.2.2 Air Quality and Meteorology

The CGS site is located within the Pasco Basin of the Columbia Plateau in southeastern Washington State. The climate for this region is classified as semi-arid shrub-steppe, which is characteristic of areas that receive little—but consistent—annual precipitation to support perennial grass and shrub vegetation (Hoitink, et al., 2005). The region’s temperature and precipitation are greatly influenced by the presence of large mountain barriers. The Cascade Mountains to the west form a barrier to the easterly movement of moist air from the Pacific, resulting in a sharp west-to-east gradient in precipitation. The Rocky Mountains in southern British Columbia generally block polar air masses moving south during the winter months.

Regionally, the prevailing wind direction is from the southwest or west during most of the year (WRCC, 2010). However, the predominate wind direction near the CGS site is modified by nearby terrain features, such as Rattlesnake Mountain to the southwest and Saddle Mountains to the north, as well as cold-air drainage flows forming along the Columbia River, which is just east of the site. Historical wind observations for a 60-year period (1945–2004), from the primary meteorological tower at the DOE’s Hanford Site, show that the prevailing wind direction is generally from the west-northwest or northwest for every month of the year, with an annual average windspeed of 7.6 miles per hour (mph) (Hoitink, et al., 2005). Peak wind gusts, however, generally have a southwesterly component and average around 80 mph (69.5 knots) (Hoitink, et al., 2005).

Monthly mean temperatures near CGS range from a low of 31.8 degrees F (-0.1 degrees C) in January to a high of 76.3 degrees F (24.6 degrees C) in July. Extreme temperatures range from a low of -23.0 degrees F (-30.6 degrees C) on January 3, 1950, to a high of 113.0 degrees F (45.0 degrees C) on July 13, 2002 (Hoitink, et al., 2005).

Approximately 7 in. (17.78 cm) of liquid precipitation fall throughout the year, with December being the wettest month (1.11 in. (2.82 cm)) and July and August being the driest months (0.27 in. (0.69 cm)). The driest and wettest years on record are 1978 (2.99 in. (7.59 cm)) and 1996 (12.31 in. (31.27 cm)), respectively. Annual snowfall for the area is normally 15.4 in. (39.12 cm). Severe weather is not common to the area; thunderstorms are observed normally 10 days throughout the year. Dense fog, with visibility less or equal to 0.25 mi (0.40 km), occurs 24 days during a normal year, with the majority of these days occurring during the winter months of December–February (Hoitink, et al., 2005).

2.2.2.1 Air Quality

The CGS site is located in Benton County, Washington, which is part of the South Central Washington Intrastate Air Quality Control Region (AQCR) (40 CFR 81.189). Additional counties in this AQCR include Franklin, Kittitas, Klickitat, Walla Walla, and Yakima Counties.

The EPA regulates six criteria pollutants under the National Ambient Air Quality Standards (NAAQS)—carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter. Benton County is designated as unclassified or in attainment for all NAAQS criteria pollutants; a small portion of Benton County, which does not include the CGS site, became a maintenance area for PM_{10} (particles with a diameter of 10 micrometers or less) on September 26, 2005 (40 CFR 81.348). Portions of Yakima County, which are also part of this AQCR, are also maintenance areas for PM_{10} and carbon monoxide (40 CFR 81.348). All other counties in this AQCR are designated as unclassified or in attainment with respect to the NAAQS criteria pollutants.

Regulated air pollutants—including sulfur dioxide, nitrogen oxide, and particulates—are emitted from three standby diesel generators and an auxiliary boiler at the CGS site (EN, 2010). These sources conform to Washington State Regulatory Order 672, which limits air emissions to levels below regulatory thresholds (EFSEC, 1996). A separate State regulation, WAC 463-78-100, requires annual registration of air pollution sources. Table 2.2-1 lists the total diesel fuel usage and associated air emissions from these regulated sources (Gambhir, 2010a). There are no plans for refurbishment of structures or components at the CGS for license renewal. Therefore, there are no changes to expected air emissions associated with license renewal (EN, 2010).

Table 2.2-1. Annual fuel use and calculated air emission estimates for significant sources at CGS

Year	Fuel usage (gal)[(a)]	NO_x (T)[(b)]	CO (T)[(b)]	SO_2 (T)[(b)]	PM (T)[(b)]	PM_{10} (T)[(b)]	VOC (T)[(b)]	Pb (T)[(b)]	CO_2 (T)[(b),(c)]
2006	56,582	10.5	2.8	0.13	0.24	0.20	0.29	0.0002	650
2007	60,896	11.9	3.2	0.10	0.27	0.23	0.33	0.0003	699
2008	59,030	8.6	2.3	0.17	0.20	0.17	0.24	0.0002	678
2009	74,608	8.3	2.2	0.18	0.21	0.17	0.22	0.0002	856

(a) To convert gallons to liters, multiply by 3.8.

(b) To convert T to MT, multiply by 0.91.

(c) Estimated by staff using EPA emission factors for uncontrolled gasoline and industrial engines (EPA, 2010a).

NO_x = nitrogen oxides; CO = carbon monoxide; SO_2 = sulfur dioxide; PM = particulate matter; PM_{10} = particulate matter with an aerodynamic diameter of 10 microns or less; VOC = volatile organic compounds; Pb = lead; CO_2 = carbon dioxide.

The relative fuel use in various equipment (diesel generators vs. auxiliary boiler) changes year-to-year resulting in changes in calculated emissions.

(Gambhir, 2010a)

Mandatory Class I Federal Areas, where visibility is an important value, are listed in 40 CFR 81 Subpart D. There are no mandatory Class I Federal areas within 50 mi (81 km) of the CGS site. The closest mandatory Class I Federal area is Goat Rocks Wilderness Area, which is approximately 100 mi (161 km) west of the CGS site (40 CFR 81.434). Due to the significant distance from the site and prevailing wind direction, no adverse impacts on Class I areas are anticipated from CGS operation. Furthermore, there are no expected air emissions associated with license renewal (EN, 2010).

CGS maintains a 245-ft (75-m) meteorological tower that is approximately 450 ft (137 m) above sea level. The tower is instrumented at two levels—33 ft (10 m) and 245 ft (75 m)—to measure wind and temperature (EN, 2010). Redundant measurements are made at both levels by backup instrumentation (EN, 2010). Relative humidity is also measured at the 33-ft (10-m) level. Precipitation and pressure are measured at ground level near the tower (EN, 2010). Observations are averaged to 15-minute and hourly values and are made available to the CGS plant computer. Separately, the DOE's Hanford Site, which surrounds the CGS site, maintains a comprehensive network of meteorological stations and towers that can be used to further categorize the area (Hoitink, et al., 2005). Meteorological station 14, the closest DOE meteorological station to the CGS plant, is a 33-ft (10-m) tower that measures both wind and temperature. The National Weather Service office in Pendleton, Oregon, provides backup meteorological support for the CGS site.

2.2.3 Groundwater Resources

CGS is situated within the Hanford Site, in the east-central part of the semi-arid Pasco Basin, one of several structural and topographical depressions within the Columbia Plateau in southeastern Washington (EN, 2005), (DOE, 2005). Exploitable groundwater resources are available in the unconsolidated glaciofluvial sands and gravels of the Hanford formation, the semi-consolidated sand and gravel conglomerates of the Ringold Formation, and in the basaltic lava flows of the Columbia River Basalt Group and sedimentary interbeds of the Ellensburg Formation. Groundwater in the unconsolidated to semi-consolidated sediments above the basalt bedrock typically occurs in unconfined conditions, whereas groundwater in the basalt occurs mainly under confined conditions.

The uppermost aquifer beneath the CGS site occurs within the semi-consolidated Ringold Formation. This unconfined to semi-confined aquifer lies at a depth of about 60 ft. Two water-supply wells, Wells 699-13-1A and 699-13-1B, were constructed in the mid-1970s to tap into this aquifer, extending to depth of about 240 ft. Use of these wells was discontinued in 1979 (EN, 2010). A third well, Well 699-13-1C, was drilled to a depth of 695 ft and draws water from a confined aquifer in the basalt.

Nearby points of groundwater use include two water-supply wells located about 1 mi east for the CGS plant, at the IDC. These wells were constructed in the mid-1970s to support construction of Nuclear Projects Nos. 1 and 4 (WNP-1/4). The wells are 372 and 465 ft deep and draw from a semi-confined portion of the lower Ringold Formation and from the upper portion of the Columbia River Basalt Group, respectively (EN, 2010), (Dresel, et al., 2000).

Groundwater use on the Hanford Site is generally restricted, except for the purposes of monitoring and treatment, as approved by the EPA or the WDOE (DOE, 2003). However, a limited number of groundwater-supply wells provide drinking water at the FFTF in the 400 Area (one main and two backup wells), the Hanford Patrol Training Center (one well), and the Yakima Barricade (one well) (DOE, 2002a). Other wells supply emergency cooling water at B-Plant (two wells) and water for aquatic studies in the 300 Area (one well) (DOE, 2002a).

Hanford Site operations have disposed of large volumes of operational wastewater. This has supplied significant artificial recharge to the unconfined aquifer and led to many changes in the groundwater characteristics. Operational discharges have decreased since 1984 and were nearly eliminated by 1996. As a result of the past Hanford Site operations, the groundwater beneath the Hanford Site has become contaminated by radiological and chemical constituents unrelated to CGS operation. The most extensive contaminant plumes are those of tritium and nitrate, emanating from the 200 Areas and moving east and southeast towards the river and CGS site (DOE, 2008). In 2007, the area of groundwater with contaminants exceeding drinking water standards was about 71 square miles (mi^2) (Poston, et al., 2008).

In 1999, the DOE discovered high concentrations of tritium emanating from Burial Ground 618-11, located adjacent to the northwest corner of the CGS site (EN, 2010), (Figure 2.1-9). This burial ground (dry waste landfill) was used between 1962–1967 for the disposal of fission products and plutonium from Hanford Site operations (FH, 2003), (Dresel, et al., 2000). Tritium concentrations as high as 8 million pCi/L were found in 2000 in Well 699-13-3A next to the burial ground. Measured concentrations have been decreasing but still remain above the drinking-water threshold of 20,000 pCi/L (DOE, 2008), (Vermeul, et al., 2005). In addition, elevated nitrate, gross beta, technetium-99, and iodine-129 were detected in wells near Burial Ground 618-11 (DOE, 2008). DOE continues to monitor the groundwater around Burial Ground 618-11 and is focused on the remediation of this burial ground.

2.2.4 Surface Water Resources

The Columbia River is the fourth largest North American river flowing to the sea. It is a high-volume, high-gradient river fed by snowmelt in vast headwater mountain ranges (Benke and Cushing, 2005). The river originates at Columbia Lake in the Canadian Rockies of British Columbia and travels over 1,200 mi (1,900 km), draining a watershed covering approximately 262,480 mi^2 (USFWS, 2008). River flow is regulated by 10 mainstream dams above the CGS site (including three in British Columbia) and 4 below the site. The nearest upstream dam is

Priest Rapids, located at RM 397, 45 mi upstream of the CGS site. The nearest downstream dam is McNary, located at RM 292, 60 mi downstream (EN, 2010). The reservoir (Lake Wallula), created by the McNary Dam, extends to about 6 mi below the CGS site. The 51-mi river reach, extending from the Priest Rapids Dam to the Lake Wallula (RM 346), is free flowing following the flow released from Priest Rapids Dam. The elevation drop through this reach is approximately 70 ft. Flow typically peaks from April–July during spring runoff and is lowest from September–October. The monthly flows recorded by the USGS below Priest Rapids Dam during water years 1960–2009 range from a mean of 79,300 cfs during September to a mean of 202,000 cfs during June. Mean annual flows for the same period ranged from 80,650 cfs in 2001 to 165,600 cfs in 1997 and averaged 117,823 cfs. For water years 1984–2008, coincident with the period of CGS operation, measured flows averaged 113,712 cfs (USGS, 2010). Flow is regulated to meet electrical demands and limit the impact on spawning salmon (EN, 2010). Flows vary daily and hourly as water is released from Priest Rapids Dam, causing the river stage to fluctuate in excess of 10 ft on a daily basis. The river channel near the CGS site varies between 1200–1800 ft wide for low water and normal high water stage, respectively. River depth varies from about 25–45 ft for normal high water and flood high water levels, and velocities vary from 3 feet per second (fps) to over 11 fps depending on the section and flow (EN, 2005).

The only other significant hydrological feature in the site area is the Yakima River, which flows generally west to east and enters the Columbia River at RM 335 (EN, 2010). At its closest approach, the Yakima is about 8 mi southwest of the CGS site.

2.2.5 Description of Aquatic Resources

The Columbia River crosses east of the CGS site, and the intake and discharge structures are located at approximately RM 352. The Columbia River and associated riparian zones supply habitat for many wildlife and plant species. The portion of the Columbia River known as the Hanford Reach is the segment from Priest Rapids Dam (RM 397) to McNary Pool (RM 346) (Duncan, et al., 2007). The Hanford Reach is the last non-impounded, non-tidal segment of the Columbia River in the U.S. People have been using the aquatic resources of the river for at least 10,000 years (Duncan, et al., 2007). The river adjacent to the CGS site is part of the Hanford Reach National Monument, which is divided into units for the purpose of management. Management of the river unit within the Hanford Reach National Monument is multi-jurisdictional, involving DOE, USFWS, Washington State Department of Natural Resources and several other state and county agencies (USFWS 2008). For a vast majority of this time, the aquatic resources were the way of life for the people in the area, and the Hanford Reach still supports subsistence lifestyles. The aquatic ecosystem today is very different than it was 200 years ago when people started making significant changes to the Columbia River. Evidence of gold mining along the shoreline is still apparent today (Duncan, et al., 2007). Intensive commercial fishing during the late 19th century led to significant declines in several migratory salmon species that used the Hanford Reach for spawning, rearing, and passage. The greatest effect on the aquatic resources of the Columbia River has been the result of hydropower development that began in the 1930s (Dauble, 2009). This section describes the aquatic resources near the CGS site with emphasis on those resources present since the proposed construction of the plant.

The Hanford Reach of the Columbia River supports a large and diverse population of plankton, benthic, and lotic invertebrates, fish, and other communities. Large rivers contain significant populations of primary energy producers (e.g., algae and plants) that contribute to the ecosystem's basic energy requirements (Duncan, et al., 2007). Figure 2.2-1 (Miley, et al., 2007) illustrates the interdependencies and biomass flow of the aquatic resources in the Hanford Reach.

The food web of the Hanford Reach resembles that found in large, flowing northwest rivers. The energy sources for the food web are many and diverse (Cushing and Allan, 2001). Primary production comes from organisms that create organic carbon compounds from inorganic precursors through photosynthesis, using energy from sunlight. Secondary production comes from growing populations of organisms that are unable to synthesize energy from inorganic matter and obtain energy by consuming the organic matter formed by primary producers. The plants and animals in Figure 2.2-1 are loosely organized into trophic or feeding groups. These include the herbivores (plant eaters), carnivores (organisms that feed on other animals), and detritivores (detritus, or nonliving organic matter, feeders). Omnivores are animals that eat more than one trophic level. Ecologists often further categorize taxa within a trophic level by function (e.g., shredders, grazers or scrapers, gatherers and filters and predators).

The river supplies habitat for the organisms of the different trophic levels in the water column as well as on the bottom of the river (Cushing and Allan, 2001), (Miley, et al., 2007).

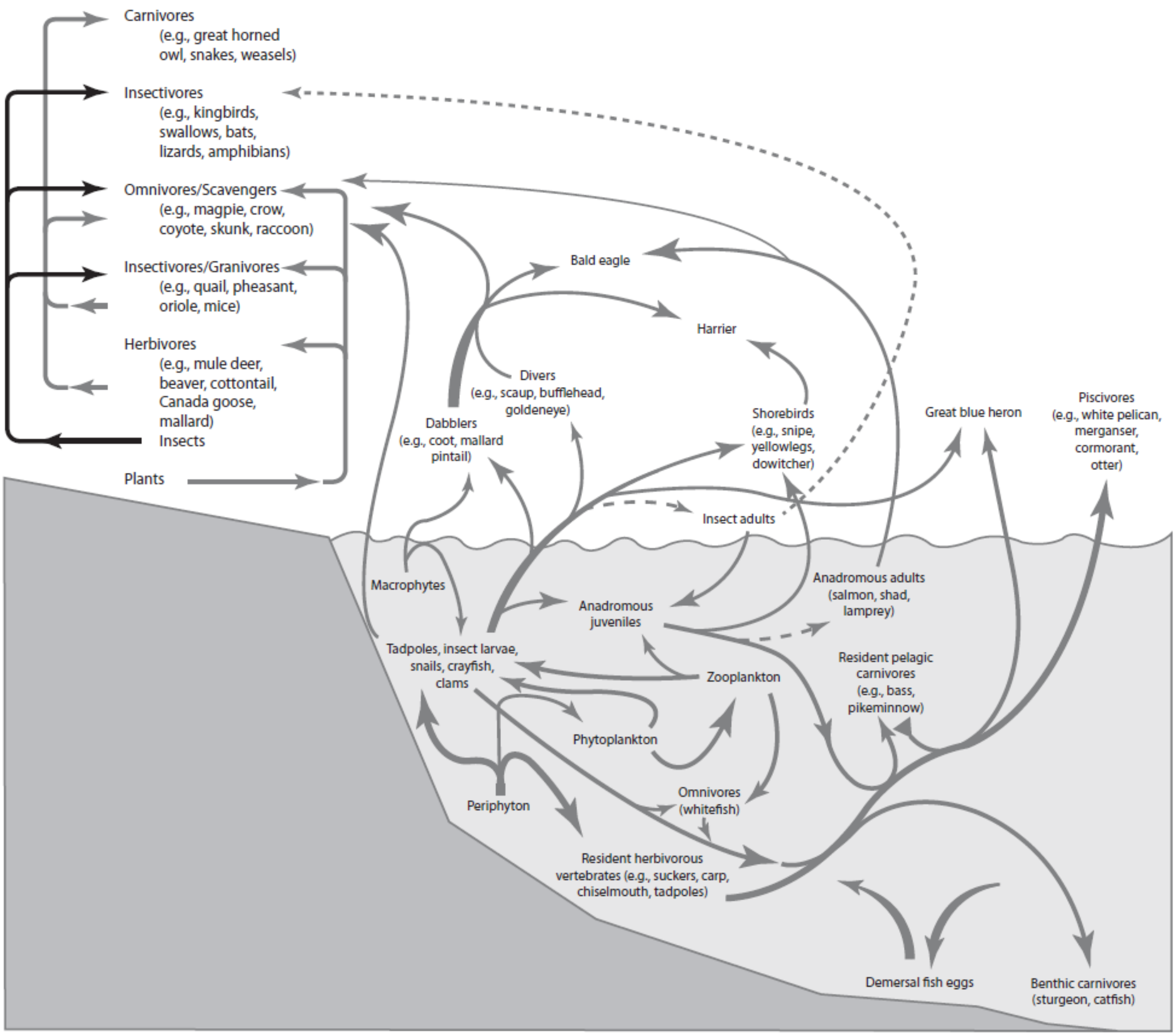

Figure 2.2-1. The aquatic and riparian food web for the Hanford Reach of the Columbia River

(Miley, et al., 2007)

2.2.5.1 Aquatic Communities in the Vicinity of the Columbia Generating Station Site

The aquatic organisms include planktonic and benthic species, macrophytes, aquatic insects, and fish. These organisms represent primary producers, herbivores, carnivores, and omnivores. Phytoplankton and zooplankton populations in the Columbia River at the CGS site are largely transient, flowing from one reservoir to another. With the relatively rapid flow of the Columbia River, there is generally insufficient time for phytoplankton and zooplankton populations to develop in the Hanford Reach compared to populations observed in impoundments and reservoirs (Duncan, et al., 2007).

The organisms in the benthic habitat represent all trophic levels. Macrophytes support grazing organisms, and when they die, their biomass becomes detritus supporting other organisms. Aquatic invertebrates and fish represent all of the trophic levels of consumers. Their function in their habitat often shapes their appearance. For example, snails and fish that feed on periphyton have mouths that point downward and “teeth” that scrape the algae off the rocks (Cushing and Allan, 2001).

Several communities or trophic levels are discussed separately below.

Phytoplankton. Phytoplankton (free-floating algae) are abundant in the Columbia River and are the basic food for organisms such as filter-feeding aquatic insects. The reservoirs upstream of Priest Rapids Dam influence the phytoplankton populations in the Hanford Reach. Major phytoplankton groups identified from the Hanford Reach include diatoms, golden or yellow-brown algae, green algae, blue-green algae, red algae, and dinoflagellates. Diatoms are the dominant algae in the Columbia River phytoplankton, usually representing more than 90 percent of the phytoplankton community (based on density and number of species). The main genera include *Asterionella*, *Cyclotella*, *Fragilaria*, *Melosira*, *Stephanodiscus*, and *Synedra* (Neitzel, et al., 1982a). These genera of diatoms are typical of diatom communities in lakes and ponds and originate in upstream reservoirs. Many algae found as free-floating species in the Hanford Reach of the Columbia River are the same as those in the attached periphyton community on the river’s substrate. The currents and frequent fluctuations of the water levels in the Hanford Reach shear and detach the periphyton and suspend the algae in the water column. Cushing (1967) found peak concentrations of phytoplankton occurred in April and May. A secondary peak in phytoplankton occurred in late summer and early autumn. Cushing hypothesized that the increased biomass in phytoplankton later in the year was likely a response to increased light and rising water temperatures, rather than to the availability of nutrients, because phosphate and nitrate nutrient concentrations are never limiting in the region. The lowest densities of phytoplankton were in December and January. Green algae (*Chlorophyta*) and blue-green algae (*Cyanophyta*) occur in phytoplankton communities during warmer weather (Duncan, et al., 2007), (Neitzel, et al., 1982a), (Wolf, 1976). These patterns are typical of large rivers and probably occur in the Columbia River today.

Zooplankton. The zooplankton populations in the Hanford Reach of the Columbia River are generally sparse. Studies by Neitzel, et al., (1982b) show crustacean species of zooplankton were numerically dominant in the open-water regions. The cladocern genus *Bosmina*, and the copepods genera *Diaptomus* and *Cyclops*, were dominant. Densities were lowest in winter and highest in the summer, with summer peaks numerically dominated by *Bosmina*, ranging up to 4,500 organisms per cubic foot (ft^3) (160,650 organisms/m^3). Winter densities were generally less than 50 organisms/ft^3 (1,785 organisms/m^3). *Diaptomus* dominated in the winter months, and *Cyclops* dominated spring months (Duncan, et al., 2007), (Neitzel, et al., 1982b).

Periphyton. Periphyton is the attached, sessile, algal community in the river, often referred to as “slime on the rocks” (Biggs, 2000). Periphyton communities develop on solid substrate wherever there is “sufficient light for photosynthesis and adequate currents to prevent sediment from covering the colonies” (Duncan, et al., 2007). Periphyton substrates include rocks, sediments, macrophytes, and even rather sedentary animals, like clams. As mentioned above, the algal community in the water column includes many periphyton species. The most common taxa in the periphyton community include diatoms (*Achnanthes*, *Asterionella*, *Cyclotella*, *Cybella*, *Cocconeis*, *Gomphonema*, *Fragilaria*, *Melosira*, *Nitzchia*, *Navicula*, and *Synedra*) and blue-green algae (*Schizothrix* and *Plectonema*) (Duncan, et al., 2007), (EN, 2010), (WPPSS, 1982), (WPPSS, 1987). Frequent river-level fluctuations in the Hanford Reach, from the operation of Priest Rapids Dam, expose the shoreline and inhibit the development of persistent periphyton communities (Duncan, et al., 2007). The periphyton community supports the scraping and grazing insects and mollusks as well as bottom-dwelling fish in the river (Cushing and Allan, 2001).

Energy Northwest did periphyton studies as part of the preoperational and operating monitoring programs (EN, 2010), (WPPSS, 1982), (WPPSS, 1987). The periphyton biomass was two–four times higher in winter than in spring and summer. This trend is similar to the biomass trend for the free-floating phytoplankton densities, which were highest in the spring and late summer and fall. Decreases in periphyton biomass are probably associated with the increased foraging and grazing on the attached primary producers by numerous species that are most active when the water temperature rises (Dauble, 2009).

Aquatic Macrophytes. Due to the strong currents, rocky bottom, and frequently fluctuating water levels in the Columbia River, aquatic plants—or macrophytes—are sparse compared to shorelines in slower-moving rivers. Upstream of CGS, rushes (*Juncus* spp.) and sedges (*Carex* spp.) occur along shorelines of the slack-water areas. Reed canary grass (*Phalaris arundinacea*) is a common non-native species found along the CGS shoreline. Macrophytes are also present along gently sloping shorelines that are subject to flooding during the spring freshet and daily fluctuating river levels. Commonly found plants include duckweed (*Lemna* sp.) and the native rooted pond weeds (*Potamogeton* sp. and *Elodea canadensis*). Macrophytes supply food and shelter for juvenile fish and spawning areas for some species of warm-water game fish (Duncan, et al., 2007).

Benthic Macroinvertebrates. Bottom-dwelling epifaunal organisms live either attached to or closely associated with the river substrate, and infaunal organisms live within the soft substrate. The Columbia River supports all major freshwater benthic animal taxa representing several trophic consumer levels. Studies in the Hanford Reach have noted 151 aquatic invertebrate taxa (Duncan, et al., 2007). Insect larvae such as caddisflies (Trichoptera), midge flies (Chironomidae), and black flies (Simuliidae) are dominant in the river. The most common caddisfly species include *Hydropsyche cockerelli*, *Cheumatopsyche campyla*, and *C. enonis*. Other benthic macroinvertebrates include clams (*Corbicula* sp., *Anodontia* spp.), limpets (*Fisherola* spp.), snails (*Physa* spp.), sponges (*Spongilla* spp.), and crayfish (identified as *Astacus trowbridgii*, renamed as *Pacifastacus leniusculus towbridgii* (Hobbs, 1974)). Suitable habitat for most benthic macroinvertebrates is at depths where they are not affected by river water-level fluctuations from the operation of Priest Rapids Dam (Duncan, et al., 2007).

Past studies have characterized the abundance and importance of benthic macroinvertebrates. Duncan et al. (2007) summarized the early Hanford studies and presented the following results. Crayfish numbers in shallow water areas ranged from 0.2–1.1 individuals per square foot (ft^2) (0.02–0.10 individuals per square meter (m^2)) of river bottom. The diet of crayfish in the Hanford Reach is primarily of vegetation, particularly periphyton. Duncan reported from a different study that insect larvae numbers were as high as 2,000/ft^2 (185.8/m^2). Peak larval insect densities are found in late fall and winter, with major emergence in spring and summer, which corresponds with the decrease of periphyton biomass. An additional study examined the stomach contents of fish collected in the Hanford Reach from 1973–1980, and it revealed that benthic invertebrates were important food items for nearly all juvenile and adult fish.

Newell (2003) summarized studies of the macroinvertebrate fauna of the Hanford Reach over the last 50 years. The major trends observed were that “mayfly diversity has increased; stoneflies have disappeared; caddisfly diversity and abundance remain high; Odonata, Hemiptera, Lepidoptera, and Coleoptera are rare; and Diptera diversity remains relatively constant.” In 2002, visual surveys for western pearlshell mussel (*Margaritifera falcata*) and crayfish (*P. leniusculus towbridgii*) showed that the mussel has all but disappeared from the Reach while the crayfish densities remain high.

The mollusks of the Hanford Reach also give insight into how people have used the river over time. Ames et al. (1998) reported investigations of pit houses, dated from the period 5000/4000-1900 BC, from locations upstream of the Hanford Reach (Wells Reservoir and Chief Joseph Reservoir) in the South-central Plateau. Faunal remains identified in these locations include freshwater mussels. Nedeau, et al., (2009) mentions the presence of western pearlshells and other freshwater species in Native American middens found in rivers in eastern Oregon, dating back more than 1,000 years. The western pearlshells are no longer found in the river today, showing that the river's conditions (e.g., water quality or loss of fish host species) have somehow changed, and the pearlshells are extirpated today from that range.

Fish. Studies of fish in the Hanford Reach of the Columbia River date back to the 1840s. Table 2.2-2 lists the 45 species of fish documented in the Hanford Reach of the Columbia River from surveys using a variety of sampling gear starting in 1973 and continuing to the present. Since Gray and Dauble (1977) first published a list of fish species collected in the Hanford Reach, three additional fish species have been collected. These include bull trout (*Salvelinus confluentus*, which had been identified in Gray and Dauble (1977) as the Dolly Varden (*S. malma*)), brown bullhead (*Ameiurus nebulosus*), and western mosquitofish (*Gambusia affinis*) (Duncan, et al., 2007). Most of the fish species are native to the Hanford Reach. Six native species are anadromous and use the river either for spawning or as a migration route to and from upstream spawning areas—upper Columbia River spring/summer/fall-run Chinook salmon (*Oncorhynchus tshawytscha*), upper Columbia River steelhead (*O. mykiss*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka*), Pacific lamprey (*Lampetra tridentata*), and American shad (*Alosa sapidissima*) (FERC, 2006). The river lamprey (*L. ayresii*) may also be present in the Hanford Reach, although detailed distribution records are not available (Wydoski and Whitney, 2003), and it is uncertain whether it spawns in this area (Dauble, 2009), (Meeuwig, et al., 2002).

Table 2.2-2. Fish species in the Hanford Reach of the Columbia River in Washington State

Common name	Scientific name
Family Acipenseridae (paddlefishes, spoonfishes, sturgeons)	
white sturgeon	*Acipenser transmontanus*
Family Clupeidae (anchovies, herrings)	
American shad	*Alosa sapidissima*
Family Catostomidae (cyprins, minnows, suckers)	
chiselmouth	*Acrocheilus alutaceus*
bridgelip sucker	*Catostomus columbianus*
largescale sucker	*Catostomus macrocheilus*
mountain sucker	*Catostomus platyrhynchus*
common carp	*Cyprinus carpio*
peamouth	*Mylocheilus caurinus*
northern pikeminnow	*Ptychocheilus oregonensis*
longnose dace	*Rhinichthys cataractae*
leopard dace	*Rhinichthys falcatus*
speckled dace	*Rhinichthys osculus*

Common name	Scientific name
redside shiner	*Richardsonius balteatus*
tench	*Tinca tinca*
Family Poeciliidae (livebearers)	
western mosquitofish	*Gambusia affinis*
Family Gadidae (cods)	
burbot	*Lota lota*
Family Gasterosteidae (pipefishes, sticklebacks)	
threespine stickleback	*Gasterosteus aculeatus*
Family Centrarchidae (perch-like fishes)	
pumpkinseed	*Lepomis gibbosus*
bluegill	*Lepomis macrochirus*
smallmouth bass	*Micropterus dolomieui*
largemouth bass	*Micropterus salmoides*
yellow perch	*Perca flavenscens*
white crappie	*Pomoxis annularis*
black crappie	*Pomoxis nigromaculatus*
walleye	*Sander vitreus*
Family Perocpsidae (trout perches)	
sand roller	*Percopsis transmontana*
Family Petromyzontidae (lampreys)	
river lamprey	*Lampetra ayresii*
Pacific lamprey	*Lampetra tridentata*
Family Salmonidae (salmonids, salmon, trout)	
lake whitefish	*Coregonus clupeaformis*
bull trout	*Salvelinus confluentus*
cutthroat trout	*Oncorhynchus clarkii*
coho salmon	*Oncorhynchus kisutch*
rainbow trout (steelhead)	*Oncorhynchus mykiss*
sockeye salmon	*Oncorhynchus nerka*
Chinook salmon	*Oncorhynchus tshawytscha*
mountain whitefish	*Prosopium williamsoni*
Family Cottidae (chabots, sculpins)	
prickley sculpin	*Cottus asper*
mottled sculpin	*Cottus bairdii*
Paiute sculpin	*Cottus beldingii*
reticulate sculpin	*Cottus perplexus*
torrent sculpin	*Cottus rhotheus*

Common name	Scientific name
Family Ictaluridae (bullhead catfishes, North American freshwater catfishes)	
yellow bullhead	*Ameiurus natalis*
brown bullhead	*Ameiurus nebulosus*
black bullhead	*Ameiurus melas*
channel catfish	*Ictalurus punctatus*

(Duncan, et al., 2007)

American shad is an introduced, anadromous fish species (Duncan, et al., 2007). The other introduced fish include common carp (*Cyprinus carpio*), tench (*Tinca tinca*), western mosquitofish (*Gambusia affinis*), pumpkinseed (*Lepomis gibbosus*), bluegill (*L. macrochirus*), smallmouth bass (*Micropterus dolomieui*), largemouth bass (*M. salmoides*), yellow perch (*Perca flavenscens*), white crappie (*Pomoxis annularis*), black crappie (*P. nigromaculatus*), walleye (*Sander vitreus*), lake whitefish (*Coregonus clupeaformis*), yellow bullhead (*A. natalis*), brown bullhead (*A. nebulosus*), black bullhead (*A. melas*), and channel catfish (*Ictalurus punctatus*) (Dauble, 2009), (Gray and Dauble, 1977).

The pre-operational monitoring program for CGS included fish sampling by beach seine, hoop nets, gill net, and electroshocking. From September 1974–March 1980 a total of 35,939 fish were collected at the CGS site, comprising of 37 species representing 12 families. Chinook salmon composed approximately 44 percent of all fish caught by all collecting methods. Table 2.2-4 lists the species caught with a relative abundance greater than 0.1 percent (all other species individually comprised less than 5 percent of the total catch) (EN, 2010), (WPPSS, 1982).

Table 2.2-3. Relative abundance of fish species collected near the CGS site, September 1974 through March 1980

Scientific name	Common name	Relative abundance (%)
Oncorhynchus tshawytscha	Chinook salmon	44.1
Richardsonius balteatus	redside shiner	11.3
Catostomus macrocheilus	largescale sucker	8.8
Ptychocheilus oregonensis	northern pikeminnow	6.9
Mylocheilus caurinus	peamouth	6.7
Prosopium williamsoni	mountain whitefish	3.7
Acrocheilus alutaceus	chiselmouth	3.5
Catostomus spp.	sucker (miscellaneous)	3.4
Catostomus columbianus	bridgelip sucker	3.3
Cottus spp.	sculpin (miscellaneous)	0.9
Perca flavescens	yellow perch	0.7
Oncorhynchus mykiss	rainbow trout/ steelhead	0.6
Cyprinidae	carps	0.6
Cottus asper	prickly sculpin	0.5
Rhinichthys cataractae	longnose dace	0.3

Scientific name	Common name	Relative abundance (%)
Acipenser transmontanus	white sturgeon	0.2
Pomoxis nigromaculatus	black crappie	0.2
Lepomis macrochirus	bluegill	0.2
Micropterus dolomieu	smallmouth bass	0.2
Cyprinidae and Catostomidae fry	carp, minnow, and sucker fry	3.1

(EN, 2010)

The fish species with the greatest economic importance in the area are anadromous species (Duncan, et al., 2007). Fall-run Chinook salmon and steelhead spawn in the Hanford Reach. The importance of the Hanford Reach to the overall population of the fall-run Chinook salmon has increased with the inundation of other mainstem Columbia River spawning grounds by dams (Dauble and Watson, 1997), (Watson, 1970), (Watson, 1973). Daily and seasonal river-level fluctuations from the operation of Priest Rapids Dam can expose the shoreline and cobble bars during low-flow periods. In recent years, the operation of Priest Rapids Dam has changed, and the more stable water levels during the fall months discourage salmon from spawning in areas that are exposed at low river flow during the winter. This strategy of water release protects salmon redds (nests) from desiccation and temperature extremes.

The river bottom supplies habitat for spawning, rearing, foraging, and shelter. Fall-run Chinook salmon select their spawning areas based on water depth, substrate, current velocity, and groundwater upwelling. Even with all these factors, Dauble and Watson (1990) stated that predicting spawning areas was difficult. Once the young salmon begin to migrate, they remain close to the bottom as they pass through the Hanford Reach (Dauble, 2009).

Aerial counts of fall-run Chinook salmon redds have been done in the Hanford Reach since 1948 (Dauble and Watson, 1997). The count of redds in the Hanford Reach has been trending upwards over time (Figure 2.2-2), and the redds have been observed throughout the Hanford Reach (Figure 2.2-3). The results of these surveys give an index of relative abundance among spawning areas and years. From 1948–1961, redd counts during peak spawning were less than 1,000 annually. The number of redds increased to as high as 9,400 in 2003 after construction of several mainstem dams both the Columbia and Snake rivers. From 1964–1982, escapement of adult fall Chinook salmon to the Hanford Reach (the number of adults that survive natural mortality and harvest to reach the spawning grounds) averaged about 25,000 fish annually. In 1987, the number of adult Chinook increased to a peak estimate of 89,000 spawning. In addition to the loss of spawning areas due to inundation by dam construction in other areas, other factors for the upward trend of Chinook salmon in the Reach are the increase in hatchery production, improved juvenile and adult passage at hydroelectric dams, changes in harvest management practices, and favorable ocean conditions (Dauble and Watson, 1990), (Poston, et al., 2009). There are presently 10 areas noted in the Hanford Reach that support salmon spawning (Dauble and Watson, 1997), (Duncan, et al., 2007), (Poston, et al., 2004).

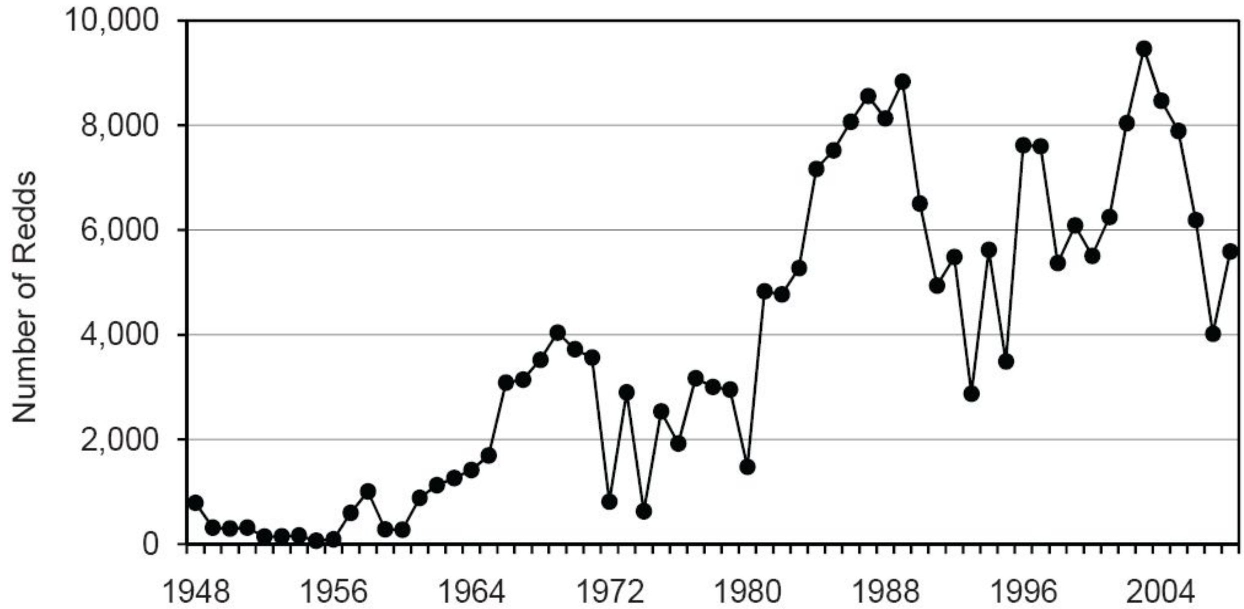

Figure 2.2-2. Number of fall-run Chinook Salmon Redds in the Hanford Reach

(Poston, et al., 2009)

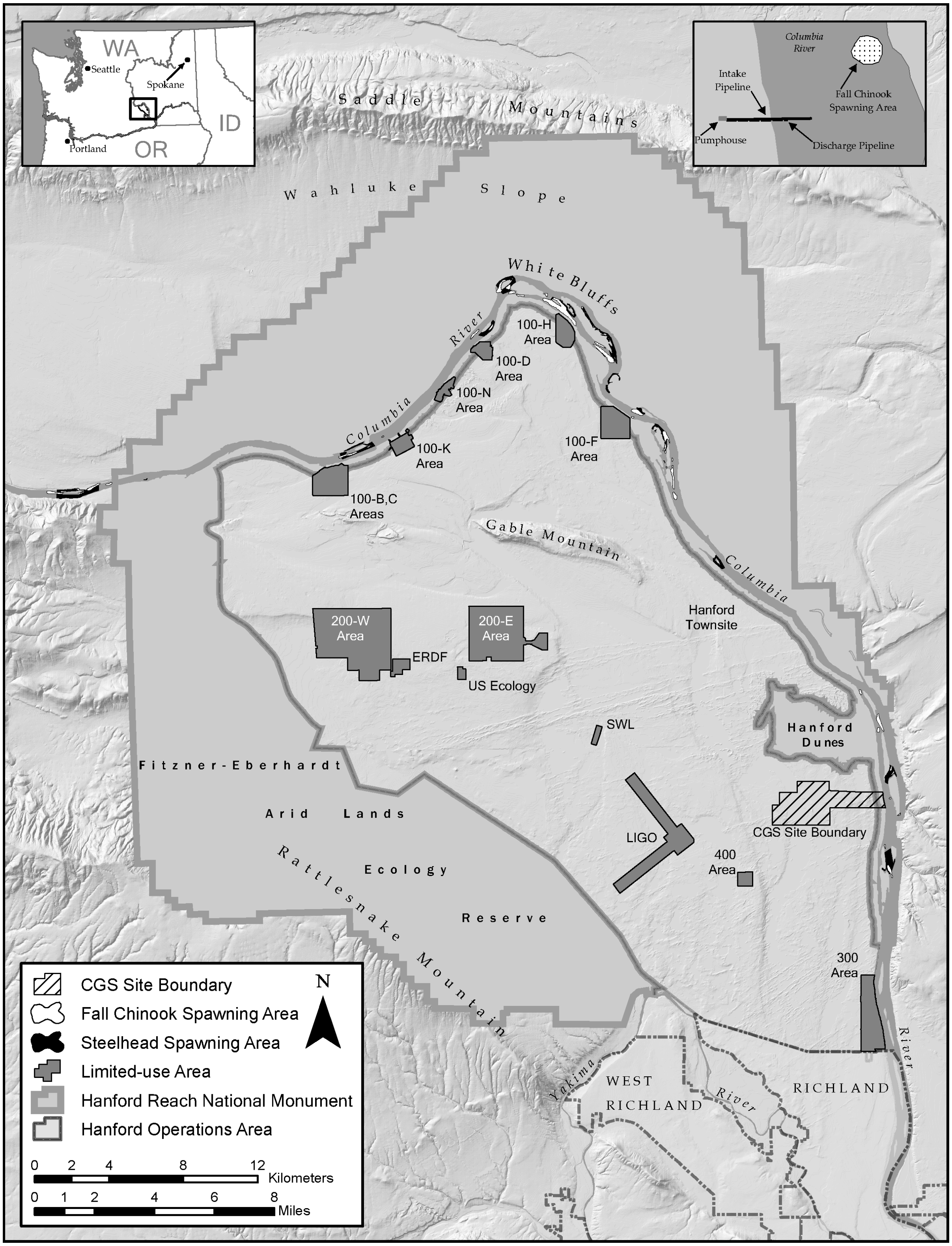

Figure 2.2-3. Fall Chinook and Steelhead spawning areas in the Hanford Reach and vicinity of the CGS site

(DOE, 2000), (Gambhir, 2010b), (Poston, et al., 2009)

The steelhead fishery in the Hanford Reach extends from Highway 395 Bridge past CGS to Priest Rapids Dam. The fishery consists almost exclusively of summer-run fish. The Washington State Department of Fish and Wildlife (WDFW) estimated steelhead sport catch for the April 2007-March 2008 season (the last season for which statistics were tabulated) to be 1,754 (Kraig, 2011b), slightly lower than the 1,906 fish in the previous year (Kraig, 2011a). All of these fish were marked hatchery fish. Sport catch in the Hanford Reach for Chinook salmon (including jacks) was estimated to be 5,782 in the April 2007-March 2008 season (Kraig, 2011b) and 4,772 in the previous year (Kraig, 2011a).

American shad may also spawn in the Hanford Reach. The upstream range of the shad has been increasing since 1956 when the construction of The Dalles Dam inundated Celilo Falls and opened passage for the shad to migrate. In 2005, 5.2 million adult shad were estimated to migrate up the Columbia River. More than 350,000 shad per day passed through Bonneville Dam (Dauble, 2009). The number of shad returning to Priest Rapids Dam increased dramatically in the 1970s and 1980s and peaked at 121,806 fish in 1992. The number of shad returning over recent years has dropped to fewer than 10,000. The species does not pass upstream of Priest Rapids dam because “they do not use or are unable to negotiate the submerged orifices of the upper sections of Priest Rapids fishways,” and this prevents them from reaching the upstream reservoir (FERC, 2006). Shad are broadcast spawners compared to salmon, which restrict their spawning to areas specific for building their redds (Dauble, 2009), (Duncan, et al., 2007), (FERC, 2006).

Near the CGS site, nine fish species are of commercial or recreational importance (Table 2.2-4) (EN, 2010). There is no commercial fishery established today in the Hanford Reach of the Columbia River, but several of the fish that occur in the Reach spend part of their life in the upper Columbia River or the ocean where a commercial fishery exists (e.g., Chinook salmon). The Hanford Reach supports a very popular recreational fishery. For example, the WDFW recommended that the Grant Public Utility District develop and carry out a Resident Fish Plan with a goal of producing 137,000 lb of fish to support recreational fisheries, including the Hanford Reach, as part of its relicensing efforts for Priest Rapids Dam (FERC, 2006). Because half of the nine recreationally important fish are introduced species, the list of species is likely to grow and change in the future (EN, 2010).

Table 2.2-4. Recreationally and commercially important fish species in or near the Hanford Reach and the CGS site

Scientific name	Common name	Distribution
Acipenser transmontanus	white sturgeon	Abundant year-round
Ictalurus punctatus	channel catfish	Common in spring and summer
Oncorhynchus tshawytscha	Chinook salmon	Abundant
Oncorhynchus kisutch	coho salmon	Uncommon
Oncorhynchus mykiss	rainbow trout/steelhead	Abundant spring through fall
Oncorhynchus nerka	sockeye salmon	Juveniles common spring & adults common summer
Micropterus salmoides	largemouth bass	Common
Micropterus dolomieui	smallmouth bass	Abundant
Sander vitreus	walleye	Common

(EN, 2010)

An uncommon type of fishery—known as a sport-reward program—exists in the Columbia River, including the Hanford Reach. The WDFW, in an effort to reduce predation by northern pikeminnow (*Ptychocheilus oregonensis*) of juvenile salmonids during their emigration from natal streams to the ocean, established a bounty program that pays recreational fisherman to harvest the adult pikeminnow. WDFW studies before the bounty program suggest that 10–20 percent of the juvenile salmonid mortality in eight Columbia and Snake River reservoirs was due to predation by northern pikeminnow (Porter, 2009). Columbia Point in Richland and the Vernita Bridge rest stop are the closest locations to the Hanford Reach where recreational fisherman can turn in their catch (Duncan, et al., 2007). In 2009, the catch-per-unit effort was 4.68 at Columbia Point and 7.37 at Vernita Bridge rest stop, the second highest within the Columbia River (Porter, 2009).

In addition to commercially and recreationally important species, the lamprey—and specifically the Pacific lamprey—have cultural, ceremonial, medicinal, subsistence, and ecological importance to Native American tribes of the region (Nez Perce, Umatilla, Yakama, and Warm Springs Tribes, 2008). Pacific lampreys are found from Hokkaido Island, Japan, along the Pacific Rim to Baja California. They are the most widely distributed lamprey species on the U.S. west coast (69 FR 77158). Adult Pacific lampreys parasitize a wide variety of fish, including the Pacific salmon. In turn, they are preyed upon by sharks, sea lions, and other marine animals. Pacific lampreys return to freshwater, and spawning occurs the following March or April after a holdover of almost a year (Dauble, 2009). Eggs are fertilized and deposited in nests, and the embryos hatch in approximately 19 days at 59 degrees F (15 degrees C) (69 FR 77158). The larvae, or "ammocoetes," remain burrowed in the sand and gravel for 5–7 years. They feed primarily on microscopic algae and become parasitic after they have reached their adult stage (Dauble, 2009).

2.2.5.2 Invasive or Introduced Aquatic Species

Washington State has an active monitoring and education program for addressing invasive species, and the program is carried out by the Washington Invasive Species Council (WISC). The top 50 priority species noted by WISC include aquatic plants and animals. The invasive aquatic plants include Eurasian watermilfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), parrotfeather (*M. aquaticum*), common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), smooth cordgrass (*Spartina alterniflora*), water chestnut (*Trapa natans*), and Brazilian elodea (*Egeria densa*). Other invasive aquatic animals include Asian carps (*Hypophthalmichthys nobilis*, *Mylopharyngodon piceus*, *Ctenopharyngodon idella*, and *H. molitrix*), American bullfrog (*Rana catesbeiana*), New Zealand mud snail (*Potamopyrgus antipodarum*), northern snakehead (*Channa argus*), red swamp crayfish (*Procambarus clarkii*), and rusty crayfish (*Orconectes rusticus*) (WISC, 2009).

Several aquatic invasive species are found near CGS. Eurasian watermilfoil, an introduced macrophyte, has increased to nuisance levels since the late 1980s and may encourage increased sedimentation of fine particulate matter (Duncan, et al., 2007). Purple loosestrife inhabits many islands in the Hanford Reach and along the east bank of the river. Biological controls have not been successful due to effects from the operation of Priest Rapids Dam and water-level fluctuations. Currently, Hanford Site personnel are working with landowners along the Columbia River to find and control purple loosestrife. While zebra (*Dreissena polymorpha*) and quagga mussels (*D. bugensis*) have not been found in Washington State waters, including the Hanford Reach, education and inspection programs are intensifying to deter these mussels from taking hold in the area (WDFW, 2010).

Asian clams (*Corbicula fluminea*) are an invasive species of concern for many nuclear facilities because they have the potential to cause biofouling in the intake and circulating-water systems (NRC, 1996). Operational monitoring studies in 1985 and 1986 included observations of several water systems (e.g., the tower makeup pump pit) to determine if Asian clams were colonizing the systems (WPPSS, 1986), (WPPSS, 1987). Live clams were found around the intake screen supports in the river and in some parts of the circulating-water system. They found few living clams and shells in the circulating-water system and attributed the biofouling treatment program to controlling the clams. Newell (2003) speculated that the rise of Asian clams might have contributed to the decline in population of western pearlshell mussels. The State of Washington is not currently documenting the occurrence of the species in the State (WISC, 2009).

As mentioned in Section 2.2.5.1, 17 of the 48 species of fish collected in the Hanford Reach are considered introduced to the area. The reasons for these introductions vary from people's desire for a particular recreational fishery to accidental releases. Western mosquitofish are used for biological control of mosquitos and likely were transplanted to the river unintentionally. This species consumes zooplankton and algae and has some value as a forage fish (Dauble, 2009). Dauble (2009) estimated that more than 60 percent of resident game fish in the Columbia River Basin are warmwater-introduced species such as bass, bluegill, crappie, and perch. Many of these introduced species consume juvenile, listed species, like Chinook (Dauble, 2009). Other negative effects of introduced species include competition food and habitat with native species (Cushing and Allan, 2001).

2.2.6 Terrestrial Resources

The CGS site and its associated transmission lines are located approximately 3.25 mi (5 km) west of the Columbia River at RM 352, within the Columbia River watershed and drainage basin, a broad area lying between the Cascade Range and the Blue Mountains in Oregon and Washington (EN, 2010). The CGS site is located in Benton County, Washington, on 1,089 ac (441 ha) of land leased from the southeastern portion of the DOE's Hanford Site (Figure 2.1-2). The site terrain is generally flat with gentle hills and an elevation ranging from about 350 ft above the MSL near the river to about 460 ft MSL on the hills. Plant grade onsite is 441 ft MSL.

The 586 mi^2 Hanford Site, on which CGS is located, is within the Columbia Plateau ecoregion. This ecoregion covers approximately one-third of the State of Washington—including the area bordered by the Cascade Mountains, Okanogan Highlands, the Blue Mountains, and the Rocky Mountains—and is the driest and hottest ecoregion in Washington because it lies within the rain shadow of the Cascade Mountains (WDNR, 2007). The habitat found on the Hanford Site is typical of a shrub-steppe ecosystem found in the Columbia Plateau ecoregion, consisting of layers of perennial grasses overlain by a discontinuous layer of shrubs (EN, 2003b). More than 50 percent of the Columbia Plateau ecoregion has been developed for agricultural or urban use, including much of the native shrub-steppe and grassland habitat (Figure 2.2-4) (WDFW, 2005), (WDNR, 2007). Conversion of land for dryland wheat and other crops has resulted in the isolation and fragmentation of shrub-steppe habitat, as well as the decline of many shrub-steppe dependent species, including the greater sage-grouse (*Centrocercus urophasianus*) (WDFW, 2005), (WDNR, 2007), (WDNR, 2009). The State of Washington currently considers shrub-steppe habitat a Priority 1 ecosystem for conservation. A Priority 1 ecosystem is defined as an ecosystem with few known occurrences in the natural areas system, the extent of which has been greatly reduced (WDNR, 2007), (WDNR, 2009). These ecosystems are considered to be at the highest risk of being destroyed or degraded (WDNR, 2007). Because of the Hanford Site's protected status following the establishment of the Manhattan Project in 1943, its resident plant and animal populations are largely made up of native species and retain shrub-steppe characteristics that have mostly disappeared in other areas of the ecoregion. Undisturbed portions of the Hanford Site are dominated by shrubland, with widely dispersed sagebrush communities (*Artemisia tridentata*) and an understory of grasses. Of the 727 vascular plant species noted on the Hanford Site, approximately 25 percent (179) were found to be non-native (Duncan, et al., 2007).

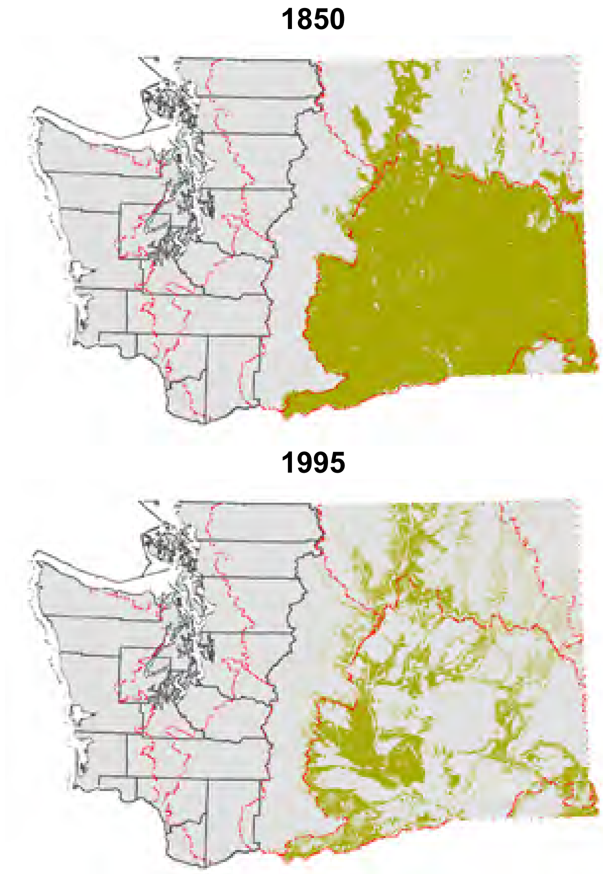

Figure 2.2-4. Distribution of shrub-steppe (shaded area) ecosystem in Washington

(Johnson and O'Neil, 2001)

A narrow portion of the CGS riparian area lies within the 305 mi^2 (79,000 ha) Hanford Reach National Monument (Figure 2.1-2). The Hanford Reach National Monument is a national wildlife refuge that was created in 2000 by a Presidential proclamation and is managed by the U.S. Fish and Wildlife Service (USFWS) (Clinton, 2000), (USFWS, 2008). Because Hanford Reach National Monument was created from buffer lands on the protected Hanford Site, the shrub-steppe habitat has remained undisturbed for 60 years, preserving important biological, historic, and cultural resources (USFWS, 2008), (USFWS, 2010a).

The habitat found on the CGS property is generally similar to that of the Hanford Site, with undisturbed areas of the site supporting a similar mix of grasses, forbs, and shrubs. The uplands area of the CGS site is also dominated by dune formations that consist of sand and gravel soils (Link, 2008). Studies done on the CGS site found 66 vascular plant species on the property and found that herbaceous cover by all grasses and forbs onsite was about 66 percent (EN, 2010). Annual grasses dominate the herbaceous ground cover at about 35 percent, with cheatgrass (*Bromus tectorum*) being the dominant annual grass. Cheatgrass is non-native and typically found on disturbed areas. Perennial grasses comprised about 17 percent of the herbaceous cover, with Sandberg bluegrass (*Poa secunda*) as the dominant grass. Commonly occurring plant cover associations on the property include Sandberg bluegrass/snow buckwheat (*P. secunda/Eriogonum niveum*) and Sandberg bluegrass/needle-and-thread grass (*P. secunda/Hesperostipa comata*) (EN, 2003b).

The dominant shrubs on the CGS site are big sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*). Shrub cover on both the Hanford and CGS sites has been greatly affected by range fires. An August 1984 range fire covered about 310 mi^2 and burned much of the sagebrush and bitterbrush cover on the CGS property, causing the amount of shrub cover found at the study plots to drop from 15 percent to 2 percent (EN, 2003b), (EN, 2010).

Generally, soil moisture levels in this habitat are insufficient to support most tree species except along the stream banks, so most of the tree species found on the Hanford Site are found in the riparian zone along the bank of the Columbia River (EN, 2003b). The Hanford Site supports 23 species of trees including cottonwood (*Populus* spp.), willow (*Salix* spp.), white mulberry (*Morus alba*), black locust (*Robinia pseudoacacia*), Russian olive (*Elaeagnus angustifolia*), and Siberian elm (*Ulmus pumila*). The tree species found specifically on the CGS site were found within a narrow 1.2 mi (2 km) stretch of the riparian zone along the bank of the Columbia River and include black cottonwood (*Populus trichocarpa*), narrowleaf willow (*Salix exigua*), Siberian elm (*Ulmus pumila*), and Rocky Mountain juniper (*Juniperus scopulorum*) (Link, 2008).

Shrub-steppe ecosystems are threatened by invasive species that can survive disturbances such as agriculture, grazing, and wildfires. One of the most problematic species in this ecoregion is cheatgrass, which has little value for wildlife populations and can pose an additional fire hazard that could be damaging to native vegetation (WDFW, 2005). Cheatgrass is the dominant annual grass found on the CGS site. Plant surveys found six additional invasive weed species, the most abundant of which were diffuse knapweed (*Centaurea diffusa*), rush skeletonweed (*Chondrilla juncea*), and Dalmation toadflax (*Linaria dalmatica*). CGS has developed a noxious weed control program with the primary goal of containment to prevent the spread of these invasive weeds to uninfested areas (EN, 2010), (Link, 2009). In addition to these, the Hanford riparian area has many noxious weeds common to dryland habitat, including purple loosestrife (*Lythrum salicaria*), smallflower tamarisk (*Tamarix parviflora*), and yellow star-thistle (*Centaurea solstitialis*). Range fires occurring in 1984 and 2000 created favorable conditions for the growth of invasive species such as Russian thistle (*Salsola tragus*) and tall tumblemustard (*Sisymbrium altissimum*) (EN, 2003b), (WDFW, 2005).

The USFWS National Wetlands Inventory database shows no wetlands areas on the CGS site (USFWS, 2010c).

More than 300 terrestrial vertebrate species have been found on the Hanford Site. This number includes 145 bird species, 46 mammal species, 5 amphibian species, and 10 reptile species (EN, 2010). The Hanford Reach is also within the Pacific Flyway, serving as a resting area for species of migrant birds, migratory waterfowl, and shorebirds. According to a CGS site study in 1987, the most-sighted birds (out of the 25 species sighted), in descending order, were the western meadowlark (*Sturnella neglecta*), red-winged blackbird (*Agelaius phoeniceus*), bank swallow (*Riparia riparia*), brown-headed cowbird (*Molothrus ater*), eastern kingbird (*Tyrannus tyrannus*), California gull (*Larus californicus*), Bullock's oriole (*Icterus bullockii*), killdeer (*Charadrius vociferus*), western kingbird (*Tyrannus verticalis*), and barn swallow (*Hirundo rustica*) (WPPSS, 1988), (EN, 2010). Most of the shorebirds and waterfowl that have been sighted on CGS property during the past decade have been seen at the sanitary waste treatment plant, where the sanitary waste ponds supply resting and feeding habitat as well as limited breeding habitat for some species. Typical sightings include broods of mallard ducks (*Anas platyrhynchos*), Brewer's blackbird (*Euphagus cyanocephalus*), killdeer, American avocet (*Recurvirostra americana*), black-necked silt (*Himantopus mexicanus*), and other waterbirds. There are 19 islands along the Columbia River within the Hanford Site. A 1.25 mi-long island located opposite the CGS makeup water pumphouse, named Homestead Island, has been used as a roosting area by sandhill cranes (*Grus canadensis*) (EN, 2010).

Generally, there are few reported bird strikes on CGS property, with no bird strikes observed at the meteorological tower, transmission line ROWs, or at the cooling towers. Most reported bird strikes have occurred near the reactor building, where cliff swallows tend to nest under the overhang (EN, 2010). CGS does have procedures in place for staff members who encounter displaced or distressed birds on the property, with most incidents being recorded through the corrective action program. Depending on the species involved, bird injuries or deaths are also reported by the Environmental Services staff to the USFWS or to the Washington Department of Wildlife (Gambhir, 2010b).

Mammals common to the CGS property include mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), cottontail rabbit (*Sylvilagus nuttalli*), and black-tailed jackrabbit (*Lepus californicus*) (EN, 2010), (WPPSS, 1988). The American badger (*Taxidea taxus*) and porcupine (*Erethizon dorsatum*) have been found onsite but are rarely seen. The most common reptile seen on the property is the Pacific gophersnake (*Pituophis catenifer*) (WPPSS, 1988). Hanford Reach management plans also protect the sand dune habitat dominated by antelope bitterbrush (*Purshia tridentata*) and Indian ricegrass (*Oryzopsis hymenoides*), which provide habitat for mule deer, burrowing owls, and coyotes (USFWS, 2008).

CGS has several procedures for protecting the environment, including environmental review checklists and environmental evaluations. If the environmental review checklist reveals that a planned activity could disturb vegetation or wildlife habitat, then an environmental evaluation must also be completed. Environmental evaluations require a qualified subject matter expert to describe and assess the potential for adverse impacts on endangered or threatened species or critical habitat and to discuss potential avoidance or mitigation options.

2.2.7 Important Species and Habitats

As delegated by the Endangered Species Act (ESA) (16 USC 1531), the National Marine Fisheries Service (NMFS) and the USFWS are responsible for listing aquatic and terrestrial species as threatened and endangered at the Federal level. The state may list additional species that are regionally threatened or endangered. For the purposes of this SEIS, all Federally and state-listed species that occur, or potentially occur, in Benton County, Washington (the location of CGS site), are included in Table 2.2-5.

Table 2.2-5. Listed aquatic and terrestrial species

Scientific name	Common name	Federal status[a]	State status[b]	Habitat
		Mammals		
Brachylagus idahoensis	pygmy rabbit	FE	SE	Columbia Basin DPS
		Birds		
Centrocercus urophasianus	greater sage grouse	FC	ST	Columbia Basin DPS[c]
Coccyzus americanus	yellow-billed cuckoo	FC	SC	Deciduous woodlands
		Plants		
Spiranthes diluvialis	Ute ladies'-tresses	FT	-	River floodplains
Eriogonum codium	Umtanum desert buckwheat	FC	-	Basalt cliffs
		Fish		
Oncorhynchus tshawytscha	upper Columbia River spring Chinook salmon	FE	SC	Anadromous; spawn in small tributaries; migrate through major rivers
Oncorhynchus mykiss	upper Columbia River steelhead	FE	SC	Anadromous; mainstem Columbia River
Salvelinus confluentus	bull trout	FT	SC	Anadromous; rivers
Catastomus platyrhynchus	mountain sucker	-	SC	Tributaries of the Columbia River
Lampetra ayresii	river lamprey	-	SC	Anadromous; spawn in small tributaries; migrate through major rivers
Rhinichthys flacatus	leopard dace	-	SC	Rivers
Rhinichthys umatilla	Umatilla dace		SC	Rivers
		Mollusks		
Anodonta californiensis	California floater	-	SC	Shallow, muddy or sandy substrate in rivers
Fluminicola columbiana	great Columbia River spire snail (Columbia pebblesnail)	-	SC	River substrate

Sources: Poston, et al., 2009; Suzumoto, 2010; USFWS, 2010a; USFWS, 2010b; WDFW, 2010.

[a] Federal status listings: FE = Federally Endangered; FT = Federally Threatened; FC= Federal Candidate.

[b] State of Washington status listings: SE = State Endangered; ST = State Threatened; SC = State Candidate.

[c] DPS—Distinct Population Segment.

In addition, NMFS is responsible for protection, management, and enhancement of the nation's marine fishery resources as designated by the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended (16 USC 1801 et seq.). The Hanford Reach of the Columbia River supplies habitat for designated species that are associated with essential fish habitat (EFH) (73 FR 60987), (Suzumoto, 2010).

Further information about the consultation between NMFS, USFWS, and NRC is found in the integrated biological assessment and EFH assessment given in Appendix D-1 to this SEIS.

2.2.7.1 Federally and State-Listed Threatened and Endangered Terrestrial Species

There is no designated critical habitat for Federally listed threatened and endangered terrestrial species near the CGS site, including the transmission corridor, and there are no Federally listed or state-listed endangered or threatened mammals, reptiles, amphibians, or invertebrates on the Hanford or CGS site. The State of Washington, however, has designated shrub-steppe environments of the Columbia Plateau ecoregion as priority habitats for preservation (WDNR, 2007).

The pygmy rabbit (*Brachylagus idahoensis*) in the Columbia Basin is Federally listed and state-listed as endangered but has never been observed on the Hanford Site. The Columbia Basin pygmy rabbit population has been extirpated from the wild (WDNR, 2009).

There are no Federally listed threatened or endangered bird species found on the Hanford Site or the CGS site. The yellow-billed cuckoo (*Coccyzus americanus*) is a candidate species for Federal listing and has been noted by the USFWS as occurring in Benton County. However, there have been no known sightings of the yellow-billed cuckoo at CGS (USFWS, 2010d). The greater sage grouse (*Centrocercus urophasianus*) is also a candidate species for Federal listing and could be observed on the Hanford Site. Federal species of concern include the northern goshawk (*Accipiter gentilis*), burrowing owl (*Athene cunicularia*), ferrunginous hawk (*Buteo regalis*), olive-sided flycatcher (*Contopus cooperi*), peregrine falcon (*Falco peregrinus*), and loggerhead shrike (*Lanius ludovicianus*). The loggerhead shrike and the burrowing owl have been sighted on, or near, the CGS site (EN, 2010).

There are no Federally listed endangered or threatened plants on the Hanford Site or the CGS property. While the Federally listed threatened species Ute ladies'-tresses (*Spiranthes diluvialis*) is known to occur in the Columbia Plateau ecoregion, it has never been observed as far south as the CGS site (Fertig, et al., 2005). The Federal candidate species Umtanum desert buckwheat (*Eriogonum codium*) is not known to occur on the CGS site, and its only known population is found along approximately 1 mi of bluffs within the Hanford Reach National Monument (USFWS, 2010e). The state-listed threatened species lowland toothcup (*Rotala ramosior*) and the watch list species shining flatsedge (*Cyperus bipartitus*) were found during surveys of the Columbia shoreline, about 0.5 mi (0.8 km) downstream of the CGS property. The survey also found the state watch list species Columbia River mugwort (*Artemisia lindleyana*) (Link, 2008).

There are two state-listed endangered birds that migrate through the area—the American white pelican (*Pelecanus erythrorhynchos*) and the sandhill crane (*Grus canadensis*). Both species have been seen on Homestead Island (EN, 2010). Threatened bird species that may occur on the Hanford Site include the ferruginous hawk (*Buteo regalis*) and the greater sage grouse (*Centrocercus urophasianus*). Bird species considered sensitive by Washington State are the common loon (*Gavia immer*), peregrine falcon (*Falco peregrinus*), and bald eagle (*Haliaeetus leucocephalus*). Both the ferruginous hawk and common loon have been observed on, or near, the CGS site (EN, 2010). The peregrine falcon was once a Federally listed species, but it was delisted in 1999. The bald eagle was likewise a listed species, but it was delisted in 2007. Both the peregrine falcon and the bald eagle are protected under the Migratory Bird Treaty Act, and the bald eagle is also protected under the Bald and Golden Eagle Protection Act. A location on the river shore about 1.25 mi (2 km) south of the plant makeup water pumphouse has been noted in surveys as a site occupied by bald eagles (EN, 2010). This site, however, is outside of the CGS leased land.

Upland area vegetation surveys of the CGS property found a small population of the state watch list species woodypod milkvetch (*Astragalus sclerocarpus*) and two plants of the state sensitive species Piper's daisy (*Erigeron piperianus*) (Link, 2009).

2.2.7.2 Federally and State-Listed Threatened and Endangered Aquatic Species

Table 2.2-5 presents aquatic species that are listed as protected by the USFWS, NMFS, and the State of Washington and have the potential to occur in the counties near the CGS site. Federally listed species include the endangered upper Columbia River spring-run Chinook salmon, the endangered upper Columbia River steelhead, and the threatened bull trout. The State of Washington lists these three species, and four additional fish species, as candidate species. Mountain sucker (*Catastomus platyrhynchus*), river lamprey (*Lampetra ayresii*), leopard dace (*Rhinichthys flacatus*), and Umatilla dace (*R. umatilla*) are the additional state candidate species. Two species of mollusks are listed by the state as candidate species, including the California floater (*Anodonta californiensis*) and the great Columbia River spire snail (also known as the Columbia pebblesnail; *Fluminicola columbiana*).

Federally Listed Species. The following sections discuss the Federally listed threatened and endangered aquatic species.

Upper Columbia River Spring-Run Chinook Salmon. NMFS listed the upper Columbia River spring-run Chinook salmon as an endangered species in 1999 and reaffirmed this status in 2005. NMFS designated all naturally spawned populations of Chinook salmon in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam, excluding the Okanogan River, as being within the Evolutionary Significant Unit (ESU) for the species (64 FR 14308; 70 FR 37160). This ESU contains the only remaining genetic resources of those spring-run Chinook salmon that migrate into the upper Columbia River Basin, and those salmon are distinct from other stream-type Chinook salmon ESUs (64 FR 14308). That is, the spring-run populations are genetically and ecologically separate from the summer- and fall-run populations of Chinook. In addition, the upper Columbia River spring-run Chinook have different spawning and rearing habitat preferences from the spring-run Chinook in the Snake and John Day River Basins (NMFS, 2004). Critical habitat for the spring-run Chinook took effect in 2006 and includes the habitat areas within the lower Methow River, Lake Entiat, Icicle/Chumstick, and Lower Wenatchee rivers (70 FR 52630).

As discussed in Section 2.2.5, Chinook salmon have characteristics specific to the location of their spawning areas and the time they spend in the river. It is an important ecological species because their lifecycle integrates across the aquatic ecosystem of the Columbia River Basin. Adults return to spawning areas where they were born and build redds in the river substrate. A female may deposit up to 5,000 eggs. Many of these eggs become food to other fish and invertebrates. Spawned-out adults become easy prey for bald eagles and other predators. Dead salmon that decompose in the river return essential nutrients to the aquatic ecosystem. In addition, predation on the live fish by birds and mammals also transfers nutrients to the terrestrial ecosystem. Juveniles forage on zooplankton and macroinvertebrates as they migrate through the Columbia River Basin, and other fish—as well as birds and mammals—prey upon them (Dauble, 2009).

Chinook salmon has been an important species for the Native Americans as well as other people in the Columbia River Basin. Commercial canning of salmon in the lower Columbia River came to a peak in the 1880s when the catch was more that 40 million lb. By the 1890s, hatcheries were releasing salmon to replenish the declining spring-runs (Dauble, 2009). The construction of Grand Coulee Dam, which started in 1938, blocked the spring-run salmon from fish habitat above Columbia RM 596.6. The Grand Coulee Fish Maintenance Project from 1939–1943 homogenized the stocks of Chinook across the currently designated ESU for the spring-run and influenced the present-day loss of genetic diversity. Subsequent construction of numerous dams and other projects on the mainstem Columbia River also contributed to the obstacles for recovery of the upper Columbia River spring-run Chinook salmon (NMFS, 2004).

Upper Columbia River spring-run Chinook salmon have a stream-type life history where the juveniles spend 1–2 years in freshwater before migrating to the Pacific Ocean. The adults are the first of the Chinook salmon to enter the estuary in a new year, travel through the mainstem Columbia River past the Hanford Reach, and arrive in the higher elevation tributaries by mid-June. The female spring-run Chinook select a nesting area in gravels similar to that discussed previously for fall-run Chinook. Peak spawning for all populations of upper Columbia River spring-run Chinook occurs from August–September. The juveniles use the Hanford Reach as a nursery area while they migrate downstream toward the ocean (Duncan, et al., 2007). At first, the diet of juveniles consists of midge larvae and zooplankton, then the juveniles switch eating to adult caddisflies and terrestrial insects. The movement of a juvenile through the Hanford Reach lasts no more than 1 week; outmigration of the juvenile spring-run Chinook extends from April to the end of August (DOE, 2000). As the young-of-year migrate to the mainstem Columbia, they are surface-oriented; however, they may migrate at deeper depths in the Hanford Reach (Dauble, 2009), (NMFS, 2004). Adult Chinook salmon returning from the ocean to spawn in the rivers stop feeding entirely after they pass through the estuaries (Higgs, et al., 1995).

The main consideration for NMFS when listing the upper Columbia River spring-run Chinook salmon as an endangered species is the concern that the species was at risk of becoming extinct in the foreseeable future (64 FR 14308). NMFS has been developing a series of Biological Opinions to address the restoration of the species from the operation of the FCRPS. FCRPS consists of 31 Federally owned and operated (U.S. Army Corps of Engineers and the Bureau of Reclamation) hydro projects in the Columbia and Snake rivers. BPA markets and distributes the power generated by these dams and the CGS (BPA, 2010). In addition, NMFS has prepared Biological Opinions for the relicensing of the five dams on the Columbia River that are owned and operated by public utilities including Priest Rapids Dam, which is owned and operated by Public Utility District of Grant County (NMFS, 2004).

The actions covered by the NMFS' Biological Opinions for the upper Columbia River spring-run Chinook salmon range from modification of the dams to habitat improvements in areas away from the dams. NMFS characterizes the program that is responsible for carrying out the Biological Opinion as being a "large and complicated program that is commensurate with the scale of the FCRPS and its impact on the listed species and critical habitat." The program calls for "increasing survival rates of fish passing through the dams; managing water to improve fish survival, reducing the numbers of juvenile and adult fish consumed by fish, avian, and marine mammal predators; improving juvenile and adult fish survival by protecting and enhancing tributary and estuary habitat; implementing safety net and conservation hatchery programs to assist recovery; and ensuring that hatchery operations do not impede recovery" (NMFS, 2010).

A recent review of the NMFS 2008 Biological Opinion for the FCRPS included evaluation of the status of the upper Columbia River spring-run Chinook salmon and additional actions to build on the 2008 Biological Opinion. The evaluation of new information collected across the critical habitat for spring-run Chinook salmon shows that the aggregate populations of the species have been stable or increasing over the last decade. These results suggest that the actions noted in the Reasonable and Prudent Alternative may be working and are encouraging for the new Adaptive Management Implementation Plan.

Upper Columbia River Steelhead. The listing of the upper Columbia River steelhead has changed many times since 1997, and NMFS presently lists the upper Columbia River steelhead as endangered (August 24, 2009; 74 FR 42605). The listing is now defined as the "Distinct Population Segment (DPS) including all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in streams in the Columbia River Basin, upstream from the Yakima River, Washington, to the U.S.-Canada border" (74 FR 42605). The steelhead associated with six artificial propagation programs are also part of the listing, including the Wenatchee River, Wells Hatchery (in the Methow and Okanogan rivers), Winthrop National Fish Hatchery, Omak Creek, and the Ringold steelhead hatchery programs (74 FR 42605). Critical habitat for the upper Columbia River steelhead was designated on September 2, 2005 (70 FR 52630).

Steelhead are the anadromous form of rainbow trout, and both forms can coexist in the same river system. The species has long been important to the people of the region for food, recreation, and commercial activities—similar to Chinook salmon. In addition, like the Chinook, the steelhead in the Columbia River Basin have experienced the same pressures on their habitat, resulting in a decline of the species (Dauble, 2009), (NMFS, 2004).

Adult steelhead return to migrate up the Columbia River during most months of the year, with peak runs occurring during the late summer months. The length and weight of steelhead varies with the distinct runs upstream, and the larger, later runs include steelhead that have remained in the ocean for 2 years. Although adult steelhead begin to move into the spawning streams September–February, they do not spawn until the following spring (Dauble, 2009). Spawning in the Hanford Reach appears to occur between February and early June, with a peak in mid-May (Mueller and Geist, 1999). They construct their redds in gravel substrate in moderate velocity waters. The construction of the redds is later in the season than other salmon (e.g., fall-run Chinook), and scientists can distinguish the steelhead redds with aerial surveys. The eggs incubate in the gravel for 2–3 months before hatching. Eggs that do not settle in the redds prepared by the adults are often consumed by other fish waiting downstream during spawning. As steelhead fry emerge from the river substrate and start to feed, they are about 1-in (2.5-cm) long and vulnerable to predation, so they seek cover. Juveniles rear in tributary streams for usually 2 years before migrating to the ocean. If they remain in freshwater for their entire life, they are considered rainbow trout (Dauble, 2009).

Juvenile steelhead behave differently in the Hanford Reach than they do in the slower moving reservoirs of the Columbia River. They move through the area past the CGS site in the deepest part of the river, although they tend to stay towards the surface when they are migrating through areas behind a dam. Most of the migration is at night, and the juvenile steelhead rest and feed near the shore during the day (Dauble, 2009). Hatchery programs, including the Ringold Facility upstream of the CGS site, augment the natural spawning efforts in the mainstem Columbia River (NMFS, 2004).

Identification of steelhead redds is difficult because of high, turbid spring runoff that obscures visibility (DOE, 2000). Aerial surveys, boat-deployed video, and digging in the gravels are methods used to confirm the existence of steelhead redds in the Hanford Reach. However, known areas where steelhead have prepared redds are shown in Figure 2.2-3. Some of the identified redds were near the intake and discharge structures for the CGS plant. The redds found near the CGS site included the area upstream of the CGS intake structure between

Islands 12 and 13 (Columbia RM 352), and another downstream near Island 15 (Columbia RM 349). Two steelhead redds were discovered in 2003 below CGS, prompting the establishment of a monitoring effort by the DOE to locate any steelhead redds in the Hanford Reach. Aerial surveys found 2 regions having characteristics associated with steelhead redds, including the area upstream of the CGS intake structure between Islands 12 and 13 (Columbia RM 352), and another downstream near Island 15 (Columbia RM 349). Using a boat-deployed video camera, 4 redds were observed in 2005 near Island 15, but there was no indication of spawning activity; no redds were found around Islands 12 and 13 (Hanf, et al., 2006). From 2006–2008, the aerial surveys have not found any evidence of steelhead spawning near the CGS intake and discharge structure (Duncan, et al., 2008), (Hanf, et al., 2006), (Hanf, et al., 2007), (Poston, et al., 2009).

Upper Columbia River steelhead are included in the Biological Opinions for the recovery of the species associated with the operation of the dams on the Columbia and Snake rivers, as discussed above for upper Columbia River spring-run Chinook salmon. Steelhead recovery in the upper Columbia River ESU is included in the same plans and programs for the spring-run Chinook (NMFS, 2010).

Bull Trout. USFWS listed the coterminous population of bull trout as a threatened species in 1999 (64 FR 58910). On October 6, 2004, the USFWS finalized the critical habitat designation for the Columbia River bull trout population (69 FR 59995). On January 14, 2010, the USFWS published a proposed revised critical habitat rule (75 FR 2270) that included the entire Columbia River as critical habitat for the bull trout. The revised designation became effective on November 17, 2010 (75 FR 63898). The CGS site occurs in the Mid-Columbia recovery unit. The decline of bull trout has been characterized as being primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of non-native species (64 FR 58910; 75 FR 2270). Recovery plans for the species across the critical habitat include reducing threats to bull trout and their habitat, ensuring corridors for interaction of populations of bull trout, and increasing habitat improvements for all life stages of the trout (75 FR 2270).

The species needs cold water to survive, and they prefer water temperatures that do not exceed 59–64 degrees F (15–18 degrees C). Bull trout "require stable stream channels, clean spawning and rearing gravel, complex and diverse cover, and unblocked migratory corridors" (USFWS, 2010f). They have more specific habitat requirements than most other salmonids (75 FR 2270). Bull trout can be resident or anadromous, and both forms can coexist and reproduce with each other. Unlike Chinook salmon, bull trout can spawn multiple times over their lifetime. They typically spawn from August–November during periods of declining water temperature. The diet of resident and juvenile bull trout consists of invertebrates and small fish. Anadromous bull trout primarily consume fish. Resident bull trout are smaller, up to 10-in. (25-cm) long, than migratory trout, which are up to 35-in. (89-cm) long and up to 32 lb (14 kg) (USFWS, 2010f).

Water temperature affects the life stages of bull trout more than other species. They seek colder water for their redds, often in areas with groundwater inflow that have an optimum incubation temperature from 35–39 degrees F (1.7–3.9 degrees C). The water temperature for rearing young is a little warmer, with an optimum temperature of 46–49 degrees F (7.8–9.4 degrees C). Bull trout preferences for varying water temperatures over their life cycle affects their distribution and their potential for recovery in the Columbia River Basin (USFWS, 2007).

Gray and Dauble (1977) reported bull trout in the Hanford Reach, but the location of the collection was unclear. The water temperatures and habitat in the Hanford Reach are not ideal for spawning, and there are no reports of spawning activity by bull trout near CGS (Dauble, 2009), (USFWS, 2007). Resource scientists at DOE's Hanford Site have characterized the use of the Hanford Reach by bull trout as transient (Poston, et al., 2009).

State Protected Aquatic Species. Near the CGS site, the State of Washington lists as candidate species the three Federally listed species mentioned above. It also lists four additional fish species—the mountain sucker, river lamprey, leopard dace, and Umatilla dace. The State of Washington includes two mollusks—the California floater and the great Columbia River spire snail.

From 1973–1975, surveys in the Hanford Reach collected mountain suckers 3–9 mi (5–14 km) above the CGS intake (Gray and Dauble, 1977). This species is smaller than, and not as common as, other sucker species within the Hanford Reach. Typically, they are restricted to tributaries of the Columbia River at higher elevations than the CGS site. They are broadcast spawners with adhesive eggs that settle on the substrate in their preferred riffles of swift running streams. Mountain suckers are listed as a species of concern because their status in Washington State is unknown (Dauble, 2009).

Documentation of the distribution and status of the river lamprey near the CGS site and the Columbia River Basin is poor (Dauble, 2009). Historic fish collections in the Hanford Reach include the river lamprey, but the location where the fish were observed is unknown (Gray and Dauble, 1977). Adult river lamprey have an elongated body, 5–11 in. (12–29 cm) long; eel-like fins; and a sucker with teeth (McCloy, 2005). Little is known about the life history of river lamprey (69 FR 77158); however, they are anadromous spending approximately 10 weeks at sea. It has been suggested that the adults return to the Columbia River Basin from the ocean likely in early autumn to hold over and spawn in April and May (Bond, et al., 1983). The larvae, or ammocoetes, burrow into the sediment and filter feed on algae and microscopic organisms. Before migrating back to the ocean, the larvae metamorphose into adults (McClory and Gotthardt, 2005). Because river lamprey remove portions of flesh from their prey, it has been suggested that this species should be considered predatory rather than parasitic (Dauble, 2009), (Wydoski and Whitney, 2003).

Leopard dace are also listed as species of concern because their status in the Washington State is unknown. From 1973–1975, surveys in the Hanford Reach collected leopard dace more than 30 mi (48 km) above the CGS intake (Gray and Dauble, 1977), but the species is probably only an occasional visitor in the Mid-Columbia region (Dauble, 2009). Adults are small, around 4 in. (10 cm) long, and they are mostly bottom-dwelling fish that consume aquatic insect larvae, zooplankton, and algae. They are broadcast spawners with adhesive eggs. Other, larger fish often consume leopard dace (Dauble, 2009).

The Umatilla dace had previously been considered to be a variant of the leopard dace because of the morphological similarity in the two species (Wydoski and Whitney, 2003). The first specimens described were from the Columbia River channel below McNary dam (first dam downstream of the Columbia Reach) near Umatilla, Oregon. They have a "spotty distribution" within the Columbia River Basin. They have been reported from tributaries of the Columbia up into British Columbia. They are similar to the leopard dace in their habitat choices and, likely, their food selection. They are considered a bottom-dwelling fish that prefers clean substrate of rock, boulders, and cobble and are located in areas where the water velocity is strong enough to prevent siltation. They are thought to spawn in early to mid-July in Washington State. (Wydoski and Whitney, 2003).

The California floater has been collected in the Hanford Reach in the 1970s, 1980s, and as recently as 2003–2004 (Hanf, et al., 2005), (TNC, 2003), (WPPSS, 1986). This mussel has a long—up to 5 in. (13 cm)—elliptical shell with a dark exterior and white interior. They prefer shallow muddy, silty, or sandy habitats in large rivers, reservoirs, and lakes. Like other mussel species, the larval form, called glochidia, develop as parasites in fish hosts. Native minnow species and introduced western mosquito fish are thought to be the host fish for these mussels. The main reasons cited for the decline of California floaters include severe water fluctuations due to hydroelectric dam operation and competition with introduced mollusks (e.g., Asian clams) and other species that may compete with their host fish or eat young mussels (e.g., common carp) (Nedeau, et al., 2009).

The great Columbia River spire snail was collected in the Hanford Reach during surveys from the 1970s–1990s, but no snails were collected during the most recent surveys in 2003 and 2004 (Hanf, et al., 2005), (TNC, 2003), (WPPSS, 1986), (WPPSS, 1987). The snails have relatively small shells (0.28–0.44 in. (7.0–11.2 mm)) that are opaque and pinkish with 4–4.5 whorls (Hershler and Frest, 1996). The snails are bottom dwellers and scrape periphyton off the rock substrate. The decline of the great Columbia River spire snail may be associated with groundwater contaminants entering the river substrate where they live, increased competition with introduced species, and predation pressures (Hanf, et al., 2005).

2.2.7.3 Essential Fish Habitat

The NMFS noted upper Columbia River Chinook salmon (spring-, summer-, and fall-runs) and coho salmon as species that have EFH (Suzumoto, 2010). A separate EFH Assessment, enclosed as Appendix D-1 in this SEIS, addresses additional consultation between the NMFS and the NRC concerning essential habitat near the CGS site.

2.2.8 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at CGS. CGS, 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. Power plant operations, in turn, supply wages and benefits for people and dollar expenditures for goods and services. The measure of a communities' ability to support CGS operations depends on their ability of the community to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomics region of influence (ROI) is defined by the areas where CGS employees and their families reside, spend their income, and use their benefits, thus affecting the economic conditions of the region. The CGS ROI consists of a two-county area (Benton and Franklin counties) and the Tri-Cities area, where approximately 95 percent of CGS employees reside.

CGS employs a permanent workforce of approximately 1,145 employees (EN, 2010). Approximately 97 percent live in Benton and Franklin County (Table 2.2-6). Most of the remaining 3 percent of the workforce are divided among 6 counties in Washington and Oregon, with numbers ranging from 1–9 employees per county. Given the residential locations of CGS employees, the most significant effects of plant operations are likely to occur in Benton and

Franklin County. The focus of the socioeconomic impact analysis in this SEIS is, therefore, on the impacts of continued CGS operations on these two counties.

Table 2.2-6. CGS, employee residence by county

County	Number of employees	Percentage of total
Benton	942	83
Franklin	165	14
Other	38	3
Total	**1,145**	**100**

Source: EN, 2010.

Refueling outages at the CGS normally occur at 24-month intervals. During refueling outages, site employment increases by as many as 1,100–1,500 temporary workers for approximately 35–45 days (EN, 2010). Most of these workers are assumed to be located in the same geographic areas as CGS employees. The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding CGS.

2.2.8.1 Housing

Table 2.2-7 lists the total number of occupied and vacant housing units, vacancy rates, and median value in the two-county ROI. According to the 2000 Census, there were approximately 72,000 housing units in the socioeconomic region, of which approximately 67,700 were occupied. The median values of owner-occupied housing units in Benton and Franklin counties were $119,900 and $102,000, respectively. The vacancy rate was the lower in Benton County (5.5 percent). The vacancy rate in Franklin County was 7.7 percent (USCB, 2010).

Table 2.2-7. Housing in Benton and Franklin County in Washington

	Benton	Franklin	ROI
		2000	
Total	55,963	16,084	72,047
Occupied housing units	52,866	14,840	67,706
Vacant units	3,097	1,244	4,341
Vacancy rate (percent)	5.5	7.7	6.0
Median value (dollars)	119,900	102,000	110,950
		2006-2008, 3-year estimate	
Total	63,307	22,239	85,546
Occupied housing units	58,013	20,332	78,345
Vacant units	5,294	1,907	7,201
Vacancy rate (percent)	8.4	8.6	8.4
Median value (dollars)	162,600	141,100	151,850

Source: USCB, 2010.

By 2008, the estimated number of housing units grew in both counties. In Benton County, the number of housing units grew by more than 7,000 units to an estimated total of approximately 63,000 units, or approximately 13 percent. The estimated total number of housing units increased by 38.3 percent in Franklin County (USCB, 2010).

2.2.8.2 Public Services

This section presents information regarding public services to include water supply, education, and transportation.

Water Supply. Kennewick and Richland (Benton County) and Pasco (Franklin County) comprise the Tri-Cities area, which is where 95 percent of workers at CGS reside. The discussion of public water supply systems is limited to major municipal water systems in these counties and cities. Information about municipal water suppliers in these counties, their permitted capacities and maximum design yields, reported annual peak usage, and population served are presented in Table 2.2-8. The source of potable water at the CGS is not tied into any Tri-Cities municipal water systems. Water from the Columbia River is treated onsite to supply the potable water needs at CGS.

Table 2.2-8. Benton and Franklin Counties public water supply systems (in million gallons per day (mgd))

Water Supplier	Primary Water Source	Average Daily Demand (mgd)	System Capacity (mgd)	Population Served
		Benton County		
Kennewick City	SW	11	30.0	68,128
Richland City	SW	14.7	36.0	47,410
		Franklin County		
City of Pasco	SW	12	30.0	48,685

Surface Water = SW

Source: EPA, 2010c and TRIDEC, 2010.

The City of Kennewick draws its water from the Columbia River and two Ranney Collector wells, depending upon the time of the year. The water is treated at the Kennewick Water Treatment Plant before distribution in the water system. In 2009, about 59 percent of the annual water use was drawn from the Columbia River, and 41 percent of the annual water use was drawn from the Ranney wells (City of Kennewick, 2010). The Kennewick water system has excess capacity to meet its average daily water needs, with 36.7 percent use of its capacity. But, during peak use periods, it uses a significant portion of its capacity (80.7 percent) (TRIDEC, 2010).

The City of Pasco obtains all of their water from the Columbia River. The water is then processed in its treatment plant before distribution (City of Pasco, 2010). The Pasco water system has excess capacity to meet its average daily use (40.0 percent) and peak use (73.3 percent) water needs (TRIDEC, 2010).

The City of Richland draws its water from the Columbia River and three groundwater wells (City of Richland, 2010). As with the City of Kennewick, withdrawals from each source vary depending upon the time of the year. The Richland water system has excess capacity to meet its average daily water needs, with 40.8 percent use of its capacity. But, during peak periods, it uses almost all of its capacity (94.4 percent) (TRIDEC, 2010).

Education. The Kennewick School District has 13 elementary schools, 4 middle schools, 3 high schools, 1 skills center, and 1 alternative school. During the 2009–2010 school year, enrollment was 15,234 students (Kennewick School District, 2010).

Pasco School District has 11 elementary schools, 3 middle schools, 2 high schools, and 1 alternative middle and high school. The enrollment in 2009 was over 14,400 students (Pasco Public School District, 2010).

The Richland School District serves the cities of Richland and West Richland. The district has 8 elementary schools, 3 middle schools, 2 high schools, 1 alternative middle school, and 1 alternative high school. The enrollment in 2010 was 11,033 students (OSPI, 2010).

Transportation. The Tri-Cities area is located at the intersection of several major highways, including Interstate (I) 182/U.S. Highway (US) 12 and US-395. I-182/US-12 is a four-lane divided highway that lies to the south of the Hanford Site and runs east and west. US-395 is also a four-lane-divided highway that lies 15 mi to the east of the Hanford Site, on the other side of the Columbia River, and runs north-south. State Route (SR) 240 runs southeast (from its junction with US-395) to the northwest. The northern part of SR-240 is a 2-lane highway, while the southern portion (Stevens Drive to Columbia Center Boulevard) is a 6-lane highway. SR-24 also is a two-lane highway that lies on the northern part of the Hanford Site and traverses east and west.

Table 2.2-9 lists commuting routes to CGS and average annual daily traffic (AADT) volume values. The AADT values represent traffic volumes for a 24-hour period factored by both day of week and month of year.

Table 2.2-9. Major commuting routes in the vicinity of Columbia Generating Station 2009 average annual daily traffic count

Roadway and location	Average annual daily traffic (AADT)[(a)]
US-395 (south of Vineyard Drive in Pasco)	14,597
US-395 (at the Columbia River Bridge)	55,742[(b)]
I-182 (at the Columbia River Bridge in Pasco)	53,828
SR-240 (west of the Columbia Park Trail interchange in Richland)	64,399
SR-24 (at the Columbia River Bridge at Vernita)	3,666

Source: WDOT, 2010.

[(a)] All AADTs represent traffic volume during the average 24-hour day during 2009.

[(b)] No data available for 2009 and 2008, 2007 AADT data is provided.

2.2.8.3 Offsite Land Use

Offsite land use conditions in Benton and Franklin County are described in this section. Of the CGS permanent workforce, 95 percent of lives in these two counties. Land use in Benton and Franklin County primarily consists of agriculture lands, with small urban areas. In addition, three other counties (Grant, Walla Walla, and Yakima) receive tax payment revenue attributable to CGS, although the estimated revenue is less than 1 percent of their general fund.

Benton County occupies approximately 1,700 mi^2 (4,400 square kilometers (km^2)) (USCB, 2010). Agricultural land and the Hanford Site make up the majority of the land used, with urban lands making up about 6 percent of the total county land area. The Hanford Site contains large undisturbed areas of semi-arid shrub and grassland and localized industrial areas that are principally supported by DOE funding. The principal agriculture land use outside of the Hanford Site is commercial dry land and irrigated crop produce and livestock products, with the market value of crops (mostly wheat for grain) being about nine times that of livestock, poultry, and their products. The number of farms in Benton County increased about 4 percent from 1997–2007. Farmland acreage in the county decreased less than 1 percent during the same period, and the average size of a farm decreased 4 percent to 388 ac (157 ha) (USDA NASS, 2008), (USDA NASS, 2009).

Franklin County occupies approximately 1,240 mi^2 (3,200 km^2) (USCB, 2010). Like Benton County, Franklin County is primarily agricultural land; 85 percent of the county land area is rangeland, with the largest urban area being Pasco at about 5 percent of the county land area. A small portion of the Hanford Reach National Monument (approximately 40 mi^2 (64.4 km^2) of the Wahluke Unit) extends into northwest Franklin County. The principal crop is livestock forage (i.e., hay and grass silage), followed by wheat for grain, potatoes, vegetables, and sweet corn. Livestock (mostly cattle and calves) is about one-sixth the market value for all agriculture products. The number of farms in Franklin County decreased from 1997–2007 by 17 percent. The number of farmland acres and average size of a farm (in acres), however, increased during the same period by 5 percent and 26 percent, respectively (USDA NASS, 2009).

Both Benton and Franklin County have experienced significant population growth in recent years and, from 2000–2009, were ranked by the Washington Department of Financial Management fifth and first, respectively, in population growth among the 39 Washington counties (WOFM, 2009).

Even though population growth is projected to continue, there is ample urban and rural land to accommodate the anticipated growth over the next 20 years. However, agricultural will continue to be the major land use outside urban areas.

2.2.8.4 Visual Aesthetics and Noise

CGS is situated on a relatively flat plain, which is shrub-steppe with sagebrush interspersed with perennial native and introduced annual grasses. The makeup water pumphouse is the closest structure to the Columbia River, and with little obstruction from vegetation, the power plant can be seen from the river.

Predominate features are the reactor building, which is approximately 230 ft (70 m) tall; the turbine generator building (139 ft (42 m)); six cooling towers each standing 60 ft (18 m) tall; and a 245 ft (75 m) meteorological tower, located west of the Reactor Building. Two abandoned power plant construction projects (WNP-1 and WNP-4) also located on the leased Energy Northwest land—now referred to as the IDC—which is comprised of several IDC facilities (e.g., shops, warehouses, office space) (EN, 2010).

There is often a visible plume of condensation rising up from the cooling towers. Its height and visibility are dependent on weather conditions such as temperature, humidity, and wind speed. It is typically several hundred feet tall and can be seen from several miles away (EN, 2012).

Noise from nuclear plant operations can be detected offsite. Sources of noise at CGS include the turbines and large pump motors. Given the industrial nature of the station, noise emissions from the station are generally nothing more than an intermittent minor nuisance. However, noise levels may sometimes exceed the 55 decibels adjusted level that the EPA uses as a threshold level to protect against excess noise during outdoor activities (EPA, 1974). However, according to the EPA this threshold does "not constitute a standard, specification, or regulation," but was intended to give a basis for state and local governments establishing noise standards.

2.2.8.5 Demography

According to the 2000 Census, an estimated 171,371 people lived within 20 mi (32 km) of CGS, which equates to a population density of 136 persons per mi^2 (EN, 2010). This translates to a Category 4, "least sparse" population density using the generic environmental impact statement (GEIS) measure of sparseness (greater than or equal to 120 persons per mi^2 within 20 mi). An estimated 387,512 people live within 50 mi (80 km) of CGS with a population density of 49.4 persons per mi^2 (EN, 2010). Since the Tri-Cities has a combined population of over 200,000 persons within 50 mi of CGS, this translates to a Category 3 density using the GEIS measure of proximity (one or more cities with 100,000 or more persons and less than 190 persons per mi^2 within 50 mi). Therefore, CGS is located in a high population area based on the GEIS sparseness and proximity matrix.

Table 2.2-10 shows population projections and growth rates from 1970–2050 in Benton and Franklin counties in Washington. The growth rate in Benton County showed an increase of 26.5 percent for the period of 1990–2000. Franklin County population also shows an increase from 1990–2000 (31.7 percent). Both counties' populations are expected to continue to increase in the next decades and through 2050.

Table 2.2-10. Population and percent growth in Benton and Franklin counties from 1970–2000 and projected for 2010–2050

	Benton		Franklin	
Year	**Population**	**Percent growth[(a)]**	**Population**	**Percent growth[(a)]**
1970	67,540	----	25,816	----
1980	109,444	62.0	35,025	35.7
1990	112,560	2.8	37,473	7.0
2000	142,475	26.6	49,347	31.7
2009	***168,294***	***18.1***	***77,355***	***56.8***
2010	168,839	18.5	70,038	41.9
2020	184,704	9.4	90,654	29.4
2030	198,528	7.5	109,861	21.2
2040	213,713	7.6	130,007	18.3
2050	228,557	6.9	149,919	15.3

---- = No data available.

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

Sources: Population data for 1970 through estimated population data for 2009 (USCB, 2010); population projections for 2010–2030 by Washington Office of Financial Management (WOFM), *Final Projections of the Total Resident Population for Growth Management, Medium Series: 2000 to 2030*, October 2007; 2040–2050 calculated.

<u>Demographic Profile</u>. The 2000 (estimate) demographic profiles of the two-county ROI population are presented in Table 2.2-11 and Table 2.2-12. In 2000, minorities (race and ethnicity combined) comprised 27.1 percent of the total two-county population. The minority population is largely Hispanic or Latino with a small percentage of Asian residents.

Table 2.2-11. Demographic profile of the population in the Columbia Generating Station two-county socioeconomic region of influence in 2000

	Benton	Franklin	ROI
Total Population	142,475	49,347	191,822
Race (percent of total population, Not-Hispanic or Latino)			
White	81.7	47.6	72.9
Black or African American	0.9	2.3	1.2
American Indian & Alaska Native	0.7	0.5	0.6
Asian	2.2	1.6	2.0
Native Hawaiian Other Pacific Islander	0.1	0.1	0.1
Some other race	0.1	0.1	0.1
Two or more races	1.8	1.3	1.7
Ethnicity			
Hispanic or Latino	17,806	23,032	40,838
Percent of total population	12.5	46.7	21.3
Minority population (including Hispanic or Latino ethnicity)			
Total minority population	26,018	25,877	51,895
Percent minority	18.3	52.4	27.1

Source: USCB, 2010.

According to the U.S. Census Bureau's (USCB) 2006–2008 American Community Survey 3-Year Estimates, minority populations were estimated to have increased by approximately 20,600 persons and comprised 31.7 percent of the county population (see Table 2.2-12). Most of this increase was due to an estimated influx of Hispanic or Latinos (over 18,300 persons), an increase of over 45 percent from 2000. The next largest increase in minority population was Asian, an increase of approximately 1,000 persons, or 26 percent, from 2000.

Table 2.2-12. Demographic profile of the population in the Columbia Generating Station two-county socioeconomic region of influence, 2006–2008 3-year estimate

	Benton	Franklin	ROI
Population	159,629	69,241	228,870
Race (percent of total population, not-Hispanic or Latino)			
White	78.0	45.9	68.3
Black or African American	1.3	1.6	1.4
American Indian & Alaska Native	0.6	0.6	0.6
Asian	2.3	1.7	2.1
Native Hawaiian Other Pacific Islander	0.0	0.1	0.0
Some other race	0.2	0.1	0.2
Two or more races	1.5	1.3	1.5
Ethnicity			
Hispanic or Latino	25,404	33,737	59,141
Percent of total population	15.9	48.7	25.8
Minority population (including Hispanic or Latino ethnicity)			
Total minority population	35,049	37,431	72,480
Percent minority	22.0	54.1	31.7

Source: USCB, 2010.

Transient Population. Within 50 mi (80 km) of CGS, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services. In 2010, there were approximately 19,189 students attending colleges and universities within 50 mi (80 km) of CGS (IES, 2010).

In 2000, 0.3 percent of all housing units are considered temporary housing for seasonal, recreational, or occasional use in Benton County. By comparison, seasonal housing accounted for 1.0 percent, 5.4 percent, 10.9 percent, 5.5 percent, 0.8 percent, and 1.1 percent of total housing units in Adams, Grant, Kittitas, Klickitat, Walla Walla, and Yakima counties in Washington, respectively (USCB, 2010). Two counties in the state of Oregon are within 50 mi of CGS, Morrow and Umatilla, which make up 4.7 percent and 2.5 percent of the total seasonal housing units. Seasonal housing accounted for 0.5 percent of total housing units in Franklin County, respectively (USCB, 2010). Table 2.2-13 supplies information on seasonal housing for the 10 counties located all or partly within 50 mi of CGS.

Table 2.2-13. Seasonal housing in counties located within 50 miles of Columbia Generating Station

County[a]	Housing units	Vacant housing units: for seasonal, recreational, or occasional use	Percent
		Washington	
Adams	5,773	59	1.0
Benton	55,963	184	0.3
Franklin	16,084	76	0.5
Grant	29,081	1,576	5.4
Kittitas	16,475	1,791	10.9
Klickitat	8,633	475	5.5
Walla Walla	21,147	178	0.8
Yakima	79,174	850	1.1
County Subtotal	**232,330**	**5,189**	**2.2**
		Oregon	
Morrow	4,276	202	4.7
Umatilla	25,195	705	2.5
County Subtotal	**31,952**	**907**	**2.8**
Total	**264,282**	**6,096**	**2.3**

Source: USCB, 2010.

[a] Counties within 50 mi (80 km) of CGS with at least one block group located within the 50-mi (80-km) radius.

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

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

Information on migrant farm and temporary labor was collected in the 2007 Census of Agriculture. Table 2.2-14 supplies information on migrant farm workers and temporary farm labor (less than 150 days) within 50 mi of CGS. According to the 2007 Census of Agriculture, approximately 123,879 farm workers were hired to work for less than 150 days and were employed on 3,958 farms within 50 mi of CGS. The county with the largest number of temporary farm workers (52,428) on 1,350 farms was Yakima County, Washington (USDA NASS, 2009).

Table 2.2-14. Migrant farm workers and temporary farm labor in counties located within 50 miles of Columbia Generating Station

County[(a)]	Number of farms with hired farm labor[(b)]	Number of farms hiring workers for less than 150 days [(b)]	Number of farm workers working for less than 150 days[(b)]	Number of farms reporting migrant farm labor[(b)]
		Washington		
Adams	251	197	4,637	40
Benton	466	412	15,347	132
Franklin	427	334	10,787	151
Grant	745	598	27,032	281
Kittitas	222	187	1,032	22
Klickitat	185	139	1,804	31
Walla Walla	284	240	6,217	40
Yakima	1,483	1,350	52,428	465
County Subtotal	**4,063**	**3,457**	**119,284**	**1,162**
		Oregon		
Morrow	127	109	772	10
Umatilla	454	392	3,823	66
County Subtotal	**581**	**501**	**4,595**	**76**
Total	**4,644**	**3,958**	**123,879**	**1,238**

Source: 2007 Census of Agriculture

—County Data (NASS, 2009).

[(a)] Counties within 50 miles of CGS with at least one block group located within the 50-mi radius.

[(b)] Table 7. Hired farm Labor—Workers and Payroll: 2007.

In the 2002 Census of Agriculture, farm operators were asked for the first time whether or not they hired migrant workers—defined as a farm worker whose employment required travel—to do work that prevented the migrant worker from returning to their permanent place of residence the same day. A total of 1,238 farms, in the 50-mi radius of the CGS, reported hiring migrant workers in the 2007 Census of Agriculture. Yakima and Grant County reported the most farms (465 and 281, respectively) with hired migrant workers, followed by Franklin and Benton County, with 151 and 132 farms, respectively (USDA NASS, 2009).

According to the 2007 Census of Agriculture estimates, 15,347 temporary farm workers (those working fewer than 150 days per year) were employed on 412 farms in Benton County, and 10,787 temporary farm workers were employed on 334 farms in Franklin County (USDA NASS, 2009).

2.2.8.6 Economy

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

Employment and Income. From 2000–2009, the civilian labor force in Benton County increased 13.9 percent from 70,520 to an estimated 80,305. Franklin County also increased during that time period, 48.0 percent, from 21,875 to an estimated 32,372 (USCB, 2010).

In 2008, educational, health, and social services represented the largest sector of employment (19.3 percent) in Benton County followed by professional, scientific, management, administration, and waste management (18.0 percent). In Franklin County, educational, health, and social services represented the largest sector of employment (16.7 percent) followed by agriculture, forestry, fishing, and hunting and mining (16.5 percent). A list of some of the major employers in the Tri-City area is given in Table 2.2-15. As shown in the table, the largest employer in the Tri-City area is the Pacific Northwest National Laboratory. Energy Northwest is the seventh largest employer.

Table 2.2-15. Major employers of the Tri-City area in 2007

Employer	Number of employees
Battelle/PNNL	4,188
Fluor	3,597
Bechtel National, Inc.	2,400
ConAgra/Lamb Weston	1,685
Kadlec Medical Center	1,486
Tyson Fresh Meats	1,235
Energy Northwest	1,072
CH2M Hill Handford Group, Inc.	1,060
Broetje Orchards (seasonal)	988
Kennewick General Hospital	805
Tri-Cities Airport	703
Benton County	664
Lockheed Martin Services, Inc.	650
Lourdes Health Network	640
AREVA, Inc.	625
Apollo, Inc.	490
DOE Richland Operations	231
AgriNorthwest	200
DOE Office of River Protection	102

Source: EN, 2010.

Estimated income information for the CGS ROI is presented in Table 2.2-16. According to the USCB's 2006–2008 American Community Survey 3-Year Estimates, people living in Benton and Franklin counties had median household and per capita incomes below the state average. Benton County had a higher median household and per capita income between the two counties. An estimated 12.7 and 20.9 percent of the population in Benton and Franklin counties were living below the official poverty level, respectively. The State of Washington, as a whole, had a lower percentage of persons living below the poverty level (11.6 percent). The percentage of families living below the poverty level in Benton and Franklin County (9.9 and

17.2 percent, respectively) was higher than the percentage of families in the State of Washington as a whole (7.9 percent) (USCB, 2010).

Table 2.2-16. Estimated income information for the Columbia Generating Station region of influence in 2008

	Benton	Franklin	Washington
Median household income (dollars)[(a)]	54,544	44,744	57,234
Per capita income (dollars)[(a)]	26,542	18,220	29,927
Individuals living below the poverty level (percent)	12.7	20.9	11.6
Families living below the poverty level (percent)	9.9	17.2	7.9

Source: USCB, 2010.

[(a)] In 2008 inflation-adjusted dollars.

Unemployment. According to the USCB's 2006–2008 American Community Survey 3-Year Estimates, the unemployment rates in Benton and Franklin counties were 6.2 and 7.9 percent, respectively, which was higher than the unemployment rate of 6.0 percent for the State of Washington (USCB, 2010).

Taxes. Energy Northwest, a municipal corporation and joint operating agency of the State of Washington, is exempt from paying local property taxes but is required to pay a public utility district (PUD) privilege tax (state excise tax) for the privilege of operating. The tax is authorized by State law (Revised Code of Washington, Chapter 54.28). The tax is "measured by gross income derived from the sale of electric energy, the number of kilowatt hours of self-generated energy which is either distributed to consumers or resold to other utilities, and the wholesale value of energy produced in thermal plants." (WDOR 2010).

The PUD privilege tax on thermal generating facilities, including CGS, is assessed on the wholesale value of energy produced for sale or use. The basic rate portion of the tax is distributed by the Washington Department of Revenue (WDOR) in accordance with specified formulas. About 4 percent is deposited in the state general fund, with the remaining 96 percent split evenly (50-50) between the state general fund for public schools and local taxing districts within a defined "impacted area." The surtax portion of the PUD privilege tax goes directly to the state general fund (WDOR 2010).

The CGS "impacted area" (also defined by state law) is as an area within 35 mi of the southern entrance to the DOE Hanford Site (WDOR 2010). The local taxing districts in the "impacted area" include 5 counties (Benton, Franklin, Grant, Walla Walla, and Yakima), 10 cities (Richland, Kennewick, Pasco, Benton City, Prosser, West Richland, Connell, Mesa, Grandview, Sunnyside), 17 fire districts, and 4 library districts. Distribution is based on the population in each area. Counties receive 22 percent of the local taxing districts portion of the tax payment, cities receive 23 percent, fire districts receive 3 percent, and library districts receive 2 percent (WDOR 2010). Privilege taxes paid by Energy Northwest for CGS energy generation over a 5-year period are presented in Table 2.2-17.

Table 2.2-17. Columbia Generating Station privilege tax distribution, 2004–2008

	Calendar Year(a)				
	2004	**2005**	**2006**	**2007**	**2008**
State General Fund	261,217	291,650	266,691	303,216	330,598
Public Schools	1,139,855	127,654	1,163,743	1,323,123	1,442,610
Countries (5)	501,536	559,968	512,047	582,174	634,748
Cities (10)	524,333	585,421	535,322	608,636	663,601
Fire Districts (17)	68,391	76,359	69,825	79,387	86,557
Library Districts (4)	45,594	50,906	46,550	52,925	57,704
Total	**2,540,927**	**2,836,959**	**2,594,178**	**2,949,461**	**3,215,818**

Source: EN, 2010.

(a) Taxes, payable in June of each year, are based on the generation during the preceding calendar year.

The retail sales and use tax is an important revenue source for state and local government in Washington State. This excise tax is levied on retail transactions and supplied about 55 percent of state revenues supporting the state general fund and 47.5 percent of total state and local tax receipts (WDOR 2010).

The leasehold excise tax is another tax that applies to leases of public property to private lessees. All receipts are deposited in the state general fund, and about half is returned to the cities and counties in which the property is located (WDOR 2010). Energy Northwest owns and leases office buildings in Benton County that are underwritten, in part, by bonds financing CGS. Accordingly, a leasehold tax is collected and paid to the state. The sales and use and leasehold taxes attributable to CGS for fiscal years 2004–2008 are presented in Table 2.2-18.

Table 2.2-18. Columbia Generating Station Sales and Use and Leasehold Taxes, FY 2004–2008

	Fiscal Year (July 1–June 30)				
	2004	**2005**	**2006**	**2007**	**2008**
Sales & Use Tax (dollars)	2,799,321	7,767,808	2,570,866	11,489,074	4,602,412
Leasehold Tax (dollars)	41,587	43,032	39,499	45,654	59,818

Source: EN, 2010.

The sales and use tax fluctuates year-to-year, largely because of the cyclical nature of procurement activities and refueling and maintenance outages at CGS every 2 years. Nuclear fuel purchases comprise a significant component of the use tax. However, taxes do not represent significant percentage of the revenue of the local taxing jurisdictions. In addition, there is no direct correlation between the amount of taxes paid to the State of Washington and the distribution of funds to local taxing jurisdictions. The allocation of tax revenue attributable to CGS to local taxing districts is not recorded. To give a sense of the relative support provided by CGS, estimates for several taxing districts are listed in Table 2.2-19 for 2007. The listed jurisdictions are representative of the many that could derive some revenue from sales taxes or privilege taxes paid by CGS. For most jurisdictions, the estimated revenue attributable to CGS is less than 1 percent of their general fund revenues.

Table 2.2-19. Estimated relative contribution of Columbia Generating Station to revenue of selected jurisdictions, 2007

Jurisdiction	General fund revenue (1,000 dollars)	Estimated tax revenue from CGS (1,000 dollars)	Percent of general fund revenue from CGS taxes
Counties			
Benton	51,493	393.9	0.77
Franklin	20,760	146.2	0.70
Yakima	51,055	74.9	0.15
Cities			
Richland	37,920	276.5	0.73
Kennewick	34,122	306.4	0.90
Pasco	29,967	315.1	1.05
West Richland	4,943	45.6	0.92
Prosser	3,929	15.9	0.41
Connell	2,683	10.1	0.38
Grandview	4,400	27.9	0.63
Fire districts			
Benton County No. 1	2,487	21.6	0.87
Benton County No. 4	1,343	14.9	1.11
Yakima County No. 5	3,626	8.6	0.24
Walla Walla County No. 5	729	4.6	0.63
Library district			
Mid-Columbia	5,599	41.3	0.74
Yakima Valley Regional	5,946	6.8	0.11
School district			
Kennewick	84,830	39.0	0.05
Richland	126,905	59.3	0.05
Pasco	97,605	52.2	0.05
Other			
Ben Franklin Transit Authority	26,414	290.8	1.10

Jurisdiction	General fund revenue (1,000 dollars)	Estimated tax revenue from CGS (1,000 dollars)	Percent of general fund revenue from CGS taxes

Source: EN, 2010.

Notes:

(1) General fund revenue is normally for the operation and maintenance of the respective governmental function. Sources include taxes, license and permit fees, fines and forfeits, leases and rents, and charges for services. The Washington State Auditor's Office is the source of the revenue numbers.

(2) The calendar year 2007 sale and use tax is assumed to be the average of the fiscal year 2007 and fiscal year 2008 tax in Table 2.2-18. Thus, calendar year 2007 sales and use taxes from Table 2.2-18 are estimated to be $8,046,000. Similarly, the calendar year 2007 leasehold taxes are estimated to be $52,700.

(3) For estimation, it is assumed that 50 percent of the procurement subject to sales and use tax occurs locally with 30 percent in Benton County and 20 percent in Franklin County. Additional assumptions are made regarding the distribution of sales and use tax revenue among the cities. Benton County and the City of Richland are assumed to share half of the leasehold taxes that are paid.

(4) Estimated distribution of privilege taxes to school districts is based on fractional share of the total basic program support received by the district. Distribution also assumes 33.4 percent of state general fund revenue supports K-12 education.

(5) Intergovernmental transfers of tax revenues are not considered.

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources found on and near CGS. The discussion is based on a review of recent historic and archaeological resource studies and other background information on Hanford and the region surrounding CGS. The National Environmental Policy Act (NEPA) Characterization Report and the Hanford Cultural Resources Management Plan describe in detail most of the cultural resources in the Hanford region, including CGS (Duncan, et al., 2007), (Gambhir, 2010b). Additional historic resource overviews are summarized in the Comprehensive Conservation Plan EIS for the Hanford Reach National Monument (USFWS, 2008). Regional context for the pre-contact and ethnohistoric Native American land use in the Columbia River Basin is available in the Handbook of North American Indians and the Hanford Cultural Resources Management Plan (Walker and Sprague, 1998). In addition, a records search was performed at the DOE Cultural and Historic Resources Program archives for the Hanford Site and the Washington State Department of Archaeology and Historic Preservation to obtain the most updated information about historic and archaeological resources in the region.

2.2.9.1 Cultural Background

Historic and archaeological resources at the Hanford Site are highly significant given the extensive number of archaeological sites that have been found along the Columbia River. These archaeological sites have helped define thousands of years of human occupation in the region, and the Hanford Site has served to protect these resources. Hydroelectric development, agricultural activities, and commercial and industrial development elsewhere in the Columbia River Basin have damaged, destroyed, or covered over many other archeological sites (Duncan, et al., 2007).

American Indian tribes with historical ties to the Hanford Site include four Federally recognized tribes—the Yakama Nation, the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Confederated Tribes of the Colville Reservation. Another American Indian tribe, the Wanapum, historically carried out most of their seasonal rounds on the Hanford Site. Today the Wanapum reside just upstream from the Hanford Site at Priest Rapids. Access and protection of these resources is an integral part of their cultural heritage and perpetuates their cultural practices, beliefs, and values (Duncan, et al., 2007), (USFWS, 2008).

There are 49 historic and archaeological sites listed on the National Register of Historic Places (NRHP) on the Hanford Site. Most of these sites are associated with the Native American cultural landscape and are part of six archaeological districts situated on the banks and islands of the Columbia River. None of the listed sites is on the CGS site. The Wooded Island Archaeological District is the closest archaeological district to CGS. This district is comprised of several archaeological sites connected with the location of a prehistoric and historic Wanapum fishing village (Fuller, 1974).

Over 30 other archaeological sites at Hanford, including one archaeological district and several places of traditional cultural value have also been determined to be eligible for listing on the NRHP. The Manhattan Project and Cold War Era Historic District on the Hanford Site, with over 500 buildings and structures as well as several archaeological sites, has been determined eligible for listing on the NRHP. The nearest NRHP-eligible property to CGS in this district consists of several buildings associated with the FFTF, the Midway Benton Line operated by the BPA, and the Hanford Site Plant Railroad operated and maintained by the DOE.

NRHP-eligible traditional cultural properties (TCPs) nearest to CGS include Gable Mountain/Gable Butte and *Laliik*. CGS can be seen from both TCPs. These TCPs are highly revered by the tribes and are considered to be sacred sites. Although Gable Mountain/Gable Butte is closer, *Laliik* is located 3,000 ft (914 m) on top of Rattlesnake Mountain and is visible from CGS (Gambhir, 2010b).

In addition, 47 of Hanford's historic and archaeological sites are listed on the State of Washington's Heritage Register. These sites are associated with the Native American cultural landscape and are located mostly along the Columbia River (Duncan, et al., 2007).

2.2.9.2 Native American History

Archaeological evidence suggests that Native American people existed in the Columbia Plateau for more than 10,000 years. The following major periods of presence and culture have been documented for the Columbia River Basin (Ames, et al., 1988), (Gambhir, 2010b):

- Period 1a/b (Paleo-Indian/Windhurst) (13,500–7000/6400 before present (BP))
- Period II (7000/6400–3900 BP
- Period III (3900 BP–1720 AD)
- Ethnohistoric Period (1720 AD–present)

<u>Period 1a/b (Paleo-Indian/Windhurst) (13,500–7000/6400 BP)</u>. The prehistory of the lower Columbia River Basin spans approximately 13,000 years. Archaeological evidence associated with the Clovis culture, which is represented by Period 1a, are rare throughout the Columbia Plateau region (Ames, et al., 1988), (Gambhir, 2010b). Period 1b is characterized by Paleo-Indian cultures that were highly mobile relying on a foraging subsistence strategy consisting mostly of large mammals supplemented by some fish and small mammals. Artifact assemblages from this time period include Clovis, Windhurst, and Cascade style projectile points, cobble tools, hammerstones, scrapers, and used lithic flakes (Ames, et al., 1988), (Gambhir, 2010b).

<u>Period II (7000/6400–3900 BP)</u>. During Period II, bands of people traveled throughout the region to exploit a wide range of seasonally or locally available food sources with increased

reliance on fish and exploitation of plants and roots (Ames, et al., 1988), (Gambhir, 2010b). Pithouses appear for the first time during this period around 5000 BP, suggesting evidence of a semi-sedentary lifestyle. Characteristic artifact assemblages include stemmed projectile points, leaf-shaped Cascade projectile points, milling stones, hammerstones, scrapers, core tools, and microblades (Ames, et al., 1988), (Gambhir, 2010b).

Period III (3900 BP–1720 AD). The most significant change during this time period is the prevalence of pithouses and the long-term storage of foods. Although bands of people were still highly mobile at this time, they adapted to a mostly riverine environment and began to rely increasingly on fish rather than game, but increased diversification with reliance also on plants and roots. Bermed pithouses and more specialized camps for hunting, root collection, and plant processing also appeared at this time. Inhabitants built more permanent winter villages along the river consisting of long, tule mat community lodges surrounded by family pithouses (USFWS, 2008). The longhouse was used for council meetings, religious ceremonies, dances, and funerals. Sweathouses also were constructed along streams and rivers and were used for physical and spiritual purification, socializing, and physical curing. Diagnostic artifacts from this period include projectile points that become smaller and more variable. Netweights are more prominent; the bow and arrow was introduced; and basketry, wood, and fiber appear in the archeological record (Ames, et al., 1988), (Gambhir, 2010b). The Columbia River provided an important fishery—particularly at Priest Rapids, Coyote Rapids, and Locke Island. Fishing techniques included spears, nets, traps, and weirs. This period ends with the appearance of the horse and Euro-Americans on the Plateau (Ames, et al., 1998).

Ethnohistoric Period (1720–1943 AD). The ethnohistoric period covers the period of time and the changes that occurred since the arrival of Euro-American settlers in the region. The arrival of Euro-American settlers brought fatal epidemic diseases serving to reduce Native American populations and, in some instances, eradicate whole groups (Walker and Sprague, 1998). Historically, the Wanapum people—from the village of Priest Rapids located upstream from the Hanford Site—conducted seasonal rounds of hunting and fishing throughout the Hanford Site and established several village sites along the Columbia River. Over 30 other Native American groups also lived and relied on resources in the Hanford area. These include the Columbia, Sanpoil, Southern Okanaogan, Umatilla, Yakama, Nespelem, Nez Perce, Palus, Cayuse, and the Colville to name a few (Gambhir, 2010b). These groups engaged in intermarriage, trade, resource-gathering, and ceremonial activities on the Hanford Site. The Wanapum continued to fish, camp, and winter on the Hanford Site until 1943.

Negotiations with the U.S. Government in 1855 resulted in three treaties with the Nez Perce Tribe, the CTUIR, and the Yakama Nation. Each tribe ceded large amounts of land to the U.S. Government but retained the right to continue traditional activities, including the right to fish, pasture horses and cattle, hunt, and gather traditional foods (Gambhir, 2010b). A Presidential Executive Order, passed in 1872, established The Confederated Tribes of the Colville Reservation (Gambhir, 2010b).

2.2.9.3 European American History

European Americans began to arrive in the Columbia River Basin in the early 1800s. This period overlaps with the ethnohistoric period associated with the Native American history and land use in the region.

Explorers, Trappers, Military Units, and Miners. European American presence in the Mid-Columbia region began when the Lewis and Clark Expedition passed through the area during its 1803–1806 exploration of the Louisiana Territory. David Thompson was the first

European explorer to cross the Hanford area, traveling through in 1811 as part of his exploration of the Columbia River. He was followed by fur trappers, military units, and miners who traveled through the Hanford Site on their way to lands up and down the Columbia River and across the Columbia River Basin (Duncan, et al., 2007).

Early Settlers and Farmers. During the 1860s, merchants began to set up stores, a freight depot, and the White Bluffs Ferry on the Hanford Reach of the Columbia River. Chinese miners worked the gravel bars for gold. Cattle ranches were built in the 1880s, followed by the establishment of farms over the next two decades. In the early 20th century, agricultural development, irrigation districts, and roads were established in the area, and several small towns—Hanford, White Bluffs, Richland, and Ringold—grew up along the riverbanks. Additional ferries became available at Richland, Hanford, Wahluke, and Vernita. In 1913, the Chicago, Milwaukee, St. Paul, and Pacific railroad branch line arrived from Beverly, Washington, providing access to outside markets. The towns, and nearly all other structures on the Hanford Site, were razed in 1943 when the U.S. Government acquired the land for the Manhattan Project (Duncan, et al., 2007).

The Manhattan Project and Cold War. The Manhattan Project was established during World War II to construct a secret plutonium production plant. Fuel elements were irradiated in up to nine reactors located along the Columbia River. The fuel was then processed and separated in the central part of the Hanford Site. Production activities at Hanford also included research and development, environmental monitoring, and waste management. The FFTF, constructed in the early 1970s, was used to test nuclear fuel types (Gambhir, 2010b).

Since 1990, DOE has focused its efforts on the environmental cleanup of radioactive and chemical waste from nuclear material production activities. Many of the buildings and structures associated with these activities have since been demolished and removed. Before demolition, historic building surveys were completed to record history and significant engineering attributes (DOE, 2002b). Over 500 buildings and structures were determined to be eligible for listing on the NRHP and are now considered part of the Hanford Site Manhattan Project and Cold War Era District (Gambhir, 2010b).

2.2.10 Historic and Archaeological Resources at the Columbia Generating Station Site

Although there are no known ethnohistoric references to the CGS site, archaeological site 45BN257, located along the Columbia River on CGS (suggesting Wanapum land use), shows ethnohistoric and pre-contact land use of the CGS site. In addition, the presence of several fishing stations and a village site (45BN113 and 45BN114 and Wooded Island Archaeological District) located near CGS confirms extensive and long-term, pre-historic and historic land use in the area.

According to a review of historic maps, very little historic development occurred on or near CGS from 1880–1943, with the exception of roads south of CGS, the Midway Benton transmission line, and the Hanford-Richland Railroad. Between 1943 and the construction of CGS in 1983, the powerline and railroad were both used to support Hanford Site operations (DOE, 2002b).

Several historic and archaeological resource surveys and investigations were carried out on CGS land leased from DOE from 1972–2005. This section will summarize each of the investigations and describe cultural resources located by these investigations.

Before the construction of CGS, several archaeological investigations and surveys were carried out from 1972–1978, resulting in a 100-percent surface survey of CGS leased lands. The surveys covered both WPPSS Nuclear Projects Nos. 1 and 4 (WNP-1/4) and CGS, previously referred to as WNP-2 (EN, 2010), (NRC, 1981), (Rice, 1983), (WPPSS, 1980). Archaeological materials were found along the river near the intake and pumphouse structures for WNP-1/4 and WNP-2. Observations at WNP-2 included a scattering of fire-cracked rock, a few lithic flakes, and one cobble tool. Observations at WNP-1/4 included cobble implements, fire-cracked rock, and a few lithic flakes. None of the material was formally recorded as an archaeological site at that time. Archaeological monitoring was recommended during construction of the intake and pumphouse structures. Archaeological monitoring at WNP-2 resulted in the additional discovery of fire-cracked rock, but no discrete archaeological features or substantive archaeological material was found. In addition, monitoring during the construction of WNP-2 intake and pumphouse structure ensured that effects on nearby fishing station archaeological sites (45BN113 and 45BN114), located outside of the leased boundary, were avoided (Rice, 1983). Archaeological materials during construction are stored in the DOE Hanford Site Cultural and Historical Resources Program curation and storage facility.

Archaeological monitoring during the construction of WNP-1/4 resulted in the recording of a multi-component site (45BN257) containing both pre-contact and historic era material. Surface investigations revealed a ceramic Chinese rice bowl fragment, assumed to be linked to Chinese placer mining in the 1860s (EN, 2010). During excavation for the makeup water intake pipes, archaeologists also discovered pre-contact materials consisting of a fire hearth, cobble tools, and stone flakes. Radiocarbon dating of a piece of sagebrush charcoal found with the materials suggested the location was a late pre-contact fishing camp dating to around 1600 AD (Rice, 1983). Additional surveys done before the construction of support facilities near the reactors found no archaeological material (Rice, 1983).

Construction of WNP-1/4 and WNP-2 resulted in significant disturbance to large portions of lands leased by Energy Northwest (Gambhir, 2010c). Since construction, from 1987–2008, several additional archaeological surveys were conducted of undisturbed areas within CGS. In 1987, a small survey partially overlapping the southern boundary of CGS leased lands was done for a proposed container test facility (Chatters and Hoover, 1988). One isolated find (45BN687), consisting of a prehistoric projectile point dating to 200–1200 AD, was found just south of the leased lands. In 1989, a short linear area on the southeast side of CGS leased lands was surveyed for a proposed project to upgrade the Hanford Site 400 area sewage treatment facility, resulting in no cultural resources findings (Cadoret and Chatters, 1989). In 1990, another linear archaeological survey was done through the southern portion of CGS leased lands for the installation of fiber optic lines between the then WPPSS (now Energy Northwest) headquarters in north Richland, Washington, and the WNP-2. Again, no significant cultural resources were located on CGS leased lands (Minthorn and Chatters, 1990). In 1998, no archaeological resources were found during surveys of two 150 ac (61 ha) undisturbed areas on lands leased for CGS Units 1 and 4 (Hale, 1998).

Several archaeological surveys were carried out near CGS for BPA-proposed transmission-line corridors originating at the Ashe Substation and spanning to the east, west, and north (Rice, 1983), (WPPSS, 1980). The surveys found no significant cultural resources located close to CGS (Gambhir, 2010b), (Jackson and Hartmann, 1977), (Smith, et al., 1977), (WPPSS, 1980).

In 1999, an archaeological survey was carried out through the eastern edge of CGS along the Columbia River inland approximately 2,300 ft (700 m) (Hale, 1999). Four isolated finds, consisting of two historic cans (HI-99-039 and HT-99-041) and two prehistoric artifacts consisting of a lithic core and an anvil stone (45BN706 and 45BN700), were recorded. Two sites of questionable age and function were also found, including industrial debris of indeterminate age associated with a bulldozed mound (45BN689) and a small pile of cobbles also of indeterminate age (45BN688). Archaeological site 45BN257 was also revisited during this survey. However, the original site surveyed in 1983 could not be located, possibly because of the construction of the intake structure. Nevertheless, two lithic flakes were recorded and added to the site description. With the exception of archaeological site HI-99-039, all of the finds were recorded within 300 m of the river corridor. The two new prehistoric isolates could be part of 45BN257 given their proximity.

No cultural resources were found during a 2002 survey done for the installation security barriers around CGS (Prendergast-Kennedy, 2002). Also in 2002, a survey done by the CTUIR of the eastern 1.2 mi (2 km) of CGS located four historic isolated finds (three cans and one glass fragment) (HI-2002-021–HI-2002-024) along the powerline road (Steinmetz, 2005). No cultural resources were located during two more surveys that crossed over onto CGS along the Midway-Benton transmission and the 1.8 mi long transmission line that supplies offsite power to CGS in 2003 and 2005 (Prendergast-Kennedy, 2003), (Prendergast-Kennedy, 2005). A reconnaissance field inspection in 2008, along the main CGS access ROW as part of a road-widening project, found no archaeological resources (Prendergast-Kennedy, 2008).

During 2008, Energy Northwest needed to upgrade its communication facility on Rattlesnake Mountain, which is located on lands Energy Northwest leases from DOE. As part of this action, DOE did a National Historic Preservation Act Section 106 cultural resources review and concluded that the upgrades and ongoing maintenance and operations would result in an adverse effect to *Laliik*, a National Register-eligible TCP (DOE, 2009). A Memorandum of Agreement was developed, and is currently in place, that resolves these adverse effects (DOE, 2009).

In summary, six historic and two prehistoric isolated archaeological finds have been recorded on CGS land. Three archaeological sites, consisting of two historic sites of undetermined affiliation or age and one multi-component site, have been recorded. Although the integrity and significance of these resources have not been determined, it is evident that a cultural sensitivity zone exists along the Columbia River shore. Two National Register-eligible Manhattan Project and Cold War Era Historic District properties traverse CGS (the Hanford Site Plant Railroad and the Midway Benton transmission line operated by the BPA). CGS is also within view of two National Register-eligible TCPs. With the exception of three historic isolated finds (HI-2002-021, HI-2002-022, and HI-2002-023), all cultural resources are located within the area of potential effect (APE) for CGS.

2.2.10.1 Consultation

In March 2010, the NRC initiated consultations on the proposed action by writing to the Advisory Council on Historic Preservation (ACHP) and the State Historic Preservation Office (SHPO). Also in March 2010, the NRC initiated consultation with three of the potentially affected Federally recognized tribes—the CTUIR, Yakama Nation, and the Nez Perce (see Appendix D for copies of these letters). The NRC supplied information about the proposed action, the definition of APE, and noted that the NHPA review would be integrated with the NEPA process, according to 36 CFR 800.8. The NRC invited the potentially affected tribes to participate in the identification of historic properties, the discussion of cultural concerns, and the scoping process. The NRC held a meeting with the tribes on April 27, 2010, to explain the license renewal process and to listen to any expressions of concern with the proposed action. Representatives from two Federally recognized tribes (Yakama Nation and the CTUIR) and one non-Federally recognized tribe (Wanapum) attended this meeting. The SHPO and the CTUIR provided comments on the draft SEIS in September and November 2011. These letters are included in Appendix D. An overview of consultation activities that occurred during the preparation of the SEIS with the SHPO and tribes is given in Section 4.9.6. The consultation process is complete. The NRC responded to the CTUIR by letter dated January 31, 2012 (NRC, 2012).

2.2.11 Geologic Environment

This section describes the current geologic environment of the CGS site and vicinity including landforms, geology, soils, and seismic conditions.

Physiography. CGS is situated in the Pasco Basin, a structural and topographic depression within the Columbia Plateau physiographic province (EN, 2005). The topography of the site is relatively flat and of low relief. The land surface reflects the accumulation of sediment within the basin and the effects of Pleistocene cataclysmic flooding between 15,000 and 1.8 million years ago and more recent eolian activity. Elevations across the plant site range from about 350 ft (107 m) above MSL at the Columbia River to about 460 ft (140 m) above MSL on the hills southwest of the plant in the vicinity of the Plant Support Facility. The finished ground elevation in the vicinity of the power block is approximately 441 ft (134 m) (EN, 2010).

Geology. The plant is sited on a shallow erosional channel incised into a relatively flat alluvial plain underlain by Pleistocene flood deposits of the Hanford formation. These glaciofluvial sands and gravels are approximately 45–50 ft (14–15 m) thick and are underlain by a thick (approximately 480 ft (146 m) thick) sequence of dense silt, sand, and gravel conglomerate of the Miocene-Pliocene age Ringold Formation (EN, 2010). Bedrock beneath the site consists of Miocene age basalt of the Columbia River Basalt Group, at a depth of approximately 168 m (550 ft) (EN, 2005). The flood basalts erupted between about 6 and 17 million years ago and are interbedded in places with sedimentary rocks of the Ellensburg Formation (EN, 2005), (Duncan, et al., 2007). CGS is founded on the Ringold Formation, which is further described in Section 2.1.7.1.

All safety-related site structures are founded on structural backfill. No subsurface geologic structures, including geologic faults, have been identified that might pose a hazard to plant facilities. No geologic faults were encountered in excavations during plant construction, and no active or capable faults are known to occur within 5 mi (8 km) of the CGS site (EN, 2005).

Soils. A total of 15 different soil types have been categorized for the Hanford Site, varying from sand to silty and sandy loam. Note that while these soil classifications have not been updated to reflect current reinterpretations of soil classifications, they are useful in providing a generalized description of the soils. The predominant soil type in the vicinity of CGS is Rupert Sand, described as brown to grayish-brown coarse sand grading to dark grayish-brown at a depth of 90 cm (35 in.). This soil developed under grass, sagebrush, and hopsage in coarse sandy alluvial deposits that were mantled by wind-blown sand and formed hummocky terraces and dune-like ridges (Duncan, et al., 2007).

Seismology. The recent (since 1973) seismicity of the region is characterized by occasional minor (magnitude 4.3 or weaker) earthquake activity. Most seismic activity is situated near the eastern margin of the Cascade Range, west of Yakima, Washington (60+mi (100 km) west of the site); two events in the area near Walla Walla, Washington (59 mi (95 km) east of the site—magnitude 4.1 and 4.3); and one event near the Saddle Mountains (32 mi (52 km) north of the site—magnitude 4.1) (USGS, 2011a). A total of 118 small earthquakes (ranging in magnitude from 2.5–4.3) have been recorded within a radius of 62 mi (100 km) of the CGS location. The largest was the magnitude 4.3 event near Walla Walla in 1991, centered 58 mi (94 km) east-southeast of the site. The closest events were from a cluster or "earthquake swarm" of about 20 recurring events, mostly in February–May 2009. The largest events in this cluster area included two magnitude 3.3 events and one magnitude 3.0 event that were located approximately 4–6 mi (7–9 km) south-southeast of the site at shallow depths (0–1.2 mi (0–2 km)) (USGS, 2011a).

However, larger, more distant earthquakes have affected the plant region in the past. Most notably, the Lake Chelan (formerly named North Cascades) earthquake of 1872 was centered about 108 mi (174 km) to the north-northwest of the CGS site (USGS, 2011b), (USGS, 2011c). This event produced Modified Mercalli Intensity (MMI) VIII–IX shaking at its epicenter and is estimated to have produced MMI VI shaking near the CGS site (USGS, 2011b). Its estimated magnitude was 6.8–7.0 (USGS 2011b), (USGS, 2011c).

The 1936 Milton-Freewater earthquake occurred 64 mi (103 km) east-southeast of the CGS site and had an estimated magnitude of 5.7 (USGS, 2011c), (Duncan, et al., 2007). An epicenter intensity MMI VII event was established as the maximum earthquake for CGS. An earthquake with an MMI VII epicenter intensity would be expected to cause slight damage to well-built ordinary structures and negligible damage to buildings of good design and construction (USGS, 2011d). The horizontal peak ground acceleration associated with this maximum earthquake potential is 0.18–0.34 g (i.e., acceleration relative to that of Earth's gravity, "g") (USGS, 2011e). The CGS final safety analysis report (FSAR) (EN, 2005) documents the use of a safe shutdown earthquake of 0.25 g for the plant based on a combination of deterministic and probabilistic assessments.

NRC staff compared current peak ground acceleration data from the USGS National Seismic Hazard Mapping Project to the safe shutdown earthquake. The peak ground acceleration value cited is based on a 2 percent probability of exceedance in 50 years. This corresponds to an annual frequency (chance) of occurrence of about 1 in 2,500 or 4×10^{-4} per year. For CGS, the calculated peak ground acceleration is approximately 0.17 g (USGS, 2011f).

2.3 Related Federal and State Activities

The staff reviewed the possibility that activities of other Federal agencies might affect the renewal of the operating license for CGS. Any such activity could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency in the preparation of the CGS SEIS. However, no Federal agency has expressed the desire to become a cooperating agency in the preparation of the SEIS.

Given that CGS is located on DOE's Hanford Site, any significant long-term projects in the vicinity of CGS will likely have some Federal sponsorship. In addition, there are American Indian lands within 50 mi of CGS. The Yakama Indian Nation reservation is located approximately 40 mi west of the CGS site. Other Federal lands, facilities, national wildlife refuges, wilderness, and reclamation land within 50 mi of CGS are listed below:

- U.S. Department of Defense land
  - Boardman Naval Bombing Range
  - Desert Survival Training Site
  - McChord Training Annex
  - Yakima Training Center
- U.S. Department of Energy land

  - Hanford Site
- U.S. Department of the Interior, Bureau of Indian Affairs land
  - Yakama Indian Reservation
- U.S. Department of the Interior, Bureau of Land Management land
  - Juniper Dunes Wilderness
- U.S. Department of the Interior, Bureau of Reclamation land
  - Potholes Reservoir
- U.S. Fish and Wildlife Service land
  - Cold Springs National Wildlife Refuge
  - Columbia National Wildlife Refuge
  - Hanford Reach National Monument
  - McNary National Wildlife Refuge
  - Saddle Mountain National Wildlife Refuge
  - Toppenish National Wildlife Refuge
  - Umatilla National Wildlife Refuge

The NRC is required, under Section 102(2)(c) of NEPA, to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. The NRC has consulted with the USFWS and the NMFS. Federal Agency consultation correspondence is presented in Appendix D.

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

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

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

Table 3-1. Category 1 issues for refurbishment evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B	GEIS sections
Surface water quality, hydrology, and use (for all plants)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
Aquatic ecology (for all plants)	
Refurbishment	3.5
Groundwater use and quality	
Impacts of refurbishment on groundwater use and quality	3.4.2
Land use	
Onsite land use	3.2
Human health	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	3.7.4; 3.7.4.3; 3.7.4.4; 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Environmental issues related to refurbishment considered in NUREG-1437, “Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants,” Volumes 1 and 2 (NRC 1996) that are inconclusive for all plants, or for specific classes of plants, are Category 2 issues. Table 3-2 lists these issues.

Table 3-2. Category 2 issues for refurbishment evaluation

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

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

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

The results of the evaluation of systems, structures, and components for CGS, as required by 10 CFR 54.21, do not currently note the need to undertake any major refurbishment or replacement actions associated with license renewal to support the continued operation of CGS beyond the end of the existing operating license.

3.1 References

U.S. Code of Federal Regulations (CFR), “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” Part 51, Chapter 1, Title 10, “Energy.”

CFR, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants,” Part 54, Chapter 1, Title 10, “Energy.”

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

NRC, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” NUREG-1437, Office of Nuclear Reactor Regulation, Washington, D.C., Volume 1, Addendum 1, 1999, ADAMS Accession No. ML040690720.

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

This chapter addresses potential environmental impacts related to the period of extended operation of Columbia Generating Station (CGS). These impacts are grouped and presented according to resource. Generic issues (Category 1) rely on the analysis given in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, prepared by the U.S. Nuclear Regulatory Commission (NRC) and are discussed briefly (NRC, 1996), (NRC, 1999). Site-specific issues (Category 2) have been analyzed for CGS and assigned a significance level of SMALL, MODERATE, or LARGE, accordingly. Some issues are not applicable to CGS because of site characteristics or plant features. For an explanation of the criteria for Category 1 and Category 2 issues, as well as the definitions of SMALL, MODERATE, and LARGE, refer to Section 1.4.

4.1 Land Use

Section 2.2.1 of this supplemental environmental impact statement (SEIS) describes the land use around CGS.

Table 4.1-1, "Land Use Issues" lists Category 1 issues (from Title 10 Part 51 of the *Code of Federal Regulations* (CFR), Subpart A, Appendix B, Table B-1), which are applicable to onsite land use and powerline right-of-way (ROW) impacts during the renewal term. As stated in the GEIS, the impacts associated with the Category 1 issues were determined to be SMALL, and plant-specific mitigation measures would not be sufficiently beneficial to be warranted.

Table 4.1-1. Land use issues

Issues	GEIS section	Category
Onsite land use	4.5.3	1
Powerline ROW	4.5.3	1

The NRC staff (staff) reviewed and evaluated the Energy Northwest Environmental Report (ER) (EN, 2010a), scoping comments, other available information, and visited CGS in search of new and significant information that would change the conclusions presented in the GEIS. No new and significant information was found during this review and evaluation. Therefore, it is expected that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS.

4.2 Air Quality

Section 2.2.2 of this SEIS describes the meteorology and air quality in the vicinity of the CGS site. Title 10 CFR Part 51, Subpart A, Appendix B, Table B-1 summarizes findings on NEPA issues for license renewal of nuclear power plants. One Category 1 air quality issue is applicable to CGS—air quality effects of transmission lines (Table 4.2-1). No Category 2 issues apply for air quality because there is no planned refurbishment associated with license renewal. The staff did not find any new and significant information during the review of Energy Northwest's ER, the site visit, or during the scoping process. No major facility construction or refurbishment is planned to occur during the license renewal period. Therefore, there are no impacts related to this issue beyond those discussed in the GEIS. For these issues, the staff concludes in the GEIS that the impacts are SMALL.

Table 4.2-1. Air quality issues

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

4.3 Groundwater

The Category 1 groundwater issues applicable to CGS are listed in Table 4.3-1 and discussed below. An overview of groundwater use and quality at the CGS site is provided in Sections 2.1.7 and 2.2.3.

Table 4.3-1. Groundwater use and quality issues

Issue	GEIS section	Category
Impacts of refurbishment on groundwater use & quality	3.4.2	1
Groundwater quality degradation (saltwater intrusion)	4.8.2	1

4.3.1 Generic Groundwater Issues

The staff did not find any new and significant information about Category 1 or generic groundwater issues during the review of the ER, the site visit, or the scoping process. Therefore, no impacts are related to these issues beyond those discussed in the GEIS. For these issues, the staff concludes that the impacts are SMALL, and additional site-specific mitigation measures are not warranted.

4.3.2 Groundwater Use Conflicts

Groundwater onsite at CGS is pumped at a rate of 200 gallons per minute (gpm) from a single well quarterly for about one-half hour (2 hours total per year) (EN, 2010a) for an annual average of less than 0.05 gpm. An occasional supply of groundwater for the CGS potable water system is also provided from a crosstie with two offsite wells supporting the industrial development complex (IDC). Typically, the crosstie is open less than 50 hours per year, and, although the water is not metered, the estimated annual average usage rate is estimated to be about 1 gpm (EN, 2010a).

Because the annual average withdrawal rate from these sources is much less than 100 gpm, no Category 2 groundwater use issues were noted for the CGS license renewal term (NRC, 1996), (NRC, 1999).

4.3.3 Groundwater Quality

Groundwater monitoring has not found any gamma-emitting radionuclides of interest (EN, 2009a). Elevated concentrations of tritium have been observed in groundwater adjacent to the CGS site. However, the highest concentrations, up to 17,400 pCi/L, have been found in an upgradient well, MW-5, and have been attributed to Department of Energy (DOE) Hanford Site operations (EN, 2009a), (EN, 2010a). Elevated conductivity and concentrations of chloride and sulfate have also been detected adjacent to the CGS site and have been attributed to the infiltration of circulating cooling water that entered the soil through drywells (EN, 2002), (EN, 2010a). However, these elevated concentrations have not affected the groundwater used for drinking water; thus, groundwater quality impacts are SMALL, and additional site-specific mitigation measures are not warranted.

4.4 Surface Water

The Category 1 surface water quality issues applicable to CGS are listed in Table 4.4-1 and are discussed below. An overview of surface water use and quality at the CGS site is provided in Sections 2.1.7 and 2.2.4. None of the Category 2 surface water issues set forth in the GEIS apply to CGS.

Table 4.4-1. Surface water quality issues

Issues	GEIS Section	Category
Impacts of refurbishment on surface water quality	3.4.1	1
Impacts of refurbishment on surface water use	3.4.1	1
Altered current patterns at intake & discharge structures	4.2.1.2.1	1
Altered salinity gradients	4.2.1.2.2	1
Temperature effects on sediment transport capacity	4.2.1.2.3	1
Scouring caused by discharged cooling water	4.2.1.2.3	1
Eutrophication	4.2.1.2.3	1
Discharge of chlorine or other biocides	4.2.1.2.4	1
Discharge of other metals in wastewater	4.2.1.2.4	1

4.4.1 Generic Surface-Water Issues

CGS has a closed-cycle heat-dissipation system that uses mechanical draft cooling towers with makeup water pumped from a large river—the Columbia River (with an average mean annual flow rate greater than the threshold of 3.15×10^{12} cubic feet (ft^3) per year (100,000 cubic feet per second (cfs)) (10 CFR 51.53(c)(3)(ii)(A)). The staff did not find any new and significant information with respect to the Category 1 issues below during the review of the ER, the site visit, or the scoping process. In addition, the staff did not find any Category 2 issues related to surface-water issues in the GEIS. Therefore, no impacts are related to these issues beyond those discussed in the GEIS. For these issues, the staff concludes that the impacts are SMALL, and additional site-specific mitigation measures are not warranted.

4.4.2 Surface-Water Use Conflicts

CGS has a closed-cycle heat-dissipation system that uses mechanical draft cooling towers with makeup water pumped from the Columbia River (see Section 2.1.7). As noted in Section 2.2.4, the Columbia River at the CGS site has an average mean annual flow rate greater than the threshold of 3.15×10^{12} ft^3/year (100,000 cfs) (10 CFR 51.53(c)(3)(ii)(A)). Therefore, this issue does not apply to CGS, and no further analysis is required. No Category 2 surface-water issues were noted for the CGS license renewal term.

4.5 Aquatic Resources

Section 2.1.6 of this SEIS describes the CGS cooling-water system; Section 2.2.5 describes the aquatic resources. Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to the operation of the CGS cooling-water system during the renewal term are listed in Table 4.5-1. These issues are considered generic (Category 1) for facilities with cooling-tower-based heat-dissipation systems.

Table 4.5-1. Aquatic resources issues

Issues	GEIS section	Category
For all plants		
Accumulation of contaminants in sediments or biota	4.1.1.2.4	1
Entrainment of phytoplankton & zooplankton	4.2.2.1.1	1
Cold shock	4.2.2.1.5	1
Thermal plume barrier to migrating fish	4.2.2.1.6	1
Distribution of aquatic organisms	4.2.2.1.6	1
Premature emergence of aquatic insects	4.2.2.1.7	1
Gas supersaturation (gas bubble disease)	4.2.2.1.8	1
Low dissolved oxygen in the discharge	4.2.2.1.9	1
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10	1
Stimulation of nuisance organisms	4.2.2.1.11	1
For plants with cooling tower-based heat-dissipation systems		
Entrainment of fish & shellfish in early life stages	4.3.3	1
Impingement of fish & shellfish	4.3.3	1
Heat shock	4.3.3	1

4.5.1 Generic Aquatic Ecology Issues

The generic (Category 1) issues related to aquatic resources applicable to CGS are discussed below and listed in Table 4.5-1. There are no site-specific (Category 2) issues related to aquatic resources for CGS. The staff did not find any new and significant information during the review of the Energy Northwest ER (EN, 2010a), the site visit, the scoping process, or the evaluation of other available information. However, the staff does note that the GEIS (NRC 1996) states the following:

> However, even low rates of entrainment and impingement at a closed-cycle cooling system can be a concern when an unusually important resource is affected. Such aquatic resources would include threatened or endangered species or anadromous fish that are undergoing restoration. For example, concern about potential impacts of the Washington Nuclear Project (WNP-2) on Chinook salmon has been raised by the Washington Department of Fisheries (Cynthia A. Wilson, Washington Department of Fisheries, letter to G.F. Cada, ORNL, Oak Ridge, Tennessee, July 5, 1990). Although entrainment, impingement, and thermal discharges are not believed to be a problem at WNP-2, the importance of the Columbia River salmon stocks are such that the resource agency feels that monitoring should continue.

As a result, further examination of the normally generic impacts of entrainment, impingement, and heat shock (thermal plume barriers) from the operation of CGS are considered for anadromous fish in the Columbia River.

4.5.2 Entrainment

Entrainment occurs when small aquatic organisms are carried into the intake system and through the cooling system, and it primarily affects organisms with limited swimming ability that can pass through the screens on the intake system. As described in Section 2.1.6, the CGS intake system is a perforated pipe with an outside sleeve that has 3/8-inch (in.) (9.5-millimeter (mm))-diameter holes and an inside sleeve that has 3/4-in. (19-mm)-diameter holes (Figure 2-5) (EN, 2010a). Organisms typically entrained by intake systems include phytoplankton, zooplankton, and the eggs, larvae, and juvenile forms of many of the fish and invertebrates. As entrained organisms pass through the intake, they may be injured by abrasion or compression. Once entrained, organisms pass through the makeup-water pumps and are carried with the water flow to the mechanical draft cooling towers. Within the cooling system, they encounter physical and chemical stressors that likely lead to 100-percent mortality (WPPSS, 1982).

In the GEIS (NRC, 1996), the NRC reviewed entrainment for once-through cooling systems for nuclear facilities and determined that the relatively small volumes of makeup water needed for those facilities result in low entrainment effects. However, the effect of the withdrawal of Columbia River water by CGS should be considered separately for the anadromous fish species in the area. The anadromous fish that might spawn near the site include American shad (*Alosa sapidissima*), upper Columbia River fall-run Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka*), and Pacific lamprey (*Lampetra tridentata*). Entrainment could affect these species directly (capturing eggs or juveniles) or indirectly (removing their food source) (WPPSS, 1982).

Entrainment studies were done in 1979–1980 and 1985, and no fish, fish eggs, or larvae were collected during the studies. In 1985, during the entrainment studies, beach seine samples collected juvenile Chinook salmon (averaging 43 mm in length), confirming their presence in the area (EN, 2010a), (WPPSS, 1986). As discussed in Chapter 2, the fall-run Chinook salmon and steelhead redds are upstream of the intake system (Figure 2-3). The location of the intake screens is in the deepest part of the channel, and the river bottom varies around the intake structure from exposed Ringold conglomerate to boulders, cobble, gravel, and sand (WPPSS, 1987). The type of substrate in this area is not ideal spawning habitat for the fall-run Chinook salmon or for the steelhead (Dauble, 2009).

Most fish species in the Hanford Reach of the Columbia River are dependent on food sources that are attached to the substrate (e.g., periphyton) rather than food in the water column (e.g., phytoplankton and zooplankton) (Dauble, 2009). The phytoplankton and zooplankton populations are sparser in the Hanford Reach of the Columbia River than in the reservoirs because of the river's high flow rate. The Washington Public Power Supply System (WPPSS) estimated that the maximum river water withdrawal through the intake structures is less than 0.15 percent of the river volume at the lowest regulated flow in the river of 36,000 cfs (WPPSS, 1982). Periodically, the CGS staff has examined the intake screens and has not observed growth of periphyton or other debris that could attract anadromous fish (EN, 2010a), (WPPSS, 1987).

The staff concludes that past entrainment studies support the overall conclusions of the staff in the GEIS that entrainment is minimal at facilities with closed-cycle cooling systems and will neither destabilize nor noticeably alter the population of anadromous fish including their early life stages. The staff concludes that the level of impact from the cooling-water intake system from entrainment on anadromous fish in early life stages is SMALL.

4.5.3 Impingement

Impingement occurs when organisms are trapped against cooling-water intake screens by the force of moving water. Impingement can kill organisms immediately or contribute to a slower death resulting from exhaustion, suffocation, or injury. The amount of time an organism is impinged, its susceptibility to injury, and the physical characteristics of the intake screen are factors that can lead to injury or death. Section 2.1.6 described the intake screens for the CGS plant.

In the GEIS (NRC, 1996), the NRC reviewed impingement for once-through cooling systems for nuclear facilities and determined that the relatively small volumes of makeup water needed for those facilities result in low entrainment effects. However, the effect of the withdrawal of Columbia River water by CGS should be considered separately for the anadromous fish species in the area.

The CGS intake screens in the Columbia River consist of perforated pipes on supports over the river substrate. The intake system is small in comparison to the width of the river. The area of the 2 intake screens and the support system is approximately 30 feet (ft) by 46 ft (9.1 meters (m) by 14 m), and the width of the river is approximately 1,200 ft (370 m) at a river elevation of 345 ft (105 m) (WPPSS, 1987). The inlet velocities are within acceptable limits for best available technology for minimizing impacts (69 FR 41576). The velocity through the external screen openings is approximately 0.5 feet per second (fps) under normal operating conditions where 12,500 gpm is removed through both intake structures. The approach velocity to the intake screens under the same conditions is less than 0.2 fps (WPPSS, 1980). This compares to river velocities measured near the perforated pipes ranging from 4–5 fps (1.2–1.5 m/s (meters per second)) (WPPSS, 1986). Impingement of aquatic organisms is unlikely because the velocity of the water across the face of the intake system is several times faster than the intake velocity (WPPSS, 1982). Studies conducted in 1978, 1979, and 1985 looked for—but did not find—any fish or debris impinged on the screens (EN, 2010a), (WPPSS, 1986). However, the 1985 study did find that fish were using the intake support system for cover and resting, including large scale suckers (*Catostomus macrocheilus*), mountain whitefish (*Prosopium williamsoni*), sculpins (*Cottus* spp.), Northern pikeminnow (*Ptychocheilus oregonensis*), bass (*Micropterus* spp.), redside shiner (*Richardsonius balteatus*), and American shad (*Alosa sapidissima*) (WPPSS, 1986). During one of the observation periods for impingement in 1985, samples of juvenile Chinook were collected, showing that anadromous species were in the area of the intake screens but were not being affected by the water withdrawal (WPPSS, 1986).

The staff concludes that past impingement studies and the design and operation of the intake screen supports the overall conclusions of the staff in the GEIS that impingement is minimal at facilities with closed-cycle cooling systems and will neither destabilize or noticeably alter the population of anadromous fish. The staff concludes that the level of impact from the cooling-water intake system from impingement on anadromous fish is SMALL.

4.5.4 Heat Shock

Thermal discharges can kill or harm fish and aquatic organisms that migrate or pass through the blowdown at operating nuclear facilities. The CGS has a closed-cycle cooling system that uses mechanical draft cooling towers with blowdown discharged to the Columbia River. The GEIS assessed the effect of heated water from the blowdown at closed-cycle cooling systems on aquatic resources and determined that heat shock has not been found to be a problem with this type of cooling system. However, the temperature of the Columbia River water discharged from CGS should be considered separately for the anadromous fish in the area.

The anadromous fish resources in the Columbia River are influenced directly or indirectly by water temperature changes. A review of tolerance and thermal requirements of aquatic species found near the CGS site showed that salmonids are the species most sensitive to, and directly affected by, thermal discharges (WPPSS, 1982).

Studies in 1985 evaluated the thermal plume in summer and winter months at above normal operating conditions for the CGS (EN, 2010a). These studies reported that the water temperature was not elevated at distances beyond 10 ft (3 m) from the discharge structure and was imperceptible at the surface of the river in the summer. In the winter months, the maximum plume length detected had a temperature rise of 0.7 degrees Fahrenheit (F) (0.4 degrees Celsius (C)) at 500 ft (152 m), and a temperature rise of 0.2 degrees F (0.1 degrees C) isotherm was approximately 40 ft (12 m) wide. The width of the river is about 1,200 ft (370 m) wide near the blowdown discharge; thus, the size of the plume would not likely block fish passage through the area. While the plant discharge created a long, narrow, low incremental thermal plume, the increase in temperature did not exceed Washington State regulations and the limits of the CGS NPDES permit (EN, 2010a), (WPPSS, 1986).

The staff considered the possible effects of temperature on salmonid species in the Hanford Reach and determined that the relatively small plume that could occur in the winter months would likely have a minimal effect on the fish species. No major facility construction or refurbishments are planned to occur during the license renewal period. Therefore, the staff concludes that the overall conclusions of the staff in the GEIS that heat shock from facilities with closed-cycle cooling systems will neither destabilize or noticeably alter the population of anadromous fish including their early life stages. Therefore, the staff concludes that the impacts from heat shock on anadromous fish is SMALL.

4.5.5 Total Impacts on Aquatic Resources

Closed-cycle cooling systems generally have minor effects resulting from entrainment, impingement, and heat shock on aquatic resources. The staff evaluated the ER and past studies of entrainment and impingement at the CGS site specifically for anadromous fish, as recommended by the GEIS (NRC, 1996), and it determined the intake structure design and operation had minimal impact on these aquatic resources in the Hanford Reach of the Columbia River. In addition, thermal plumes from the blowdown discharge in the river are likely to have minimal impact on aquatic organisms (e.g., heat shock). The staff concludes that the impacts from entrainment, impingement, and heat shock on anadromous fish would be SMALL from the continued operation of CGS.

4.6 Terrestrial Resources

The issues related to terrestrial resources applicable to CGS site are discussed below and listed in Table 4.6-1. There are no Category 2 issues related to terrestrial resources for license renewal. The staff did not find any new and significant information during the review of the ER (EN, 2010a), the site visit, the scoping process, or the evaluation of other available information. Therefore, the staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS (NRC, 1996). The GEIS concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to carry out.

Table 4.6-1. Terrestrial resources issues

Section 2.2.6 of this SEIS provides a description of the terrestrial resources at CGS and in the surrounding area.

Issues	GEIS section	Category
Powerline ROW management (cutting, herbicide application)	4.5.6.1	1
Bird collisions with powerlines	4.5.6.1	1
Impacts of electromagnetic fields on flora & fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3	1
Floodplains & wetlands on powerline ROW	4.5.7	1

4.7 Special Status Species and Habitats

The impact to threatened or endangered species is a Category 2 issue. It requires consultation with the appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of CGS during the license renewal term. Section 2.2.7 describes the characteristics of threatened or endangered species and critical habitats near CGS. The staff concluded informal consultation under section 7 of the Endangered Species Act of 1973, as amended (ESA), with the U.S. Fish and Wildlife Service (USFWS) in October 2011. Informal section 7 consultation with the National Marine Fisheries Service (NMFS) is still ongoing to evaluate the potential impacts on Federally listed aquatic species and critical habitats near CGS under the NMFS's jurisdiction.

Table 4.7-1. Threatened or endangered species

Issues	GEIS section	Category
Threatened or endangered species	4.1	2

4.7.1 Aquatic Species

Section 2.2.7 of this SEIS describes the Federally listed, threatened, or endangered species and critical habitats on or near the CGS site. The species include the threatened bull trout, the endangered upper Columbia River steelhead, and the threatened upper Columbia River spring-run Chinook salmon (Suzumoto, 2010), (USFWS, 2010). In addition, the Columbia River near the CGS site is essential fish habitat (EFH) for upper Columbia River Chinook salmon (spring-, summer-, and fall-runs) and coho salmon. Critical habitat for the threatened bull trout includes the entire Columbia River Basin (75 FR 2270). The USFWS published, in its recent ruling on bull trout, that the mainstem of the Columbia River is more important for providing foraging, migration, and overwintering habitat than was previously understood. Bull trout have only rarely been found in the Hanford Reach of the Columbia River (Gray and Dauble, 1977). Observations of the bull trout have usually been in association with the spring freshet (Duncan, et al., 2007), leading some scientists to believe that the species is transient near the CGS site (Dauble, 2009), (Poston, et al., 2009).

As mentioned in Section 4.5, the design and operation of the intake and discharge structures for the CGS in the Columbia River will likely have minimal effects on adult fish (e.g., transient bull trout and their food sources (small fish)). Entrainment studies done in 1979–1980 and 1985 did not collect any life stage of fish (EN, 2010a), (WPPSS, 1986). Impingement studies done over the same period did not observe any fish impinged on the intake screens (EN, 2010a), (WPPSS, 1986). Juvenile bull trout consume aquatic insects (Dauble, 2009). The operation of the intake structure would remove from the river any aquatic insect in life stages that are up in the water column and are the food source for the insects and small fish (e.g., phytoplankton and zooplankton). However, the fraction of the river flow withdrawn from the plant (0.03–0.05 percent of the annual discharge of the river) is small. Thus, withdrawals by the intake system will not significantly reduce the amount of food available to the juvenile bull trout. The thermal effluent from the blowdown discharge during the spring is a long, narrow plume, approximately 1 percent of the width of the river, and likely will not affect the migration or foraging of the bull trout (WPPSS, 1986).

The endangered upper Columbia River spring-run Chinook salmon and threatened upper Columbia River steelhead are found near the intake and discharge systems for the CGS and were evaluated to determine if they have the potential to be adversely affected by continued operation of the CGS plant during the renewal period. Critical habitat for the spring Chinook is located upstream of the CGS site. Previously, steelhead redds were observed near the intake structure.

Upper Columbia River spring Chinook salmon do not spawn in the Hanford Reach. The adults start returning from the ocean in early spring and then pass through the Hanford Reach while migrating to upstream spawning grounds in the Wenatchee, Entiat, Methow, and Okanogan river basins (NMFS, 2007). As discussed in Section 2.2.7, the adult Chinook do not eat while ascending the river. The juveniles use the Hanford Reach as a nursery area while they migrate downstream toward the ocean (Duncan, et al., 2007), foraging on aquatic insects (Dauble, 2009). The movement of a juvenile through the Hanford Reach lasts no more than one week; outmigration of the juvenile spring Chinook extends from April to the end of August (DOE, 2000). The design and operation of the intake and discharge structures are likely to have a similar effect on the juvenile and adult spring Chinook as discussed for the bull trout.

Upper Columbia River steelhead have been observed spawning in the Hanford Reach and near the intake and discharge structures for the CGS plant in the past. The most recent confirmed observations of active steelhead redds were in 2003, below the CGS intake. From 2006–2008, the aerial surveys did not find any evidence of steelhead spawning near the CGS intake and discharge structure or in the Hanford Reach (Hanf, et al., 2007), (Poston, et al., 2008), (Poston, et al., 2009).

The concern for the steelhead near the intake and discharge structures is the possible entrainment of eggs and larval steelhead from the upstream redds. Adults and juveniles can avoid the influence of the intake and discharge structures during operation activities. Juvenile steelhead migrate through the Hanford Reach in the deepest part of the river and stay near the river bottom (Dauble, 2009). Eggs that do not settle in the redds prepared by the adults are often consumed by other fish waiting downstream during spawning. Considering the distance upstream of previously observed redds, it is unlikely that steelhead eggs would travel to the intake structure and be removed from the environment.

As steelhead fry emerge from the river substrate and start to feed, they are about 1 in. (2.5 centimeters (cm)) long and vulnerable to predation, so they seek cover. If steelhead fry were upstream of the intake structure, their tendency to stay close to the river substrate would keep them away from the pull of the operating intake structure and minimize the direct effects of entrainment and impingement. However, as observed by divers in 1985, the support and riprap around the intake structure provides shelter for fish species that consume other fish (WPPSS, 1986); thus, indirectly, the intake structure might affect the survival of the fry. During thermal drift studies in 1985, juvenile fall Chinook and steelhead floated in cages through the thermal and chemical effluent of the blowdown discharge were not measurably affected by exposure to the heated water and blowdown chemicals (WPPSS, 1986).

With the draft SEIS, the NRC prepared an integrated biological assessment and EFH Assessment, which appear in Appendix D-1 to this SEIS. On August 23, 2011, the NRC submitted a copy of the draft SEIS and integrated assessment to the USFWS and NMFS with a request for informal section 7 consultation (with both the USFWS and NMFS) and EFH Consultation (with NMFS) (NRC 2011a; 2011b).

Informal Section 7 Consultation with the USFWS

During phone discussions with the USFWS concerning the potential effects of the proposed license renewal on the bull trout, the USFWS and NRC agreed that the proposed license renewal would not be likely to adversely affect the species. The NRC revised its biological assessment conclusion via e-mail on September 28, 2011 (NRC 2011c) from “no effect” to “not likely to adversely affect” the bull trout. The USFWS concurred on this determination in a letter dated October 5, 2011 (USFWS 2011), at which point informal section 7 consultation between the USFWS and NRC concluded.

Based on the occurrence of the life stages of bull trout in the Hanford Reach; the design and operation of the the CGS intake and discharge structure; and the FWS’s determination that the proposed license renewal is unlikely to adversely affect the species, the NRC staff conclude that the proposed license renewal would have SMALL impacts on the bull trout.

Informal Section 7 Consultation with the NMFS

The NRC staff is still in informal section 7 consultation with the NMFS regarding the potential effects of the proposed license renewal on the upper Columbia River spring Chinook salmon and upper Columbia River steelhead. By letter dated October 24, 2011 (NMFS 2011), the NMFS informed the NRC that they did not concur on the NRC’s biological assessment. The NMFS also directed the NRC to initiate formal section 7 consultation. The NRC replied to the NMFS letter on December 20, 2011 (NRC 2011d). In its response, the NRC staff explained that informal -section 7 consultation is the appropriate means of fulfilling NRC’s obligation under the ESA for the proposed CGS license renewal because the NRC does not have any information indicating that CGS is adversely affecting any Federally listed species. The NRC and NMFS held a teleconference on January 31, 2011. The NMFS agreed that continuing informal consultation was the appropriate path forward. The NMFS discussed additional information that it would need from the NRC to make a determination of effects, and on February 10, 2011, the NMFS submitted these requests via e-mail (NMFS 2012).

At this time, informal section 7 consultation between the NRC and NMFS regarding the is ongoing. Though the NRC has not concluded consultation at this time, for purposes of NEPA, the NRC has used the best available information to make conclusions regarding the upper Columbia River spring Chinook salmon and upper Columbia River steelhead. Based on the analysis in the NRC’s biological assessment (Appendix D-1), neither species were ever collected during entrainment and impingement studies and thermal drift studies indicated not measureable impact on the either species. Therefore, the NRC staff concludes that the impacts of the proposed license renewal on the upper Columbia River spring Chinook and upper Columbia River steelhead would be SMALL.

Essential Fish Habitat Consultation

The NRC requested initiation of abbreviated EFH Consultation under the Magnuson-Stevens Fishery and Conservation Management Act, as amended (MSA), with the NMFS on August 23, 2011 (NRC 2011b). The NMFS has not responded with EFH Conservation Recommendations to date. Because the NMFS did not provide the NRC with EFH Conservation Recommendations within the 30-day timeframe established at 50 CFR 600.920(h)(4) and has not indicated via letter, e-mail, or phone that it intends to provide the NRC with EFH Conservation Recommendations, the NRC considers its obligations under the MSA fulfilled and this consultation to be closed. The NRC concludes that the impacts of the proposed CGS license renewal on EFH would be SMALL.

Overall Special Status Species and Habitats Conclusion

The NRC staff concludes that the impacts of an additional 20 years of operation of CGS on aquatic special status species and habitats would be SMALL as defined by the NRC for the purposes of NEPA.

4.7.2 Terrestrial Species

Sections 2.2.6 and 2.2.7 of this SEIS discuss the characteristics and habitat of threatened and endangered species near the CGS site.

The staff contacted the USFWS to request information that could help in assessing the environmental impacts associated with license renewal. On November 8, 2010, the USFWS noted that the Federally listed species the Columbia Basin pygmy rabbit (*Brachylagus idahoensis*) and the Ute ladies'-tresses (*Spiranthes diluvialis*) could potentially occur within Benton County where the project area and the adjacent, 2,900 ft-long (880 m) transmission line corridor are located (Kurz, 2010). As discussed previously, in Section 2.2.7.1, both species are not known to occur on the CGS site or the surrounding Hanford Site. The Columbia Basin pygmy rabbit has never been documented on the site, has been extirpated from the wild, and is presumed extinct (EN, 2010a), (WDNR, 2009). The Ute ladies'-tresses is known to occur within the Columbia Plateau ecoregion, but it has not been observed as far south as the CGS site (Fertig, et al., 2005).

The bald eagle (*Haliaeetus leucocephalus*) and the peregrine falcon (*Falco peregrinus*) were both previously Federally listed as threatened and may be found near the CGS site (Welch, 2009). The bald eagle is still protected under the Bald and Golden Eagle Protection Act. Both the bald eagle and peregrine falcon are protected under the Migratory Bird Treaty Act. Four state-listed threatened or endangered species that could potentially occur on the CGS site include the sandhill crane (*Grus canadensis*), the American white pelican (*Pelecanus erythrorhynchos*), the ferruginous hawk (*Buteo regalis*), and the lowland toothcup (*Rotala ramosior*) (EN, 2010a).

There are no Federally listed threatened or endangered terrestrial species that occur along the in-scope transmission line ROWs. The staff encourages Energy Northwest to report the existence of any Federally listed or state-listed endangered or threatened species within or near the CGS site or the transmission line ROWs to the Washington Department of Natural Resources (WDNR) and USFWS, or both, if any such species are identified during the license renewal term. In particular, if any evidence of injury to or mortality of, migratory birds, or any other threatened or endangered species is observed at the CGS site or within the transmission line corridor during the license renewal period, the staff encourages Energy Northwest to promptly report this to the appropriate wildlife management agencies.

Because no threatened or endangered species are known to occur on or near the CGS site or within the transmission line corridors, operation of the site and its associated transmission lines are not expected to adversely affect any threatened or endangered terrestrial species during the license renewal term. Therefore, the staff concludes that adverse impacts to threatened or endangered terrestrial species during the period of extend operation would be SMALL. The staff finds several mitigation measures currently in place at the CGS site and along the associated transmission lines to be adequate. They include environmental review checklists, environmental evaluation forms, and best management practices for reporting species sightings and dealing with distressed species.

4.8 Human Health

The human health issues applicable to CGS are discussed below and listed in Table 4.8-1 for Category 1, Category 2, and uncategorized issues.

Table 4.8-1. Human health issues

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 contains more information on these issues.

Issues	GEIS section	Category
Radiation exposures to the public during refurbishment	3.8.1[(a)]	1
Occupational radiation exposures during refurbishment	3.8.2[(a)]	1
Microbiological organisms (occupational health)	4.3.6	1
Microbiological organisms (public health, for plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	4.3.6[(b)]	2
Noise	4.3.7	1
Radiation exposures to public (license renewal term)	4.6.2	1
Occupational radiation exposures (license renewal term)	4.6.3	1
Electromagnetic fields—acute effects (electric shock)	4.5.4.1	2
Electromagnetic fields—chronic effects	4.5.4.2	Uncategorized

[(a)] Issues apply to refurbishment, an activity that CGS does not plan to undertake.

[(b)] Issue applies to plants with features such as cooling lakes or cooling towers that discharge to a small river. The issue does not apply to CGS.

4.8.1 Generic Human Health Issues

The staff did not find any new and significant information related to human health issues or radiation exposures during its review of the Energy Northwest ER, the site visit, or the scoping process. Energy Northwest found and evaluated a potentially new and significant issue related to groundwater contamination. Energy Northwest's evaluation concluded that the issue is not new and significant. The staff agrees with that conclusion. Section 4.10 of this chapter contains the discussion of this issue. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to be warranted (Category 1 issues). These impacts are expected to remain SMALL through the license renewal term.

4.8.2 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1—applicable to CGS in regard to radiological impacts—are listed in Table 4.8-1. The staff has not found any new and significant information during its independent review of Energy Northwest's ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

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

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

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

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

According to the GEIS, the impacts to human health are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

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

The information presented below is a discussion of selected radiological programs carried out at CGS.

CGS Radiological Environmental Monitoring Program. CGS conducts a radiological environmental monitoring program (REMP) to assess the radiological impact, if any, to its employees, the public, and the environment around the plant site. The preoperational phase of the program, which lasted from March 1978 until initial criticality in January 1984, gave a baseline of background, including any contribution from the Hanford Site, radiological environmental data. The REMP supplies measurements of radiation and of radioactive materials for the exposure pathways and the radionuclides, which lead to the highest potential radiation exposures to the public. The REMP supplements the radioactive effluent monitoring program by verifying that any measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than those calculated using the radioactive effluent release measurements and transport models.

The REMP gives an independent mechanism for determining the levels of radioactivity in the environment to ensure that any accumulation of radionuclides released into the environment will not become significant as a result of station operations. While in-plant radiation monitoring programs are used to ensure that the dose to members of the public from radioactive effluents are within the dose limits in 10 CFR Part 20 and the as low as is reasonably achievable (ALARA) design criteria in Appendix I to 10 CFR Part 50, the REMP directly verifies any environmental impact that may result from plant effluents.

An annual radiological environmental operating report is issued, which contains numerical data and a discussion of the results of the monitoring program for the past year. The REMP collects samples of environmental media in order to measure the radioactivity levels that may be present. The locations of most monitoring stations have been selected based on an exposure pathway analysis. The exposure pathway analysis considers factors such as weather patterns, anticipated radioactive emissions, likely receptors, and land use in the surrounding areas. Samples collected from monitoring stations located in areas that potentially could be influenced by CGS operation are used as indicators. Samples collected from locations that are not likely to be influenced by CGS operation serve as controls. Results from indicator monitoring stations are compared to the results from control monitoring stations and results obtained during the previous operational and preoperational years of the program in order to assess the impact CGS operation may be having on the environment. The media samples are representative of the radiation exposure pathways that may affect the public. The REMP measures the aquatic, terrestrial, and atmospheric environment for radioactivity, as well as the ambient radiation. Ambient radiation pathways include radiation from radioactive material inside buildings and plant structures and airborne material that may be released from CGS. In addition, the REMP measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). Thermoluminescent dosimeters (TLDs) are used to measure ambient radiation. The atmospheric environmental monitoring consists of sampling and analyzing the air for particulates and radioiodine. Terrestrial environmental monitoring consists of analyzing samples of local garden produce, groundwater, plant discharge water, storm drain water, sanitary wastewater, soil, and milk. The aquatic environmental monitoring consists of analyzing samples of river water, river sediment, and fish. An annual land use census is done to determine if the REMP needs to be revised to reflect changes in the environment or population that might alter the radiation exposure pathways. CGS has an onsite groundwater protection program designed to monitor the onsite plant environment near the reactor building for early detection of leaks from plant systems and pipes containing radioactive liquid. CGS is located in an area where the unconfined aquifer under the site is known to be contaminated with tritium as a result of past DOE activities on the Hanford Site. The CGS groundwater program is intended to assess any additional contribution CGS may be making to the known groundwater contamination levels (EN, 2010c). The CGS groundwater program is not designed to monitor and assess radioactive contamination originating from past nuclear activities at the Hanford Site. The DOE has its own environmental monitoring program, which is presented later in this section, to assess radioactive contamination levels on the Hanford Site and outside the boundary of the Hanford Site.

Due to the location of CGS on the Hanford Site, there are other sources of radioactive material in close proximity to the plant. CGS is unique in the U.S. commercial nuclear power industry in this respect. Radionuclides related to past DOE activities on the Hanford Site, most notably tritium, are found in some CGS REMP samples. Though the presence of these radionuclides near CGS is not necessarily reflective of CGS activity, changes in the levels of these radionuclides are monitored to assess any contribution that CGS may be making to the local background radiation levels.

In the draft SEIS, the staff reviewed the CGS annual radiological environmental operating reports for 2005–2009, to look for any significant impacts to the environment or any unusual trends in the data (EN, 2006a), (EN, 2007a), (EN, 2008a), (EN, 2009a), (EN, 2010b). A 5-year period gives a representative data set that covers a broad range of activities that occur at a nuclear power plant such as refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities. In addition, the staff reviewed recent DOE Hanford ERs (DOE, 2010d) and Washington State's Hanford Environmental Radiation Oversight Program reports (WDOH, 2011).

Since the publication of the draft SEIS, Energy Northwest submitted their 2010 annual radiological environmental operating report (EN, 2011a). Below is a summary of those results:

Direct Radiation. Offsite direct radiation monitoring results are consistent with previous years. The 2010 results show no measurable dose contribution due to plant operations at locations outside the CGS controlled area.

Airborne Particulate and Iodine. Results for these locations are within the range observed in previous years and closely follow the trend observed for the control location. Based on these results, there is no evidence of any measurable environmental radiological air quality impact that can be attributed to CGS operation during 2010.

Surface Water. Tritium results for all plant intakes, plant discharge, and river or drinking samples were so low as to be below the detection capability of the analysis method (i.e., less than the lower limit of detection (LLD)). This is consistent with results seen in previous years. The analysis for gamma radiation emitting material in samples from all plant intake, plant discharge, and river or drinking water showed no indication of any gamma-emitting radionuclides related to CGS operation. There is no evidence of significant impact to the environment due to CGS operation in the plant intake, plant discharge, or river or drinking water results analyzed in 2010.

Groundwater. The CGS groundwater monitoring program is carried out to meet the Nuclear Energy Institute (NEI) Groundwater Protection Initiative (NEI 07-07) guidelines and to support Washington State environmental permit requirements. The 11 shallow wells allow water to be sampled from the unconfined aquifer around the CGS site. None of these monitoring wells is used as a source of drinking water. As previously noted, CGS is unique in the commercial nuclear power industry in that it is located in an area where the unconfined aquifer under the site is known to be contaminated with tritium and other radionuclides as a result of past DOE activities on the Hanford Site. The CGS groundwater program is intended to assess any contribution CGS may be making to the known groundwater contamination levels associated with Hanford Site operations.

Tritium concentrations in these samples ranged from less than the LLD to 17,000 picocuries (pCi) per liter (L). Tritium results from each well were consistent during the year. The tritium levels were below the NRC's reporting level of 20,000 pCi/L. For samples that have tritium concentrations greater than 20,000 pCi/L, Energy Northwest would have to submit a special report to the NRC documenting the occurrence and noting any corrective actions plans to prevent a reoccurrence.

Soil. Analysis of soil samples for gamma emitting radionuclides showed the presence of naturally occurring radionuclides and Cesium 137 (Cs 137) in three of five samples. The Cs-137 level identified in June at Station 7 was higher than normally identified by the CGS REMP at this location but still within the range historically seen in Hanford site soils. A confirmation soil sample taken in October at Station 7 gave Cs-137 results below the LLD. The level of Cs-137 identified in the other samples was similar to that seen in the past and within the concentration range that is considered normal background. The soil sample results do not show any measurable impact from CGS operation.

River Sediment. Analysis of river sediment noted naturally occurring radionuclides and Cs-137. Cs-137 was detected in both upstream stations and both downstream stations (relative to the cooling tower discharge point). As observed in previous years, Cs-137 downstream activity was slightly higher than the activity identified upstream. The downstream Cs-137 activity levels were slightly higher than the levels identified in previous years but remained within the range known to be present in Hanford area sediment and soil. The sediment sample results do not show any measurable impact from CGS operation. It is noted that CGS has not made a radioactive liquid effluent discharge to the Columbia River since 1998.

Fish. Analysis of fish samples collected at both the indicator location (Columbia River) and the control location (Snake River) noted the presence of only naturally occurring radionuclides. These results are consistent with results seen from past years.

Milk. There was no iodine-131 (I-131) activity identified in any of the milk samples collected in 2010. Analysis of milk samples did not find any gamma emitting radionuclides of interest above the detection limits of the analysis method. Naturally occurring potassium-40 (K-40) was found in all milk samples.

Garden Produce. Analysis for gamma emitting radionuclides was done on 15 different fruit and vegetable crops in 2010. No radionuclides of interest were found in any of the samples. Naturally occurring K-40 was found in all samples.

Special Interest Monitoring Stations. Additional sampling and analysis beyond the requirements of the REMP is done to comply with Washington State's Energy Facility Site Evaluation Council resolutions. The locations and monitoring results are presented below.

Storm Drain Pond. The storm drain pond is located approximately 1,500 ft northeast of CGS. The storm drain pond area is fenced, and access is restricted. Water samples were analyzed for gamma emitting radionuclides, tritium, and gross beta. Gamma analysis did not find the presence of any gamma emitting radionuclides of interest. Gross beta was positively noted in only 1 of the 12 samples; the level noted was just above the analysis method's detection limit and within the range observed in previous years. Tritium was detected in 8 of the 12 samples. The samples with the highest tritium activity were from colder, wetter months and are consistent with results seen in previous years. The source of the tritium in these samples is believed to be from tritium contained in CGS routine radioactive gaseous effluents, which "rain out" of the atmosphere during the cooler, rainier periods of the year.

Sanitary Waste Treatment Facility. The Sanitary Waste Treatment Facility (SWTF) is located approximately 0.5 miles (mi) south-southeast of the CGS. The facility processes sanitary wastewater from CGS, the Energy Northwest IDC (formerly referred to as WNP-1 and WNP-4), the Kootenai Building, and the DOE 400 Area. The sample results were consistent with results seen in previous years. Low level gross beta was noted in all samples; gross alpha was not noted above the LLD in any of the samples. Gamma analysis results of the SWTF water samples found I-131 in the December 2010 Station 102B composite sample. Since the radioiodine was not expected, Energy Northwest documented the results and carried out an investigation to determine its source. Since no other CGS radionuclides were found in the sample, Energy Northwest determined that the source of the radioiodine was from a medically administered treatment. No other gamma emitting radionuclides of interest were detected in any of the other samples analyzed in 2010. Tritium activity was identified in all SWTF Station 102A and 102B samples. Tritium levels in the January 2010 Station 102A sample were observed to have increased by approximately 4 times above the normal trend level to approximately 8200 pCi/L. This upward trend continued until May 2010 with a reported sample of 11,200 pCi/L. No samples reported during this period were over the EPA drinking water standard of 20,000 pCi/L. Energy Northwest documented the results and carried out an investigation to determine the source. Discussions with DOE personnel revealed that the source of the water supply at the DOE 400 area was switched in December 2009 to a well known to contain higher levels of tritium. In June 2010, DOE personnel indicated that they had switched back to their normal, lower tritium level well. Tritium concentrations were observed to start trending down in June 2010, and tritium levels in both the Station 102A and Station 102B samples returned to the normal trend levels by August 2010. The source of the Station 102A tritium is from an unconfined aquifer that is known to be contaminated with tritium as a result of past DOE activities on the Hanford site. Tritium activity coming from the DOE 400 area is the main source of the tritium identified in the station 102B samples.

Cooling Tower Sediment Disposal Area. Washington State authorizes the onsite disposal of sediments from CGS's cooling systems containing low levels of radionuclides. The disposal area for these sediments is located just south of the cooling towers. The State requires direct radiation monitoring using quarterly and annual TLDs near the disposal cells and the collection and analysis of a dry composite sediment sample from the disposal cell within thirty days following each disposal to confirm that the disposal criteria outlined in the State's criteria have not been exceeded. All results of disposed sediment were well below the State's disposal concentration limits. Cs 137 is routinely detected in the sediment disposal samples, and the Cs 137 level noted in the 2010 samples was within the range seen in previous years and only slightly higher that the Cs 137 levels found in Columbia River sediment. Co 60 was reported in one of the 2010 samples at approximately 320 pCi/kg, which is well below the disposal concentration limit of 5000 pCi/kg. , Measurements of direct radiation at the disposal basin were taken using TLDs. Two locations were used, an indicator location next to the collection area and a control location approximately 100 yards to the east. The mean quarterly and annual TLD results agree well with results from previous operational years. The negligible difference between the indicator and the control TLDs show that there was no measureable dose contribution above background due to material in the disposal cells.

Spray Pond Drain Field. There were no discharges to the spray pond drain field in 2010. The TLD results are in agreement with those seen in previous operational years.

Independent Spent Fuel Storage Installation. The independent spent fuel storage installation (ISFSI) is a fenced, secured area north-northwest of CGS. There are 10 TLD stations located on the outer security fence surrounding the ISFSI. Other TLD stations are located just north of the ISFSI between the ISFSI and the plant access road, and one is approximately 0.1 mi north of CGS between the transformer yard and the ISFSI. Radiological exposure rates at the ISFSI security fence are elevated, and access to the area directly outside the fence requires notification and approval by CGS's radiation protection personnel and security to enter. In addition to the TLD monitoring program, quarterly radiological surveys of the ISFSI are carried out by the CGS Radiation Protection Department.

No spent fuel storage casks were added to the ISFSI during 2010. The TLD results showed a lowering trend for the ISFSI.

Additional Air Sample and TLD Locations. Four additional air sample locations and five TLD stations were established in 2008–2009 in order to monitor air quality and direct radiation during remediation work at the DOE 618 11 burial ground located just west of CGS. During 2010, air samples were collected monthly during the first six months and TLDs were exchanged quarterly at these locations. Air sampling was suspended in July as no remediation work was taking place and none was scheduled to occur during the rest of the year. Air particulate data from the four locations show no indication of any effects from CGS effluents. Three of the TLD stations had results slightly higher than background due to the station's close proximity to the turbine building and the ISFSI.

Summary. Based on the review of the radiological environmental monitoring data, the staff found that there were no unusual and adverse trends, and there was no measurable impact to the offsite environment from operations at CGS.

Hanford Site Radiological Environmental Monitoring Program. Federal, state, and local government agencies monitor and enforce compliance with applicable environmental regulations at the Hanford Site. Major agencies include the U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology, Washington State Department of Health (WDOH), and Benton Clean Air Agency. These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with regulations. A key feature in the Hanford Site compliance program is the *Hanford Federal Facility Agreement and Consent Order* (also known as the Tri-Party Agreement). The Tri-Party Agreement is an agreement between DOE, EPA, and the Washington State Department of Ecology delineating specific requirements, actions, plans, and schedules required to achieve compliance with the *Comprehensive Environmental Resource, Compensation, and Liability Act of 1980* (CERCLA) and *Resource Conservation and Recovery Act of 1976* (RCRA) regulations and provisions.

The staff reviewed the Hanford Site ERs for the years 2005–2008 (the latest report available at the time of this review) (DOE, 2010d). The staff's focus is on the monitoring data that assesses the potential impact to areas and members of the public beyond the Hanford Site boundary. The following is a summary of the Hanford Site radiological environmental monitoring data for 2008.

Air. Radioactive emissions were monitored at Hanford Site facilities. Air particles and gases were monitored for radioactivity onsite near facilities and offsite. Air samples were collected at 92 locations near Hanford Site facilities, at 23 locations around the site away from facilities, at 11 site perimeter locations, and at 8 community locations.

All measurements of radioactive materials in air were below recommended regulatory guidelines. In general, radionuclide concentrations near facilities were at or near Hanford Site background levels and were much less than DOE-derived concentration guides. Some Hanford Site values were greater than concentrations measured offsite. The data also show that concentrations of certain radionuclides were higher and widely variable within different onsite operational areas. All offsite air sample results showed very low radiological concentrations in 2008 and were below the EPA *Clean Air Act* dose standard of 10 millirem (mrem) per year.

Columbia River Water and Sediment. Columbia River water and sediment samples were collected from multiple Hanford Reach sampling points and from locations upstream and downstream of the Hanford Site. The samples were analyzed for radioactive contaminants. As in past years, small amounts of radioactive materials were detected downriver from the Hanford Site. However, the amounts were far below Federal and state limits. During 2008, there was no indication of any deterioration of Columbia River water or sediment quality resulting from operations at the Hanford Site.

Columbia River, Shoreline, Spring Water, Hanford Site Drinking Water, and Sediment. Groundwater beneath the Hanford Site discharges to the Columbia River along the Hanford Site shoreline. Discharges above the water level of the river are identified as shoreline springs. Samples of spring water and sediment were collected at locations along the Hanford Reach. Measurements of radiological contaminants in samples collected at the shoreline springs were less than applicable DOE concentration guides. During 2008, annual average concentrations of all monitored radionuclides in Hanford Site drinking water were below Federal and state maximum allowable contaminant levels. Radionuclide concentrations measured in shoreline sediment samples were similar to concentrations measured in Columbia River sediment, with the exception of the 300 Area where uranium concentrations were above the background concentration measured in the sediments from the reservoir behind Priest Rapids Dam.

Hanford Site Drinking Water. During 2008, annual average concentrations of all monitored radionuclides in Hanford Site drinking water were below Federal and state maximum allowable contaminant levels.

Hanford Groundwater. Liquid waste released to the ground at the Hanford Site during many years of nuclear materials production has reached the onsite groundwater. Radioactive contaminants include tritium, Sr-90, Tc-99, I-129, and uranium. Currently, groundwater contaminant levels are greater than drinking water standards (DWSs) beneath 12 percent (approximately 70 square miles (mi^2)) of the area of the Hanford Site. The report states that the levels are decreasing with time due to radioactive decay and dispersion. Tritium is a significant contaminant of the Hanford onsite groundwater. For example, in 2008 the concentrations of tritium in groundwater near onsite facilities and waste sites range from 5,000–1,200,000 pCi/L. This is well above the EPA's DWS of 20,000 pCi/L. However, site groundwater is not a source of public drinking water and, as reported in the drinking water monitoring section above, does not significantly affect offsite drinking water sources such as the Columbia River and city wells.

Food and Farm Products. Samples of milk, potatoes, tomatoes, and cherries were collected from locations upwind and downwind of the Hanford Site. Radionuclide concentrations in samples of food and farm products were at normal environmental levels.

Fish and Wildlife. Game animals and other animals of interest on the Hanford Site, and fish from the Hanford Reach of the Columbia River, were monitored. Carcass, liver, and muscle samples were analyzed to evaluate radionuclide concentrations. Populations of selected fish and wildlife species were also surveyed or monitored. Samples of carp, suckers, smallmouth bass, mule deer, and clams were collected and analyzed. Radionuclide levels in wildlife samples were well below levels that are estimated to cause adverse health effects to animals or to the people who may consume them.

Soil. To verify known radiological conditions, 95 routine soil samples were collected onsite near facilities and operations in 2008. There were also 41 soil samples collected site-wide and at offsite locations to investigate potential contamination. In general, radionuclide concentrations in routine samples collected from or adjacent to waste disposal facilities in 2008 were higher than concentrations measured in distant communities in previous years. There were 16 instances of radiological contamination in soil samples investigated in 2008. Of the 16, 9 were cleaned up. The contamination levels at the other locations did not exceed the radiological control limits for the sites, and the soil was left in place.

Vegetation. Vegetation samples were collected on, or adjacent to, former waste disposal sites and from locations downwind and near, or within, the boundaries of operating facilities and remedial action sites to monitor for radioactive contaminants. In general, radionuclide concentrations in vegetation samples collected from, or adjacent to, waste disposal facilities in

2008 were higher than concentrations in samples collected farther away, including concentrations measured offsite. During 2008, radiological contamination was found in 127 vegetation samples collected around areas of known or suspected contamination, or around specific project regions, on the Hanford Site. All the samples were disposed of at a licensed facility.

Potential Radiological Doses from 2008 Hanford Site Operations. During 2008, potential radiological doses to the public and biota from Hanford Site operations were evaluated to determine compliance with pertinent regulations and limits. Doses were assessed in the following terms:

- total dose (multiple pathways) to the hypothetical, maximally exposed individual at an offsite location
- average dose to the collective population living within 50 mi of Hanford Site operating areas
- dose for air pathways using EPA methods
- dose to workers on the site consuming drinking water
- doses from non-DOE industrial sources on and near the Hanford Site
- absorbed dose received by animals exposed to contaminants released to the Columbia River and in onsite surface water bodies

All doses from Hanford Site activities in 2008 were lower than EPA and DOE standards.

Summary. The DOE ERs state that the levels of radioactivity in the offsite environment had no measurable impact to the offsite environment from the Hanford Site. The measured offsite radioactivity levels are generally trending downward to levels approaching background. This is due to a combination of DOE's clean-up work and radioactive decay of the residual radioactivity.

Washington State Department of Health's Hanford Environmental Radiation Oversight Program. Since 1985, the WDOH's Hanford Environmental Radiation oversight program has participated with the DOE in the collection of environmental samples on or near the Hanford Site. The purpose of the program is to independently verify the quality of DOE environmental monitoring programs at the Hanford Site and to assess the potential for public health impacts (WDOH, 2011).

The oversight program's objectives are met through collection and analysis of environmental samples and interpretation of results. WDOH's environmental samples are either split or collocated with DOE contractors, and the results are compared to verify the quality of the DOE monitoring programs at Hanford. Samples of air, groundwater, surface water, riverbank seep water, drinking water, discharge water, sediment, food and farm products, fish and wildlife, and vegetation are collected. In addition, ambient external radiation levels are measured using radiation dosimeters.

For 2008, most environmental samples analyzed by WDOH have radioactivity concentrations that are either below detection limits or consistent with background. A few samples have concentrations elevated above background; however, in most cases the concentrations are consistent with historical trends. For example, carbon-14 (C-14), tritium, I-129, Sr-90, technetium-99 (Tc-99), and isotopes of uranium were detected above background levels in some Hanford Site and Hanford boundary water samples. A variety of radionuclides, including

Cs-137, europium-152 (Eu-152), plutonium-239/240 (Pu-239/240), Sr-90, and isotopes of uranium, were found above background levels in some Columbia River sediment samples. Most of the elevated concentrations are consistent with historical trends. Anomalously elevated radionuclide concentrations were found in selected samples—air samples from onsite locations near the 100K Area, groundwater samples from the 200 West and 200 East Areas, Columbia River surface water samples from the 100N Area, and TLD results at the 100KE Area.

In summary, the 2008 report states that while Hanford operations have resulted in radionuclides entering the environment, the data from the WDOH oversight program show that public exposure to radioactivity from Hanford is far below regulatory limits (WDOH 2011).

Columbia Generating Station Radioactive Effluent Release Program. All nuclear plants were licensed with the expectation that they would release radioactive material to both the air and water during normal operation. However, NRC regulations require that radioactive gaseous and liquid releases from nuclear power plants must meet radiation dose-based limits, specified in 10 CFR Part 20, and ALARA criteria in Appendix I to 10 CFR Part 50. Regulatory limits are placed on the radiation dose that members of the public can receive from radioactive material released by a nuclear power plant. In addition, nuclear power plants are required to file an annual report to the NRC, which lists the types and quantities of radioactive effluents released into the environment. The radioactive effluent release reports are available for review by the public through the Agencywide Documents Access and Management System (ADAMS) electronic reading room, available through the NRC Web site.

In the draft SEIS, the staff reviewed the annual radioactive effluent release reports for 2005–2009 (EN, 2006b), (EN, 2007b), (EN, 2008b), (EN, 2009b), (EN, 2010c). The review focused on the calculated doses to a member of the public from radioactive effluents released from CGS. The doses were compared to the radiation protection standards in 10 CFR 20.1301 and the ALARA dose design objectives in Appendix I to 10 CFR Part 50.

Dose estimates for members of the public are calculated based on radioactive gaseous and liquid effluent release data and atmospheric and aquatic transport models. For the draft SEIS, NRC staff reviewed and presented data from the the 2009 annual radioactive material release report (EN, 2010d). Since the publication of the draft SEIS, Energy Northwest submitted their 2010 annual radioactive material release report (EN, 2011b). This report contains a detailed presentation of the radioactive discharges and the resultant calculated doses for 2010. CGS water management practices are carried out so that there is no need to discharge radioactive liquid effluents into the Columbia River. No radioactive liquid effluents have been discharged in 11 years. The liquid waste is processed into solid waste and disposed of in a low level radioactive waste disposal facility.

The following summarizes the calculated hypothetical maximum dose to a member of the public located outside the CGS site boundary from radioactive gaseous and liquid effluents released during 2010:

- The maximum whole-body dose to an offsite member of the public from radioactive liquid effluents was 0 mrem (0 mSv) because there were no radioactive liquid discharges during 2010.
- The maximum organ dose to an offsite member of the public from radioactive liquid effluents was 0 mrem (0 mSv) because there were no radioactive liquid discharges to the Columbia River during 2010.

- The maximum air dose at the site boundary from gamma radiation in gaseous effluents was 5.15 E-02 mrad (5.15 E-04 mGy), which is well below the 10 mrad (0.1 mGy) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum air dose at the site boundary from beta radiation in gaseous effluents was 1.82 E-03 mrad (1.82 E-05 mGy), which is well below the 20 mrad (0.2 mGy) dose criterion in Appendix I to 10 CFR Part 50.
- The maximum organ (skin) dose to an offsite member of the public at the site boundary from radioactive iodine and radioactive material in particulate form was 5.57 E-02 mrem (5.57 E-04 mSv), which is well below the 15 mrem (0.15 mSv) dose criterion in Appendix I to 10 CFR Part 50.

The staff's review of CGS's radioactive waste system performance in controlling radioactive effluents found that the radiological doses to members of the public for the years 2005–2009 and 2010 comply with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190.

Routine plant operational and maintenance activities currently carried out will continue during the license renewal term. Based on the past performance of the radioactive waste system to maintain the dose from radioactive effluents to be ALARA, similar performance is expected during the license renewal term.

The radiological impacts from the current operation of CGS are not expected to change significantly. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the impacts from radioactive effluents would be SMALL.

4.8.3 Microbiological Organisms

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 lists the effects of thermophilic microbiological organisms on public health as a Category 2 issue that applies to nuclear plants that discharge to small rivers (those with an annual average flow rate of less than 3.15×10^{12} ft^3/year). As discussed in section 2.1.6, CGS has a closed-cycle heat-dissipation system that uses mechanical draft cooling towers for which make-up water is pumped from the Columbia River. From 1960–2009, the average mean annual discharge of the Columbia River below Priest Rapids Dam was 117,823 cfs (USGS, 2010), which is approximately 3.72×10^{12} ft^3/year. Since this flow rate is greater than 3.15×10^{12} ft^3/year, the Columbia River does not meet the definition of a small river. Therefore, this issue does not apply to CGS.

4.8.4 Electromagnetic Fields–Acute Effects

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

In the GEIS (NRC, 1996), the staff found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) criteria, it was not possible to determine the significance of the electric shock potential (IEEE, 2002). Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use near transmission lines may have changed or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), Energy Northwest must supply an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

CGS electrical output is delivered to the Bonneville Power Administration (BPA) at the H.J. Ashe Substation located 0.5 mi north of the plant via an elevated 500-kilovolt (kV) line. CGS startup power comes from the Ashe Substation to the CGS transformer yard on a 230-kV parallel line. A third line supporting CGS serves as a backup power source. This line runs between the CGS transformer yard and a tap off the 115-kV line running between the Benton Switchyard and the Fast Flux Test Facility. These are the lines that are within the scope of license renewal. BPA developed an electric field strength policy for the design and operation of its transmission system. The policy is intended to minimize shock hazards consistent with the NESC criteria. Energy Northwest's analysis determined that there are no locations within the ROW under the transmission lines that have the capacity to induce more than 5 milliamperes (mA) in a vehicle parked beneath the lines. Therefore, the lines meet the NESC 5 mA criterion. The maximum induced current calculated for the powerlines was 4.4 mA (EN, 2010a), (Gambhir, 2010c).

The CGS transmission line corridor crosses developed portions of the CGS site and open range type space. No land use changes are anticipated near the corridor. Energy Northwest and BPA periodic surveillance of the transmission system assures that ground clearances remain in compliance with NESC criteria (EN, 2010a).

The staff reviewed the available information, including Energy Northwest's evaluation and results. Based on this information, the staff concludes that the potential impacts from electric shock during the renewal period would be SMALL.

4.8.5 Electromagnetic Fields–Chronic Effects

In the GEIS, the effects of chronic exposure to 60-Hertz electromagnetic fields from powerlines were not designated as Category 1 or 2 and will not be until a scientific consensus is reached on the health implications of these fields.

The potential effects of chronic exposure from these fields continue to be studied and are not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the DOE.

The report by NIEHS (NIEHS, 1999) contains the following conclusion:

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

This statement is not sufficient to cause the staff to change its position with respect to the chronic effects of electromagnetic fields. The staff considers the GEIS finding of “UNCERTAIN” still appropriate and will continue to follow developments on this issue.

4.9 Socioeconomics

The socioeconomic issues applicable to CGS are shown in Table 4.9-1 for Category 1, Category 2, and one uncategorized issue (environmental justice). Section 2.2.9 of this SEIS describes the socioeconomic conditions near CGS.

Table 4.9-1. Socioeconomics issues during the renewal term

Issues	GEIS section	Category
Housing Impacts	4.7.1	2
Public Services: public safety, social services, & tourism & recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6	1
Public Services: public utilities	4.7.3.5	2
Public Services: education (license renewal term)	4.7.3.1	1
Offsite Land Use (license renewal term)	4.7.4	2
Public Services: transportation	4.7.3.2	2
Historic and Archaeological Resources	4.7.7	2
Aesthetic Impacts (license renewal term)	4.7.6	1
Aesthetic impacts of transmission lines (license renewal term)	4.5.8	1
Environmental Justice	Not addressed[(a)]	Uncategorized[(a)]

[(a)] Guidance for implementing EO 12898 and conducting an environmental justice impact analysis was not available before completion of the GEIS. This issue must be addressed in plant-specific reviews.

4.9.1 Generic Socioeconomic Issues

The staff reviewed and evaluated the CGS ER, scoping comments, other available information, and visited CGS and did not find any new and significant information that would change the conclusions presented in the GEIS. Therefore, it is expected that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS. For CGS, the NRC incorporates the GEIS conclusions by reference. Impacts for Category 2 and the uncategorized issue (environmental justice) are discussed in Sections 4.9.2–4.9.7.

4.9.2 Housing Impacts

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

According to the 2000 Census, an estimated 171,371 people lived within 20 mi (32 km) of CGS, which equates to a population density of 136 persons per mi^2 (EN, 2010a). This translates to a Category 4, “least sparse” population density using the GEIS measure of sparseness (greater than or equal to 120 persons per mi^2 within 20 mi). An estimated 387,512 people live within

50 mi (80 km) of CGS with a population density of 49.4 persons per mi^2 (EN, 2010a). Since the Tri-Cities of Richland, Kennewick, and Pasco have a combined population of over 100,000 persons and is located within 50 mi of CGS, this translates to a Category 3 density using the GEIS measure of proximity (one or more cities with 100,000 or more persons and less than 190 persons per mi^2 within 50 mi). Therefore, CGS is located in a high population area based on the GEIS sparseness and proximity matrix.

Table B-1 of 10 CFR Part 51, Subpart A, Appendix B states that impacts on housing availability are expected to be of small significance in a medium or high-density population area where growth-control measures are not in effect. Since CGS is located in a medium to high population area, and Benton and Franklin Counties are not subject to growth-control measures that would limit housing development, any changes in employment at CGS would have little noticeable effect on housing availability in these counties. Since Energy Northwest has no plans to add additional outage and non-outage employees during the license renewal period, employment levels at CGS would remain relatively constant with no additional demand for permanent housing during the license renewal term. Based on this information, there would be no impact on housing during the license renewal term beyond what has already been experienced.

4.9.3 Public Services: Public Utility Impacts

Impacts on public utility services (e.g., water, sewer) are considered SMALL if the public utility has the ability to respond to changes in demand and would have no need to add or modify facilities. Impacts are considered MODERATE if service capabilities are overtaxed during periods of peak demand. Impacts are considered LARGE if additional system capacity is needed to meet ongoing demand.

Analysis of impacts on the public water systems considered both plant demand and plant-related population growth. Section 2.1.3 describes the permitted withdrawal rate and actual use of water for reactor cooling at CGS.

Since Energy Northwest has no plans to add non-outage employees during the license renewal period, employment levels at CGS would remain relatively unchanged with no additional demand for public water services. Public water systems in the region are adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no additional impact to public water services during the license renewal term beyond what is currently being experienced.

4.9.4 Offsite Land Use—License Renewal Period

Offsite land use during the license renewal term is a Category 2 issue (10 CFR Part 51, Subpart A, Appendix B, Table B-1). Table B-1 notes that "significant changes in land use may be associated with population and tax revenue changes resulting from license renewal." Section 4.7.4 of the GEIS defines the magnitude of land-use changes as a result of plant operation during the license renewal term as SMALL when there will be little new development and minimal changes to an area's land-use pattern, as MODERATE when there will be considerable new development and some changes to the land-use pattern, and as LARGE when there will be large-scale new development and major changes in the land-use pattern.

Tax revenue can affect land use because it enables local jurisdictions to supply the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land-use impacts during the license renewal term should consider the following:

- the size of the plant's tax payments relative to the community's total revenues
- the nature of the community's existing land-use pattern
- the extent to which the community already has public services in place to support and guide development

If the plant's tax payments are projected to be small relative to the community's total revenue, tax driven land-use changes during the plant's license renewal term would be SMALL, especially where the community has pre-established patterns of development and has supplied public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction's revenue, the significance level would be SMALL. If tax payments are 10–20 percent of the community's total revenue, new tax-driven land-use changes would be MODERATE. If tax payments are greater than 20 percent of the community's total revenue, new tax-driven land-use changes would be LARGE. This would be especially true where the community has no pre-established pattern of development or has not supplied adequate public services to support and guide development.

4.9.4.1 Population-Related Impacts

Since Energy Northwest has no plans to add non-outage employees during the license renewal period, there would be no plant operations-driven population increase near CGS. Therefore, there would be no additional population-related offsite land use impacts during the license renewal term beyond those already being experienced.

4.9.4.2 Tax Revenue-Related Impacts

As previously discussed in Chapter 2, Energy Northwest makes annual payments in lieu of taxes (PILOT) to 5 counties (Benton, Franklin, Grant, Walla Walla, and Yakima), 10 cities (Richland, Kennewick, Pasco, Benton City, Prosser, West Richland, Connell, Mesa, Grandview, Sunnyside), 17 fire districts, and 4 library districts where Energy Northwest sells power. Since Energy Northwest started making payments to local jurisdictions, population levels and land use conditions have not changed significantly, which might show that these tax revenues have had little or no effect on land use activities within the county. PILOT payments are based upon the gross revenues Energy Northwest receives from electricity sales in the five counties, regardless of where the power is generated. The magnitude of the PILOT payments relative to the county's total revenues is not relevant in assessing tax revenue-related offsite land use impacts since Energy Northwest is responsible for producing and distributing electricity and PILOT payments even if the CGS does not produce electricity or the operating license is not renewed.

Since Energy Northwest has no plans to add non-outage employees during the license renewal period, employment levels at CGS would remain relatively unchanged. Annual PILOT payments would also remain relatively unchanged throughout the license renewal period. Based on this information, there would be no additional tax-revenue-related offsite land use impacts during the license renewal term beyond those already being experienced.

4.9.5 Public Services: Transportation Impacts

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

> Transportation impacts (level of service) of highway traffic generated...during the term of the renewed license are generally expected to be of SMALL significance. However, the increase in traffic associated with additional workers and the local

road and traffic control conditions may lead to impacts of MODERATE or LARGE significance at some sites.

The regulation in 10 CFR 51.53(c)(3)(ii)(J) requires all applicants to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license. Since Energy Northwest has no plans to add non-outage employees during the license renewal period, traffic volume and levels of service on roadways near CGS would not change. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

4.9.6 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to consider the effects of their undertakings on historic properties, and renewing the operating license of a nuclear power plant is an undertaking that could potentially affect historic properties. Historic properties are defined as resources that are eligible for listing in the National Register of Historic Places (NRHP). The criteria for eligibility are listed in 36 CFR 60.4 and include the following (ACHP, 2008):

- association with significant events in history
- association with the lives of persons significant in the past
- embodiment of distinctive characteristics of type, period, or construction
- sites or places that have yielded or are likely to yield important information

The historic preservation review process (Section 106 of the NHPA) is outlined in regulations issued by the Advisory Council on Historic Preservation (ACHP) in 36 CFR Part 800.

In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to note historic properties included in or eligible for inclusion on the NRHP in the area of potential effect (APE). The APE for license renewal generally consists of the nuclear power plant site, transmission lines connected to the power plant, and the immediate environs. If historic properties are present, the NRC is required to contact the State Historic Preservation Office (SHPO), assess the potential impact, and resolve any possible adverse effects of the undertaking (license renewal) on historic properties. The NRC is also required to notify the SHPO if historic properties would not be affected by license renewal or if no historic properties are present. This section assesses the potential effects of license renewal on historic properties on or near the CGS site. Section 2.2.9 describes potentially affected historic properties near CGS.

Before submitting an operating license renewal application (LRA) for CGS, Energy Northwest contacted the Washington SHPO in April 2008, requesting information about historic and archaeological resources near CGS (EN, 2010a). The Washington SHPO responded in April 2008, requesting information about the proposed APE (EN, 2010a). In May 2008, Energy Northwest submitted a detailed map to the Washington SHPO showing the leased boundaries of CGS overlaid on a USGS topographic map. A third letter from Energy Northwest was sent in July 2008, which proposed expanding the CGS APE to include three transmission lines that were part of the original CGS construction and operation licenses (EN, 2010a). These transmission lines were constructed by BPA before the construction of CGS and are currently maintained by BPA. In August 2008, SHPO concurred with this APE designation (EN, 2010a).

In accordance with 36 CFR 800.8(c), the NRC initiated Section 106 consultation with the ACHP and the Washington SHPO in March 2010, by notifying them of the agency’s intent to conduct a review of a request from Energy Northwest to renew the CGS operating license. On March 29, 2010, the SHPO responded to the NRC's letter by requesting a map depicting the proposed APE (Whitlam, 2010b). In April, via letter to the Washington SHPO, the NRC reiterated the proposed APE information presented in Energy Northwest's ER, Appendix D (EN, 2010a). At the time, the proposed APE included CGS leased lands, as well as the three BPA-operated transmission lines. In April 2010, the Washington SHPO concurred with this APE designation (Whitlam, 2010c). No comments were received from the ACHP as a result of these consultation letters.

The issue of whether to include the BPA-operated transmission lines in the CGS APE was revisited during a meeting between the staff and the Washington SHPO in June 2010. During the meeting, the staff explained that although the transmission lines were part of the CGS operating license, the lines were constructed by BPA before the construction of CGS and are currently maintained by BPA. On July 22, 2010, Energy Northwest sent a revised CGS APE to the Washington SHPO, which proposed reverting back to the original CGS APE without the BPA-operated transmission lines (Coleman, 2010). The Washington SHPO concurred with this revised CGS APE on July 29, 2010 (Whitlam, 2010a). The three BPA-operated transmission lines are not part of the CGS APE because BPA adheres to its own NHPA and NEPA requirements for the operation and maintenance of these lines (Coleman, 2010). In late November, 2010, the APE was expanded to include an additional 1.8 mi of CGS-supported transmission line to the southeast of CGS that provides backup power to CGS during plant shutdowns (Pham, 2010e). The SHPO concurred with this final APE (Whitlam, 2010d).

The NRC also initiated consultation on the proposed CGS license renewal with three Federally recognized tribes: the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Yakama Nation, and the Nez Perce (Pham, 2010a), (Pham, 2010b), (Pham, 2010c). In letters to the tribes, the NRC supplied information about the proposed action (license renewal) and the definition of the APE and stated that the NHPA review would be integrated with the NEPA process, according to 36 CFR 800.8. The NRC invited the tribes to participate in the identification of potentially affected historic properties near CGS and the scoping process.

The NRC held a meeting with the tribes on April 27, 2010, to explain the license renewal process and to listen to any expressions of concern with the proposed action. Representatives from two Federally recognized tribes (Yakama Nation and the CTUIR) and one non-Federally recognized tribe (Wanapum) attended this meeting. Discussions focused on environmental justice concerns and human health and environmental risk scenarios (NRC, 2010).

In June 2010, several Tribal members from the Wanapum, Nez Perce Tribe, and CTUIR participated in a tour of the culturally sensitive area along the Columbia River and review of Energy Northwest's cultural resources protection procedure. A brief overview of historic and archaeological resource surveys and sites recorded on CGS was also supplied. After the tour and review, Tribal representatives recommended that Energy Northwest work with Tribal representatives to develop cultural resources sensitivity and awareness training for CGS (NRC, 2011a).

On September 1, 2011, the NRC received a comment letter from the Washington SHPO on the draft SEIS for the CGS license renewal. The Washington SHPO concurred with the determination of no adverse effect based upon the implementation of Energy Northwest's cultural resources protection plan (CRPP) and cultural awareness training (Whitlam, 2011).

On November 14, 2011, the NRC received comments by e-mail from the CTUIR on the draft SEIS. The NRC revised the SEIS to address the CTUIR comments that were within the scope of license renewal and forwarded the remaining comments to Energy Northwest and DOE for consideration due to the comments being outside the NRC's regulatory authority. These letters are included in Appendix D.

Energy Northwest currently has no planned changes or ground disturbing activities associated with license renewal at CGS. However, given the potential for the discovery of additional historic and archaeological resources at the CGS site, Energy Northwest developed a cultural resources protection procedure. The procedure ensures resources are considered before any ground disturbance during future plant operations and maintenance activities (Gambhir, 2010a), (Gambhir, 2010b). The procedure is overseen by Energy Northwest personnel who have received training on the NHPA Section 106 consultation process (Gambhir, 2010a). The procedure identifies situations requiring coordination with archaeological professionals and the SHPO. In addition, certain restrictions apply for performing work in the culturally sensitive zone. The procedure further shows that because CGS is located on lands leased from DOE, discoveries of human remains and other items of cultural patrimony covered under the *Native American Graves Protection and Repatriation Act* would follow DOE procedures outlined in the Hanford Cultural Resources Management Plan. Energy Northwest sent its cultural resources protection procedure to the Washington SHPO on November 2009 (Gambhir, 2010b). No comments were given by the SHPO at that time. Because there are no planned changes to CGS, no additional visual impacts would occur, which means there will be no indirect impacts to the traditional cultural properties on *Laliik* and Gable Mountain and Gable Butte. A signed Memorandum of Agreement is in place between DOE, Energy Northwest, and SHPO to resolve any adverse effects related to the ongoing operation of the Energy Northwest communication facility located on top of *Laliik* (DOE, 2009a).

Based on review of archaeological surveys, assessments, and other information, the potential impacts of continued operations and maintenance on historic and archaeological resources at CGS would be SMALL, and there would be no adverse effect on historic properties (36 CFR Section 800.4(d)(1)). Energy Northwest could reduce the risk of potential impacts to historic and archaeological resources located on or near CGS by following their Cultural Resources Protection Plan and by providing training for enhanced cultural awareness by staff engaged in planning and executing ground-disturbing activities. Substantive revisions to the Cultural Resources Protection Plan should be developed in coordination with the Washington SHPO and consulting tribes. In addition, lands not surveyed should be investigated by a qualified archaeologist before any ground disturbing activity. Given the potential for discovery of subsurface archaeological material within the culturally sensitivity zone, Energy Northwest needs to ensure that these areas are considered during future plant operations and maintenance activities.

4.9.7 Environmental Justice

Under Executive Order (EO) 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing, as appropriate, potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the NRC issued a *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (69 FR 52040), which states that "[t]he Commission is committed to the general goals set forth in EO 12898, and strives to meet those goals as part of its NEPA review process."

The Council of Environmental Quality (CEQ) provides the following information in *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ, 1997):

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

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

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

- **Minority individuals**. Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races—meaning individuals who identified themselves on a Census form as being a member of two or more races (e.g., Hispanic and Asian).
- **Minority populations**. Minority populations are identified when the minority population of an affected area exceeds 50 percent or the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
- **Low-income population**. Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series P60, on Income and Poverty.

4.9.7.1 Minority Population

There are a total of 10 counties in the 50-mi (80-km) radius surrounding CGS. Of these, eight are in Washington (Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima), and two are in Oregon (Morrow and Umatilla).

According to 2000 Census data, 36.9 percent of the population (356,404 persons) residing within a 80-km (50-mi) radius of CGS identified themselves as minority individuals. The largest minority group was Hispanic or Latino (113,000 persons or 31.7 percent), followed by persons identifying themselves as "Some other race" (80,000 persons or 22.5 percent) (USCB, 2003).

Of the approximately 300 census block groups located within the 50-mi radius of CGS, 54 block groups were determined to have minority race population percentages that exceeded the comparison area average by 20 percent or more. Persons identifying themselves as "Some other race" comprised the largest minority race population with 49 block groups. These block groups are concentrated primarily in the Tri-Cities area and Yakima. There were 5 American Indian or Alaska Native block groups that exceeded the comparison area average by 20 percent or more. An additional 61 block groups exceeded the comparison area average by 20 percent or more for Hispanic or Latino ethnicity. The minority population nearest to CGS is located in the Tri-Cities.

According to American Community Survey 3-Year Census data estimates, minority populations in the two county region (Benton and Franklin) increased by approximately 34,000 persons and comprised 42.9 percent of the total two county population (see Table 2.2.8.5-3). Most of this increase was due to an estimated influx of Hispanic or Latinos (over 18,000 persons), an increase in population of 44.8 percent from 2000. The highest percentage increase in minority population was "Some other race," an increase of 54.3 percent from 2000. The next highest percentage increase in minority population was American Indian and Alaska Natives, an increase of 53.3 percent from 2000 (USCB, 2010).

Based on 2000 Census data, Figure 4.9-1 shows minority block groups within a 50-mi (80-km) radius of CGS.

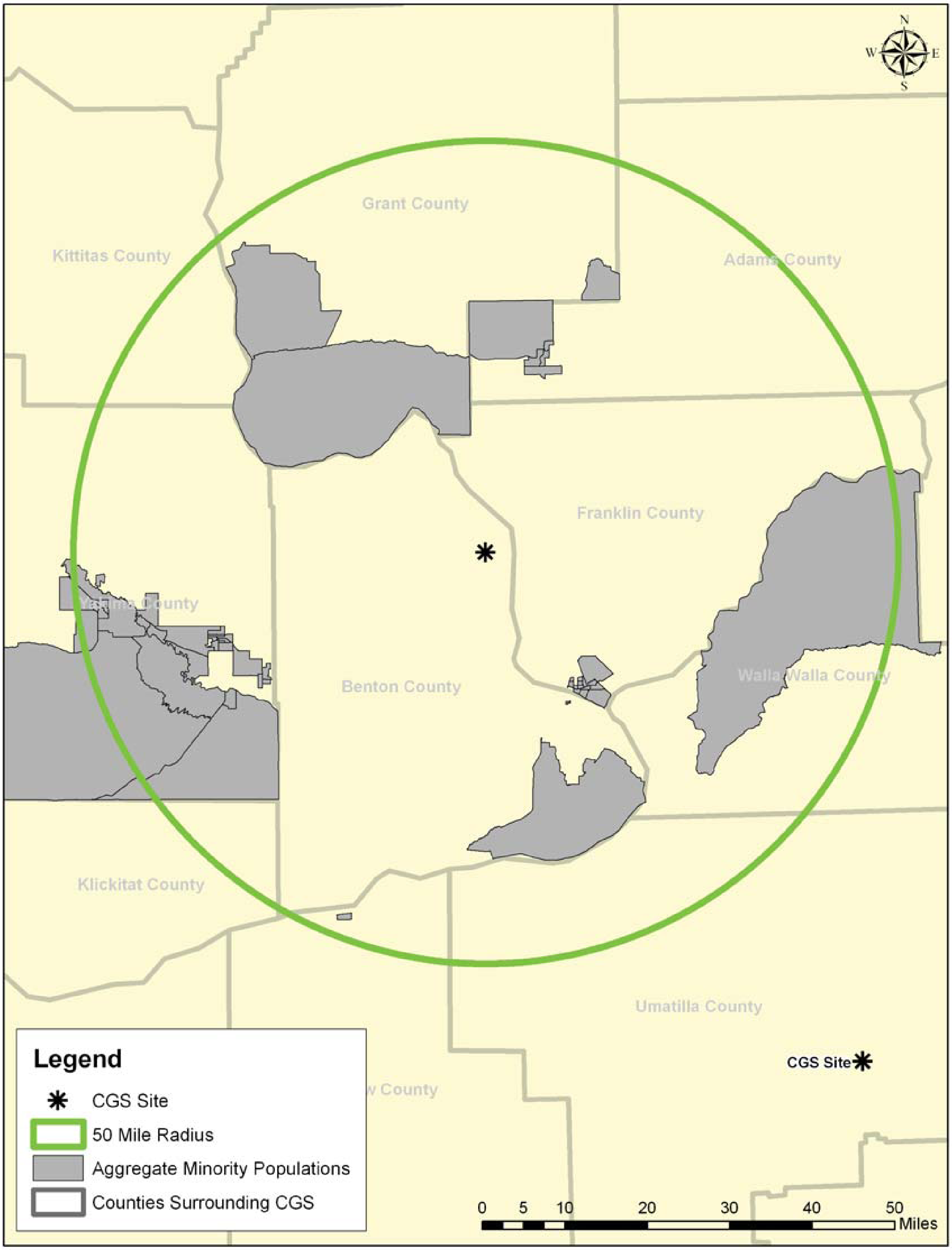

Figure 4.9-1. Census 2000 minority block groups within a 50-mi radius of CGS

(Source: EN, 2010a)

4.9.7.2 Low-Income Population

According to 2000 Census data, approximately 11,000 families (12.2 percent) and 56,000 individuals (15.8 percent) residing within a 50-mi (80 km) radius of CGS were identified as living below the Federal poverty threshold in 1999 (USCB, 2003). The 1999 Federal poverty threshold was $17,029 for a family of four. According to the 2000 Census, 7.3 percent of families and 10.6 percent of individuals in Washington—and 7.9 percent of families and 11.6 percent of individuals in Oregon—were living below the Federal poverty threshold in 1999 (USCB, 2010).

Census block groups were considered low-income block groups if the percentage of families and individuals living below the Federal poverty threshold exceeded the comparison area average by 20 percent or more. Based on 2000 Census data, there were 13 block groups within a 50-mi (80 km) radius of CGS that could be considered low-income block groups. The majority of low-income population census block groups were located in the Tri-Cities area.

According to American Community Survey 3-Year Census data estimates, the median household income for Washington for the years 2006–2008 was $57,234, with 11.6 percent of the state population and 7.9 percent of families living below the Federal poverty threshold. Benton County had a slightly lower median household income average ($54,544) and higher percentages of individuals (12.7 percent) and families (9.9 percent) living below the poverty level when compared to the state average. Franklin County had the lowest median household income between the two counties ($44,744) and higher percentages of individuals (20.9 percent) and families (17.2 percent) living below the poverty level when compared to Benton County and the state (USCB, 2010).

Figure 4.9-2 shows low-income census block groups within a 50-mi (80 km) radius of CGS.

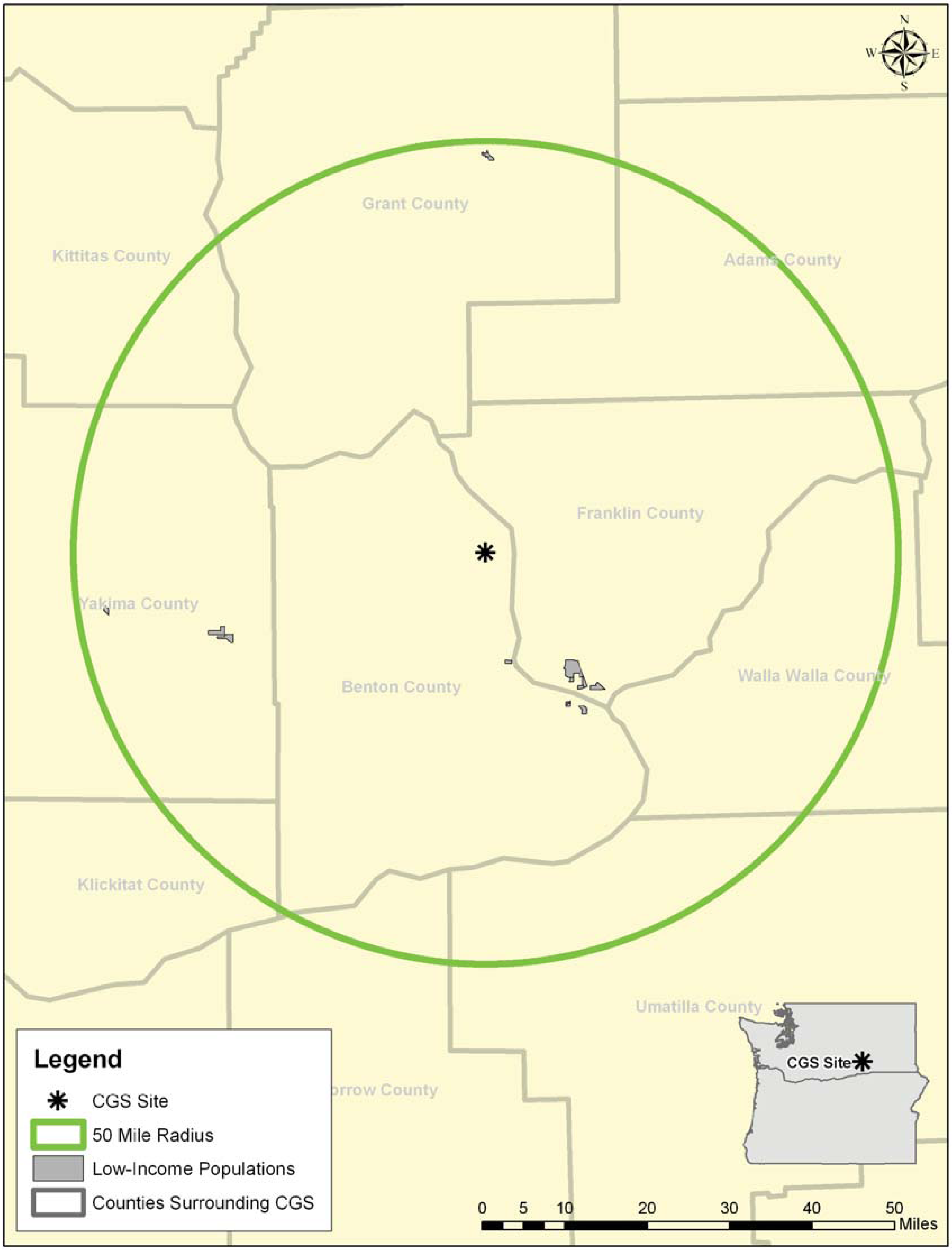

Figure 4.9-2. Census 2000 low-income block groups within a 50-mi radius of CGS

(Source: EN, 2010a)

4.9.7.3 Analysis of Impacts

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

The discussion and figures above identify the minority and low-income populations residing within a 50-mi (80-km) radius of CGS. This area of impact is consistent with the impact analysis for public and occupational health and safety, which also focuses on populations within a 50-mi (80-km) radius of the plant. As previously discussed for the other resource areas in Chapter 4, the analyses of impacts for all environmental resource areas showed that the impact from license renewal would be SMALL.

Potential impacts to minority and low-income populations (such as migrant workers or Native Americans) would mostly consist of radiological effects; however, radiation doses from continued operations associated with this license renewal are expected to continue at current levels and would remain within regulatory limits. Chapter 5 of this SEIS discusses the environmental impacts from postulated accidents that might occur during the license renewal term, which include design basis accidents. The NRC has generically determined that impacts associated with such accidents are SMALL because the plant was designed to successfully withstand design basis accidents.

Socioeconomic conditions at the Yakama Indian Reservation would not change as a result of renewing the CGS operating license. Employment levels at CGS would remain relatively unchanged, so employment opportunities at CGS would remain unchanged. In addition, the Yakama Indian Reservation does not receive income from public utility tax monies paid by Energy Northwest. Therefore, there would be no additional socioeconomic impact to minority and low-income populations on the Yakama Indian Reservation during the license renewal term beyond what is currently being experienced locally.

Therefore, based on this information and the analysis of human health and environmental impacts presented in Chapters 4 and 5, it is not likely there would be any disproportionately high and adverse impacts to minority and low-income populations from the continued operation of CGS during the license renewal term.

As part of addressing environmental justice concerns associated with license renewal, the NRC also assessed the potential radiological risk to special population groups (such as migrant workers or Native Americans) from exposure to radioactive material received through their unique consumption and interaction with the environment patterns including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of airborne radioactive material released from the plant during routine operation. This analysis is presented in Section 4.9.7.4.

The NRC also considered information supplied by American Indian Tribal representatives during this review. The following is a brief summary of the reports submitted to the NRC for consideration in conjunction with its evaluation of the environmental justice impacts from the continued operation of CGS.

<u>Human Scenarios for the Screening Assessment, Columbia River Comprehensive Impact Assessment—March 1996</u>. Because of past nuclear production operations along the Columbia

River, there is intense public and Tribal interest in assessing any residual Hanford Site related contamination along the river from the Hanford Reach to the Pacific Ocean. The Columbia River Comprehensive Impact Assessment was proposed to address these concerns. The assessment of the Columbia River is being carried out in phases. The initial phase is a screening assessment of risk, which addresses current environmental conditions for a range of potential uses.

One component of the screening assessment estimates the risk from contaminants in the Columbia River to humans. Because humans affected by the Columbia River are involved in a wide range of activities, various scenarios have been developed on which to base risk assessments. The scenarios illustrate the range of activities possible by members of the public coming in contact with the Columbia River so that the impact of contaminants in the river on human health can be assessed. Each scenario illustrates particular activity patterns by a specific rate. Risk will be assessed at the screening level for each scenario. This report defines the scenarios and the exposure factors that will be the basis for estimating the potential range of risk to human health from Hanford-derived radioactive as well as non radioactive contaminants associated with the Columbia River. The potential range of risk will be assessed and published in a separate report on the screening assessment of risk. In line with the scope of the screening assessment, the scenarios are Hanford Site-specific (PNNL, 1996).

Yakama Nation Exposure Scenario for Hanford Site Risk Assessment, Richland, Washington, prepared for the Yakama Nation ERWM Program—September, 2007. An exposure scenario for risk assessment was developed for the Confederated Tribes and Bands of the Yakama Nation to describe their traditional subsistence lifestyle, including dietary patterns and seasonal activities. This lifestyle may result in exposure to radioactive and hazardous chemical contamination, now and in the future, from the nearby Hanford Nuclear Reservation in southeastern Washington. The Hanford Site is located within the Yakama Nation ceded territory.

This scenario describes the maximum exposure reasonably expected to occur in the Yakama population, who currently subsist on natural resources near Hanford. Upon adequate cleanup, the Yakama hope to regain access to the Hanford Site, which is part of their usual and accustomed use areas. Without compromising confidential information, details of this scenario will be used by the DOE to complete an exposure assessment to evaluate potential risks to the Yakama Nation from Hanford-associated contamination.

Using ethnographic interview methods, adult Yakama members described fishing, hunting, and gathering practices, sweathouse use, feasts, and ceremonies—all of which remain critical aspects of their subsistence lifestyle and unique culture. These data were compiled to give a qualitative description of the current and anticipated future Yakama lifestyle and develop quantitative exposure parameters.

This project resulted in a conceptual site model that was developed to illustrate potential exposure pathways from Hanford Site contaminant releases to soil, water, plants, fish and other animals, which may ultimately impact the Yakama people. Surveys found that the Yakama depend heavily on the harvest and consumption of fish from local rivers, including the Columbia River, which passes through the Hanford Site. They also depend upon wild game and an abundance of local native plants, including shoots, roots, leafy material, and berries. These resources provide not only foods and medicines, but also material for tools, shelter, and accessories.

Federal guidance documents currently do not include adequate exposure information pertinent to a Native American subsistence lifestyle. This scenario compiles information specific to the Yakama Nation to be considered in evaluating potential risk from Hanford Site contamination and to support appropriate cleanup decisions. Exposure parameters were estimated for inhalation, dermal contact, and ingestion of air, soil, water, fish, meat, vegetables, fruit, and milk, and these parameters reflect the current and anticipated subsistence lifestyle. The Yakama expect that this scenario will be used to evaluate risk in a comprehensive manner for the entire Hanford Site—incorporating all sources, radiological and chemical contaminants, exposure pathways, and natural resource uses appropriately (RIDOLFI Inc., 2007).

Exposure Scenario for CTUIR Traditional Subsistence Lifeways. CTUIR—September, 2004. This report presents updated exposure factors for the CTUIR exposure scenario. Tribal exposure scenarios pose a unique problem in that much of the specific cultural information about the uses of plants and animals for food, medicine, ceremonial, and religious purposes is proprietary. Therefore, the challenge to the scenario developer is to ensure that all human exposures received during the procurement and use of every natural resource are accounted for, without revealing confidential information. Risk assessment methods are fairly qualitative and high-level. Risk assessment exposure equations require simple summary input parameters. For example, the dietary portion of most risk assessments is quite general (fish, meat, above-ground and below-ground vegetation, or root-fruit-leafy plants—sometimes with a little more detail), and typically uses generic soil-to-plant transfer factors that are not species specific.

The report discusses a wide range of factors, directly tied to the traditional Native Americans of the CTUIR, for a risk assessment that is designed and scaled appropriately (Harris and Harper, 2004).

The above reports provided by the CTUIR and Yakama Nation contain information and guidance to be used in the development of a dose assessment model that takes the cultural lifestyle of Native Americans into consideration. The staff did not use the reports to develop a new dose assessment model specific to the Native American community for this SEIS. The staff used the radiological assessment data and conclusions from the radiological environmental monitoring programs conducted by Energy Northwest, DOE, and the State of Washington. These data include monitoring of local vegetation, milk, fish, and game animals that could potentially impact all members of the public in the vicinity of CGS.

4.9.7.4 Subsistence Consumption of Fish and Wildlife

The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area, such as migrant workers or Native Americans.

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

The following is a summary discussion of the NRC's evaluation (from Section 4.8.2) of the REMPs that assess the potential impacts for subsistence consumption of fish and wildlife near the CGS site.

Columbia Generating Station. Energy Northwest has an ongoing comprehensive REMP at CGS to assess the impact of site operations on the environment. To assess the impact of the plant on the environment, samples of environmental media are collected and analyzed for radioactivity. A plant effect would be noted if the radioactive material detected in a sample was significantly larger than the background level.

Samples of environmental media are collected from the aquatic and terrestrial pathways near CGS. The aquatic pathways include fish, Columbia River surface water, sediment, fish, and groundwater. The terrestrial pathways include airborne particulates, milk, local garden produce, and direct radiation. During 2009, analyses performed on samples of environmental media showed no significant or measurable radiological impact above background levels from CGS site operations (EN, 2010c).

Washington State Department of Health. The WDOH is responsible for protecting human health and the environment from the effects of nuclear radiation. The Office of Radiation Protection, Environmental Radiation Monitoring and Assessment Section carries out a REMP. The purpose of the program is to collect samples from the environment, analyze them for trace amounts of radioactive contaminants, and use the results to ultimately determine if the public and the environment are safe from hazards associated with exposure to radioactivity. The surveillance emphasizes major nuclear facilities with known or potential environmental radioactive contamination associated with each facility's operation, decommissioning, or cleanup. Most of the assessment effort relates to radiological surveillance in southeast Washington State at the DOE's Hanford Site and at other nearby nuclear facilities including Energy Northwest's CGS.

Each year, WDOH's Radiation Control Unit typically collects samples of air, Columbia river water, well water, milk, game animals and birds (i.e., deer, rabbit, and pheasant), fish, food crops (i.e., grapes, leafy vegetables, and potatoes), soil, and sediment near CGS and Hanford. In addition to the environmental samples, ambient radiation levels are measured using TLDs.

For 2008, most environmental samples analyzed by WDOH have radioactivity concentrations that are either below detection limits or consistent with background. A few samples have concentrations elevated above background; however, in most cases the concentrations are consistent with historical trends. For example, C-14, tritium, iodine-129 (I-129), Sr-90, Tc-99, and isotopes of uranium were detected above background levels in some Hanford Site and Hanford boundary water samples. A variety of radionuclides—including Cs-137, Eu-152, Pu-239/240, Sr-90, and isotopes of uranium—were found above background levels in some Columbia River sediment samples. Most of the elevated concentrations are consistent with historical trends.

In summary, the 2008 report states that while Hanford operations have resulted in radionuclides entering the environment, the data from the WDOH Oversight Program show that public exposure to radioactivity from Hanford is far below regulatory limits (WDOH, 2011).

U.S. Department of Energy. DOE conducts a REMP at the Hanford Site that includes monitoring of the onsite and offsite environment. During 2008, potential radiological doses to the public and biota from Hanford Site operations were evaluated to determine compliance with pertinent regulations and limits. Doses were assessed in terms of the following:

- total dose (multiple pathways) to the hypothetical, maximally exposed individual at an offsite location
- average dose to the collective population living within 50 mi of Hanford Site operating areas
- dose for air pathways using EPA methods
- dose to workers on the site consuming drinking water
- doses from non-DOE industrial sources on and near the Hanford Site
- absorbed dose received by animals exposed to contaminants released to the Columbia River and in onsite surface water bodies

The DOE’s 2008 Hanford ER states that DOE also maintains an awareness of the other sources of radiation on the Hanford Site (i.e., AREVA NP, Perma-Fix Northwest, and CGS, etc.), which—if combined with the DOE sources—might have the potential to cause an annual dose exceeding 10 mrem (0.10 mSv) to any member of the public. With information gathered from the companies via personal communication and annual reports, the DOE estimated that the total 2008 annual dose to a member of the public from the combined activities was less than 3.0 E-03 mrem (3.0 E-05 mSv). Therefore, the combined annual dose from non-DOE and DOE sources on and near the Hanford Site to a member of the public for 2008 was well below any EPA and DOE regulatory dose limits. Additionally, the levels of radioactivity in the offsite environment had no measurable impact to the offsite environment from the Hanford Site (DOE, 2010d).

Conclusion. Based on the radiological environmental monitoring data from CGS, Washington State, and the DOE, the NRC finds that no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

4.10 Evaluation of New and Potentially Significant Information

New and significant information is information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

The new and significant assessment that Energy Northwest conducted during preparation of this LRA included the following:

- review of documents related to environmental issues at CGS and the site environs
- review of current site activities and interview of site personnel
- review of internal procedures for reporting to the NRC events that could have environmental impacts
- credit for the oversight provided by inspections of plant facilities by state and Federal regulatory agencies
- participation in review of other licensees' ERs, audits, and industry initiatives
- review of SEISs that the NRC has prepared for other LRAs

The NRC also has a process for identifying new and significant information. That process is described in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC, 1999b). The search for new information includes the following:

- review of an applicant's ER and the process for discovering and evaluating the significance of new information
- review of records of public comments
- review of environmental quality standards and regulations
- coordination with Federal, state, and local environmental protection and resource agencies
- review of the technical literature

New information discovered by the staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of an issue that are not affected by the new information.

Energy Northwest reported in its ER that it is aware of one potentially new and significant issue related to its LRA—groundwater contamination. The CGS site is unique among commercial nuclear power reactor sites because the groundwater under the site is contaminated due to nuclear activities largely unrelated to the operation of its nuclear power plant. CGS occupies a small portion of the much larger DOE Hanford Site. The Hanford Site was used for the production of nuclear materials, waste storage, and waste disposal. As a result of historical DOE Hanford Site operations, the groundwater is known to be contaminated with residual radioactive and hazardous materials released into the ground from past nuclear operations that occurred before the construction and operation of CGS. The DOE is currently performing a clean-up of the onsite groundwater and the removal or stabilization of residual contamination. Information on the scope and type of remediation work being done on the Hanford Site is presented in Appendix G of this SEIS.

CGS discharges non-radioactive liquid system effluents from its circulating water blowdown, equipment and floor drains, storm water run-off from plant roofs, treated raw water, and sanitary wastes. Discharges to the Columbia River, and most discharges to the soil, are controlled through operational and administrative procedures to ensure compliance with the limits of its NPDES permit. Water is collected by the storm water drainage system and is piped to an unlined evaporation and percolation pond. While this pond is designed to receive liquids from non-radioactive sources, CGS is aware that the pond contains tritium that is washed off of plant roofs and walls. The source of the tritium is believed to be from tritium contained in CGS routine radioactive gaseous effluents which "rain out" of the atmosphere during the cooler, rainier periods of the year. However, it is not part of CGS's radioactive liquid effluent release pathway that is designed to discharge into the Columbia River. As previously noted in Section 4.8.2 of this SEIS, there have not been any radioactive liquid effluent discharges into the Columbia River in over 10 years.

Energy Northwest performs groundwater monitoring near CGS to characterize the effects of their liquid discharges and to detect unanticipated leakage from plant systems. Energy Northwest reports that the water monitored at the nearest down-gradient water supply wells from CGS located on the IDC have not been impacted with radioactive effluents from the plant. Energy Northwest plans to continue monitoring the wells for contamination. Additionally, DOE plans to continue monitoring the quality of the area-wide aquifer. Energy Northwest does not believe this issue is a new and significant issue in the context of NRC requirements contained in 10 CFR 51.53(c)(3)(iv).

The staff's evaluation of the radiological environmental monitoring data in Section 4.8.2 of this chapter shows that CGS's REMP monitors the onsite and offsite environment for radioactivity. The REMP data supports Energy Northwest's position that the groundwater contamination issue has not had a significant impact on members of the public and environment. In addition, the NRC periodically inspects CGS's radioactive effluent, radiological environmental monitoring, and groundwater protection programs for compliance with regulatory standards. The staff reviewed the most recent NRC inspection report covering the scope of these programs (NRC, 2009). The inspection report stated that there were no findings of significance. The staff will continue to periodically inspect Energy Northwest's compliance with NRC requirements in these areas. Therefore, the staff agrees with Energy Northwest's position that the groundwater contamination issue is not a new and significant issue.

The staff concludes that there is no new and significant information on environmental issues listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, related to the operation of CGS during the period of license renewal.

4.11 Cumulative Impacts

The staff considered potential cumulative impacts in the environmental analysis of continued operation of CGS nuclear plant during the renewed license term. Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with other past, present, and reasonably foreseeable actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE cumulative impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

For the purposes of this cumulative analysis, past actions are those before the receipt of the LRA. Present actions are those related to the resources at the time of current operation of the power plant, and future actions are those that are reasonably foreseeable through the end of plant operation including the period of extended operation. Therefore, the analysis considers potential impacts through the end of the current license terms as well as the renewed license term. The geographic area over which past, present, and reasonably foreseeable actions would occur is dependent on the type of action considered and is described below for each resource area.

To evaluate cumulative impacts, the incremental impacts of the proposed action, as described in Sections 4.1–4.9, are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. The staff used the information provided in the ER; responses to requests for additional information; information from other Federal, state, and local agencies; scoping comments; and information gathered during the visits to the CGS site to identify other past, present, and reasonably foreseeable actions. To be considered in the cumulative analysis, the staff determined if the project would occur within the noted geographic areas of interest and within the period of extended operation, was reasonably foreseeable, and if there would be potential overlapping effect with the proposed project. For past actions, consideration within the cumulative impacts assessment is resource and project-specific. In general, the effects of past actions are included in the description of the affected environment in Chapter 2, which serves as the baseline for the cumulative impacts analysis. However, past actions that continue to have an overlapping effect on a resource potentially affected by the proposed action are considered in the cumulative analysis.

Other actions and projects that were identified during this review and considered in the staff's independent analysis of the potential cumulative effects are described in Appendix G. Examples of other actions that were considered in this analysis include the following:

- proposed reduction of the Hanford Site footprint, including consolidation and acceleration of cleanup and restoration activities, such as cleanup of the 618-11 and 618-10 Burial Grounds
- waste disposal and tank waste stabilization and closure at Hanford, including operation of the Waste Treatment Plant
- decommissioning, deactivation, and closure of various facilities at Hanford, including the Fast Fuel Test Facility (FFTF)
- transportation of radioactive and chemical waste throughout Hanford
- proposed conversion of a portion of the Hanford Site to an energy park
- proposed construction of new energy projects, such as the Desert Claim Wind Project and the McNary-John Day Transmission Line
- operation of dams along the Columbia River, such as Priest Rapids and Wanapum Dams
- Columbia River and Yakima River water management activities
- future urbanization

4.11.1 Cumulative Impacts on Water Resources

The staff conducted an assessment of other projects and actions for consideration in determining their cumulative effects on water resources (Appendix G). This section addresses the direct and indirect effects of license renewal on water resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The geographic area considered in the cumulative water resources analysis covers the unconfined aquifer beneath the Hanford Site and the Hanford Reach portion of the Columbia River from Priest Rapids Dam to Lake Wallula (the McNary Pool) including portions of Benton and Franklin Counties. The Columbia River and unconfined aquifer beneath CGS are hydraulically connected. This review focused on those projects and activities that would use groundwater or could affect the unconfined aquifer beneath the CGS site and/or would withdraw from or discharge water to the Columbia River within this geographic area.

4.11.1.1 Groundwater Resources

Groundwater use by the CGS and in the surrounding area is very small (approximately 1 gpm annual average; Section 4.3), thus groundwater issues are related to quality, not quantity.

There are few users of the unconfined aquifer and no new project with a substantial demand for groundwater is anticipated (EN, 2010a). Reviews of other existing or planned projects in the surrounding area show that some minor use of groundwater will continue. For example, two water-supply wells are being installed to supply water for dust suppression during the decommissioning of the 618-10 Burial Ground. These wells, located approximately 5 km southeast of the CGS site, are planned to produce a combined pumping rate of 250 gpm for 5 days per week, 10 hours per day, for a period of 3–5 years (Nichols, 2010). Other decommissioning activities associated with the 618-11 Burial Ground and FFTF are not expected to use groundwater resources over and above existing uses. Groundwater could be used if future energy projects are developed at the IDC or other areas within Hanford.

As discussed in Section 2.1, groundwater quality at the CGS site is predominately influenced by historical and ongoing activities on the DOE Hanford Site (see Section 2.1.7). Wastewater disposal from Hanford Site activities led to widespread contamination of the unconfined aquifer. Elevated concentrations of tritium, Tc-99, I-129, and nitrate underlie the CGS site, coming from both large dilute plumes emanating from the Hanford Site's 200-East Area and from a small concentrated plume from the 618-11 Burial Ground (DOE, 2010a).

High concentrations of tritium in groundwater from DOE activities were detected in early 1999 at well 699-13-3A, located next to the eastern fence line of the 618-11 Burial Ground, northwest of the CGS site (DOE, 2010a). The contamination was unexpected, and concentrations greatly exceeded the 20,000 pCi/L DWS, with peak concentrations reaching 8 million pCi/L (DOE, 2010a). Subsequent investigations revealed a narrow plume that extends eastward beneath the CGS site with concentrations that are much higher than the surrounding site-wide plume from the 200-East Area (DOE, 2010a). Concentrations near the burial ground have declined, while concentrations at wells farther away from the burial ground reflect migration of the plume (i.e., constant or gradually increasing concentrations trends) (DOE, 2010a). Groundwater monitoring at the CGS site in 2008 found tritium concentrations ranged from less than detectable to 17,400 pCi/L (EN, 2009a).

Tc-99 has also been detected near Burial Ground 618-11 at several hundred pCi/L-still well below the 900 pCi/L DWS (DOE, 2010a). At least some of the Tc-99 contamination observed near this burial ground is associated with the site-wide plume emanating from the 200-East Area. However, historical concentration trends for Tc-99 and tritium at well 699-13-3A are similar, showing that small amounts of Tc-99 may have been associated with the release that created the local tritium plume in 1999 (DOE, 2010a). Nitrate concentrations near the 618-11 Burial Ground and the CGS site have remained elevated above the DWS for many years, with concentrations as high as 113 mg/L at well 699-13-3A, adjacent to the burial ground (DOE, 2010a). With the cessation of wastewater discharges to ground in the central Hanford Site (e.g., 200-East Area), as well as ongoing and future site remediation activities at the 618-11 Burial Ground, the source of these contaminant plumes is being cut off, and the remnant plumes are expected to slowly dissipate.

Discharges to ground at the CGS site also have the potential to alter the quality of the groundwater in the unconfined aquifer. Discharges of stormwater from plant roofs contain tritium, but the concentrations are less than those currently in the groundwater and result in an apparent dilution effect (Section 2.1).

Because the groundwater beneath and adjacent to the CGS site has been noticeably altered by DOE activities, the cumulative impacts on groundwater resources could be characterized as being SMALL to LARGE, depending on location. However, the incremental contribution from

CGS during the extended operations would be SMALL since CGS withdraws a minor amount of groundwater and would not noticeably alter groundwater quality.

4.11.1.2 Surface Water Resources

Withdrawal from the Columbia River is a general concern in the region. To address this concern, resource agencies try to balance the needs of communities, industries, agriculture, hydropower, and aquatic life by regulating the development of water supplies to benefit both in-stream and out-of-stream water uses (WDOE, 2010a). Washington State law requires any users of surface water (lakes, ponds, rivers, streams, or springs) that began after the State water code was enacted in 1917 to obtain a water-right permit or certificate (WDOE, 2010b).

As discussed in Sections 2.1 and 3.2, CGS withdraws about 38 cfs (17,000 gpm) to replenish losses in the evaporative cooling system and to supply water needed for plant processes and drinking (EN, 2010a). This is about 0.03 percent of the averaged mean annual discharge of the Columbia River below Priest Rapids Dam for water years 1960–2009 of 117,823 cfs, or about 0.05 percent of the minimum mean annual discharge of 80,650 cfs (USGS, 2010).

A search of other surface-water withdrawals from the Columbia River in the region of interest shows that the largest user of Columbia River water is the City of Richland, which has active water rights for an estimated maximum combined withdrawal rate of 194 cfs (87,073 gpm). Irrigation is the next greatest use of Columbia River water in this region, with an estimated 17 users accounting for a total active water-rights withdrawal rate of approximately 31.5 cfs (14,138 gpm). DOE has a Federally reserved water-withdrawal right for withdrawals from the Columbia River to support Hanford Site operations (DOE, 1999). In fiscal year 2006, Hanford Site operations withdrew about 817 million L (215.7 million gallons) of water from the Columbia River (DOE, 2009). This is equivalent to an average withdrawal rate of about 0.9 cfs (410 gpm).

The total combined active maximum surface-water-right withdrawal rate (including the CGS) is estimated to be 270 cfs (121,184 gpm); equivalent to about 0.3 percent of the minimum mean-annual discharge of the Columbia River.

There are currently no other substantial withdrawals of Columbia River water within about 6 mi (10 km) of the CGS site. The most significant reasonably foreseeable current and future actions potentially affecting surface-water use include the potential development of an energy project at the IDC site and future urbanization. Both of these actions would likely take advantage of the WNP-1/4 in-river intake and pumphouse, located about 650 ft upstream of the CGS water-withdrawal facilities. Presumably, if a project materialized for the IDC that required substantial water, the sponsor would seek a surface-water right (EN, 2010a). The cities of Richland, Pasco, and Kennewick (Tri-Cities) are expected to withdraw an additional 178 cfs per year for municipal, industrial, and commercial uses (Barwin, 2002).

Potential cumulative effects of climate change on the Columbia River could result from a variety of changes in snowpack, stream flows, and sea level over the coming decades in response to continued and more rapid increases in temperature (Karl, et al., 2009). Declines in the snowpack and earlier snowmelt are projected to cause major changes in the timing of runoff and stream flow, with runoff shifting 20–40 days earlier within this century (Karl, et al., 2009). These changes are projected to cause a reduction in the amount of water available during the warm season leading to increased conflicts between all of the water uses, including hydroelectric power, irrigated agriculture, protecting fish species, reservoir and river recreation, and urban uses (Karl, et al., 2009).

The surface-water quality of the Columbia River in the region of interest is affected by irrigation returns, stormwater, and other effluent discharges—as well as the inflow of groundwater. Small amounts of radioactive materials have been detected downriver from the Hanford Site, but the amounts were far below Federal and state limits. Likewise, other water-quality parameters measured near Richland (USGS Station No. 12473520 at RM 340) found no indication of any deterioration of Columbia River water quality along the Hanford Reach (Poston, et al., 2009). The 2008 assessment of water quality by the State of Washington also found no quality impairments based on water samples in the river reach below Vernita Bridge. However, it did find organic elements in fish tissue and pH and temperature in irrigation return flows as a basis for water-quality impairment at discrete locations (EN, 2010a), (WDOE, 2008).

The staff did not find any foreseeable projects that would impair the water quality of the Columbia River in the region of interest.

Withdrawals at the CGS site are a very small fraction (0.03–0.05 percent) of the river flow, and cooling-tower blowdown has not significantly affected surface-water quality. All current and foreseeable activities are expected to have a combined withdrawal equivalent to about 0.3 percent of the minimum mean-annual discharge of the Columbia River and would not result in significant impacts on surface-water quality. Therefore, the staff concludes that the cumulative surface water use and quality impacts from the proposed license renewal and other past, present, and reasonably foreseeable projects would be SMALL.

4.11.2 Cumulative Impacts on Aquatic Resources

This section addresses the direct and indirect effects of license renewal on aquatic resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. As described in Section 4.5, the incremental impacts on aquatic biota from the proposed license renewal would be SMALL. The geographic area considered in the cumulative aquatic resources analysis includes the migratory pathway for the important anadromous aquatic fish species and EFH in the Columbia River Basin. Fish passage for anadromous species starts in the Pacific Ocean and extends to Chief Joseph Dam (RM 545) on the Columbia River, including the major tributaries upstream of Rock Island Dam that support the upper Columbia River spring-run Chinook salmon (*Oncorhynchus tshawytscha*) (Dauble, 2009). This review focused on the projects and activities that would affect the aquatic biota of the Columbia River within this geographic area.

The benchmark for assessing cumulative impacts on aquatic resources takes into account the pre-operational environment, as recommended by the EPA (1999) for its review of NEPA documents as follows:

> Designating existing environmental conditions as a benchmark may focus the environmental impact assessment too narrowly, overlooking cumulative impacts of past and present actions or limiting assessment to the proposed action and future actions. For example, if the current environmental condition were to serve as the condition for assessing the impacts of relicensing a dam, the analysis would only identify the marginal environmental changes between the continued operation of the dam and the existing degraded state of the environment. In this hypothetical case, the affected environment has been seriously degraded for more than 50 years with accompanying declines in flows, reductions in fish stocks, habitat loss, and disruption of hydrologic functions. If the assessment took into account the full extent of continued impacts, the significance of the

continued operation would more accurately express the state of the environment and thereby better predict the consequences of relicensing the dam.

Sections 2.2.5 and 2.2.7 present an overview of the condition of the Columbia River aquatic ecosystem and the history and factors that led to its current condition. Commercial fisheries in the lower Columbia River in the 1800s reduced the populations of salmon and steelhead to such an extent that efforts to augment the population with fish hatcheries began at the end of the century and continues to the present (Dauble, 2009), (Dauble and Watson, 1997). Also during the 1800s, the ecosystem was further altered by the introduction of non-indigenous commercial and recreational fish species such as American shad (*Alosa sapidissima*), catfish (*Ictaluridae*), and bass (*Centrarchidae*) species (Dauble, 2009).

The irreversible changes to aquatic life in the Columbia River started with the completion of the first hydropower project, Rock Island Dam, in 1933. There are specific alterations documented with the completion of other dams in the Columbia River Basin. Bonneville Dam is 146 mi (235 km) from the Pacific Ocean, and the dam—on which construction began in 1933—became a migratory barrier for many native species such as white sturgeon (*Acipenser transmontanus*) (Dauble, 2009). Construction on The Dalles Dam began in 1957 and inundated Celilo Falls, the natural barrier to the migration of American shad upstream into the mainstem of the Columbia River (Dauble, 2009). Hydropower has been a significant contributor to the decline of native anadromous species such as the upper Columbia River spring-run Chinook salmon (Dauble, 2009), (Dauble and Watson, 1997), (NMFS, 2005).

The biological opinion prepared by the NMFS in 2008 (and supplemented in 2010) for the owners and operators of the Federal Columbia River Power System (FCRPS) describes the historical, current, and forecasted changes to aquatic life in the Columbia River from hydropower operations (NMFS, 2010). Sections 2.2.7 and 4.7 of this SEIS supply additional information on the biological opinion and specifically on the listed salmonid species. The biological opinion also describes actions that FCRPS must take to improve fish survival at Federal dams and throughout the life cycle for the 13 fish species affected by the FCRPS. To complete the actions described in the biological opinion, FCRPS programs include extensive research, monitoring, and evaluation of the fish species and their habitats. The programs noted in the biological opinion incorporate concepts of adaptive management to demonstrate species recovery (NMFS, 2010).

The operation of Priest Rapids Dam noticeably changes the water levels and affects the aquatic resources associated with the CGS (FERC, 2006). Daily water fluctuations limit aquatic habitat (e.g., periphyton growth and shoreline usage by crayfish), encourage invasive species colonization (e.g., purple loosestrife (*Lythrum salicaria*)), and promote predation (e.g., birds access to fish stranded in shallows). The effects of Priest Rapids Dam on the operation of CGS intake and discharge systems are minimal because the intake and discharge structures are deep in the river channel.

Construction and operation of nine nuclear reactors on the Hanford Site from 1943–1987 influenced the aquatic environment of the Hanford Reach. Cofferdams restricted water flow during the placement of shoreline intake structures and discharge lines within the river. The operation of the Hanford Site led to the release of more than 60 radionuclides, many process chemicals, and waste heat into the Hanford Reach (Becker, 1990), (Duncan, et al., 2007). The overall impact to the aquatic resources from the operation of the Hanford Site has yet to be determined and drives ongoing cleanup activities as well as a natural resource damage assessment (Poston, et al., 2009).

The seasonal and daily water fluctuations associated with the operation of Priest Rapids Dam also may affect exposure of aquatic life to environmental contaminants from the Hanford Site. Groundwater transports contaminants from the Hanford Site to the Columbia River. High river stages can retard groundwater transport and concentrate the contaminants in the river bank at low river stage. The benthic organisms in the river are the first receptors of contaminated groundwater. Groundwater plumes from the Hanford Site that are close to, or flowing into, the river include chemicals and radionuclides such as chromium, nitrate, Sr-90, tritium, and uranium. Concentrations of the chemical contaminants in the river are below ambient-water quality criteria for the protection of aquatic species. Although small amounts of radioactive materials were detected in the Columbia River water and sediment samples downstream from the Hanford Site, the amounts were far below Federal and state limits, as discussed previously in Section 4.8.2. Other sources that may contribute to the cumulative effect of chemical contaminant exposure to aquatic resources in the Hanford Reach include high concentrations of nitrate in the groundwater across from the Hanford Site, agricultural returns flowing into the river, and upstream mining activities. DOE's monitoring and remediation programs are addressing the risk to aquatic species in the Hanford Reach from the influence of contaminated groundwater (see Appendix G Table G-1) (Duncan, et al., 2007), (DOE, 2009), (Miley, et al., 2007), (Poston, et al., 2009).

As discussed in Section 4.11.1.2, one regional concern is the withdrawal of Columbia River water. Permitting by resource agencies limits the total consumptive loss and balances the need of multiple water users (EN, 2010a). While the relatively few water withdrawal systems within 20 mi (32 km) are primarily for municipal use, the number of permitted withdrawals within the geographic area of interest is considerable. Direct impacts on aquatic biota can occur from the intake structures (e.g., entrainment and impingement), and oversight by resource agencies and best available technologies that consider protection of aquatic life (e.g., screen systems and fish diversions) may minimize the effects on aquatic life. Indirect impacts on aquatic biota from consumptive water loss in the area of interest range from contributions to extreme seasonal water level fluctuations to the loss of habitat or fish passage, water quality, and water temperature.

Development within the geographic area of interest also contributes to cumulative effects on aquatic life due to decreases in water quality and available habitat. The increase in urbanization within the Columbia River Basin may lead to changes in water quality from point and non-point contaminant discharges. Water temperatures in the tributaries of the Columbia River can increase from changes to shorelines and removal of shade structures (USFWS, 2007). The recovery programs for Federally listed species (e.g., upper Columbia River steelhead (*Oncorhynchus mykiss*)) may affect some of these changes by enhancing fish habitat (NMFS, 2010). Resource agencies can address and minimize impacts through monitoring and permitting programs, such as Washington State Department of Transportation's Fish Passage Program, to minimize impacts from highway crossings (WSDOT, 2010).

Pressures from recreational and commercial fishing within the Columbia River Basin contribute to the cumulative effects on the aquatic resources near CGS. Historically, the fitness of some species has declined (e.g., upper Columbia River spring-run Chinook salmon) because of the mismanagement of some hatchery programs. Release of fish that are not genetically diverse and have behaviors that may result in increased predation are some of the issues of past hatchery practices that are currently being addressed in new programs (NMFS, 2010). Enforcement of fishing regulations for white sturgeon limited the take of sexually mature fish, resulting in an increased population in the Columbia River Basin (Dauble, 2009). USFWS (2007) identified the development of recreational facilities (e.g., boat launches and shoreline camping sites) as contributing to effects on critical habitat for and the recovery of bull trout as part of the biological opinion for relicensing Priest Rapids Dam. For example, accelerated erosion and impacts on riparian function from the construction and operation of recreational facilities may lead to choking of spawning habitat from siltation and increased water temperatures affecting trout development (USFWS, 2007). Recreational fishing activities may encourage the introduction of invasive species (e.g., zebra mussels (*Dreissena polymorpha*)) into the Columbia River Basin (WDFW, 2010) that would not only compete with native aquatic species for food but have the potential to biofoul water-intake systems and affect the operation of facilities like CGS (NRC, 1996).

Reasonably foreseeable future activities include the installation of a proposed gas pipeline, discussed further in Section 4.11.3 (DOE, 2012). The proposed pipeline would be routed under the Columbia River near the 300 area which is located downstream of CGS.

Potential cumulative effects of climate change on the aquatic species of the Columbia River could result from changes in water flow through the river. Climate changes include warmer temperatures with more winter rainfall, less snowpack, and lower summer stream flows. These conditions change the balance of all aquatic resources in the Columbia Basin. For the salmonids, redds could be damaged by higher winter stream flows. Less snowpack and lower summer stream flows could prevent salmonid migration into or out of smaller tributaries, and warmer waters could limit the distribution of some species. Conditions in the ocean could also be less favorable for adult salmonids from the Columbia River Basin. Climate change would lead to unfavorable conditions for Federally and state-listed species as well as other resident aquatic species near CGS (Karl, et al., 2009).

The number of alterations of aquatic habitat and fish passage from past activities, and the number of water withdrawals and water-quality inputs in the Columbia River, has had a significant effect on aquatic resources in the geographic area of interest. The Columbia River aquatic ecosystem has been noticeably altered and continues to require considerable resources to curtail the destabilizing factors that could jeopardize the existence of aquatic species or adversely affect their designated critical habitat in the reasonably foreseeable future. Although the incremental impacts from CGS are minimal because of the use of closed-cycle cooling systems, the cumulative stress from all the alterations to the aquatic habitat, spread across the geographic area of interest, have destabilized the aquatic resources. Therefore, the staff concludes that the cumulative impacts from the proposed license renewal and other past, present, and reasonably foreseeable projects would be LARGE. The incremental impacts from the proposed license renewal would be SMALL since the proposed project would have minimal impacts on aquatic resources.

4.11.3 Cumulative Impacts on Terrestrial Resources

This section addresses the direct and indirect effects of license renewal on terrestrial resources—to include wildlife populations, riparian zones, invasive species, protected species, and land use—when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The geographic area considered in this analysis includes the CGS site, the adjacent habitat along the bank of the Columbia River, and the in-scope transmission line ROWs noted in Section 2.1.5. This area encompasses the primary vegetation and wildlife communities that are affected by operations of the plant.

Before the construction of CGS and its supporting facilities, terrestrial communities in the surrounding area represented typical habitat found in the Columbia Basin shrub-steppe ecosystem, as described previously in Section 2.2.6. Construction of CGS facilities caused land disturbances, including the destruction of sagebrush and non-sagebrush habitat as well as the temporary displacement of wildlife populations, resulting in the spread of invasive species such as cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsoa tragus*). Because of the Hanford Site's protected status since the establishment of the Manhattan Project in 1943, the affected area now serves as an important refuge for the shrub-steppe ecosystem (EN, 2010a). This is largely because much of the land in the Columbia Basin has been converted to agricultural land over the years, while the Hanford and CGS property remains protected by State of Washington resource agencies. This protected area includes the Hanford Reach National Monument, a 305 mi^2 (790 square kilometers (km^2)) reserve on the Hanford Site established in 2000, a small portion of which overlaps with the CGS property (EN, 2010a). Hanford Reach is managed by the USFWS (Kurz, 2010). Construction and operation of the Priest Rapids Dam (RM 397)—located approximately 45 mi (72 km) upriver of CGS (RM 352)—and the McNary Lock and Dam (RM 292)—located 60 mi (97 km) downriver of the CGS—in the 1950s likely raised water levels along the Columbia River and may have had an effect on the vegetation along the riparian corridor adjacent to the CGS (FERC, 2006). The Priest Rapids Dam was recently granted a license extension of 44 years and is discussed in more detail in Section 4.11.2. Land located on the east side of the Columbia River across from the affected area was previously shrub-steppe habitat similar to that of the CGS site but has since been converted to agricultural use.

Construction of the 2,900 ft (880 m) transmission line ROW running north from the CGS, and the 1.8 mi (2.9 km) backup transmission line ROW running southeast from CGS and maintained by BPA for the CGS site, likely resulted in land disturbances similar to those caused by the construction of CGS facilities, including an increased susceptibility to invasive species. Because the shrub-steppe vegetation found under the in-scope transmission lines is slow-growing, vegetation management is not required underneath the transmission lines. Therefore, ROW maintenance is not likely to have present and future impacts on the terrestrial habitat. No additional terrestrial habitat would be affected from CGS license renewal.

Previous and continued residential, commercial, agricultural, and industrial development of the Richland, Pasco, and Kennewick (Tri-Cities) areas surrounding the CGS site are unlikely to affect terrestrial habitat within the affected area. The CGS site is isolated from current and past increases in both commercial and residential development because it is located on land within the Hanford Site that is protected from the public and is located about 12 mi north of any residential developments in Richland, which makes it unlikely that increased urbanization in the Tri-Cities area would affect terrestrial habitat at CGS.

Agricultural land near the CGS site is used largely for irrigated and dryland farming as well as for grazing. Most of the agricultural land is designated as cropland, with a smaller percentage being used for pastureland. It is unlikely that the shrub-steppe terrestrial habitat at CGS or the Hanford Site would be similarly converted for agricultural use in the future because the State of Washington now considers shrub-steppe habitat a Priority 1 ecosystem for conservation due to its scarcity, and the WDNR currently lists shrub-steppe conservation as one of its two most significant projects (WDFW, 2005), (WDNR, 2009). A Priority 1 ecosystem is defined by the State of Washington as an ecosystem with few known occurrences in the natural areas system, the extent of which has been greatly reduced (WDNR, 2007). These ecosystems are considered to be at the highest risk of being destroyed or degraded (WDNR, 2007).

Continued operation and management of the Hanford Site, including cleanup and restoration activities, tank closures, decommissioning, deactivation, and closure of various facilities on the Hanford Site, are likely to have some continued impacts on the surrounding terrestrial habitat. One example of cleanup and restoration activities on the Hanford Site is DOE's Columbia River

Closure Project, which includes approximately 218 mi^2 (565 km^2) of the Columbia River corridor at Hanford. The primary goal of this cleanup project is to remove groundwater contaminating materials, and includes the 618-11 Burial Ground adjacent to the CGS site (WCH, 2010). Characterization and remediation of the 618-11 Burial Ground is scheduled to begin in 2011 and to be completed by 2018 (DOE, 2011).

DOE is currently evaluating plans for constructing a 15-mi pipeline spur from the regional gas transmission line in Pasco to the Hanford Site (DOE, 2012). This pipeline would provide natural gas to the waste treatment plant currently under construction at Hanford and other industrial facilities on the Hanford Site. Natural gas would also be available via this pipeline for future industrial facilities at the Hanford Site.

Any new construction or ground disturbing activities on the Hanford Site would have a potential impact on terrestrial resources in the area. For example, the proposed Mid-Columbia Energy Initiative Energy Park at Hanford would use a portion of the Hanford Site for renewable energy production. Initial construction of such a facility would affect the surrounding terrestrial resources, much like the impacts from the original CGS construction. Plant communities (including sagebrush and non-sagebrush habitat) would be affected by any new construction carried out in previously undisturbed areas. Wildlife species such as mule deer, coyotes, northern pocket gopher, sage sparrow, and western meadowlark could be temporarily displaced from their current habitat by ground disturbing activities onsite, particularly if construction were to take place during the breeding season for ground-nesting birds (DOE, 2009). Increased noise levels due to construction and additional workers could also result in the temporary displacement of some wildlife species in the immediate area (DOE, 2009). However, because the Hanford Site is a protected resource area, it is a reasonable conclusion that best management practices would be used during construction to protect the area's unique shrub-steppe ecosystem. The continued operation of the adjacent Hanford Reach National Monument and Saddle Mountain National Wildlife Refuge would ensure additional protection for terrestrial resources in the area and refuge for temporarily displaced wildlife (USFWS, 2008).

The potential cumulative effects of climate change could result in a variety of changes to terrestrial resources on and around the CGS site. Average temperatures in the northwest region are projected to rise over the next century, as well as increased precipitation projected for the winter and decreased precipitation projected for the summer (Karl, et al., 2009). Inadequate water availability during the summer season as a result of reduced springtime snowpack could affect terrestrial ecosystems in the northwest region to include wildlife populations, species of concern, upland habitats, riparian zones, and invasive species. Increased precipitation, insect outbreaks, and wildfires could change vegetation composition on the CGS site. Long-term effects of climate change on terrestrial resources could include a shift in vegetation composition, loss of bird diversity, a change in local mammal populations, and an increase in invasive species and other pests (Karl, et al., 2009).

The staff examined the cumulative effects of initial construction of the site and transmission lines, impacts to protected species, effects of existing and proposed neighboring facilities at the Hanford Site, surrounding agricultural use, and land development in the Tri-Cities area. The staff concludes that the minimal terrestrial impacts expected from continued CGS operations, including the operation and maintenance of the in-scope transmission line corridors, would not contribute to the overall decline in the condition of terrestrial resources. Based on both the protected status of the terrestrial resources in the CGS area and the potential incremental impacts from the ongoing activities on the adjacent Hanford Site, including its potential use as a power generating facility, the staff concludes that the cumulative terrestrial resource impacts from the proposed license renewal and other past, present, and reasonably foreseeable projects would be MODERATE.

4.11.4 Cumulative Impacts on Human Health

This section addresses the direct and indirect effects of license renewal on human health when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. For the purpose of this analysis, the geographic area considered is a 50-mi (80.4-km) radius of CGS. Within the 50-mi (80-km) radius of the CGS site is the Hanford Site, and immediately adjacent to the southern boundary of the Hanford Site, AREVA NP, Inc. operates a commercial nuclear fuel fabrication facility and Perma-Fix Northwest, Inc. operates a low-level and mixed low-level radioactive waste processing facility. Westinghouse Electric Company operates the Richland Service Center, located in north Richland, which provides chemical cleaning, decontamination, and other waste processing services to the nuclear industry.

The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190.

The REMP carried out by Energy Northwest near the CGS site measures radiation and radioactive materials from all sources, such as hospitals, other licensed users of radioactive material, and facilities described in Appendix G, Table G-1; therefore, the monitoring program measures cumulative radiological impacts. Radioactive effluent and environmental monitoring data from CGS's annual REMP reports for the 5-year period from 2005–2009 were reviewed as part of the cumulative impacts assessment. In Section 4.8.2, the staff concluded that impacts of radiation exposure to the public and workers (occupational) from operation of CGS, and the storage of spent nuclear fuel, during the renewal term are SMALL. In addition, the staff reviewed the environmental monitoring data for the Hanford Site measured by Washington State and the DOE. The data show that there is no significant radiological impact to the public and environment (see Section 4.8.2). The DOE's Hanford ERs stated that the potential radiation doses from the Hanford Site to members of the public in the offsite environment were lower than EPA and DOE standards.

Energy Northwest constructed an ISFSI on the CGS site in 2000 for the storage of its spent fuel. The installation and monitoring of this facility is governed by NRC requirements in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste." Radiation from this facility, as well as from the operation of CGS, is required to be within the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 72. The NRC carries out periodic inspections of the ISFSI to verify its compliance with its licensing and regulatory requirements.

Current and reasonably foreseeable actions on the Hanford Site include restoration and remediation of contaminated areas; decommissioning of various facilities; tank waste storage, retrieval, treatment, disposal, and final tank closure; expansion or upgrades to the existing waste storage, treatment, and disposal capacity; and transportation of nuclear waste within and off of the Hanford Site (DOE, 2009),(WCH, 2010). Additional details on these activities are given in Appendix G, Table G-1.

While not considered to be a reasonably foreseeable action, the staff is aware of information concerning the use of a new type of fuel at CGS. In February 2011, the staff, through newspaper articles, became aware that Energy Northwest is considering the potential use of mixed oxide (MOX) fuel at CGS. MOX fuel is produced by taking nuclear weapons plutonium oxide at about 10–15 percent concentration levels and blending it with uranium oxide to enrichment levels suitable for commercial nuclear reactors.

Energy Northwest is interested in advanced fuel technologies, including MOX fuel, said a spokesperson for Energy Northwest. The spokesperson also stated that Energy Northwest has no plans to use MOX fuel without more research and cannot predict the viability of the fuel for use at CGS. Energy Northwest is talking with Pacific Northwest National Laboratory in Richland about a study to evaluate the feasibility of using the fuel at CGS (Cary, 2011a).

At this time, the NRC has not received notification from Energy Northwest on its plans to use MOX fuel in the future. The staff notes that a change in the type of fuel used at CGS will require a thorough evaluation by the NRC on the safety and environmental impacts associated with the new fuel prior to receiving approval for its use.

Based on its review of the DOE's annual Hanford Site ERs, the staff noted that the Hanford Site is subject to many safety standards and regulations. There are three categories of standards and regulations: (1) DOE directives; (2) Federal legislation and EOs; and (3) state and local statutes, regulations, and requirements. Several Federal, state, and local government agencies monitor and enforce compliance with applicable environmental regulations for ongoing operations and for the remediation work being performed at the Hanford Site. Some of those agencies include the EPA, Washington State Department of Ecology, WDOH, and Benton Clean Air Authority. These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations. There are specific requirements, actions, plans, and schedules identified in the Tri-Party Agreement and other agreements. Therefore, the staff has reasonable assurance that future nuclear operations and remediation activities carried out at the Hanford Site will be done in accordance with all applicable Federal, state, and local government agencies requirements to limit the radiological impact to the public and the environment.

The DOE's 2008 Hanford ER states that DOE maintains an awareness of the other sources of radiation on the Hanford Site (e.g., AREVA NP, Perma-Fix Northwest, and CGS) that, if combined with the DOE sources, might have the potential to cause an annual dose exceeding DOE's annual radiation standard of 100 mrem (1.0 mSv) for all radiation exposure pathways or EPA's 10 mrem (0.10 mSv) standard for the air intake radiation exposure pathway in 40 CFR Part 61 to any member of the public (Poston, et al., 2009). With information gathered from the companies via personal communication and annual reports, the DOE estimated that the total 2008 annual dose to a member of the public from the combined activities was less than 3.0 E-03 mrem (3.0 E-05 mSv). Therefore, the combined annual dose from non-DOE and DOE sources on and near the Hanford Site to a member of the public for 2008 was well below any EPA and DOE regulatory dose limits. The staff has reasonable assurance that DOE will continue to comply with radiation protection standards in the future.

The NRC, State of Washington, and DOE would regulate any future actions near the CGS site that could contribute to cumulative radiological impacts. The environmental monitoring performed by CGS, Washington State, and DOE would measure the cumulative impact from any future nuclear operations.

Based on the above information, the staff concludes that cumulative radiological impacts would be SMALL.

For electromagnetic fields, the staff determined that the CGS transmission lines are operating within design specifications and meet current NESC criteria; therefore, the transmission lines do not significantly affect the overall potential for electric shock from induced currents within the analyzed area of interest. With respect to the effects of chronic exposure to extremely low frequency-electromagnetic fields, although the GEIS finding of "not applicable" is appropriate to CGS, the transmission lines associated with CGS are not likely to significantly contribute to the regional exposure to ELF-EMFs. The proposed McNary-John Day transmission line would also conform to design specifications that meet current NESC criteria (DOE, 2002a). The proposed Vantage-Pomona transmission line would be built to meet National Electrical Safety Standard requirements (Pacific Power, 2011). Therefore, the staff has determined that the cumulative impacts of continued operation of the CGS transmission lines and other transmission lines in the affected area would be SMALL.

4.11.5 Cumulative Socioeconomic Impacts

4.11.5.1 Socioeconomics

This section addresses socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at the CGS in addition to the aggregate effects of other past, present, and reasonably foreseeable future actions. The primary geographic area of interest considered in this cumulative analysis is Benton and Franklin Counties, which includes the Tri-Cities area, where approximately 95 percent of CGS employees reside. This area is where the economy, tax base, and infrastructure would most likely be affected since CGS employees and their families reside, spend their income, and use their benefits within these counties.

Located in Benton County, the Hanford Site was selected by the Federal government for the Manhattan Project in 1942. The need for workers at Hanford resulted in a significant increase in the regional population. A summary of past socioeconomic conditions since 1970 can be found in the Final Environmental Statements for the Construction Permit and Operational Stage of WPPSS Nuclear Project No. 2 (AEC, 1972), (NRC, 1981).

DOE is currently focused on cleaning up defense wastes at Hanford. Restoring burial waste sites, decommissioning various facilities, conducting tank closures, and conducting other activities to reduce the Hanford footprint are described in Appendix G, Table G-1 (DOE, 2009). Any sizeable increase in the Hanford workforce supporting site restoration activities would have a noticeable effect on socioeconomic conditions in the Tri-Cities area by noticeably increasing the regional population—including the demand for community services and housing—and straining local transportation. Most of the workers at the Hanford Site would likely live in the same communities where CGS employees and their families currently reside. The socioeconomic impact from CGS operations and Hanford restoration activities, therefore, overlap.

As part of Hanford restoration activities, DOE has proposed to develop an energy park to sustain the local and regional economies by supplying jobs at new energy production facilities (DOE, 2010c). The area would be made available for public and private energy demonstration projects and partnerships (EN, 2010a). Construction of the energy park would occur after the majority of restoration activities have been completed at the Hanford Site, and it could provide a source of employment for workers formerly employed by the Hanford restoration effort. Since the energy park would hire significantly fewer workers than the Hanford restoration effort, there would be no significant cumulative impacts. In addition, construction of new facilities to build new solar panels, wind turbines, nuclear generators, or other facilities could result in some aesthetic impacts.

Socioeconomic impacts from reasonably foreseeable activities at the Hanford Site are likely to noticeably increase the population, along with the demand for community services and housing, while straining local transportation. The primary cause for this impact would be DOE's restoration efforts on the Hanford Site.

As discussed in Section 4.9, continued operation of CGS during the license renewal term would have no effect on socioeconomic conditions in the region beyond those already experienced. Since Energy Northwest has no plans to hire additional workers during the license renewal term, overall expenditures and employment levels at CGS would remain relatively constant with no additional demand for permanent housing and public services. In addition, since employment levels and tax payments would not change, there would be no population or tax revenue-related land use impacts. Based on this, and other information presented in Chapter 4, there would be no additional contributory effect on socioeconomic conditions in the future from the continued operation of CGS during the license renewal term beyond what is currently being experienced.

4.11.5.2 Environmental Justice

The environmental justice cumulative impact analysis assesses the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from past, present, and reasonably foreseeable future actions including CGS operations during the renewal term. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts, or risk of impact, on the natural or physical environment in a minority or low-income community that are significant and appreciably exceeds the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been noted in resource areas presented in Chapter 4. Minority and low-income populations are subsets of the general public residing in the Tri-Cities area and all would be exposed to the same hazards generated from CGS operations and restoration activities at the Hanford Site.

As discussed in Section 4.9.7, minority and low-income populations residing within a 50-mi (80-km) radius of CGS would not be disproportionately affected by the continued operation of CGS. As previously discussed in this chapter, the impact from license renewal for all resource areas (e.g., land, air, water, ecology, and human health) would be SMALL.

Potential impacts to minority and low-income populations from continued CGS operations during the license renewal term and ongoing restoration activities at the Hanford Site would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from Hanford restoration activities would be primarily limited to onsite activities. Minority and low-income populations residing along site access roads would continue to be affected by commuter vehicle and truck traffic. However, these effects occur during certain hours of the day and are not likely to be high and adverse. Increased demand for rental housing during certain periods of increased restoration activities at Hanford could also affect low-income populations. Given the close proximity to the Tri-Cities area, however, most workers would likely commute to the Hanford Site, thus reducing the potential demand for rental housing.

This cumulative impact assessment also considered the potential radiological risk to special population groups from CGS as well as other sources of radiation from projects described in Appendix G, Table G-1, including past and present activities at the Hanford Site. In Sections 4.9.7 and 4.11.4, the NRC analyzed human health impacts to traditional lifestyle pathway receptors. Local American Indian Tribes depend heavily on the harvest and consumption of fish from local rivers—including the Columbia River, which passes through the Hanford Site—wild game, and an abundance of local native plants to include shoots, roots, leafy material, and berries for foods, medicines, material for tools, shelter, and accessories. Any impact to the Columbia River due to increased population and residential and commercial development could disproportionately affect American Indian and low-income peoples who rely on fishing and hunting along the river.

The assessment also considered whether other cumulative environmental impacts could result in disproportionate adverse impacts on minority or low-income populations. As described above, there could be general adverse socioeconomic impacts through increased population, commercial and residential developments, demand for community services and housing, and traffic from the number of workers needed to support restoration activities at the Hanford Site. However, such impacts would likely be the same for all segments of the population.

As discussed in Section 4.9.7, there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of CGS during the license renewal term. Since Energy Northwest has no plans to hire additional workers during the license renewal term, employment levels at CGS would remain relatively constant with no additional demand for housing or increased traffic. Based on this information, and the analysis of human health and environmental impacts presented in Chapters 4 and 5, it is not likely there would be any disproportionately high and adverse contributory effect on minority and low-income populations from the continued operation of CGS during the license renewal term.

4.11.6 Cumulative Impacts on Cultural Resources

This section addresses the direct and indirect effects of license renewal on historic and archaeological resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The geographic area considered in this analysis is the APE associated with the proposed undertaking, as defined in Section 4.9.6. In addition to the APE, potential indirect effects were assessed within the viewshed between CGS and Gable Mountain and between CGS and Rattlesnake Mountain because both Gable and Rattlesnake Mountains (two National Register-eligible traditional cultural properties) are significant cultural resources that overlook the CGS site.

Before major land development, the area was largely undisturbed and contained several intact archaeological sites. Section 2.2.9 presents an overview of the existing historic and archaeological resources located on the CGS site. Past land development has resulted in impacts on, and the loss of cultural resources near and at, the CGS site.

As described in Section 4.9.6, no significant cultural resources would be adversely affected by relicensing activities associated with the CGS site because there would be no ground-disturbing activities that would occur as part of relicensing. In addition, continued operations at the CGS site would result in no additional visual intrusions beyond those that currently exist.

To address the impacts from other present and reasonably foreseeable projects, the list of projects noted in Appendix G, Table G-1, was reviewed to analyze overlapping impacts that might directly or indirectly affect cultural resources. Direct impacts would occur if archaeological sites in the APE are physically removed or disturbed, and indirect impacts would occur if projects result in the introduction of significant visual intrusions within the viewshed between CGS and Gable and Rattlesnake Mountains. There are several proposed projects on the Hanford Site that are located between the CGS site and Gable and Rattlesnake Mountains. These projects include the following (DOE, 2009):

- cleanup of debris and infrastructure and construction of the new Combined Community Communication Facility on Rattlesnake Mountain
- decommissioning, deactivation, and closure of the FFTF
- ongoing waste management activities on the Hanford Site
- tank closure and Waste Treatment Plant construction
- any additional ground-disturbing or construction activities occurring in this area for the development of energy or other projects

Construction and operation of these projects has the potential to result in short- and long-term visual intrusions within the viewshed of traditional cultural properties at Gable and Rattlesnake Mountains.

The cumulative impacts on cultural resources from ongoing construction, restoration, and waste management activities on the Hanford Site have the potential to be significant, particularly within the viewshed of Gable and Rattlesnake Mountains. The incremental contribution from the proposed license renewal would not adversely change the viewshed or directly affect cultural resources. The review team concludes that the cumulative impacts of the proposed license renewal plus other past, present, and reasonable foreseeable future activities on the cultural resources would be MODERATE. The incremental impacts from CGS would be SMALL because relicensing would not adversely change the viewshed or directly affect cultural resources.

4.11.7 Cumulative Impacts on Air Quality

This section addresses the direct and indirect effects of license renewal on air quality resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The geographic area considered in the cumulative air quality analysis is the county of the proposed action because air quality designations for criteria air pollutants are generally made at the county level. Counties are further grouped together based on a common air shed—known as an air quality control region (AQCR)—to provide for the attainment and maintenance of the National Ambient Air Quality Standards (NAAQS). The CGS site is located in Benton County, Washington, which is part of the South Central Washington Intrastate AQCR (40 CFR 81.189). Additional counties in this AQCR include Franklin, Kittitas, Klickitat, Walla Walla, and Yakima Counties.

Section 2.2.2 summarizes the air quality designation status for Benton County as well as other counties in the South Central Washington Intrastate AQCR. As noted in Section 2.2.2, the EPA regulates six criteria pollutants under the NAAQS to include carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter. Benton County is designated as unclassified or in attainment for all NAAQS criteria pollutants; a portion of Benton County, which does not include the CGS site, became a maintenance area for PM-10 (particles with a diameter of 10 micrometers or less) on September 26, 2005 (40 CFR 81.348). Portions of Yakima County, which are also part of this AQCR, are also maintenance areas for PM-10 as well as carbon monoxide (40 CFR 81.348). All other counties in this AQCR are designated as unclassified or in attainment with respect to the NAAQS criteria pollutants.

Criteria pollutant air emissions from the CGS site are presented in Section 2.2.2.1. These emissions are principally from standby diesel generators and conform to Washington State Regulatory Order 672 which limits fuel consumption and associated air emissions (EFSEC, 1996). Continued operations of the CGS site would result in annual air emissions comparable to those noted in Section 2.2.2.1. Assuming an average annual emission rate of 721 tons per year (656 metric tons per year) for carbon dioxide, an additional 20 years of operation would result in approximately 14,420 tons (13,122 metric tons) of carbon dioxide. There is no planned site refurbishment associated with license renewal; therefore, there are no additional air emissions beyond those noted in Section 2.2.2.1 for normal operations.

Appendix G, Table G-1 describes foreseeable projects that could contribute to cumulative impacts to air quality. Many of the projects are related to DOE's efforts to restore burial waste sites, decommission various facilities, conduct tank closures, and conduct other activities to reduce the Hanford footprint (DOE, 2009). Notable Hanford-related projects that would affect future air quality include the following:

- decommissioning of the remaining production reactors and support facilities in the 100 Area (DOE, 1992)
- decommissioning of the N-Reactor and support facilities (DOE, 2005)
- disposition of the PUREX plant, canyons, and tunnels, and other 200 Area facilities (Fluor Hanford, 2004)
- deactivation of the FFTF in the 400 Area (DOE, 2002b)
- actions related to tank closure and waste management, including the construction and operation of the Waste Treatment Plant (DOE, 2009)

As discussed in several of the environmental impact documents for these projects (e.g., DOE, 2009), various control and mitigation measures would be instituted to reduce air emissions to an acceptable level so as to not exceed any applicable standard.

Continued air emissions from non-DOE activities at the Hanford Site include emissions from transport of U.S. Navy reactor plants to the 200-East Area (Navy, 1996) and operation of the U.S. Ecology commercial low-level radioactive waste disposal site (WDOE and WDOH, 2004). Other projects and actions listed in Appendix G, Table G-1, that would contribute to air emissions in Benton and nearby counties include base realignment and closure activities at nearby Department of Defense (DoD) facilities, future power and biofuel projects, oil and gas exploration, and surface mining. Development and construction activities associated with regional growth of housing, business, and industry—as well as associated vehicular traffic—would also result in additional air emissions. Project timing and location, which are difficult to predict, affect cumulative impacts to air quality. However, permitting and licensing requirements, efficiencies in equipment, cleaner fuels, and various mitigation measures can be used to minimize cumulative air quality impacts.

Potential cumulative effects of climate change in central Washington, where CGS is located, could result in a variety of changes to the air quality of the area. As projected in the "Global Climate Change Impacts in the United States" report by Karl, et al. (2010), the temperatures in this region are expected to rise 6 degrees F (14 degrees C) to 10 degrees F (12 degrees C) by the end of this century, causing more frequent extreme weather events. Increases in average annual temperatures, higher probabilities of extreme heat events, higher occurrences of extreme rainfall (intense rainfall or drought), and changes in the wind patterns could affect concentrations of the air pollutants and their long-range transport because their formation partially depends on the temperature and humidity and is a result of the interactions between hourly changes in the physical and dynamic properties of the atmosphere, atmospheric circulation features, wind, topography, and energy use (IPCC, 2010).

Given that there is no planned site refurbishment associated with the CGS license renewal and, therefore, no additional air emissions beyond those noted in Section 2.2.2.1 from continued operations of CGS, the incremental impacts to cumulative air quality impacts in Benton County would be minimal. Other reasonably foreseeable projects described above—such as construction and operation of waste disposal facilities, decommissioning, and remediation efforts on the Hanford Site—could result in cumulative impacts to air quality. However, permitting and licensing requirements and various mitigation measures would likely limit air quality impacts such that they remain below applicable air quality standards. Therefore, the staff concludes that the cumulative air quality impacts from the proposed license renewal and other past, present, and reasonably foreseeable projects would be SMALL.

4.11.8 Summary of Cumulative Impacts

The staff considered the potential impacts resulting from the operation of CGS during the period of extended operation and other past, present, and reasonably foreseeable future actions near CGS. The staff's determination is that the potential cumulative impacts would range from SMALL to LARGE, depending on the resource. Table 4.11-1 summarizes the cumulative impacts on resources areas.

Table 4.11-1. Summary of cumulative impacts on resources areas

Resource area	Cumulative impact
Water Resources	Because the groundwater beneath and adjacent to the CGS site has been noticeably altered by DOE activities at Hanford, the cumulative impacts on groundwater resources are SMALL to LARGE, depending on location. However, the incremental contribution from CGS operations would be SMALL. Cumulative surface water impacts would be SMALL because CGS and other water users would withdraw a small fraction of the river flow, and CGS activities would not result in significant impacts on surface-water quality.
Aquatic Ecology	Past alterations of aquatic habitat and fish passage has noticeably altered the Columbia River aquatic ecosystem. Considerable resources would be required to curtail the destabilizing factors that could jeopardize the existence of aquatic species or adversely affect their designated critical habitat in the reasonably foreseeable future. This condition meets NRC's definition of a LARGE level of impact. The incremental impact from CGS license renewal is SMALL.
Terrestrial Ecology	Past, current, and future construction, restoration, and waste management activities on the Hanford Site have the potential to affect terrestrial resources. Therefore, the cumulative impacts would be MODERATE, although the incremental contribution from the proposed license renewal would be SMALL and would not adversely affect terrestrial resources.
Human Health	The REMP carried out by Energy Northwest near the CGS site measures radiation and radioactive materials from all sources, such as hospitals, other licensed users of radioactive material, and facilities described in Appendix G, Table G-1; therefore, the monitoring program measures cumulative radiological impacts. Staff reviewed environmental monitoring data for the CGS site, measured by Energy Northwest, and for the Hanford Site, measured by Washington State and the DOE. The data show that there is no significant radiological impact to the public and environment; therefore, the cumulative impacts are SMALL.

Resource area	Cumulative impact
Socioeconomics	Socioeconomic impacts from reasonably foreseeable activities at the Hanford Site are likely to noticeably increase the population along with the demand for community services and housing, while straining local transportation. As discussed in Section 4.9, continued operation of CGS during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already experienced.
Cultural Resources	Ongoing construction, restoration, and waste management activities on the Hanford Site have the potential to significantly affect cultural resources, particularly within the viewshed of Gable and Rattlesnake Mountains. Therefore, the cumulative impacts would be MODERATE, although the incremental contribution from the proposed license renewal would be SMALL and would not adversely change the viewshed or directly affect cultural resources.
Air Quality	Reasonably foreseeable activities—such as construction and operation of waste disposal facilities, decommissioning, and remediation efforts on the Hanford Site—could result in cumulative impacts to air quality. However, permitting and licensing requirements and various mitigation measures would likely limit air quality impacts such that they remain below applicable air quality standards. The incremental impacts from CGS operations would be minimal since no refurbishment activities are planned. Therefore, the staff concludes that the cumulative air quality impacts would be SMALL.

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This chapter describes the environmental impacts from postulated accidents that Columbia Generating Station (CGS) might experience during the period of extended operation. Appendix F contains a more detailed discussion of this assessment. The term "accident" refers to any unintentional event outside the normal plant operational envelope that results in a release or the potential for release of radioactive materials into the environment. Two classes of postulated accidents are evaluated in the generic environmental impact statement (GEIS), as listed in Table 5.1-1. These two classes include the following:

- design basis accidents (DBAs)
- severe accidents

Table 5.1-1. Issues related to postulated accidents

Two issues related to postulated accidents are evaluated under the National Environmental Policy Act (NEPA) in the license renewal review: DBAs and severe accidents.

Issues	GEIS section	Category
DBAs	5.3.2; 5.5.1	1
Severe accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	2

5.1 DBAs

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

DBAs are those accidents that both the licensee and the staff evaluate to ensure that the plant can withstand normal and abnormal transients and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. Many of these postulated accidents are not expected to occur during the life of the plant but are evaluated to establish the design basis for the preventive and mitigative safety systems of the nuclear power plant. Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 and 10 CFR Part 100 describe the acceptance criteria for DBAs.

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

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all nuclear power plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, DBAs are designated as a Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The early resolution of the DBAs makes them a part of the current licensing basis (CLB) of the plant; the CLB of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This issue is applicable to CGS.

Based on information in the GEIS, the NRC found that "[t]he environmental impacts of design basis accidents are of small significance for all plants."

Energy Northwest (EN) stated in its Environmental Report (ER) (EN, 2010a) that it is not aware of any new and significant information related to DBAs associated with the renewal of the CGS OL. The staff has not noted any new and significant information during its independent review of the Energy Northwest ER, the scoping process, the staff's site visit, or its evaluation of other available information. Therefore, the staff concludes that there are no impacts related to DBAs, beyond those discussed in the GEIS.

5.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the staff assessed the effects of severe accidents during the period of extended operation, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the period of extended operation.

Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, fires, and sabotage have not traditionally been discussed in quantitative terms in FESs and were not specifically considered for CGS in the GEIS. However, the GEIS did evaluate existing impact assessments—performed by the staff and by the industry at 44 nuclear power plants in the U.S.—and concluded that the risk from beyond design-basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal performed a discretionary analysis of sabotage, in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally-initiated events. In the GEIS, the NRC concludes that the risk from sabotage at existing nuclear power plants is SMALL and, additionally, that the risks from other external events are adequately addressed by a generic consideration of internally-initiated severe accidents (NRC, 1996). Section 5.2.1 of this chapter gives a more detailed discussion of severe accidents initiated by terrorism associated with license renewal.

Based on information in the GEIS, the NRC noted the following:

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

The staff found no new and significant information related to postulated accidents during the review of Energy Northwest's ER (EN, 2010a), the site visit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues, beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the staff reviewed severe accident mitigation alternatives (SAMAs) for CGS. Section 5.3 discusses the results of the review.

5.2.1 Severe Accidents Initiated by Sabotage and Terrorism

5.2.1.1 Background

Generic Finding for Sabotage and Terrorism for License Renewal of Nuclear Power Plants. The 1996 GEIS for License Renewal of Nuclear Plants (NUREG-1437) addresses environmental impact of terrorist acts. Section 5.3.3.1 of the GEIS states the following:

> Although the threat of sabotage events cannot be accurately quantified, the Commission believes that acts of sabotage are not reasonably expected. Nonetheless, if such events were to occur, the Commission would expect that resultant core damage and radiological releases would be no worse than those expected from internally initiated events.

Based on this statement, the NRC concluded in the GEIS that the risk from sabotage at existing nuclear power plants is small.

Implications of 9/11. As a result of the terrorist attacks of September 11, 2001, (9/11) the NRC carried out a comprehensive review of the agency's security program and required significant enhancements to security at a wide range of NRC-regulated facilities. These enhancements included significant reinforcement of the security response capabilities for nuclear facilities, better control of sensitive information, and implementation of mitigating strategies to deal with postulated events potentially causing loss of large areas of the plant due to explosions or fires, including those that an aircraft impact might create. These measures are outlined in greater detail in NUREG/BR-0314 (NRC, 2004), NUREG-1850 (NRC, 2006a), and Sandia National Laboratory's "Mitigation of Spent Fuel Loss-of-Coolant Inventory Accidents and Extension of Reference Plant Analyses to Other Spent Fuel Pools" (NRC, 2006b).

The NRC continues to routinely assess threats and other information from a variety of Federal agencies and sources. The NRC also ensures that licensees meet appropriate security-level requirements. The NRC will continue to focus on the prevention of terrorist acts for all nuclear facilities and will not focus on site-specific evaluations of speculative environmental impacts resulting from terrorist acts. While these are legitimate matters of concern, the NRC will continue to address them through the ongoing regulatory process as a current and generic regulatory issue that affects all nuclear facilities and many of the activities carried out at nuclear facilities. The issue of security and risk from malevolent acts at nuclear power facilities is not unique to facilities that have requested a renewal of their licenses (NRC, 2006a).

Implications of NRC Licensing Actions Located in the Jurisdiction of the U.S. Court of Appeals for the Ninth Circuit. The NRC has stated that licensing actions for facilities subject to the jurisdiction of the U.S. Court of Appeals for the Ninth Circuit will include an analysis of the environmental impacts of a terrorist attack (*San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016, 1028 (9th Cir. 2006)).

5.2.1.2 Security Requirements and Federal and Industry Actions in Response to September 11, 2001

General Security Considerations. The NRC has historically considered the potential impacts of sabotage and terrorist acts in the development and implementation of its security requirements. Nuclear power plants are among the most secure commercial facilities in the country. Nuclear power plant security is achieved in layers as described below:

- Nuclear power plants are inherently secure, robust structures, built to withstand hurricanes, tornadoes and earthquakes. Nuclear power plants have redundant safety systems and multiple barriers to protect the reactor and prevent or minimize offsite releases.
- Security measures are in place including, but not limited to, trained and armed security officers, physical barriers, intrusion detection and surveillance systems, and access control features. These measures are routinely inspected and evaluated via force-on-force exercises.
- An additional layer of protection involves coordinating threat information and offsite response. The NRC works closely with the Department of Homeland Security, Federal Bureau of Investigation, intelligence agencies, the Department of Defense, Department of Energy (DOE), states, and local law enforcement. These relationships ensure that the NRC can act quickly on any threats that might affect its licensed facilities and allows effective emergency response from "outside the fence" should a terrorist attack occur (NRC, 2004).

Federal and Industry Actions in Response to 9/11. Since 9/11, detailed assessments were done, a spectrum of measures was evaluated to reduce the likelihood or consequences of terrorist attacks, and additional requirements were issued to prevent or mitigate the consequences of acts of sabotage or terrorism. The scope of the threats considered, assessments done, and additional regulatory requirements include the following, among other issues:

- ground-based, water-based, cyber-based, and air-based attacks
- reactor, containment, and spent fuel
- generic communications, orders, license conditions, and new regulations and rules

The following is a brief discussion of some post-9/11 studies, strengthened security requirements, and enhanced liaison with Federal, state, and local agencies.

NRC Studies. The NRC carried out detailed site-specific engineering studies of a limited number of nuclear power plants to assess potential vulnerabilities to deliberate attacks involving large commercial aircraft. The NRC also assessed the potential effects of other types of terrorist attacks. In doing these studies, the NRC drew on national experts from several DOE laboratories using state-of-the-art experiments, structural analyses, and fire analyses. While the details are classified, the studies confirmed that the plants are robust, and the likelihood of a radioactive release affecting public health and safety is very low.

Another study analyzed the ability of nuclear power plants to withstand damage to, or loss of, large areas of the plant caused by a range of postulated attacks that could result in large fires and explosions. After examining many emergency scenarios involving operating reactors, spent fuel pools (SFPs) and dry-cask storage installations, the NRC concluded that the existing planning basis used to develop nuclear power plant emergency plans remains valid, and it is confident that the public near those facilities can be adequately protected should an attack occur.

As part of these analyses, enhancements were identified, and the NRC ordered changes at nuclear power plants. Moreover, based on insights from these studies, industry best practices, and lessons-learned from the response to the attacks of September 11, 2001, additional mitigating capabilities have been put in place at all nuclear power plants (NRC, 2008b).

Strengthened Security Requirements. After consideration of terrorist actions, the NRC strengthened security requirements at nuclear power plants. Major NRC actions included the following (NRC, 2008b):

- ordering plant owners to sharply increase physical security programs to defend against a more challenging adversarial threat
- requiring more restrictive site access controls for all personnel
- enhancing communication and liaison with the intelligence community
- ordering plant owners to improve their capability to respond to events involving explosions or fires
- enhancing readiness of security organizations by strengthening training and qualifications programs for plant security forces
- requiring vehicle checks at greater stand-off distances
- enhancing force-on-force exercises to provide a more realistic test of plant capabilities to defend against an adversary force
- improving liaison with Federal, state, and local agencies responsible for protection of the national critical infrastructure through integrated response training

NRC also issued additional security-related regulations including those listed below:

- a revision to the design basis threat rule in 2007 to impose generic security requirements similar to those previously imposed on operating nuclear power plants by the NRC's April 29, 2003, design basis threat orders (72 FR 12705)
- issuance of a new Power Reactor Security Requirements rule in 2009 to establish and update generically applicable security requirements for power reactors—similar to those previously imposed by several NRC orders issued after 9/11—including security requirements for ground-based, water-based, cyber-based, and air-based attacks (74 FR 13926)

Enhanced Government-to-Government Coordination. The NRC continues to work with other Governmental agencies to assure consistency and effectiveness in thwarting a potential attack on a nuclear power plant. For example, the NRC has worked with the Transportation Security Administration and the Federal Aviation Administration to develop guidance for general aviation pilots flying near nuclear power plants. The Transportation Security Administration has initiated some other programs to reduce the likelihood that an aircraft could be used to attack any type of facility in the United States. Some of these programs are listed below (NRC, 2008a):

- criminal history checks on flight crew members
- reinforced cockpit doors
- checking of passenger lists against “no-fly” lists
- increased control of cargo
- random inspections
- increased number of Federal Air Marshals
- improved screening of passengers and baggage
- controls on foreign airlines operating to and from the U.S.
- additional requirements for charter aircraft
- improved coordination and communication between civilian and military authorities

Plant-Specific Actions in Response to 9/11. Following the events of 9/11, the NRC issued more robust security requirements, as discussed above, and the NRC routinely verifies that CGS complies with those requirements. Thus, it is highly unlikely that an adversary force could successfully overcome these security measures and gain entry into the sensitive facilities, and it is even less likely that they could do this quickly enough to prevent operators from placing the plant's reactor into a safe shutdown mode.

Multiple plant-specific assessments, with respect to potential malevolent acts, have been and will continue to be completed for CGS. An example of an on-going, plant-specific evaluation is the periodic NRC security inspections at CGS that occur as part of operating reactor oversight. In response to these evaluations, many enhancements were carried out at CGS. Examples of resulting enhancements, stemming from the various assessments completed, include the following:

- plant hardware changes
- improved maintenance, testing, and calibration of security equipment
- improved training for both security and non-security personnel
- improved procedures in emergency planning and safeguards contingency planning

An example of a post-9/11 industry-wide initiative to enhance nuclear power plant security and how it was addressed at CGS is given below (the "B.5.b" mitigation strategies).

Mitigation Strategies for Reactor, Containment, and SFPs (B.5.b). An Interim Compensatory Measures (ICM) Order was issued February 25, 2002, as part of a comprehensive effort by the NRC, in coordination with other Government agencies, to improve the capabilities of commercial nuclear reactor facilities to respond to terrorist threats. Section B.5.b of the ICM Order required licensees to develop specific guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities—using existing or readily available resources (equipment and personnel)—that could be effectively carried out under the circumstances associated with loss of large areas of the plant due to explosions or fire, including those that a large aircraft impact might create. Although it was recognized before 9/11 that nuclear power plants already had significant capabilities to withstand a broad range of attacks, carrying out these mitigation strategies significantly enhances the nuclear power plants' capabilities to withstand a broad range of threats (NRC, 2007).

The staff carried out inspections of the implementation of the Section B.5.b requirements in 2002 and 2003. Next, engineering studies were done by the NRC, supplying insight into the implementation of mitigation strategies. In 2005, additional guidance was issued by the NRC establishing a phased approach for responding to Section B.5.b of the February 25, 2002, ICM Order. Determination of the specific strategies required to satisfy the Order was termed Phase 1. Site-specific assessments of SFPs were deemed Phase 2, and site-specific assessments of reactor core and containment were deemed Phase 3. During 2005 and 2006, the NRC staff performed Phase 1 inspections and Phases 2 and 3 assessments (NRC, 2007).

The NRC staff's technical evaluation for CGS is described in a publicly-available SER (NRC, 2007). The NRC staff concluded that CGS's responses to the February 25, 2005, Phase 1 guidance document and the Phases 2 and 3 SFP and reactor core and containment mitigating strategy assessments meet the requirements of Section B.5.b of the February 25, 2002, ICM Order. Additionally, the staff concluded that full implementation of Energy Northwest's enhancements constitutes satisfactory compliance with Section B.5.b and that they represent reasonable measures to enhance Energy Northwest's effectiveness in maintaining reactor core and SFP cooling and containment integrity under circumstances involving the loss of large areas of the plant due to fires or explosions.

The requirements for the B.5.b mitigating strategies were incorporated into the facility OL for CGS. The effectiveness of Energy Northwest's actions to implement the mitigative strategies implemented in response to the ICM Order (which were subsequently codified in 10 CFR 50.54(hh)(2)) is subject to NRC review and inspection.

5.2.1.3 Consideration of Environmental Impacts from Sabotage or Terrorist Acts

In describing the potential for environmental impacts from terrorist activities, a description of the relevant terminology is necessary and includes four broad topics: threat, vulnerability, frequency of malevolent acts, and consequences.

<u>Threat</u>. A threat is considered present when an organization or person has the intent and capability to cause damage to a target.

NRC currently assesses that there is a general, credible threat to NRC-licensed facilities and materials, although there is no specific information available that shows a specific threat to nuclear power plant facilities.

<u>Vulnerability</u>. Vulnerability, in this context, refers to a weakness in physical protection or mitigation capabilities, which can lead to unacceptable consequences. Vulnerabilities are specific to the type of attack.

<u>Frequency of Malevolent Acts</u>. With regard to the frequency of malevolent acts, the NRC has determined that security and mitigation measures the NRC has imposed upon its licensees since 9/11 coupled with national anti-terrorist measures and the robust nature of reactor containments and SFPs, make the probability of a successful terrorist attack, though numerically indeterminate, very low.

The security-related measures and other mitigation measures carried out since 9/11 include actions that would improve the likelihood of finding and thwarting the attack before it is initiated, mitigating the attack before it results in damage to the plant, and mitigating the impact of the plant damage such that reactor core damage or an SFP fire is avoided. Given the implementation of additional security enhancements and mitigation strategies, as well as further consideration of the factors noted above, the NRC staff concludes that the frequency of large radionuclide releases due to malevolent acts is very low.

Consequences. Consequences relate to the magnitude and type of effect from terrorist actions. A range of consequences can result from sabotage and malevolent acts. Nuclear power plants have many security measures and protective features that help to prevent or mitigate consequences of potential terrorist attacks. Physical protection was described previously and generally consists of the robust characteristics of the containment and SFP structures; redundant safety systems; and additional security measures in place, including trained and armed security officers, physical barriers, intrusion detection and surveillance systems. Mitigating strategies have also been carried out to deal with postulated events potentially causing loss of large areas of the plant due to explosions or fires, including those that an aircraft impact might create.

Potential consequences are highly dependent on the type of attack or event scenario. Based on the plant-specific, probabilistic risk assessment (PRA) for CGS (as summarized in Attachment E to the ER), the reactor accidents with the highest offsite consequences at CGS are fairly equally distributed among the four categories involving “large” releases of radionuclides outside the containment, whether these releases occur "early" or "late" in the sequence (i.e., after core damage) or are “scrubbed” or “non-scrubbed” prior to escaping from the containment. These events result in release of a significant fraction of the reactor core radionuclide inventory to the environment. Accident consequences are described in Table E.7-5 of Attachment E to the ER.

Although SFP accidents are not specifically addressed in the CGS ER, the consequences of the most severe SFP accident, culminating in an SFP fire, were assessed in several previous NRC studies to include the following:

NUREG-1353, “Regulatory Analysis for the Resolution of Generic Issue 82, “Beyond Design Basis Accidents in Spent Fuel Pools,” April 1989

NUREG-1738, “Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants,” January 2001

NUREG-1738 states that seismic hazard studies conducted by Lawrence Livermore National Laboratories and the Electric Power Research Institute (EPRI) did not include western plants, including CGS; however, its analysis addressed most power stations. Accident consequence results are given in Table 4.8.3 of NUREG-1353 for site population densities of 340 persons per square mile (reflective of the mean population density around all nuclear power plants in year 2000) and 860 persons per square mile (reflective of a high population site). Given that the projected 2045-population density within 50 miles (mi) of the CGS site is approximately 84 persons per square mile (based on a projected population of 655,617 reported in Table E.6-3 of Attachment E to the ER), these results are considered reasonably representative of CGS.

Potential consequences from malevolent acts against the CGS reactor or SFP would not exceed those for a reactor or SFP accident and would likely be much less due to the need for the adversaries to rapidly defeat physical protection and access controls, as well as the redundant safety system functions. This would be extremely difficult given the significant physical protection (e.g., robust containment and SFP structures, redundant safety systems, and additional security measures) and the post-9/11 mitigating strategies to deal with postulated events involving loss of large areas of the plant due to explosions or fires. Even if the physical protection and mitigating strategies were only partially effective, these features and measures would delay the time to core damage and radionuclide release and reduce the consequences of any such release.

In the unlikely event that a terrorist attack did successfully breach the physical and other safeguards at CGS, resulting in the release of radionuclides, the consequences of such a release are discussed in the 1996 GEIS for license renewal. In the GEIS, the NRC considered sabotage as the potential initiator of a severe accident. The NRC generically determined the risk to be of SMALL significance for all nuclear power plants. The NRC's evaluation of the potential environmental impacts of a terrorist attack, including the GEIS analysis of severe accident consequences, considers the potential consequences that might result from a large-scale radiological release, irrespective of the initiating cause.

5.2.1.4 SAMAs for Sabotage or Terrorist Initiated Events

The focus of the SAMA evaluation is on plant improvements (e.g., hardware, procedures, and training) that would both substantially reduce plant risk and be cost-beneficial. Given that risk from terrorist events is already reduced by carrying out post-9/11 existing security enhancements and mitigation strategies, the staff considers it unlikely that there are any additional enhancements that would both substantially reduce plant risk and be cost-beneficial.

5.2.1.5 Consideration of SAMAs for SFPs

<u>GEIS Conclusions for SFP Accidents</u>. The GEIS for license renewal gives a generic evaluation of potential SFP accidents, encompassing the potentially most serious accident (a seismically-generated accident causing catastrophic failure of the pool), and concludes that there is no further need for a site-specific SFP accident or mitigation analysis for license renewal. The GEIS concludes, without exception or qualification for any type of SFP accident, that "regulatory requirements already in place provide adequate mitigation incentives for onsite storage of spent fuel," and, therefore, mitigation alternatives for the SFP need not be considered for the license renewal review. See GEIS at 6-86, 6-91, and 6-92.

<u>Risk Associated with SFP Accidents</u>. Risk is defined as the probability of the occurrence of a given event multiplied by the consequences of that event. The risk of beyond-DBAs in SFPs was first examined as part of the landmark "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants" (WASH-1400, NUREG-75/014, 1975), and was found to be several orders of magnitude below those involving the reactor core. The risk of an SFP accident was re-examined in the 1980s as Generic Issue 82, "Beyond Design Basis Accidents in Spent Fuel Pools," in light of increased use of high-density storage racks and laboratory studies that showed the possibility of zirconium fire propagation between assemblies in an air-cooled environment. The risk assessment and cost-benefit analyses developed through this effort, NUREG–1353, "Regulatory Analysis for the Resolution of Generic Issue 82, Beyond Design Basis Accidents in Spent Fuel Pools," Section 6.2, April 1989, concluded that the risk of a severe accident in the SFP was low and "appear[s] to meet"' the objectives of the NRC's "Safety Goals for the Operations of Nuclear Power Plants; Policy Statement," (August 4, 1986; 51 FR 28044), as amended (August 21, 1986; 51 FR 30028), and no new regulatory requirements were warranted.

SFP accident risk was re-assessed in the late 1990s to support a risk-informed rulemaking for permanently shutdown, or decommissioned, nuclear power plants. The study—NUREG–1738, "Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants," January 2001—conservatively assumed that if the water level in the SFP dropped below the top of the spent fuel, an SFP zirconium fire involving all of the spent fuel would occur. Therefore, the study bounded those conditions associated with air-cooling of the fuel (including partial-draindown scenarios) and fire propagation. Even when all events leading to the spent fuel assemblies becoming partially or completely uncovered were assumed to result in an SFP zirconium fire, the study found the risk of an SFP fire to be low and well within the NRC's safety goals.

Several analyses done by Sandia National Laboratories since 9/11, collectively referred to in this SEIS as the "Sandia studies," show that the risk of a successful terrorist attack (i.e., one that results in an SFP zirconium fire) is very low. The Sandia studies include sensitive security-related information and are not available to the public. The Sandia studies considered spent fuel loading patterns and other aspects of a pressurized-water reactor SFP and a boiling-water reactor SFP, including the role that the circulation of air plays in the cooling of spent fuel. The Sandia studies showed that there may be a significant amount of time between the initiating event (i.e., the event that causes the SFP water level to drop) and the spent fuel assemblies becoming partially or completely uncovered. In addition, the Sandia studies showed that for those hypothetical conditions where air cooling may not be effective in preventing a zirconium fire (i.e., the partial drain down scenario), there is a significant amount of time between the spent fuel becoming uncovered and the possible onset of such a zirconium fire, giving a substantial opportunity for event mitigation. The Sandia studies, which address relevant heat transfer and fluid flow mechanisms, also showed that air-cooling of spent fuel would be sufficient to prevent SFP zirconium fires at a point much earlier following fuel offload from the reactor than previously considered (e.g., in NUREG–1738). Thus, the fuel would be more easily cooled, and the likelihood of an SFP fire would be reduced (FR 46207, Volume 73, No. 154).

Additional mitigation strategies carried out after 9/11 enhance spent fuel coolability and the potential to recover SFP water level and cooling before a potential SFP zirconium fire. The Sandia studies also confirmed the effectiveness of these additional mitigation strategies to maintain spent fuel cooling in the event the pool is drained, and its initial water inventory is reduced or lost entirely. Based on this more recent information, and the implementation of additional strategies following 9/11, the probability and the risk of an SFP zirconium fire initiation is expected to be less than reported in NUREG–1738 and previous studies. In view of the physical robustness of SFPs, the physical security measures, and SFP mitigation measures, and based upon NRC site evaluations of every SFP in the U.S., the NRC has determined that the risk of an SFP zirconium fire, whether caused by an accident or a terrorist attack, is very low and less than that for a reactor accident.

The NRC and licensees' efforts to address SFP vulnerabilities through enhancements since 9/11 have focused on "readily available mitigation strategies," which are typically the most cost-effective alternatives. The NRC's ongoing oversight of plant security and safety will continue to include review of SFPs and, in some cases, may require changes associated with SFPs.

5.2.1.6 Conclusions Regarding Sabotage and Terrorism

NRC's efforts to protect against terrorism, including efforts to evaluate potential options or alternatives to reduce the likelihood or severity of a terrorist attack, will continue during the current licensing period and any potential license renewal periods. The NRC staff's consideration of terrorism is a matter of ongoing regulatory oversight and one that will continue to be dealt with on a daily basis. Based on this and the many actions that have been taken since, the NRC staff maintains the NRC's 1996 finding that, although the threat of terrorist or sabotage events cannot be accurately quantified, acts of terrorism or sabotage are not reasonably expected and that even if such events were to occur, the resultant core damage and radiological releases would be no worse than those expected from internally-initiated events.

5.3 SAMAs

Pursuant to 10 CFR Section 51.53(c)(3)(ii)(L), license renewal applicants are required to consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS) or related supplement or in an environmental assessment. The purpose of this requirement is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered by Energy Northwest, formerly known as Washington Public Power Supply System (WPPSS), for CGS; therefore, the remainder of Section 5.3 addresses those alternatives.

Energy Northwest submitted an assessment of SAMAs for CGS as part of the ER (EN, 2010a) based on what was then the most recently available CGS PRA. This was supplemented by a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) (NRC, 1998) computer code and insights from the CGS individual plant examination (IPE) (Parrish, 1994) and individual plant examination of external events (IPEEE) (Parrish, 1995). In identifying and evaluating potential SAMAs, Energy Northwest considered SAMAs that addressed the major contributors to core damage frequency (CDF) and large early release frequency (LERF) at CGS, as well as a generic list of SAMA candidates for other operating reactor plants identified from other industry studies. Energy Northwest identified 150 potential SAMA candidates. This list was reduced to 28 SAMA candidates by eliminating the following SAMAs:

- SAMAs that are not applicable to CGS due to design differences or have already been implemented at CGS
- SAMAs that have estimated implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at CGS
- SAMAs that are related to a non-risk significant system and, therefore, have a very low benefit
- SAMAs that were similar in nature and could be combined with another SAMA candidate

Energy Northwest assessed the costs and benefits associated with each of the remaining SAMA candidates and concluded in the ER that three of the candidate SAMAs evaluated are potentially cost-beneficial.

Based on its review, the U.S. Nuclear Regulatory Commission (NRC) issued requests for additional information (RAIs) to Energy Northwest (Doyle, 2010a), (Doyle, 2010b), (Doyle, 2010c), (Doyle, 2011a). Energy Northwest's responses addressed the NRC staff's concerns and resulted in the identification of additional potentially cost-beneficial SAMAs (Gambhir, 2010), (Gambhir, 2011a), (Gambhir, 2011b).

5.3.1 Risk Estimates for CGS

Energy Northwest combined two distinct analyses to form the basis for the risk estimates used in the SAMA analysis—the CGS Level 1 and 2 probabilistic safety assessment (PSA) models, which is an updated version of the IPE (Parrish, 1994) and a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent CGS Level 1 and Level 2 PSA models available at the time of the ER, referred to as PSA Revision 6.2. Subsequently, in response to NRC staff RAIs, a sensitivity analysis of the SAMA results was provided based on the updated CGS PSA Revision 7.1 (Gambhir, 2011a), (Gambhir, 2011b).

The baseline CDF for the purposes of the SAMA evaluation, based on CGS PSA Revision 6.2, is approximately 4.8×10^{-6} per year for internal events (which includes internal flooding), 7.4×10^{-6} per year for fire events, and 5.2×10^{-6} per year for seismic events as determined from quantification of the Level 1 PSA models. The sensitivity analysis CDF, based on CGS PSA Revision 7.1, is approximately 7.4×10^{-6} per year for internal events, 1.4×10^{-5} per year for fire events, and 4.9×10^{-6} per year for seismic events (Gambhir, 2011a). For both the baseline and sensitivity analysis, the risk reduction benefits associated with internal, fire, and seismic events were separately estimated based on the internal events, fire, and seismic Level 1 and Level 2 PSAs. Energy Northwest accounted for the potential risk reduction benefits associated with non-fire and non-seismic external events (e.g., high wind, external flood, and other (HFO) events) by multiplying the estimated benefits for internal events by a factor of 2 (i.e., the contribution from HFO events was assumed to be the same as that from internal events). The estimated SAMA benefits for internal events, fire events, seismic events, and non-fire and non-seismic external events were then summed to provide an overall benefit.

The following tables break down CDF by initiating event for internal events, fire compartments, and seismic damage sequences (SDSs), respectively. The results from both the baseline PSA model (Revision 6.2) and the sensitivity analysis PSA model (Revision 7.1) are provided. As shown in Table 5.3-1, events initiated by station blackout (SBO), internal flooding, and special initiators—such as loss of direct current (DC) and alternating current (AC) buses, loss of heating, ventilation and air conditioning (HVAC), and loss of service water (SW) and air systems—are the dominant contributors to the internal event CDF for CGS PSA Revision 6.2. The dominant contributors to internal event CDF for CGS PSA Revision 7.1 are internal flooding, anticipated transients without scram (ATWS), loss of feedwater, and manual shutdown. As shown in Table 5.3-2, the dominant contributors to fire CDF are fires in the radwaste building for both CGS PSA Revisions 6.2 and 7.1. As shown in Table 5.3-3, the dominant contributors to seismic CDF are structural failures of the reactor pressure vessel (RPV) or Category 1 buildings or both and wide-spread failure of safe shutdown equipment list (SSEL) equipment for both CGS PSA Revisions 6.2 and 7.1.

Table 5.3-1. CGS CDF for internal events

Initiating event	PSA Model Revision 6.2		PSA Model Revision 7.1	
	CDF (per year)	% contribution to CDF[a]	CDF (per year)	% contribution to CDF[b]
SBO	$1.6x10^{-6}$	33	$1.3x10^{-7}$	2
Internal flooding	$7.4x10^{-7}$	15	$2.3x10^{-6}$	31
Special initiators	$7.2x10^{-7}$	15	$3.0x10^{-7}$	4
Loss-of-offsite power (LOOP)	$3.0x10^{-7}$	6	$9.3x10^{-8}$	1
RPV rupture	$3.0x10^{-7}$	6	$1.0x10^{-8}$	<1
Loss of condenser	$2.2x10^{-7}$	5	$3.7x10^{-7}$	5
Inadvertent/stuck open main steam safety relief valve	$2.1x10^{-7}$	4	$8.3x10^{-8}$	1
Loss of feedwater	$1.9x10^{-7}$	4	$7.2x10^{-7}$	10
Steam line break outside containment	$1.5x10^{-7}$	3	$5.8x10^{-7}$	8
Manual shutdown	$1.3x10^{-7}$	3	$7.9x10^{-7}$	10
Turbine trip	$1.2x10^{-7}$	2	$1.5x10^{-7}$	2
ATWS	$8.4x10^{-8}$	2	$1.4x10^{-6}$	19
Main steam isolation valve (MSIV) closure	$4.6x10^{-8}$	1	$3.6x10^{-7}$	5
Loss–of-coolant accidents (LOCAs)	$4.8x10^{-9}$	<1	$2.0x10^{-7}$	3
Total CDF (internal events)[c]	$4.8x10^{-6}$	100	$7.4x10^{-6}$	100

[a] This is based on internal event CDF contribution in ER Table E.3-3 (EN, 2010a) and total internal event CDF.

[b] This is based on internal event CDF contribution in Table A-1 of the responses to NRC staff RAIs (Gambhir, 2011a) and total internal event CDF.

[c] Columns may not sum to reported totals due to round off.

Table 5.3-2. Important CGS fire compartments and their contribution to fire CDF

Fire compartment	PSA Model Revision 6.2		PSA Model Revision 7.1	
	CDF (per year)	% contribution to CDF[(a)]	CDF (per year)	% contribution to CDF[(a)]
R1J: Reactor Building 522'[(c)]	$1.2x10^{-6}$	16	≤$1.2x10^{-6}$	≤9
W14: Radwaste 467' Switchgear Room 1	$1.0x10^{-6}$	14	$1.4x10^{-6}$	10
W04: Radwaste 467' electrical equipment room	$8.4x10^{-7}$	11	$1.7x10^{-6}$	12
R1D: Northeast Reactor Building 471'[(c)]	$7.4x10^{-7}$	10	≤$7.4x10^{-7}$	≤5
W11: Radwaste A/C Room[(c)]	$7.3x10^{-7}$	10	≤$7.3x10^{-7}$	≤5
W03: Radwaste 467' cable chase	$4.5x10^{-7}$	6	$9.4x10^{-7}$	7
W08: Radwaste 467' Switchgear Room 2	$3.6x10^{-7}$	5	$9.7x10^{-7}$	7
Y01: Transformer Yard[(c)]	$3.2x10^{-7}$	4	≤$3.2x10^{-7}$	≤2
W10: Radwaste Main Control Room[(c)]	$3.0x10^{-7}$	4	≤$3.0x10^{-7}$	≤2
W05: Radwaste 467' Battery Room 1	$2.5x10^{-7}$	3	$3.2x10^{-7}$	2
W02: Radwaste cable spreading room	$2.2x10^{-7}$	3	$4.4x10^{-7}$	3
W13: Radwaste 525' emergency chiller	$2.0x10^{-7}$	3	$4.9x10^{-7}$	4
T1A: Turbine Generator West 441'	$1.6x10^{-7}$	2	$2.9x10^{-7}$	2
T12: Turbine Generator South Corridors[(c)]	$1.3x10^{-7}$	2	≤$1.3x10^{-7}$	≤1
W1A: Radwaste Building 441'	$1.2x10^{-7}$	2	$4.4x10^{-7}$	3
W07: Radwaste 467' Division 2 electrical	$9.0x10^{-8}$	1	$1.7x10^{-6}$	12
R1B: Northwest Reactor Building 471'	$5.8x10^{-8}$	<1	$1.6x10^{-7}$	1
T1C: Turbine Generator East 441'	$5.2x10^{-8}$	<1	$1.3x10^{-6}$	9
T1D: Turbine Generator West 471'	$4.9x10^{-8}$	<1	$1.6x10^{-7}$	1
R1C: Southeast Reactor Building 471'	$2.0x10^{-8}$	<1	$3.9x10^{-7}$	3
R1L: Reactor Building 572'	$3.3x10^{-9}$	<1	$2.4x10^{-7}$	2
Total fire CDF[(b)]	$7.4x10^{-6}$	100	$1.4x10^{-5}$	100

[(a)]This is based on fire CDF contribution in Table A-1 of the responses to NRC staff RAIs (Gambhir, 2011a) and total fire CDF.

[(b)]Columns may not sum to reported totals due to round off or assumptions about bounding values for selected compartments in PSA Revision 7.1 (see footnote 3).

[(c)]Only fire CDF contributions for compartments that increased by at least 1 percent from PSA Revision 6.2 were provided for Revision 7.1. Contributions for these others remaining from Revision 6.2 are shown as bounding values, based on their previous contributions in Revision 6.2, since it was reported that none increased by more than 1 percent.

Table 5.3-3. Important SDSs and their contribution to seismic CDF

SDS sequence	SDS sequence description	PSA Model Revision 6.2		PSA Model Revision 7.1	
		CDF (per year)	% contribution to CDF[(a)]	CDF (per year)	% contribution to CDF[(a)]
SDS42	Failure of RPV or Category I buildings or both	2.4×10^{-6}	46	2.4×10^{-6}	49
SDS41	Wide-spread failure of safety SSEL equipment	1.6×10^{-6}	31	1.6×10^{-6}	33
S2P2	Balance of plant (BOP), condensate storage tank (CST), LOOP, small-small LOCA	1.8×10^{-7}	3	0	0
S624	LOOP, small-small LOCA, and Division 1 & 2 AC distribution, BOP, and CST failure	2.2×10^{-7}	4	9.0×10^{-8}	2
SDS4	BOP, CST, LOOP, small-small LOCA, diesel generator (DG) 1 & 2	1.8×10^{-7}	3	8.2×10^{-8}	2
S523	BOP, CST, LOOP, nitrogen (N_2) tank, small-small LOCA, DG 1 & 2, Division III	1.3×10^{-7}	2	1.4×10^{-7}	3
SLAC	BOP, CST, LOOP, N_2 tank, medium LOCA, Division I & II, Division III, offsite AC not recoverable	1.1×10^{-7}	2	1.1×10^{-7}	2
S725	BOP, CST, LOOP, N_2 Tank, small-small LOCA, Division I & II, Division III, offsite AC not recoverable	1.0×10^{-7}	2	1.0×10^{-7}	2
SDS22	BOP, CST, LOOP, N_2 tank, small-small LOCA, DG 1 & 2	6.2×10^{-8}	1	2.8×10^{-8}	1
SDS38	BOP, CST, LOOP, N_2 tank, DGs stalled and not restarted	5.8×10^{-8}	1	9.5×10^{-8}	2
S1836	BOP, CST, LOOP, N_2 tank, medium LOCA, Division I & II, offsite AC not recoverable	2.0×10^{-8}	<1	8.1×10^{-9}	<1
S1230	BOP, CST, LOOP, N_2 tank, small LOCA (SLOCA), Division I & II, offsite AC not recoverable	1.8×10^{-8}	<1	7.4×10^{-9}	<1
S1129	BOP, CST, LOOP, N_2 tank, SLOCA, DG 1 & 2, Division III	1.6×10^{-8}	<1	1.8×10^{-8}	<1
S1331	BOP, CST, LOOP, N_2 tank, SLOCA, Division I & II, Division III, offsite AC not recoverable	1.6×10^{-8}	<1	1.6×10^{-8}	<1
Other		8.6×10^{-8}	2	9.0×10^{-8}	2
Total seismic CDF[(b)]		5.3×10^{-6}	100	4.9×10^{-6}	100

		PSA Model Revision 6.2		PSA Model Revision 7.1	
SDS sequence	**SDS sequence description**	**CDF (per year)**	**% contribution to CDF[(a)]**	**CDF (per year)**	**% contribution to CDF[(a)]**

[(a)] This is based on seismic CDF contribution in Table A-1 of the responses to NRC staff RAIs (Gambhir, 2011a) and total seismic CDF.

[(b)] Columns may not total to reported totals due to round off.

The Level 2 CGS PSA models that form the basis for the SAMA evaluation is an updated versions of the Level 2 IPE model (Parrish, 1994) and IPEEE model (Parrish, 1995), linked to the Level 1 model by assigning each Level 1 core damage sequence to a plant damage state (PDS). The Level 1 core damage sequences are binned into 21 PDSs for internal and fire events and 12 PDSs for seismic events. The Level 2 model uses a set of containment event trees (CETs), one for each PDS, containing both phenomenological and systemic events, and subsequently assigns the PDSs to release categories. Source terms were developed for each of the 13 release categories (four in the baseline and nine in the sensitivity analysis) using the results of Modular Accident Analysis Program (MAAP) computer code calculations. The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for these analyses include the following:

- plant-specific and site-specific input values for core radionuclide inventory
- source term and release characteristics
- site meteorological data
- projected population distribution within an 80-kilometer (km) (50-mi) radius for the year 2045
- emergency response evacuation modeling
- economic data

The core radionuclide inventory corresponds to the end-of-cycle values for CGS operating at 3,486 megawatts thermal (MWt). The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC, 1997a).

Energy Northwest estimated the dose to the population within 80 km (50 mi) of the CGS site to be approximately 0.037 person-Sievert (Sv) (3.7 person-roentgen equivalent man (rem)) per year for internal events, 0.086 person-Sv (8.6 person-rem) per year for fire events, and 0.067 person-Sv (6.7 person-rem) per year for seismic events. This equals a total population dose from internal and external events of 0.190 person-Sv (19.0 person-rem) per year for the baseline analysis using CGS PSA Revision 6.2. In response to NRC staff RAIs, Energy Northwest estimated the dose to the population within 80 km (50 mi) of the CGS site to be approximately 0.055 person-Sv (5.5 person-rem) per year for internal events, 0.090 person-Sv (9.0 person-rem) per year for fire events, and 0.059 person-Sv (5.9 person-rem) per year for seismic events. This equals a total population dose from internal and external events of 0.204 person-Sv (20.4 person-rem) per year for the sensitivity analysis using CGS PSA Revision 7.1. Both sets of results are shown in Table 5.3-4 and Table 5.3-5. For PSA Revision 6.2, large, late, not-scrubbed release is the dominant contributor to the population dose risk at CGS for all three hazard types. For Revision 7.1, moderate and intermediate release is the dominant contributor to the population dose risk at CGS for internal and fire events while high/early release (H/E) is the dominant contributor to population dose risk for seismic events.

Table 5.3-4. Breakdown of population dose by containment release mode for PSA Revision 6.2

Containment release mode	Internal events		Fire events		Seismic events	
	Pop. dose (person-rem/yr[a])	% contribution[a]	Pop. dose (person-rem/yr[a])	% contribution[b]	Pop. dose (person-rem/yr[a])	% contribution[b]
Large, late, not-scrubbed (LLN)	2.1	57	7.6	88	3.9	58
Large, early, not-scrubbed (LEN)	0.9	23	0.3	4	2.8	42
Large, late scrubbed (LLS)	0.7	20	0.7	8	negligible	negligible
Large early scrubbed (LES)	0.0	0	0.0	0	0.0	0
Containment intact (COK)	negligible	negligible	negligible	negligible	negligible	negligible
Total	3.7	100	8.6	100	6.7	100

[a] One person-rem = 0.01 person-Sv

[b] This is based on population dose contribution in Tables E.7-1, E.7-2, and E.7-3 of the ER (EN, 2010a) for internal events, fire events, and seismic events, respectively, and total population dose for each hazard.

Table 5.3-5. Breakdown of population dose by containment release mode for PSA Revision 7.1

Containment release mode	Internal events		Fire events		Seismic events	
	Pop. dose (person-rem/yr[a])	% contribution[b]	Pop. dose (person-rem/yr[a])	% contribution[b]	Pop. dose (person-rem/yr[a])	% contribution[b]
High/early release (H/E)	0.7	13	0.1	1	3.8	64
High/intermediate release (H/I)	0.3	6	0.1	1	0.9	15
Moderate/early release (M/E)	0.2	4	<0.1	<1	negligible	negligible
Moderate/ intermediate release (M/I)	4.0	74	8.5	94	1.1	19
Low/early release (L/E)	<0.1	1	<0.1	<1	<0.1	<1
Low/intermediate release (L/I)	negligible	negligible	<0.1	<1	negligible	negligible
Low-low/early release (LL/E)	<0.1	<1	0.1	1	<0.1	<1
Low-low/intermediate release (LL/I)	0.1	2	0.1	1	0.1	2

Containment release mode	Internal events		Fire events		Seismic events	
	Pop. dose (person-rem/yr[a])	% contribution[b]	Pop. dose (person-rem/yr[a])	% contribution[b]	Pop. dose (person-rem/yr[a])	% contribution[b]
Containment intact (COK)	negligible	0	negligible	0	negligible	0
Total[c]	5.5	100	9.0	100	5.9	100

[a] One person-rem = 0.01 person-Sv

[b] This is based on population dose contribution in Tables A-6, A-7, and A-8 of the RAI responses (Gambhir, 2011a) for internal events, fire events, and seismic events, respectively, and total population dose for each hazard.

[c] Column may not total to reported totals due to round off.

5.3.2 Adequacy of CGS PSA for SAMA Evaluation

The CGS PSA evolved from the original IPE (Sorensen, 1992) and it subsequent revision (Parrish, 1994), for which the NRC staff concluded that the IPE submittal met the intent of GL 88-20 (NRC, 1988), (NRC, 1997a). Although no vulnerabilities were identified in the IPE, several improvements to the plant or procedures were identified. These improvements have been either implemented at the site or addressed in the SAMA evaluation process. There have been 12 revisions to the internal events PSA model since the 1994 IPE submittal, for which a listing of the major changes was provided by Energy Northwest in the ER (EN, 2010a) and in response to an NRC staff RAI (Gambhir, 2011a). The 1994 IPE internal events CDF value ($1.8x10^{-5}$ per year) is in the middle of the range of the CDF values reported in the IPEs for BWR 5/6 plants, which ranges from about $1x10^{-5}$ per year to $4x10^{-5}$ per year, with an average CDF for the group of $2x10^{-5}$ per year (NRC, 1997a). It is recognized that plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. Based on CDF values reported in the SAMA analyses for license renewal applications (LRAs), the internal events CDF result for CGS used for the SAMA analysis ($4.8x10^{-6}$ per year used for the baseline analysis and $7.4x10^{-6}$ per year used for the sensitivity analysis, including internal flooding) is less than that for other plants of similar vintage and characteristics.

There have been three revisions to the fire PSA model and two revisions to the seismic PSA model since the 1995 IPEEE submittal. A comparison of the fire events CDF between the 1995 IPEEE and Revision 2 of the CGS fire events PSA model used for the baseline SAMA evaluation indicates a decrease of approximately 58 percent (from $1.8x10^{-5}$ per year to $7.4x10^{-6}$ per year). A comparison of the seismic events CDF between the 1995 IPEEE and Revision 1 of the CGS seismic events PSA model used for the baseline SAMA evaluation indicates a decrease of approximately 75 percent (from $2.1x10^{-5}$ per year to $5.2x10^{-6}$ per year). Subsequently, as a result of integrating Revision 2 of the fire PSA model and Revision 1 of the seismic PSA model with internal events PSA Revision 7.1 (no upgrades to the fire or seismic models were performed), the fire CDF increased to $1.4x10^{-5}$ per year and the seismic CDF decreased to $4.9x10^{-6}$ per year (Gambhir, 2011a). The integrated PSA Revision 7.1 model was then used for the sensitivity analysis.

Internal Events CDF

Energy Northwest identified four external reviews and seven technical reviews that have been performed for the CGS PSA. The first, conducted by the BWR Owners' Group (BWROG) in 1997, reviewed PSA model Revision 3 Level 1 and 2 internal events (including internal flooding). Energy Northwest stated that all comments produced by this review were resolved. Two external reviews, an industry peer review, and an NRC inspection of the CGS PSA were conducted in 2004 in support of Energy Northwest's participation in the NRC's RG 1.200 pilot program. The industry reviewed PSA model Revision 5.0 Level 1 and 2 internal and fire events PSA (Webring, 2004) against the American Society of Mechanical Engineers (ASME) Standard RA-Sa-2003 (ASME, 2003), as modified by the trial use version of NRC RG 1.200 (NRC, 2004b). Energy Northwest stated that there were no Level A (extremely important) facts and observations (F&Os) from this review and identified all Level B (important) F&Os, with the exception of F&Os categorized as having only documentation impacts, that are not resolved in the Revision 6.2 PSA model (Gambhir, 2010). Furthermore, Energy Northwest stated that all of the identified Level B F&Os have been resolved in the PSA Revision 7.1 model used for the SAMA sensitivity analysis.

Energy Northwest identified three physical plant changes since PSA model Revision 6.2 that could potentially impact the SAMA evaluation (Gambhir, 2010). The first provides for the ability to cross-connect a DG to either the Division 1 or 2 emergency buses during extended SBO and included changes to LOOP and SBO procedures, reducing CDF and, therefore, the benefits associated with SAMAs identified to improve plant response to LOOP or SBO. The second change added a portable 480 V DG (DG-4) and included associated procedure changes to provide an alternate source of AC power, improving the ability of CGS to cope with an SBO and, therefore, reducing CDF. The third change was an upgrade of the feedwater and turbine control systems, which, despite yielding an anticipated higher reliability, has not been credited in the PSA because of insufficient operational history. Since each of the three changes either reduces or maintains (i.e., does not increase) plant risk, Energy Northwest concluded that implementation of these changes either reduces or maintains (i.e., does not increase) the benefits calculated for the evaluated SAMA candidates (Gambhir, 2010).

Energy Northwest explained that the CGS internal events PSA model had been updated to Revision 7.1 since the SAMA evaluation reported in the ER, which resulted in a higher CDF and a lower LERF (Gambhir, 2010). PSA Revision 7.1 model incorporated the following (Gambhir, 2011a):

- resolution of F&Os from the 2004 peer review
- resolution of areas of model incompleteness identified by CGS internal technical reviews
- upgrades to meet NRC RG 1.200 Revision 2 (NRC, 2009a) and the associated ASME standard RA-S-2008 (ASME, 2008) for Level 1, LERF, and flooding modeling
- plant and procedure changes, such as the DG cross-connect discussed previously)

These changes were first incorporated in the PSA Revision 7.0 model, for which a peer review was performed on Level 1 and 2 internal events (with internal flooding) in 2009 and a report was issued in January 2010. Energy Northwest explains that F&Os from this peer review that could significantly impact the model quantification were incorporated into the Revision 7.1 model, and a review of the remaining F&Os associated with SRs that were graded as CC-I or not met identified none that would significantly impact the results of the SAMA analysis (Gambhir, 2011a).

Energy Northwest described that the process for controlling the technical adequacy of the PSA is contained in a CGS engineering procedure that is consistent with guidance in NRC RG 1.174 (NRC, 2002). This PSA configuration procedure covers monitoring PSA input and collecting new information for incorporation, updating the PSA to be consistent with the as-built and as-operated plant, assessing cumulative impact of pending PSA changes, control of computer codes supporting the PSA, documentation, and qualification of PSA reviewers. The CGS internal events PSA model has been peer-reviewed, the peer review findings were all resolved and their impact assessed in a sensitivity analysis using the updated PSA model, and Energy Northwest has satisfactorily addressed NRC staff questions regarding the PSA. Based on this information, the NRC staff concludes that the internal events Level 1 PSA model is of sufficient quality to support the SAMA evaluation.

Seismic CDF

The CGS IPEEE was submitted in June 1995 (EN, 1995) and included an internal fire PSA, a seismic PSA, and a screening analysis for other external events. In a letter dated February 26, 2001, the NRC staff concluded that the submittal met the intent of Supplement 4 to GL 88-20, and the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC, 2001b). The seismic portion of the IPEEE consisted of a seismic PSA completed in accordance with NRC guidance (NRC, 1983), (NRC, 1991a). Major inputs were from plant walkdowns conducted in accordance with the EPRI methodology for Seismic Margins Assessment (EPRI, 1991), relay chatter evaluation conducted in accordance with NRC guidance for IPEEE submittals, and seismic fragility evaluation conducted per the EPRI methodology for developing seismic fragilities (EPRI, 1994). A site-specific seismic hazard estimate was developed by Geomatrix (Geomatrix, 1994a). The seismic CDF resulting from the CGS IPEEE was calculated to be 2.1×10^{-5} per year. The CGS IPEEE did not identify any vulnerabilities due to seismic events but did identify several improvements to the plant or procedures to reduce seismic risk, which have been either implemented or addressed in the SAMA evaluation process

Energy Northwest subsequently upgraded the seismic PSA to be consistent with the American Nuclear Society (ANS) standard for external events PSAs, American National Standards Institute (ANSI)/ANS-58.21-2003 (ANS, 2003) and with EPRI seismic PSA implementation guidance (EPRI, 2003). Major inputs included the following:

- a plant-specific hazard curve
- results and insights obtained from seismic plant walkdowns conducted in support of the IPEEE (Parrish, 1995)
- plant-specific structural and component seismic fragility analyses
- relay chatter evaluation
- Level 1 and 2 Revision 6.2 PSA models

These upgrades to the seismic PSA resulted in a seismic CDF of 5.2×10^{-6} per year, which decreased slightly to 4.9×10^{-6} per year in PSA Revision 7.1 due to integration of the seismic PSA model with the updated internal events model (Gambhir, 2011a).

The NRC staff requested that Energy Northwest address whether seismic hazard analysis information developed later for the nearby DOE Hanford Site and by the U.S. Geological Survey (USGS, 2008) could impact the results of the SAMA analysis (Doyle, 2010a). In response to the RAI, Energy Northwest concludes that the 1994 seismic hazard study used in the CGS seismic PSA model used in the SAMA evaluation (Geomatrix, 1994b) still provides an adequate seismic input to the PSA models to effectively identify relevant SAMA candidates (Gambhir, 2010). Energy Northwest bases their conclusion on the fact that this and several Hanford waste treatment plant (WTP) site seismic studies evaluated locations that are at least 10 mi distant from the CGS site and that the soil structure at the CGS site is thicker than at the WTP site. Energy Northwest also compares the peak ground acceleration (PGA) at times 500 and 2,500 years calculated using the 2008 USGS data (USGS, 2008) for the coordinates corresponding to the CGS site, which are lower than the PGAs predicted by the Geomatrix CGS model (Geomatrix, 1994a), (Geomatrix, 1994b), (Geomatrix, 1996). Based on these results, Energy Northwest concludes that the CGS seismic model is conservative relative to the latest USGS seismic hazard data in predicting an appropriate ground motion for the CGS site.

The CGS internal events modeling is an input to the seismic PSA model, the seismic PSA has been updated to a more recent external events PSA standard, the SAMA evaluation included a sensitivity analysis of the seismic CDF, and Energy Northwest has satisfactorily addressed NRC staff RAIs regarding the seismic PSA. Based on this information, the NRC staff concludes that the seismic PSA model in combination with the sensitivity analysis of the seismic CDF provides an acceptable basis for identifying and evaluating the benefits of SAMAs.

Fire CDF

The IPEEE fire analysis was performed with PSA technology but employed elements of EPRI's fire-induced vulnerability evaluation (FIVE) methodology (EPRI, 1992) for systemic screening and ignition source frequency determination. The IPEEE fire areas were based on definitions of Appendix R fire areas for CGS. Of the 93 fire areas, 36 were qualitatively screened. Fire-initiating event frequencies were estimated for each of the remaining 57 unscreened fire areas using the FIVE methodology. Computerized fire simulations were performed with COMPBRN III (NRC, 1986). The likelihood for fire suppression was determined based on the availability of automatic fire suppression as well as the likelihood that fires would not significantly affect the PSA-related components and cables located in the fire area. Fire-initiating events in each fire area and fire-induced failures were combined with random equipment failure modes using the internal events PSA to determine the fire CDF for each unscreened fire area. All but 16 fire areas were quantitatively screened from further analysis based on a fire-induced CDF being less than $1\text{x}10^{-6}$ per year. As reported in the IPEEE, the fire CDF for these 16 important fire areas was $9.2\text{x}10^{-6}$ per year. A separate control room fire evaluation estimated its fire CDF to be $8.4\text{x}10^{-6}$ per year, bringing the total to 1.8×10^{-5} per year. No vulnerabilities due to fire events were identified, but several suggested improvements to plant procedures to reduce fire risk have been either implemented at the site or addressed in the SAMA evaluation process.

Energy Northwest subsequently created a fire PSA based on the internal events PSA model but using elements of NUREG/CR-6850 (NRC, 2005b). For screening, the loss scenarios were simplified into loss of the single worst equipment or cable or loss of all equipment and cables in the compartment. Each compartment has a fire-initiating event tree, initiated by either turbine trip or loss of feedwater, as appropriate for the compartment losses. In performing the fire analysis, consideration was given to all fire damage mechanisms, including smoke, loss of lighting and indication, and fire suppression system impacts on equipment. The fire PSA explicitly examined the human error probabilities (HEPs) used for the fire scenarios. The CGS IPEEE demonstrated that only a few fire compartments had the potential for fire propagation from one compartment to another; thus, detailed evaluation of potential fire propagation between compartments was not performed.

For each scenario, fire-induced equipment failures were determined, including hot short events in over 120 locations that could spuriously actuate components and result in undesired configurations. The hot short impact included failure of minimum-flow valves in pathways needed for the emergency core cooling injection and valves and dampers needed for containment isolation. Detailed analysis of the main control room was performed, and the potential for control room evacuation considered. These upgrades to the fire PSA resulted in a fire CDF of 7.4×10^{-6} per year for CGS PSA Revision 6.2, which was used for the baseline SAMA evaluation. This value nearly doubled to 1.4×10^{-5} per year in PSA Revision 7.1 used in the SAMA sensitivity analysis due to integration of the fire PSA model with the updated internal events model (Gambhir, 2011a).

The fire PSA was included in the industry peer review conducted in 2004, which produced 33 findings. All Level A and B F&Os were addressed and resolved in the Revision 6.2 PSA model used in the SAMA evaluation. The remaining unresolved findings are not expected to significantly alter the results of the SAMA analysis. Energy Northwest discussed areas of potential non-conservatism and provided the basis for concluding that resolution of these issues will not impact the results of the SAMA evaluation. Energy Northwest will address these issues in a future upgrade of the fire PSA; any impacts are judged to be encompassed by the 95th percentile CDF uncertainty analysis. The NRC staff considers Energy Northwest's explanation and assessment of areas of incompleteness in the fire PSA reasonable and that, in light of the known conservatisms in the PSA model, resolution of these incompleteness issues is not likely to impact the results of the SAMA analysis. The CGS internal events modeling is an input to the fire PSA model, the fire PSA has been updated to incorporate industry fire data and NRC guidance, the fire PSA model has been peer reviewed and the peer review findings were all addressed, and Energy Northwest has satisfactorily addressed NRC staff RAIs regarding the fire PSA. Based on this information, the NRC staff concludes that the fire PSA model provides an acceptable basis for identifying and evaluating the benefits of SAMAs.

"Other" External Event CDF

The Energy Northwest IPEEE analysis of HFO external events followed the screening and evaluation approaches specified in Supplement 4 to GL 88-20 (NRC, 1991a) and in associated guidance in NUREG-1407 (1991b). For high winds, external floods, volcanic activity, and accidents at nearby facilities, the IPEEE concluded that Energy Northwest meets the 1975 Standard Review Plan criteria (NRC, 1975b); therefore, the contribution from these hazards to CDF is less than the $1.0\text{x}10^{-6}$ per year criterion (Parrish, 1995). Although the CGS IPEEE did not identify any vulnerability due to HFO events, one improvement to reduce risk has been implemented. In the SAMA analysis, the benefit from HFO events was assumed to be equivalent to the benefit that was derived from the internal events model. The bases for this assumption are as follows:

- Some of the HFO events are captured in the LOOP contributor.
- The IPEEE analysis found that all of the HFO events contributed less than the screening CDF of $1.0\text{x}10^{-6}$ per year.
- The internal events CDF is more than a factor of four greater than the HFO screening CDF.

Based on the low contribution to CDF from HFO events, and the internal events CDF of $4.5\text{x}10^{-6}$ per year for CGS PSA Revision 6.2, the NRC staff agrees that assuming the benefits from HFO events is equivalent to the benefits from internal events is reasonable and conservative (Gambhir, 2011a). This same assumption, albeit at the higher internal events CDF of 7.4×10^{-6} per year, was also used for CGS PSA Revision 7.1 in the sensitivity analysis.

Level 2 and LERF

The Level 2 analysis is linked to the Level 1 model by assigning each Level 1 core damage sequence to one of 21 PDSs based on the functional characteristics of the sequence and the status of systems that were important to containment performance. A CET is developed for each PDS and quantified via fault tree analysis and the use of split fractions. The PDSs are organized by accident type, initiator type, systems available to mitigate the accident, and power and system recoverability (Gambhir, 2010). Each PDS is analyzed through the Level 2 CETs to evaluate the phenomenological progression of the sequence. In the baseline analysis, CET end-states are assigned to one of the five release categories (see Table 5.3-4), each of which was defined based on characteristics that determine the timing and magnitude of the release and whether the fission products were or were not scrubbed prior to release. The frequency of each release category is the sum of the frequencies of the individual accident progression CET endpoints binned into the release category. Source term release fractions were developed for each of the five release categories based on the results of plant-specific calculations using the MAAP Version 4.0.4 (Gambhir, 2010).

The Level 2 model was included in the 1997 and 2004 peer reviews. Energy Northwest stated that all comments produced by the 1997 review were resolved. Of the 11 unresolved Level B F&Os identified in the 2004 review, 9 were resolved in response involved the Level 2 (LERF) analysis (Gambhir, 2010). Energy Northwest determined that resolution of these F&Os will not impact the SAMA analysis. Furthermore, Energy Northwest stated that all of the identified Level B F&Os have been resolved in the PSA Revision 7.1 model used for the SAMA sensitivity analysis. In the PSA Revision 7.1 sensitivity analysis, 13 release categories were defined. The “late” time category was not used leaving nine release categories to which CET end-states were assigned (Gambhir, 2011b). The definition for the “early” time category was changed from “less than 4 hours” assumed in the baseline analysis to “less than 3 hours” based on the latest CGS emergency action levels and the latest evacuation time estimates. Source term release fractions were also developed for each of the nine release categories based on the results of plant-specific calculations using MAAP Version 4.0.4, as revised to represent the current CGS configuration (Gambhir, 2011a). The nine release categories are updated from the five used in the baseline analysis, including quantitative weighting based on the dominant cutset contributors to, and the associated MAAP cases available for, each release category.

The Level 2 model was included in the 2009 peer review of PSA Revision 7.0, with F&Os that could significantly impact the model quantification now incorporated into Revision 7.1. Energy Northwest concluded that resolution of any remaining unresolved F&Os would not impact the SAMA analysis. The NRC staff reviewed the Level 2 methodology and found that Energy Northwest adequately addressed NRC staff RAIs, the Level 2 PSA model was reviewed in more detail as part of the 1997 and 2004 peer reviews, and the findings from these peer reviews have been resolved and their impact assessed in a sensitivity analysis using the updated PSA model. Based on this information, the NRC staff concludes that the Level 2 PSA provides an acceptable basis for evaluating the benefits associated with various SAMAs.

Level 3—Population Dose

Energy Northwest extended the containment performance (Level 2) portion of the PRA to assess offsite consequences (essentially a Level 3 PRA) via the MACCS2 code (NRC, 1998). This included consideration of the following information:

- source terms for each release category and the reactor core radionuclide inventory

- site-specific meteorological data for calendar year 2006
- projected population distribution within an 80 km (50-mi) radius for the year 2045 based on year 2000 census data from SECPOP2000 (NRC, 2003)
- emergency evacuation modeling using only 95 percent of the population (conservative relative to NUREG-1150, which assumed 99.5 percent (NRC 1990))
- economic parameters including agricultural production

Multiple sensitivity cases were run, including releases 13–44 m above ground level; variation in release duration; meteorological data from 2003; variation in rainfall up to maximum for 2006; variation in population growth rate; and variations in evacuation parameters, such as percent of population, evacuation speed, and delay time. Energy Northwest's results showed only minor variations from the baseline for these sensitivities, which is consistent with previous SAMA analyses. The NRC staff concludes that the methodology used by Energy Northwest to estimate the offsite consequences for CGS provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDF and offsite doses reported by Energy Northwest.

5.3.3 Potential Plant Improvements

CGS's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- review of the dominant cutsets and most significant plant systems from the current, plant-specific Level 1 internal events PSA
- review of the most significant initiating events and sequences from the current, plant-specific Level 2 internal events PSA contributing to each release category
- review of potential plant improvements and PSA insights identified in the CGS IPE and IPEEE
- review of SAMA candidates identified for LRAs for selected BWR plants
- review of other industry documentation discussing potential plant improvements

Based on this process, an initial set of 150 "Phase I" candidate SAMAs was identified. Subsequently, after further review of the IPEEE, one of these SAMA candidates was further divided into two, resulting in a total of 151. Energy Northwest performed a qualitative screening of this initial list of Phase I SAMAs and eliminated 124 SAMAs from further consideration, leaving 27 for "Phase II," using the following criteria:

- The SAMA is not applicable to CGS due to design differences or has already been implemented at CGS (66 SAMAs screened).
- The SAMA was determined to provide very little benefit (36 SAMAs screened).
- The SAMA is similar to another SAMA under consideration and was subsumed into the similar SAMA (seven SAMAs screened).
- The SAMA has estimated implementation costs that would exceed the dollar value associated with eliminating all severe accident risk at CGS (15 SAMAs screened).

The NRC staff reviewed Energy Northwest's process for identifying and screening potential SAMA candidates, as well as the methods for quantifying the benefits associated with potential risk reduction. This included reviewing insights from the plant-specific risk studies and reviewing plant improvements considered in previous SAMA analyses. The NRC staff notes that the set of SAMAs submitted is not all-inclusive, since additional, possibly even less expensive design alternatives can always be postulated. However, the NRC staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for fire risks and the absence of external event vulnerabilities constituted reasonable justification for examining primarily the internal events risk results for this purpose. The NRC staff concludes that Energy Northwest used a systematic and comprehensive process for identifying potential plant improvements for CGS, and the set of SAMAs evaluated in the ER, together with those evaluated in response to NRC staff inquiries, is reasonably comprehensive and, therefore, acceptable.

5.3.3.1 Risk Reduction

Energy Northwest evaluated the risk-reduction potential of the 28 SAMAs retained for the Phase II evaluation that were not screened for excessive cost. For the baseline analysis, Energy Northwest used model re-quantification to determine the potential benefits based on CGS internal events PSA Revision 6.2 model for internal events, the CGS fire PSA Revision 2 model for fire events, and the CGS seismic PSA Revision 1 model for seismic events. The majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to eliminate the risk associated with the proposed enhancement. On balance, such calculations overestimate the benefit and are conservative. The NRC staff reviewed Energy Northwest's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on Energy Northwest's risk reduction estimates.

5.3.3.2 Cost Impacts

Energy Northwest developed plant-specific costs of implementing the 28 Phase II candidate SAMAs using by a team of three Energy Northwest and consultant personnel having over 50 years of cumulative experience at CGS and over 90 years of collective experience in the nuclear industry in areas of electrical and mechanical engineering, field engineering, design engineering, construction management, operations and maintenance support, licensing, and PSA (Gambhir, 2010). The cost estimates, conservatively, did not include contingency costs for unforeseen implementation obstacles, the cost of replacement power during extended outages required to implement the modifications, or the costs associated with recurring training, maintenance, and surveillance (Gambhir, 2010). Energy Northwest noted that if the estimated implementation cost was sufficiently greater than the maximum estimated benefit, a more detailed cost estimate was not developed. Based on the use of personnel having significant nuclear plant engineering and operating experience, the NRC staff considers the process Energy Northwest used to develop the site-specific cost estimates reasonable.

The NRC staff reviewed the bases for the applicant's cost estimates, including comparison with estimates developed elsewhere for similar improvements (e.g., estimates developed as part of other licensees' analyses of SAMAs for operating reactors). The staff also reviewed Energy Northwest's results from a sensitivity study using PSA model Revision 7.1 (Gambhir, 2011a). The NRC staff concludes that the cost estimates provided by Energy Northwest are sufficient and appropriate for use in the SAMA evaluation.

5.3.3.3 Cost-Benefit Comparison

The methodology used by Energy Northwest was based primarily on NRC's guidance for performing cost-benefit analysis—NUREG/BR-0184, Regulatory Analysis Technical Evaluation Handbook (NRC, 1997a)—with the discount rate guidelines in NUREG/BR-0058 (NRC, 2004a). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC)—COE

where:

APE = present value of averted public exposure ($)

AOC = present value of averted offsite property damage costs ($)

AOE = present value of averted occupational exposure costs ($)

AOSC = present value of averted onsite costs ($)

COE = cost of enhancement ($)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. Present values for both a 3 percent and 7 percent discount rate were considered. Using the NUREG/BR-0184 methods, Energy Northwest estimated the total present dollar value equivalent associated with eliminating severe accidents from internal and external events at CGS to be about $1,887,000 for the baseline analysis (PSA Revision 6.2) and $2,300,000 for the sensitivity analysis (PSA Revision 7.1), also referred to as the maximum averted cost risk.

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was considered not to be cost-beneficial. In the baseline analysis (using a 7 percent discount rate), Energy Northwest identified no potentially cost-beneficial SAMA. Based on a sensitivity analysis using a 3 percent discount rate, three SAMA candidates—AC/DC-28, FR-07a and FR-07b—were determined to be potentially cost-beneficial (see Table 5.3-6). Energy Northwest also provided the results of a sensitivity study to evaluate the Phase II SAMAs using PSA model Revision 7.1 (Gambhir, 2011a). Energy Northwest's analysis (using a 7 percent discount rate) determined that SAMA candidates FW-05R, FL-05R, FL-06R, CC-24R, OT-07R, and OT-09R were also potentially cost-beneficial (see Table 5.3-6). SAMAs previously identified as potentially cost-beneficial are not repeated even though they may also be cost-beneficial "again" based on these additional analysis cases (e.g., SAMA FL-05R). Since Energy Northwest did not provide in the ER an assessment of the impact on the SAMA evaluation of CDF uncertainties, the NRC requested this (Doyle, 2010a), (Doyle, 2010c). Energy Northwest responded that SAMAs CC-03b, HV-02, FR-08, SR-05R, FL-04R, CC-25R, and FR-11R are also potentially cost-beneficial (see Table 5.3-6), based on either the baseline (PSA Revision 6.2) or sensitivity analysis (PSA Revision 7.1) (Gambhir, 2011a). Also in the sensitivity study, Energy Northwest did not identify any additional potentially cost-beneficial SAMAs using a 3 percent discount rate (Gambhir, 2011a).

Energy Northwest stated that the six potentially cost-beneficial SAMAs (SAMAs AC/DC-28, CC-03b, FR-07a, FR-07b, FR-08, and HV-02), identified via PSA Revision 6.2, will be further evaluated through the normal processes for evaluating possible plant changes at CGS (EN, 2010a), (EN, 2011). Energy Northwest also stated that the 10 additional potentially cost-beneficial SAMAs (SAMAs SR-05R, FL-05R, FL-04R, FL-06R, CC-24R, CC-25R, OT-07R, FW-05R, OT-09R, and FR-11R), identified via PSA Revision 7.1, will be further evaluated through the same processes. This process involves first entering the cost-beneficial SAMA candidate into the action request system for SAMAs that require plant modifications or procedure changes and submitting a training request for SAMAs that require training (Gambhir, 2011a). After the requests are submitted, formal processes are followed for each SAMA type (i.e., hardware modification, procedure change, training) to determine if the SAMA is ultimately implemented. The NRC staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the other SAMAs evaluated would be higher than the associated benefits.

5.3.4 Cost-Beneficial SAMAs

Highlighted in ***bold italics*** in Table 5.3-6 are the 16 potentially cost-beneficial SAMAs identified in the previous section:

Table 5.3-6. Summary of cost-benefit analyses for CGS

<table>
<tr><th rowspan="2">SAMA[a]</th><th colspan="2">% Risk Reduction[f]
(PSA Revision 6.2/PSA Revision 7.1)[c]</th><th colspan="2">Total Benefit ($)[b, f]
(PSA Revision 6.2/PSA Revision 7.1)[c]</th><th rowspan="2">Cost ($)</th></tr>
<tr><th>CDF[d]</th><th>Pop. Dose[d]</th><th>Internal External[e]</th><th>With Uncertainty[e]</th></tr>
<tr><td>Increase availability of DC power</td><td rowspan="4">Internal—5/1
Fire—0/0
Seismic—1/ 0</td><td rowspan="4">Internal—4/0
Fire—0/0
Seismic—1/<1</td><td rowspan="4">37K/3.3K</td><td rowspan="4">100K/8.1K</td><td></td></tr>
<tr><td>AC/DC-01—Provide additional DC battery capacity</td><td>1.8M</td></tr>
<tr><td>AC/DC-02—Replace lead-acid batteries with fuel cells</td><td>1.0M</td></tr>
<tr><td>AC/DC-03—Add a portable, diesel-driven battery charger to existing DC system</td><td>500K</td></tr>
<tr><td>Increase availability of onsite AC power</td><td rowspan="4">Internal—32/2
Fire—11/9
Seismic—4/1</td><td rowspan="4">Internal—15/<1
Fire—9/7
Seismic—4/2</td><td rowspan="4">250K/88K</td><td rowspan="4">720K/230K</td><td></td></tr>
<tr><td>AC/DC-10—Provide an additional DG</td><td>11M</td></tr>
<tr><td>AC/DC-15—Install a gas turbine generator</td><td>2.1M</td></tr>
<tr><td>AC/DC-16—Install tornado protection of gas turbine generator</td><td>2.1M</td></tr>
<tr><td>AC/DC-23—Develop procedures to repair or replace failed 4 kV breakers</td><td>Internal—1/5
Fire—2/1
Seismic—<1/0</td><td>Internal—<1/6
Fire—2/2
Seismic—<1/0</td><td>20K/71K</td><td>61K/170K</td><td>375K</td></tr>
</table>

SAMA[a]	% Risk Reduction[f] (PSA Revision 6.2/PSA Revision 7.1)[c] CDF[d]	% Risk Reduction[f] (PSA Revision 6.2/PSA Revision 7.1)[c] Pop. Dose[d]	Total Benefit ($)[b, f] (PSA Revision 6.2/PSA Revision 7.1)[c] Internal External[e]	Total Benefit ($)[b, f] (PSA Revision 6.2/PSA Revision 7.1)[c] With Uncertainty[e]	Cost ($)
AC/DC-27—Install permanent hardware changes that make it possible to establish 500 kV backfeed through the main step-up transformer	Internal—24/10 Fire—25/38 Seismic—0/0	Internal—9/9 Fire—26/37 Seismic—0/0	300K/420K	870K/1.1M	1.7M
AC/DC-28—Reduce common cause failures (CCFs) between EDG-3 and EDG-1/2	Internal—12/<1 Fire—2/1 Seismic—<1/0	Internal—6/0 Fire—1/<1 Seismic—<1/<1	73K/6.8K	***200K***/17K	***100K***
AC/DC-29—Replace EDG-3 with a diesel diverse from EDG-1 and EDG-2	Internal—26/1 Fire—4/2 Seismic—<1/0	Internal—12/<1 Fire—2/1 Seismic—<1/<1	150K/18K	420K/46K	4.2M
AT-05—Add an independent boron injection system	Internal—<1/2 Fire—0/0 Seismic—<1/0	Internal—<1/7 Fire—0/0 Seismic—<1/<1	5.6K/41K	16K/100K	800K
AT-07—Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS	Internal—0/0 Fire—0/0 Seismic—0/0	Internal—0/0 Fire—0/0 Seismic—0/0	0/0	0/0	1.1M
AT-13—Automate standby liquid control (SLC) injection in response to ATWS event	Internal—~0/<1 Fire—0/0 Seismic—0/0	Internal—~0/1 Fire—0/0 Seismic—0/0	0.2K/9.7K	0.5K/23K	660K
AT-14—Diversify SLC explosive valve operation	Internal—~0/0 Fire—0/0 Seismic—0/0	Internal—~0/0 Fire—0/0 Seismic—0/0	0.4K/0	1.0K/0	370K
Reduce probability of an interfacing systems loss-of-coolant accident (ISLOCA)	Internal—~0/1 Fire—0/0 Seismic—0/0	Internal—~0/3 Fire—0/0 Seismic—0/0	0/20K	0/49K	
CB-01—Install additional pressure or leak monitoring instruments for detection of ISLOCAs					5.6M
CB-03—Increase leak testing of valves in ISLOCA paths					400K
CB-08—Revise emergency operating procedures (EOPs) to improve ISLOCA identification					5.6M
CB-09—Improve operator training on ISLOCA coping					5.6M
CC-01—Install an independent active or passive high pressure injection system	Internal—63/60 Fire—74/74 Seismic—4/2	Internal—41/56 Fire—71/66 Seismic—4/2	875K/1.2M	2.6M/3.0M	29M
CC-02—Provide an additional high pressure injection pump with independent diesel	Internal—63/60 Fire—74/74 Seismic—4/2	Internal—41/56 Fire—71/66 Seismic—4/2	875K/1.2M	2.6M/3.0M	5.2M

SAMA[(a)]	% Risk Reduction[(f)] (PSA Revision 6.2/PSA Revision 7.1)[(c)]		Total Benefit ($)[(b, f)] (PSA Revision 6.2/PSA Revision 7.1)[(c)]		Cost ($)
	CDF[(d)]	Pop. Dose[(d)]	Internal External[(e)]	With Uncertainty[(e)]	
CC-03b—Raise reactor core isolation cooling system (RCIC) backpressure trip set points	Internal—9/<1 Fire—1/0 Seismic—<1/0	Internal—5/0 Fire—1/0 Seismic—<1/0	54K/<1K	***150K***/1.4K	***82K***
CC-20—Improve emergency core cooling system (ECCS) suction strainers	Internal—~0/1 Fire—~0/0 Seismic—~0/0	Internal—~0/1 Fire—~0/<1 Seismic—~0/0	0/7.4K	0/18K	10M
CP-01—Install an independent method of suppression pool cooling	Internal—17/33 Fire—52/54 Seismic—1/1	Internal—28/56 Fire—56/83 Seismic—1/1	540K/1.0M	1.6M/2.6M	6.0M
CW-02—Add redundant DC control power for pumps	Internal—<1/10 Fire—3/5 Seismic—<1/0	Internal—<1/13 Fire—3/-9 Seismic—<1/0	25K/100K	75K/240K	650K
Improve Reliability of ECCS Pumps	Internal—4/3 Fire—10/3 Seismic—<1/0	Internal—6/1 Fire—10/-9 Seismic—<1/0	110K/-5.8K	310K/-18K	
CW-03—Replace ECCS pump motors with air-cooled motors					1.1M
CW-04—Provide self-cooled ECCS seals					675K
CW-07—Add an SW pump	Internal—6/11 Fire—17/12 Seismic—<1/0	Internal—8/12 Fire—10/6 Seismic—1/<1	180K/190K	530K/480K	6.1M
FR-03—Install additional transfer and isolation switches	Internal—0/0 Fire—30/6 Seismic—0/0	Internal—0/0 Fire—31/2 Seismic—0/0	210K/36K	650K/93K	2.0M
FR-07a—Improve the fire resistance of critical cables for containment venting	Internal—0/0 Fire—46/30 Seismic—0/0	Internal—0/0 Fire—50/47 Seismic—0/0	330K/320K	***1.0M/840K***	***400K***
FR-07b—Improve the fire resistance of critical cables for transformer E-TR-S	Internal—0/0 Fire—11/3 Seismic—0/0	Internal—0/0 Fire—11/4 Seismic—0/0	75K/31K	***230K***/81K	***100K***
FR-08—Improve the fire resistance of cables to residual heat removal (RHR) and standby SW	Internal—0/0 Fire—72/56 Seismic—0/0	Internal—0/0 Fire—78/64 Seismic—0/0	520K/510K	***1.6M/1.3M***	***1.25M***
HV-02—Provide a redundant train or means of ventilation	Internal—11/<1 Fire—16/0 Seismic—<1/0	Internal—17/<1 Fire—16/0 Seismic—<1/0	210K/2.2K	***620K***/5.3K	***480K***
SR-03—Modify safety related CST	Internal—0/0 Fire—0/0 Seismic—~0/1	Internal—0/0 Fire—0/0 Seismic—~0/1	0/3.1K	0/9.3K	980K

	% Risk Reduction[f] (PSA Revision 6.2/PSA Revision 7.1)[c]		Total Benefit ($)[b, f] (PSA Revision 6.2/PSA Revision 7.1)[c]		
SAMA[a]	CDF[d]	Pop. Dose[d]	Internal External[e]	With Uncertainty[e]	Cost ($)
SR-05R—Improve seismic ruggedness of MCC-7F and MCC-8F	Internal—NA/0 Fire—NA/0 Seismic—NA/19	Internal—NA/0 Fire—NA/0 Seismic—NA/10	NA/57K	NA/***170K***	***150K***
OT-08R—Install explosion protection around CGS transformers	Internal—NA/1 Fire—NA/0 Seismic—NA/0	Internal—NA/<1 Fire—NA/0 Seismic—NA/0	NA/9.4K	NA/23K	700K
FL-05R—Clamp on flow instruments to certain drain lines in the control building of the radwaste building and alarm in the control room	Internal—NA/16 Fire—NA/0 Seismic—NA /0	Internal—NA/35 Fire—NA/0 Seismic—NA/0	NA/***250K***	NA/***610K***	***250K***
FL-04R—Add one isolation valve in the SW, turbine SW, and fire protection lines in the control building area of the radwaste building	Internal—NA/17 Fire—NA/0 Seismic—NA/0	Internal—NA/35 Fire—NA/0 Seismic—NA/0	NA/260K	NA/***620K***	***380K***
FL-06R—Additional non-destructive evaluation (NDE) and inspections (in the control building)	Internal—NA/8 Fire—NA/0 Seismic—NA/0	Internal—NA/18 Fire—NA/0 Seismic—NA/0	NA/***130K***	NA/***310K***	***14K***
CC-24R—Backfeed the high-pressure core spray system (HPCS) system with SM-8 to provide a third power source for HPCS	Internal—NA/7 Fire—NA/9 Seismic—NA/0	Internal—NA/7 Fire—NA/13 Seismic—NA/0	NA/***170K***	NA/***420K***	***105K***
CC-25R—Enhance alternate injection reliability by including RHR, SW and fire water cross-tie in the maintenance program	Internal—NA/1 Fire—NA/1 Seismic—NA/0	Internal—NA/1 Fire—NA/<1 Seismic—NA/ <1	NA/12K	NA/***29K***	***13K***
OT-07R—Increase operator training on systems and operator actions determined to be important from the PSA	Internal—NA/25 Fire—NA/5 Seismic—NA/0	Internal—NA/8 Fire—NA/<1 Seismic—NA/0	NA/***200K***	NA/***480K***	***40K***
FW-05R—Examine the potential for operators to control reactor feedwater (RFW) and avoid a reactor trip	Internal—NA/3 Fire—NA/7 Seismic—NA/0	Internal—NA/2 Fire—NA/4 Seismic—NA/0	NA/***72K***	NA/***180K***	***29K***
FR-09R—Install early fire detection in the following physical analysis units: R-1B, R-1D, and R-1J	Internal—NA/0 Fire—NA/15 Seismic—NA/0	Internal—NA/0 Fire—NA/7 Seismic—NA/0	NA/100K	NA/260K	680K
AT-15R—Modifications to make use of HPCS more likely for ATWS (use of auto bypass, installing throttle valve)	Internal—NA/15 Fire—NA/0 Seismic—NA/0	Internal—NA/1 Fire—NA/0 Seismic—NA/0	NA/80K	NA/190K	2.8M

SAMA[a]	% Risk Reduction[f] (PSA Revision 6.2/PSA Revision 7.1)[c]		Total Benefit ($)[b, f] (PSA Revision 6.2/PSA Revision 7.1)[c]		Cost ($)
	CDF[d]	Pop. Dose[d]	Internal External[e]	With Uncertainty[e]	
OT-09R—For the non-LOCA initiating events, credit the Z (power conversion system recovery) function	Internal—NA/4 Fire—NA/8 Seismic—NA/0	Internal—NA/5 Fire—NA/13 Seismic—NA/0	NA/***130K***	NA/***330K***	***130K***
FR-12R—Install early fire detection in the following physical analysis units: T-1A, T-12, T-1C, and T-1D	Internal—NA/0 Fire—NA/12 Seismic—NA/0	Internal—NA/0 Fire—NA/12 Seismic—NA/0	NA/110K	NA/270K	725K
FR-11R—Install early fire detection in the following analysis units: RC-02, RC-03, RC-04, RC-05, RC-07, RC-08, RC-11, RC-13, RC-14, and RC-1A	Internal—NA/0 Fire—NA/56 Seismic—NA/0	Internal—NA/0 Fire—NA/63 Seismic—NA/0	NA/510K	NA/***1.3M***	***1.0M***
FR-10R—Install early fire detection in the main control room: RC-10	Internal—NA/0 Fire—NA/1 Seismic—NA/0	Internal—NA/0 Fire—NA/2 Seismic—NA/0	NA/14K	NA/36K	535K
FL-07R—Protect the HPCS from flooding that results from ISLOCA events	Internal—NA/0 Fire—NA/0 Seismic—NA/0	Internal—NA/2 Fire—NA/0 Seismic—NA/0	NA/11K	NA/26K	1.05M
AC/DC-30R—Provide an additional DG diverse from DG-1 and DG-2	Internal—NA/-4 Fire—NA/20 Seismic—NA/2	Internal—NA/-1 Fire—NA/18 Seismic—NA/2	NA/160K	NA/410K	10M
CC-26R—Install hard pipe from diesel fire pump to vessel	Internal—NA/<1 Fire—NA/0 Seismic—NA/0	Internal—NA /<1 Fire—NA/1 Seismic—NA/0	NA/5.7K	NA/14K	710K
OT-10R—Increase fire pump house building integrity to withstand higher winds so the fire system will be capable of withstanding a severe weather event	Internal—NA/<1 Fire—NA/0 Seismic—NA/0	Internal—Na/<1 Fire—NA/0 Seismic—NA/0	NA/1.5K	NA/3.5K	735K
FW-04—Add a motor-driven feedwater pump	Internal—NA/40 Fire—NA/25 Seismic—NA/0	Internal—NA/42 Fire—NA/26 Seismic—NA/0	NA/620K	NA/1.5M	10M
CB-10R—Provide additional NDE and inspections of MS pipe in turbine building	Internal—NA/2 Fire—NA/0 Seismic—NA/0	Internal—NA/2 Fire—NA/0 Seismic—NA/0	NA/20K	NA/48K	125K

	% Risk Reduction[f] (PSA Revision 6.2/PSA Revision 7.1)[c]		Total Benefit ($)[b, f] (PSA Revision 6.2/PSA Revision 7.1)[c]		
SAMA[a]	CDF[d]	Pop. Dose[d]	Internal External[e]	With Uncertainty[e]	Cost ($)

[a] SAMAs in ***bold italics*** are potentially cost-beneficial.

[b] This includes dual contribution from internal events as a surrogate for contribution from HFO external events.

[c] Values are based on both PSA Revisions 6.2 (baseline) and 7.1 (sensitivity) are shown as Revision 6.2/Revision 7.1.

[d] Negative value indicates increase in risk.

[e] Negative value indicates non-benefit.

[f] Key: "<1" indicates value between 0.1 percent and 1 percent; "~0" indicates value <0.1 percent; "0" indicates value reported as zero; "NA" indicates "not analyzed" with respect to PSA Revision 6.2.

5.3.5 Conclusions

Energy Northwest compiled a list of 151 SAMAs based on a review of the of the dominant cutsets and most significant plant systems from the plant-specific internal events PRA, insights from the plant-specific IPE and IPEEE, Phase II SAMAs from LRAs for other plants, and review of other industry documentation. Of these, 123 SAMAs were eliminated qualitatively, leaving 28 candidate SAMAs for evaluation. These, and others subsequently identified as a result of the NRC staff RAIs and further examination by Energy Northwest, underwent more detailed design and cost estimates to show that 16 were potentially cost-beneficial. In the initial baseline analysis, using PSA Revision 6.2, Energy Northwest found that none of the SAMA candidates were potentially cost-beneficial. Energy Northwest then performed additional analyses to evaluate the impact of parameter choices, resulting in the identification of three SAMAs that were potentially cost-beneficial (SAMAs AC/DC-28, FR-07a, and FR-07b). In response to an NRC staff RAI, Energy Northwest evaluated all SAMA candidates using the 95 percentile internal, fire, and seismic event CDFs to account for uncertainties in the PSA models. This analysis identified three additional SAMAs (SAMA CC-03b, FR-08, and HV-02) as being potentially cost-beneficial via PSA Revision 6.2. In response to another NRC staff RAI, Energy Northwest performed a sensitivity study to address concerns regarding a significant update to the CGS PSA model since the SAMA analysis was developed (i.e., using PSA Revision 7.1). Energy Northwest re-evaluated each of the initial 28 candidate SAMAs and several additional SAMA candidates to show that 10 additional SAMAs (SAMA SR-05R, FL-05R, FL-04R, FL-06R, CC-24R, CC-25R, OT-07R, FW-05R, OT-09R, and FR-11R) were potentially cost-beneficial. Energy Northwest indicated that all 16 potentially cost-beneficial SAMAs will be further evaluated through the normal processes for evaluating possible plant changes at CGS.

The NRC staff reviewed the Energy Northwest analysis and concludes that the methods used, and the implementation of those methods, are acceptable. The treatment of SAMA benefits and costs supports the general conclusion that the SAMA evaluations performed by Energy Northwest are reasonable and sufficient for the license renewal submittal. The level of treatment of SAMAs for external events was deemed sufficient to support the conclusion that the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process, separate analysis of fire and seismic events, and inclusion of a multiplier to account for other external events. Therefore, the NRC staff concurs with Energy Northwest's identification of 16 potentially cost-beneficial SAMAs.

One of these 16 SAMAs, SAMA FL-06R, entails additional NDE and inspection of certain water pipes to lower the risk of flooding due to a pipe break. The NRC noted that SAMA FL-06R appears to relate to managing the effects of aging and may be mandated by the NRC as part of license renewal pursuant to 10 CFR Part 54. The NRC asked for more information about the relationship to the aging management programs proposed in the safety portion of the LRA (Doyle, 2011b), (Cunanan, 2011). Energy Northwest responded by stating that the piping is within the scope of aging management programs (Swank, 2011) but that corrective actions to adjust preventative maintenance activities have already been completed such that SAMA FL-06R would now screen out in Phase 1 as already implemented (Javorik, 2011). Because SAMA FL-06R has already been implemented at CGS, which would have constituted its being screened out during Phase 1 of the SAMA evaluation, the NRC concludes that no further actions are necessary.

Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of the remaining 15 SAMAs by Energy Northwest through its long-range planning process is appropriate. The staff concludes that the mitigative alternatives for these 15 do not involve aging management of passive, long-lived systems, structures, and components during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54.

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6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE, WASTE MANAGEMENT, AND GREENHOUSE GAS

6.1 The Uranium Fuel Cycle

This chapter addresses issues related to the uranium fuel cycle and waste management during the period of extended operation. The uranium cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the generic environmental impact statement (GEIS) (NRC, 1996), (NRC, 1999) based, in part, on the generic impacts given in Section 51.51 of Title 10 of the *Code of Federal Regulations* (10 CFR 51.51), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor."

Nine generic issues are related to the fuel cycle and waste management. These are shown in Table 6.1-1. There are no site-specific issues.

Table 6.1-1. Issues related to the uranium fuel cycle and waste management

Issues	GEIS sections	Category
Offsite radiological impacts (individual effects from other than the disposal of spent fuel & high-level waste)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6	1
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
Offsite radiological impacts (spent fuel & high-level waste disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6	1
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6	1
Low-level waste storage & disposal	6.1; 6.2.2.2;6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6;6.6	1
Mixed waste storage & disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4; 6.6	1
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6	1
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6	1
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1	1

U.S. Nuclear Regulatory Commission (NRC) staff (staff) did not find any new and significant information related to the uranium fuel cycle during the review of the Columbia Generating Station (CGS) Environmental Report (ER) (EN, 2010), the site visit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these Category 1 issues, the GEIS concludes that the impacts are SMALL, except for the offsite radiological collective impacts from the fuel cycle and from high-level waste and spent fuel disposal, which the NRC concluded are acceptable.

6.2 Greenhouse Gas Emissions

This section discusses the potential impacts from greenhouse gases (GHGs) emitted from the nuclear fuel cycle. The GEIS does not directly address these emissions, and its discussion is limited to an inference that substantial carbon dioxide (CO_2) emissions may occur if coal- or oil-fired alternatives to license renewal are carried out.

6.2.1 Existing Studies

Since the development of the GEIS, the relative volumes of GHGs emitted by nuclear and other electricity generating methods have been widely studied. However, estimates and projections of the carbon footprint of the nuclear power lifecycle vary depending on the type of study done. Additionally, considerable debate also exists among researchers on the relative effects of nuclear and other forms of electricity generation on GHG emissions. Existing studies on GHG emissions from nuclear power plants generally take two different forms:

(1) qualitative discussions of the potential to use nuclear power to reduce GHG emissions and mitigate global warming

(2) technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle or entire nuclear power plant life cycle and comparisons to the operational or life cycle emissions from other energy generation alternatives

6.2.1.1 Qualitative Studies

The qualitative studies consist primarily of broad, large-scale public policy, or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, or politically workable means of achieving global GHG reductions. Studies found by the staff during the subsequent literature search include the following:

- Evaluations to determine if investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider, 2000), (IAEA, 2000), (NEA, 2002). Ultimately, the parties to the Kyoto Protocol did not approve nuclear power as a component under the clean development mechanism (CDM) due to safety and waste disposal concerns (NEA, 2002).
- Analyses developed to assist governments, including the U.S., in making long-term investment and public policy decisions in nuclear power (Keepin, 1988), (Hagen et al., 2001), (MIT, 2003).

Although the qualitative studies sometimes reference and critique the existing quantitative estimates of GHGs produced by the nuclear fuel cycle or life cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are typically not directly applicable to an evaluation of GHG emissions associated with the proposed license renewal for a given nuclear power plant.

6.2.1.2 Quantitative Studies

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature and were useful to the staff's efforts in addressing relative GHG emission levels. Examples of these studies include—but are not limited to—Mortimer (1990), Andseta et al. (1998), Spadaro (2000), Storm van Leeuwen and Smith (2005), Fritsche (2006), Parliamentary Office of Science and Technology (POST) (2006), Atomic Energy Authority (AEA) (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparing these studies and others like them is difficult because the assumptions and components of the lifecycles the authors evaluate vary widely. Examples of areas in which differing assumptions make comparing the studies difficult include the following:

- energy sources that may be used to mine uranium deposits in the future
- reprocessing or disposal of spent nuclear fuel
- current and potential future processes to enrich uranium and the energy sources that will power them
- estimated grades and quantities of recoverable uranium resources
- estimated grades and quantities of recoverable fossil fuel resources
- estimated GHG emissions other than CO_2, including the conversion to CO_2 equivalents per unit of electric energy produced
- performance of future fossil fuel power systems
- projected capacity factors for alternatives means of generation
- current and potential future reactor technologies

In addition, studies may vary with respect to whether all or parts of a power plant's lifecycle are analyzed (i.e., a full lifecycle analysis will typically address plant construction, operations, resource extraction (for fuel and construction materials), and decommissioning, whereas, a partial lifecycle analysis primarily focus on operational differences).

In the case of license renewal, a GHG analysis for that portion of the plant's lifecycle (operation for an additional 20 years) would not involve GHG emissions associated with construction because construction activities have already been completed at the time of relicensing. In addition, the proposed action of license renewal would also not involve additional GHG emissions associated with facility decommissioning, because that decommissioning must occur whether the facility is relicensed or not. However, in some of the above-mentioned studies, the specific contribution of GHG emissions from construction, decommissioning, or other portions of a plant's lifecycle cannot be clearly separated from one another. In such cases, an analysis of GHG emissions would overestimate the GHG emissions attributed to a specific portion of a plant's lifecycle. Nonetheless, these studies supply some meaningful information with respect to the relative magnitude of the emissions among nuclear power plants and other forms of electric generation, as discussed in the following sections.

In Tables 6.2-1, 6.2--2, and 6.2-3, the staff presents the results of the above-mentioned quantitative studies to supply a weight-of-evidence evaluation of the relative GHG emissions that may result from the proposed license renewal as compared to the potential alternative use of coal-fired, natural gas-fired, and renewable generation. Most studies from Mortimer (1990) onward suggest that uranium ore grades and uranium enrichment processes are leading determinants in the ultimate GHG emissions attributable to nuclear power generation. These studies show that the relatively lower order of magnitude of GHG emissions from nuclear power, when compared to fossil-fueled alternatives (especially natural gas), could potentially disappear if available uranium ore grades drop sufficiently while enrichment processes continued to rely on the same technologies.

6.2.1.3 Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Considering that coal fuels the largest share of electricity generation in the U.S. and that its burning results in the largest emissions of GHGs for any of the likely alternatives to nuclear power generation, including CGS, most of the available quantitative studies focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent coal-fired plant, are presented in Table 6.2-1. The following chart does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-1. Nuclear greenhouse gas emissions compared to coal

Source	GHG emission results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta et al. (1998)	Nuclear energy produces 1.4% of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Coal—264–357 g C_{eq}/kWh
Storm van Leeuwen & Smith (2005)	Authors did not evaluate nuclear versus coal.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Coal—950 g C_{eq}/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g C_{eq}/kWh Coal—>1000 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90%.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Coal—950–1250 g C_{eq}/kWh
Fthenakis & Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones (2007)	Author did not evaluate nuclear versus coal.

6.2.1.4 Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent natural gas-fired plant, are presented in Table 6.2-2. The following chart does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-2. Nuclear greenhouse gas emissions compared to natural gas

Source	GHG emission results
Mortimer (1990)	Author did not evaluate nuclear versus natural gas.
Andseta et al. (1998)	Author did not evaluate nuclear versus natural gas.
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Natural Gas—120–188 g C_{eq}/kWh
Storm van Leeuwen & Smith (2005)	Nuclear fuel cycle produces 20–33% of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Cogeneration Combined Cycle Natural Gas—150 g C_{eq}/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g C_{eq}/kWh Natural Gas—500 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g Ceq/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90%.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Natural Gas—440–780 g C_{eq}/kWh
Fthenakis & Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones (2007)	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2005), and concluded that the nuclear fuel cycle produces 15–27% of the GHG emissions of natural gas.

6.2.1.5 Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6.2-3. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because of the large variation in efficiencies due to their different sources and locations. For example, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved (if used at all). Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources. As noted in Section 6.2.1.2, the following chart does not include all existing studies, but it gives an illustrative range of estimates developed by various sources.

Table 6.2-3. Nuclear greenhouse gas emissions compared to renewable energy sources

Source	GHG emission results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear are expected to increase because of declining ore grade.
Andseta et al. (1998)	Author did not evaluate nuclear versus renewable energy sources.
Spadaro (2000)	Nuclear—2.5–5.7 g C_{eq}/kWh Solar PV—27.3–76.4 g C_{eq}/kWh Hydroelectric—1.1–64.6 g C_{eq}/kWh Biomass—8.4–16.6 g C_{eq}/kWh Wind—2.5–13.1 g C_{eq}/kWh
Storm van Leeuwen & Smith (2005)	Author did not evaluate nuclear versus renewable energy sources.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g C_{eq}/kWh Solar PV—125 g C_{eq}/kWh Hydroelectric—50 g C_{eq}/kWh Wind—20 g C_{eq}/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g C_{eq}/kWh Biomass—25–93 g C_{eq}/kWh Solar PV—35–58 g C_{eq}/kWh Wave/Tidal—25–50 g C_{eq}/kWh Hydroelectric—5–30 g C_{eq}/kWh Wind—4.64–5.25 g C_{eq}/kWh Note: Decrease of uranium ore grade to 0.03% would raise nuclear to 6.8 g C_{eq}/kWh.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8–24 g C_{eq}/kWh Solar PV—43–73 g C_{eq}/kWh Hydroelectric—1–34 g C_{eq}/kWh Biomass—35–99 g C_{eq}/kWh Wind—8–30 g C_{eq}/kWh
Fthenakis & Kim (2007)	Nuclear—16–55 g C_{eq}/kWh Solar PV—17–49 g C_{eq}/kWh
Dones (2007)	Author did not evaluate nuclear versus renewable energy sources.

6.2.2 Conclusions: Relative Greenhouse Gas Emissions

The sampling of data presented in Tables 6.2-1, 6.2-2, and 6.2-3 demonstrates the challenges of any attempt to determine the specific amount of GHG emission attributable to nuclear energy production sources, as different assumptions and calculation methods will yield differing results. The differences and complexities in these assumptions and analyses will further increase when they are used to project future GHG emissions. Nevertheless, several conclusions can be drawn from the information presented.

First, the various studies show a general consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation (e.g., the GHG emissions from a complete nuclear fuel cycle currently range from 2.5–55 grams of Carbon equivalent per Kilowatt hour (g C_{eq}/kWh), as compared to the use of coal plants (264–1250 g C_{eq}/kWh) and natural gas plants (120–780 g C_{eq}/kWh)). The studies also give estimates of GHG emissions from five renewable energy sources based on current technology. These estimates included solar-photovoltaic (17–125 g C_{eq}/kWh), hydroelectric (1–64.6 g C_{eq}/kWh), biomass (8.4–99 g C_{eq}/kWh), wind (2.5–30 g C_{eq}/kWh), and tidal (25–50 g C_{eq}/kWh). The range of these estimates is wide, but the general conclusion is that current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as from these renewable energy sources.

Second, the studies show no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors about the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists about future GHG emissions associated with coal and natural gas for electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources and is expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed CGS relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The staff bases this conclusion on the following rationale:

- As shown in Tables 6.2-1 and 6.2-2, the current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources.
- CGS license renewal may involve continued GHG emissions due to uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether the license is renewed or not).
- Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the CGS periods of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for higher-grade resource discovery, and technology improvements could extend this timeframe.

With respect to comparison of GHG emissions among the proposed CGS license renewal action and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, and constructing facilities of all types. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are within the same order of magnitude. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power—and because most renewable energy sources lack a fuel component—it is likely that GHG emissions from renewable energy sources would be lower than those associated with CGS at some point during the period of extended operation.

The staff also supplies an additional discussion about the contribution of GHG to cumulative air quality impacts in Section 4.11.7 of this SEIS.

6.3 References

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Dones, R., "Critical Note on the Estimation by Storm Van Leeuwen J.W., and Smith P. of the Energy Uses and Corresponding CO_2 Emissions for the Complete Nuclear Energy Chain," Paul Sherer Institute, April 2007.

Energy Northwest (EN), "License Renewal Application, Columbia Generating Station," Appendix E, 2010, ADAMS Accession No. ML100250666.

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7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the “Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors,” NUREG-0586, Supplement 1 (NRC 2002). The U.S. Nuclear Regulatory Commission (NRC) staff's (staff's) evaluation of the environmental impacts of decommissioning—presented in NUREG-0586, Supplement 1—notes a range of impacts for each environmental issue.

Additionally, the incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are discussed in the “Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS),” NUREG-1437, Volumes 1 and 2 (NRC 1996), (NRC 1999). The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were then assigned a Category 1 or a Category 2 designation. Section 1.4 in Chapter 1 explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE. The staff analyzed site-specific issues (Category 2) for Columbia Generating Station (CGS) and assigned them a significance level of SMALL, MODERATE, LARGE, or not applicable to CGS because of site characteristics or plant features. There are no Category 2 issues related to decommissioning.

7.1 Decommissioning

Table 7.1-1 lists the Category 1 issues in Table B-1 of Title 10 of the *Code of Federal Regulations* (CFR) Part 51, Subpart A, Appendix B that are applicable to CGS decommissioning following the renewal term.

Table 7.1-1. Issues related to decommissioning

Issues	GEIS section	Category
Radiation doses	7.3.1; 7.4	1
Waste management	7.3.2; 7.4	1
Air quality	7.3.3; 7.4	1
Water quality	7.3.4; 7.4	1
Ecological resources	7.3.5; 7.4	1
Socioeconomic impacts	7.3.7; 7.4	1

Decommissioning would occur whether CGS were shut down at the end of its current operating license or at the end of the period of extended operation. There are no site-specific issues related to decommissioning.

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

Radiation doses. Based on information in the GEIS, the NRC noted that “[d]oses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 person-rem (1 person-mSv) caused by buildup of long-lived radionuclides during the license renewal term."

Waste management. Based on information in the GEIS, the NRC noted that "[d]ecommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected."

Air quality. Based on information in the GEIS, the NRC noted that "[a]ir quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term."

Water quality. Based on information in the GEIS, the NRC noted that "[t]he potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts."

Ecological resources. Based on information in the GEIS, the NRC noted that "[d]ecommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts."

Socioeconomic Impacts. Based on information in the GEIS, the NRC noted that "[d]ecommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth."

Energy Northwest stated in its Environmental Report (ER) that it is not aware of any new and significant information on the environmental impacts of CGS license renewal (EN, 2010). The staff has not found any new and significant information during its independent review of the Energy Northwest ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the NRC staff concludes that there are no impacts related to these issues, beyond those discussed in the GEIS. For all of these issues, the NRC staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

7.2 References

Energy Northwest (EN), "Appendix E, Applicant's Environmental Report Operating License Renewal Stage," License Renewal Application, Columbia Generating Station, 2010, ADAMS Accession No. ML100250666.

U.S. Code of Federal Regulations (CFR), "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Part 51, Chapter 1, Title 10, "Energy."

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

NRC, "Section 6.3 – Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report," Generic Environmental Impact

Statement for License Renewal of Nuclear Plants, NUREG-1437, Washington, D.C., Volume 1, Addendum 1, 1999, ADAMS Accession No. ML040690720.

NRC, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors" NUREG-0586, Washington, D.C., Volumes 1 and 2, Supplement 1, 2002, ADAMS Accession Nos. ML023500295 and ML023500395.

8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The National Environmental Policy Act (NEPA) requires the consideration of a range of reasonable alternatives to the proposed action in an environmental impact statement (EIS). In this case, the proposed action is whether to issue a renewed license for Columbia Generating Station (CGS), which will allow the plant to operate for 20 years beyond its current license expiration date. A license is just one of many conditions that an applicant must meet in order to operate its nuclear plant. State regulatory agencies and the owners of the nuclear power plant ultimately decide whether the plant will operate, and economic and environmental considerations play a primary role in this decision. The U.S. Nuclear Regulatory Commission's (NRC) responsibility is to ensure the safe operation of nuclear power facilities and not to formulate energy policy or encourage or discourage the development of alternative power generation.

The license renewal process is designed to assure safe operation of the nuclear power plant and protection of the environment during the license renewal term. Under the NRC's environmental protection regulations in Title 10, Part 51, of the *Code of Federal Regulations* (10 CFR Part 51), which implement Section 102(2) of NEPA, renewal of a nuclear power plant operating license requires the preparation of an EIS.

To support the preparation of these EISs, the NRC prepared the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)," NUREG-1437, in 1996 (NRC, 1996), (NRC, 1999). The 1996 GEIS for license renewal was prepared to assess the environmental impacts associated with the continued operation of nuclear power plants during the license renewal term. The intent was to determine which environmental impacts would result in essentially the same impact at all nuclear power plants and which ones could result in different levels of impacts at different plants and would require a plant-specific analysis to determine the impacts. For those issues that could not be generically addressed, the NRC will develop a plant-specific supplemental EIS (SEIS) to the GEIS.

Pursuant to 10 CFR 51.71(d), regulations for license renewal require that a SEIS "consider and weigh the environmental effects of the proposed action [license renewal]; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental effects."

In this chapter, the potential environmental impacts of alternatives to license renewal for CGS are examined as well as alternatives that may reduce or avoid adverse environmental impacts from license renewal, when and where these alternatives are applicable.

While the 1996 GEIS reached generic conclusions regarding many environmental issues associated with license renewal, it did not determine which alternatives are reasonable or reach conclusions about site-specific environmental impact levels. As such, the NRC must evaluate environmental impacts of alternatives on a site-specific basis.

Alternatives Evaluated In-Depth:

- Natural gas-fired combined-cycle (NGCC)
- New nuclear
- Combination alternative (NGCC, hydroelectric, wind, and conservation and efficiency)

Other Alternatives Considered:

- Offsite new nuclear and NGCC
- Coal-fired power
- Energy conservation and energy efficiency
- Purchased power
- Solar power
- Wind power
- Biomass waste
- Hydroelectric power
- Ocean wave and current energy
- Geothermal power
- Municipal solid waste
- Biofuels
- Oil-fired power
- Fuel cells
- Delayed retirement

As stated in Chapter 1 of this SEIS, alternatives to the proposed action of license renewal for CGS must meet the purpose and need for issuing a renewed license; they must do the following:

> provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by state, utility, and, where authorized, Federal (other than NRC) decisionmakers (NRC, 1996)

The NRC ultimately makes no decision about which alternative (or the proposed action) to carry out because that decision falls to the appropriate energy-planning decisionmakers to decide. Comparing the environmental effects of these alternatives will help the NRC decide if the adverse environmental impacts of license renewal are great enough to deny the option of license renewal for energy-planning decisionmakers (10 CFR 51.95(c)(4)). If the NRC acts to issue a renewed license, all of the alternatives, including the proposed action, will be available to energy-planning decisionmakers. If NRC decides not to renew the license (or takes no action at all), then energy-planning decisionmakers may no longer elect to continue operating CGS and will have to resort to another alternative—which may or may not be one of the alternatives considered in this section—to meet their energy needs now being satisfied by CGS.

In evaluating alternatives to license renewal, energy technologies or options currently in commercial operation are considered, as well as some technologies not currently in commercial operation but likely to be commercially available by the time the current CGS operating license expires. The current CGS operating license will expire on December 20, 2023, and an alternative must be available (constructed, permitted, and connected to the grid) by the time the current CGS license expires.

Alternatives that cannot meet future system needs and do not have costs or benefits that justify inclusion in the range of reasonable alternatives were eliminated from detailed study. The remaining alternatives were evaluated, and they are discussed in-depth in this chapter. Each alternative eliminated from detailed study is briefly discussed in Section 8.4, and a basis for its removal is provided. In Sections 8.1–8.3, 19 discrete potential alternatives to the proposed action were considered and then narrowed to the 2 discrete alternatives and 1 combination alternative.

The 1996 GEIS presents an overview of some energy technologies but does not reach any conclusions about which alternatives are most appropriate. Since 1996, many energy technologies have evolved significantly in capability and cost, while regulatory structures have changed to either promote or impede development of particular alternatives.

As a result, the analyses include updated information from sources like the Energy Information Administration (EIA), other organizations within the U.S. Department of Energy (DOE), the U.S.

Environmental Protection Agency (EPA), industry sources and publications, and information submitted by the applicant in its Environmental Report (ER).

The evaluation of each alternative considers the environmental impacts across seven impact categories: (1) air quality, (2) groundwater use and quality, (3) surface water use and quality, (4) ecology, (5) human health, (6) socioeconomics, and (7) waste management. A three-level standard of significance—SMALL, MODERATE, or LARGE—is used to show the intensity of environmental effects for each alternative that is evaluated in depth. The order of presentation is not meant to imply increasing or decreasing level of impact, nor does it imply that an energy-planning decisionmaker would select one or another alternative.

Sections 8.1–8.3 describe the environmental impacts of alternatives to license renewal. These alternatives include an NGCC power plant in Section 8.1, new nuclear generation in Section 8.2, and a combination of alternatives that includes some natural gas-fired capacity, energy conservation, a hydropower component, and a wind-power component in Section 8.3. In Section 8.4, alternatives considered but eliminated from detailed study are briefly discussed. Finally, in Section 8.5, environmental effects that may occur if NRC takes no action and does not issue a renewed license for CGS are described. Section 8.6 summarizes the impacts of each of the alternatives considered in detail.

8.1 Natural Gas-Fired Combined-Cycle Generation

This section evaluates the environmental impacts of natural gas-fired combined-cycle generation at the CGS site.

Natural gas fueled 21 percent of electricity generation in the United States in 2008, accounting for the second greatest share of electrical power after coal (EIA 2009a). Natural gas fuels roughly 13 percent of the generation in the Pacific Northwest (NWPCC 2005) and is transported from western North American gas-producing regions to eastern Washington via the Gas Transmission Northwest Line (EIA 2008). Development of new natural gas-fired plants may be affected by perceived or actual action to limit greenhouse gas (GHG) emissions, although they produce markedly fewer GHGs per unit of electrical output than coal-fired plants. Natural gas-fired power plants are feasible, commercially available options for providing electrical generating capacity beyond CGS's current license expiration. Combined-cycle power plants differ significantly from coal-fired and existing nuclear power plants. Combined-cycle power plants derive the majority of their electrical output from a gas-turbine cycle, and then generate additional power—without burning any additional fuel—through a second, steam-turbine cycle. The first gas turbine stage (similar to a large jet engine) burns natural gas, which turns a driveshaft that powers an electric generator. The exhaust gas from the gas turbine is still hot enough to boil water to steam. Ducts carry the hot exhaust to a heat-recovery steam generator, which produces steam to drive a steam turbine and produce additional electrical power. The combined-cycle approach is significantly more efficient than any one cycle on its own; thermal efficiency can exceed 60 percent. Because the natural gas-fired alternative derives much of its power from a gas turbine cycle, and because it wastes less heat than the existing CGS, it requires significantly less cooling water and smaller or fewer cooling towers.

To replace the 1,150 megawatt electric (MWe) power that CGS generates, three General Electric S107H combined-cycle natural gas-fired generating units were considered. While any number of commercially available combined-cycle power-generating units could be used in a variety of combinations to replace the generating power of CGS, the S107H unit was selected for its high efficiency and to minimize environmental impacts. Other manufacturers, like

Siemens, offer similar high-efficiency models. This natural gas-fired alternative produces a net 400 MWe per unit. Three units produce a total of 1,200 MWe, or nearly the same net output as the existing CGS.

The combined-cycle generating units operate at a heat rate of 5,690 British thermal units per kilowatt hours (BTU/kWh), or nearly 60 percent thermal efficiency (GE 2007). As noted above, this natural gas-fired alternative would require much less cooling water than CGS because it operates at a higher thermal efficiency and because it requires much less water for steam cycle condenser cooling. The existing intake and discharges on the Columbia River and existing or similar mechanical draft cooling towers would be used for this alternative.

In addition to cooling towers, other onsite visible structures would include the gas turbine buildings and heat-recovery steam generators (which may be enclosed in a single building), three exhaust stacks, an electrical switchyard, and, if necessary, equipment associated with a natural gas pipeline, such as a compressor station. Based on GEIS estimates, approximately 132 acres (ac) (56 hectares (ha)) of land would be required.

This 1,200 MWe power plant would consume 51 billion cubic feet (ft^3) (1,446 million cubic meters (m^3)) of natural gas annually assuming an average heat content of 1,029 BTU/ft^3 (EIA 2009b). Natural gas would be extracted from the ground through wells, then treated to remove impurities (like hydrogen sulfide), and blended to meet pipeline gas standards, before being piped through the interstate pipeline system to the power plant site. This natural gas-fired alternative would produce relatively little waste, primarily in the form of spent catalysts used for emissions controls.

Environmental impacts from the natural gas-fired alternative would be greatest during construction. Site crews would clear vegetation from the site, prepare the site surface, and begin excavation before other crews begin actual construction on the plant and any associated infrastructure, including a pipeline spur to connect the plant with the closest gas transmission line 15 miles (mi) (24 kilometers (km)) to the east. Constructing the natural gas-fired alternative at the Hanford Site would allow the natural gas-fired alternative to make use of CGS's existing transmission system.

DOE is currently evaluating plans for constructing a 15-mi pipeline spur from the existing regional gas transmission line in Franklin County north of the Pasco, Washington Airport to the Hanford Site (DOE, 2012). This pipeline would provide natural gas to the waste treatment plant currently under construction at Hanford and other industrial facilities on the Hanford Site. Natural gas would also be available via this pipeline for future industrial facilities at the Hanford Site. If this pipeline is constructed prior to the construction of the alternative natural gas-fired plant, the associated impacts discussed herein will have already occurred.

8.1.1 Air Quality

As discussed in Section 2.2.2.1, CGS is located in Benton County, Washington, which is part of the South Central Washington Intrastate Air Quality Control Region (AQCR) (40 CFR 81.189). The EPA has designated Benton County as unclassified or in attainment for all National Ambient Air Quality Standard (NAAQS) criteria pollutants; a portion of Benton County, which does not include the CGS site, became a maintenance area for particles with a diameter of 10 micrometers or less (PM_{10}) on September 26, 2005 (40 CFR 81.348). Portions of Yakima County, which are also part of this AQCR, are also maintenance areas for PM_{10} as well as carbon monoxide (40 CFR 81.348). All other counties in this AQCR are designated as unclassified or in attainment with respect to the NAAQS criteria pollutants.

A new natural gas-fired generating plant would qualify as a new major-emitting industrial facility and would be subject to prevention of significant deterioration (PSD) under requirements of the Clean Air Act (CAA) (EPA 2010). Washington State's Energy Facility Site Evaluation Council (EFSEC), which coordinates all evaluation and licensing steps for siting certain energy facilities in Washington State, has adopted Washington Administrative Code (WAC) 173-400-720; this code implements the EPA's PSD review. The natural gas-fired plant would need to comply with the standards of performance for electric utility steam generating units set forth in 40 CFR Part 60 Subpart Da.

Subpart P of 40 CFR Part 51 contains the visibility protection regulatory requirements, including the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Federal Class I area. If a natural gas-fired alternative was located close to a mandatory Class I area, additional air pollution control requirements would be required. As noted in Section 2.2.2.1, there are no mandatory Class I Federal areas within 50 mi of the CGS site. The closest mandatory Class I Federal area is Goat Rocks Wilderness Area, which is approximately 100 mi west of the CGS site (40 CFR 81.434).

Emissions for a natural gas-fired alternative based on data published by the EIA, EPA, and on performance characteristics for this alternative and its emissions controls are provided below:

- Sulfur oxides (SO_x)—90 tons (82 metric tons (MT)) per year
- Nitrogen oxides (NO_x)—288 tons (261 MT) per year
- Carbon monoxide (CO)—60 tons (54 MT) per year
- Total suspended particles (TSP)—51 tons (46 MT) per year
- PM_{10}—51 tons (46 MT) per year
- Carbon dioxide (CO_2)—3,075,000 tons (2,789,000 MT) per year

A new natural gas-fired plant would have to comply with Title IV of the CAA (42 USC 7651) reduction requirements for SO_x and NO_x, which are the main precursors of acid rain and the major cause of reduced visibility. Title IV establishes maximum SO_x and NO_x emission rates from the existing plants and a system of SO_x emission allowances that can be used, sold, or saved for future use by the new plants.

8.1.1.1 Sulfur Oxide, Nitrogen Oxide, Carbon Dioxide

As stated above, the new natural gas-fired alternative would produce 90 tons (82 MT) per year of SO_x and 288 tons (261 MT) per year of NO_x based on the use of the dry low-NO_x combustion technology and use of the selective catalytic reduction (SCR) to significantly reduce NO_x emissions.

The new plant would be subjected to the continuous monitoring requirements for SO_x, NO_x, and CO_2 as specified in 40 CFR Part 75. The natural gas-fired plant would emit approximately 3.1 million tons (approximately 2.8 million MT) per year of unregulated CO_2 emissions. In August 2008, the EFSEC proposed a new WAC chapter (463-90) for mandatory reporting of GHG emissions from large sources. EFSEC is working with the Washington State Department of Ecology's (WDOE) Air Quality Program to adopt the rule for sources or a combination of sources that emit at least 10,000 MT of GHGs annually in the state.

8.1.1.2 Particulates

The new natural gas-fired alternative would produce 51 T (46 MT) per year of TSP, all of which would be emitted as PM_{10}.

8.1.1.3 Hazardous Air Pollutants

In December 2000, the EPA issued regulatory findings (EPA 2000a) on emissions of hazardous air pollutants (HAPs) from electric utility steam-generating units, which said that natural gas-fired plants emit HAPs such as arsenic, formaldehyde, and nickel, and stated that:

> Also in the utility RTC (Report to Congress), the EPA indicated that the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

8.1.1.4 Construction Impacts

Activities associated with the construction of the new natural gas-fired plant on the CGS site would cause some additional, localized temporary air effects because of equipment emissions and fugitive dust from operation of the earth-moving and material-handling equipment. Emissions from workers' vehicles and motorized construction equipment exhaust would be temporary. The construction crews would be expected to use dust-control practices to control and reduce fugitive dust. The impact of vehicle exhaust emissions and fugitive dust from operation of the earth-moving and material-handling equipment would therefore be SMALL.

Based on this information, the overall air quality impacts of a new natural gas-fired plant located at the CGS site would be SMALL to MODERATE.

8.1.2 Groundwater Use and Quality

Total usage would likely be less than for the CGS because fewer workers would be onsite. The NRC also assumed the same relative ratio of groundwater use to surface-water use as that used for the CGS. Due to the temporary nature of construction and assumed minor use of groundwater during operation, the impact of the natural gas-fired combined-cycle generation alternative would be SMALL.

8.1.3 Surface-Water Use and Quality

The natural gas-fired alternative would require much less cooling water than the CGS and assumed that the existing intake and discharges on the Columbia River and the existing or similar mechanical draft cooling towers would be used for this alternative. Because the consumptive loss of this alternative is less than that of the current CGS, the impact of surface-water use would be SMALL.

Assuming the plant operates within the limits of applicable water-quality permits, the impact from any cooling-tower blowdown, site runoff, and other effluent discharges on surface-water quality would be SMALL

8.1.4 Aquatic Ecology

Section 2.2.5 describes the aquatic ecology of the CGS site, which is associated with the Columbia River. Impacts on the aquatic ecology from the CGS site are associated with construction in the Columbia River or the use of water from the river during operation of a new natural gas-fired generating plant. The NRC assumes that a new natural gas-fired generating plant would use the existing intake and discharge structures in the river for cooling a new plant.

The natural gas-fired alternative would require less cooling water to be withdrawn from the river than the CGS, and the thermal discharge would concurrently be smaller than the CGS. Therefore, the number of fish and other aquatic organisms affected by impingement, entrainment, and thermal impacts would be less for a natural gas-fired alternative than for those associated with license renewal. The cooling system for a new natural gas-fired generating plant would have similar chemical discharges as CGS, but the air emissions from the natural gas-fired generating plant would emit particulates that would settle onto the river surface and introduce a new source of pollutants that would not exist with CGS during the license renewal term. However, the flow of the Columbia River by the CGS site is fast (mean annual flow from 1960–2009 was 117,823 cubic feet per second (cfs) (3,336 m^3/s)) and would minimize the exposure of fish and other aquatic organisms to pollutants. Because there would not be any construction in the river or along the shoreline for a new natural gas-fired generating plant, the surface-water withdrawal and discharge for this alternative would be less than for the CGS, and the air deposition of pollutants from the plant's air emissions would be minimal, impacts on aquatic ecology at the CGS site would be SMALL.

8.1.5 Terrestrial Ecology

Constructing the natural gas alternative would require approximately 132 ac (53 ha) of land. This alternative would use a portion of the existing, previously undisturbed, onsite industrial footprint, switchyard, and transmission line system for construction of the natural gas-fired units. However, some fallow areas would be affected, which would result in some habitat fragmentation and loss of food resources. Gas extraction and collection would also affect terrestrial ecology in offsite gas fields, although much of this land is likely already disturbed by gas extraction, and the incremental effects of this alternative on gas field terrestrial ecology are difficult to gauge.

Continued operation of the existing mechanical draft cooling towers would produce a visible plume and cause some deposition of dissolved solids on surrounding vegetation and soil from cooling-tower drift.

Construction of the 15-mi gas pipeline would also affect fallow areas and the habitat and food sources of native species. Threatened and endangered species may also be affected by construction of the gas pipeline. The impacts from the construction of the pipeline would be MODERATE.

Based on this information, impacts on terrestrial resources could range from SMALL to MODERATE.

8.1.6 Human Health

A natural gas-fired plant would emit criteria air pollutants, but generally in smaller quantities than a coal-fired plant (except NO_x, which requires additional controls to reduce emissions). The human health effects of natural gas-fired generation are generally low, although in Table 8-2 of the GEIS (NRC 1996), the NRC identified cancer and emphysema as potential health risks from natural gas-fired plants. NO_x emissions contribute to ozone formation, which in turn contributes to human health risks. Emission controls on this natural gas-fired alternative maintain NO_x emissions well below air quality standards established for the purposes of protecting human health, and emissions trading or offset requirements mean that overall NO_x in the region would not increase. Health risks to workers may also result from handling spent catalysts that may contain heavy metals.

Overall, human health risks to occupational workers and to members of the public from natural gas-fired power plant emissions sited at the CGS site would likely be SMALL.

8.1.7 Land Use

The GEIS generically evaluates the impact of natural gas power plant operations on land use, both on and off each power plant site. The analysis of land-use impacts focuses on the amount of land area that would be affected by the construction and operation of a three-unit natural gas-fired combined-cycle power plant at the CGS site.

Based on GEIS estimates, approximately 132 ac (53 ha) of land would be needed to support a natural gas-fired alternative to replace CGS. This amount of land use would include other plant structures and associated infrastructure and is unlikely to exceed 132 ac (53 ha), excluding land for natural gas wells and collection stations. Land-use impacts from construction would be SMALL.

In addition to onsite land requirements, land would be required offsite for natural gas wells and collection stations. Scaling from GEIS estimates, approximately 11,125 ac (4,500 ha) would be required for wells, collection stations, and pipelines to bring the gas to the plant. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside the U.S. and be delivered as liquefied gas.

The elimination of uranium fuel for CGS could partially offset offsite land requirements. Scaling from GEIS estimates, approximately 1,150 ac (465 ha) would not be needed for mining and processing uranium during the operating life of the plant. Overall land-use impacts from a natural gas-fired power plant would be in the range of SMALL to MODERATE.

8.1.8 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new natural gas-fired power plant could affect regional employment, income, and expenditures. Two types of jobs would be created by this alternative: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the natural gas-fired power plant alternative were evaluated in order to measure their possible effects on current socioeconomic conditions.

Based on GEIS estimates, Energy Northwest projected a maximum construction workforce of 1,380 (Energy Northwest, 2010a). During construction of a natural gas-fired plant, the communities surrounding the power plant site would experience increased demand for rental housing and public services. The relative economic effect of construction workers on the local economy and tax base would vary over time.

After construction, local communities could be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. Since CGS is located near the Tri-Cities metropolitan area, these effects would be smaller because workers are likely to commute to the site instead of relocating to be closer to the construction site. Because of CGS's proximity to this large population center, the impact of construction on socioeconomic conditions could range from SMALL to MODERATE.

Based on GEIS estimates, Energy Northwest estimated a power plant operations workforce of approximately 173. The Energy Northwest estimate appears to be reasonable and is consistent with trends toward lowering labor costs by reducing the size of power plant operations workforces. This would result in a loss of approximately 900 relatively high-paying jobs, with a corresponding reduction in purchasing activity and tax contributions to the regional economy. The impact of the job loss, however, may not be noticeable given the amount of time required for the construction of a new natural gas-fired power plant and the decommissioning of the existing facilities and the relatively large Tri-Cities region from which CGS personnel are currently drawn. The amount of taxes paid under the natural gas-fired alternative may increase if additional land is required offsite to support this alternative. Operational impacts would, therefore, range from SMALL to MODERATE.

8.1.9 Transportation

Transportation impacts associated with construction and operation of a three-unit, natural gas-fired power plant would consist of commuting workers and truck deliveries of construction materials to the CGS site. During periods of peak construction activity, up to 1,500 workers could be commuting daily to the site. In addition to commuting workers, trucks would be transporting construction materials and equipment to the worksite, thus increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact. Traffic-related transportation impacts during construction would likely be MODERATE.

During plant operations, traffic-related transportation impacts would almost disappear. According to Energy Northwest, approximately 173 workers would be needed to operate the natural gas-fired power plant. Since fuel is transported by pipeline, the transportation infrastructure would experience little to no increased traffic from plant operations.

Overall, the natural gas-fired alternative transportation impacts would be SMALL during plant operations.

8.1.10 Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the natural gas-fired alternative and the surrounding landscape and the visibility of the natural gas-fired plant.

The three natural gas-fired units could be approximately 100 feet (ft) (30 meters (m)) tall, with two exhaust stacks up to 175 ft (53 m) tall. The facility would be visible offsite during daylight hours, and some structures may require aircraft warning lights. The power plant would be smaller and less noticeable than that of CGS, which has a reactor building height of 230 ft (70 m). Mechanical draft cooling towers would continue to generate condensate plumes and operational noise. Noise during power plant operations would be limited to industrial processes and communications. Pipelines delivering natural gas fuel could be audible offsite near compressors.

In general, aesthetic changes would be limited to the immediate vicinity of CGS and would be SMALL.

8.1.11 Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape, as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may—alone or collectively—yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the U.S., they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground-disturbing activities.

As described in Section 2.2.10, much of the CGS site has been previously disturbed by the construction of CGS and the partial construction WPPSS Nuclear Projects No. 1 and 4 (WNP-1/4). In addition, the CGS site has been surveyed for cultural resources, resulting in the identification of archaeological sites within the vicinity of the pumphouse and intake structure. There is a low potential for cultural resources to be located in previously undisturbed portions of the CGS site. If the natural gas-fired units were to be sited within undisturbed areas or within areas of known cultural sensitivity, these areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground-disturbing activities. Studies would be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction would occur (e.g., roads, transmission corridors, rail lines, or other rights-of-way (ROWs)). In most cases, projects should be sited to avoid areas that exhibit the greatest sensitivity.

As noted in Section 4.9.6, Energy Northwest has developed a Cultural Resources Protection Plan that calls for a qualified archaeologist to carry out surveys in areas deemed sensitive or in undisturbed areas before commencing work. The plan also includes an inadvertent discovery (stop work) provision to ensure that proper notification is made to protect these resources if any are discovered. Because Energy Northwest has conducted a survey and has established a protection plan, the impact of the construction and operation of a replacement natural gas-fired plant at the CGS site on historic and archaeological resources would be SMALL.

8.1.12 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health, environmental, and socioeconomic effects on minority and low-income populations that could result from the construction and operation of a new natural gas-fired power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing in the vicinity of the Hanford Site and CGS, and all are exposed to the same hazards generated from constructing and operating a new NGCC power plant. Section 4.9.7 of this SEIS provides socioeconomic data regarding the analysis of environmental justice issues.

Potential impacts to minority and low-income populations from the construction and operation of a new NGCC power plant at CGS would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day, and they are not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of the Hanford Site and CGS could affect low-income populations. Given the close proximity to the Tri-Cities metropolitan areas, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information, and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a new NGCC power plant would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of CGS.

8.1.13 Waste Management

During the construction stage of the natural gas-fired combined-cycle generation alternative, land clearing and other construction activities would generate waste that could be recycled, disposed of onsite, or shipped to an offsite waste disposal facility. Because the alternative would be constructed on or near the previously disturbed CGS site, the amounts of wastes produced during land clearing would be reduced.

During the operational stage, spent SCR catalysts, which are used to control NO_x emissions from the natural gas-fired plants, would make up the majority of the waste generated by this alternative.

According to the GEIS (NRC 1996), a natural gas-fired plant would generate minimal waste. Waste impacts would therefore be SMALL for a natural gas-fired alternative located at the CGS site or offsite.

8.1.14 Summary of Natural Gas-Fired Impacts

Table 8.1-1 summarizes the environmental impacts of the natural gas-fired alternative compared to continued operation of CGS.

Table 8.1-1. Summary of environmental impacts of the natural gas-fired combined-cycle generation alternative compared to continued operation of CGS

Category	Natural gas combined-cycle generation	Continued CGS operation
Air quality	SMALL to MODERATE	SMALL
Groundwater	SMALL	SMALL
Surface water	SMALL	SMALL
Aquatic and terrestrial resources	SMALL to MODERATE	SMALL
Human health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL
Waste management	SMALL	SMALL

8.2 New Nuclear Generation

In its ER, Energy Northwest states that it does not have any current plans to build a new nuclear reactor at the CGS site or at an alternate site and does not consider a new nuclear plant to be a reasonable alternative to renewal of CGS's operating license. However, the NRC is currently reviewing multiple combined operating license (COL) applications, and site preparation work has started for two additional units at the V.C. Summer site in South Carolina and for two additional units at the Vogtle site in Georgia. The NRC considers the construction of a new nuclear plant to be a reasonable alternative to CGS license renewal and, in this section, the environmental impacts of constructing a new nuclear power plant at the CGS site are discussed.

In evaluating the new nuclear alternative, the NRC presumed that replacement reactors would be installed on the CGS site, allowing for the maximum use of existing ancillary facilities such as the transmission and cooling systems, including the existing intake and discharge structures on the Columbia River. The NRC further presumed that the replacement reactor would be a light-water reactor such as the Advanced Passive 1000 (AP1000) model pressurized water reactor (PWR), a reactor design for which the NRC has already issued a certification. With a gross electrical output of 1,200 MWe, one AP1000 reactor would be required to approximate CGS's currently installed capacity of 1,150 MWe. To estimate the impacts of this replacement reactor, the NRC reviewed its assessment of construction and operating impacts of two AP1000 units at the Virgil C. Summer Nuclear Station (VCSNS) in Fairfield County, South Carolina (http://www.nrc.gov/reactors/new-reactors/col/summer.html). The NRC amended some parameters applied to the VCSNS site to reflect extant conditions at the CGS site. With these differences taken into consideration, the impacts of constructing and operating one AP1000 unit at the CGS site should bound the impacts of replacing CGS's currently installed capacity.

The applicant for new nuclear units at the VCSNS, South Carolina Electric and Gas, did not give a detailed construction schedule for a single new nuclear unit. However, estimates given by Southern Nuclear Corporation for the construction of two AP1000 reactors at the Vogtle Electric Generating Plant (VEGP) in Georgia included 18 months for site preparation, 48 months for construction, and 6 months from fuel loading to initial power generation (SNC 2008). The NRC considers these time frames to be reasonable and, although site conditions of VEGP and CGS are not the same and the VEGP construction included construction of a new cooling system dedicated to the two new reactors, the NRC presumes that construction of a new nuclear alternative at the CGS would generally follow the same time frame.

Regarding construction impacts, Energy Northwest estimated that the power block and ancillary facilities (excluding the cooling-water system) for the replacement reactors would require approximately 500 ac and that sufficient contiguous fallow acreage was available on the CGS site. The NRC further estimated that the existing cooling system and the Columbia River would meet the heat-rejection demands of the replacement reactors with only minor modifications.

The NRC also considered the installation of multiple small and modular reactors at the CGS site as an alternative to renewing the license for the CGS. Considerable interest in small and modular reactors along with anticipated license applications by vendors has caused the NRC to establish the Advanced Reactor Program in the Office of New Reactors. These smaller reactors have economic advantages over large light-water reactors, including lower financing costs and the ability to begin generation with the first units while others are being installed. Some designs also have environmental advantages such as the use of use passive cooling instead of water cooling. The NRC considers that the environmental impacts of constructing and operating a large light-water reactor such as the AP1000 would likely bound the impact of constructing and operating a combination of smaller modular reactors.

8.2.1 Air Quality

As discussed in Section 2.2.2.1, the CGS site is located in Benton County, Washington, which is part of the South Central Washington Intrastate AQCR (40 CFR 81.189). The EPA has designated Benton County as unclassified or in attainment for all NAAQS criteria pollutants; a portion of Benton County, which does not include the CGS site, became a maintenance area for PM_{10} on September 26, 2005 (40 CFR 81.348). Portions of Yakima County, which are also part of this AQCR, are also maintenance areas for PM_{10} as well as carbon monoxide (40 CFR 81.348). All other counties in this AQCR are designated as unclassified or in attainment with respect to the NAAQS criteria pollutants.

A new nuclear generating plant would have similar air emissions to those of the existing CGS site; air emissions would be primarily from backup diesel generators. As noted in Section 2.2.2.1, the CGS site conforms to Washington State Regulatory Order 672, which limits plant emissions to levels below regulatory thresholds (EFSEC 1996). Because air emissions would be similar for a new nuclear plant, the NRC expects similar air permitting conditions and regulatory requirements. Therefore, while the air emissions from the backup diesel generators could exceed the major source threshold for PSD review, actual plant emissions would be well below that limit.

Subpart P of 40 CFR Part 51 contains the visibility protection regulatory requirements, including the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Federal Class I area. If a new nuclear plant were located close to a mandatory Class I area, additional air pollution control requirements may be required. As noted in Section 2.2.2.1, there are no Mandatory Class I Federal areas within 50 mi of the CGS site. The closest Mandatory Class I Federal area is Goat Rocks Wilderness Area, which is approximately 100 mi west of the CGS site (40 CFR 81.434).

Energy Northwest reported the following air emissions, from the year 2009, for the existing CGS site (EN, 2010b). Similar air emissions from a new nuclear plant are expected, because these emissions are primarily from backup diesel generators that would also be used at a new nuclear plant:

- SO_x—0.18 T (0.16 MT) per year
- NO_x—8.3 T (7.5 MT) per year

- CO—2.2 tons (2.0 MT) per year
- PM_{10}—0.17 T (0.15 MT) per year.

8.2.1.1 Construction Impacts

Activities associated with the construction of the new nuclear plant would cause some additional temporary air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material-handling equipment. Emissions from workers' vehicles and motorized construction equipment exhaust would be temporary. It is expected that construction crews would use dust-control practices to control and reduce fugitive dust. The impact of vehicle exhaust emissions and fugitive dust from operation of the earth-moving and material-handling equipment would therefore be SMALL.

Based on this information, overall air quality impacts of a new nuclear plant located at the CGS site would be SMALL.

8.2.2 Groundwater Use and Quality

The NRC presumed that a new or replacement reactor would be installed on the CGS site, allowing for the maximum use of existing ancillary facilities. Excavation for new shield building foundations would presumably be to depths of approximately 40–50 ft below grade. This is well above the existing water table aquifer at a depth of about 60 ft below grade. No dewatering would be required. The NRC also presumed that existing onsite and nearby groundwater wells (one at the CGS, and two at the Industrial Development Complex (IDC)) would be used to supply relatively small amounts of water for dust suppression and other support during construction of the new plant.

Operational groundwater use at the new plant would be minor, with the total usage and groundwater-quality impacts likely to be similar to those for the CGS. Due to the temporary nature of construction and minor use of groundwater during operation, the impact of the new nuclear plant alternative on groundwater would be SMALL.

8.2.3 Surface-Water Use and Quality

The NRC presumed that a new or replacement reactor would be designed to maximize use of existing facilities, including the existing intake and discharge structures on the Columbia River. The total consumptive water loss rate for one new AP1000 unit is assumed to be approximately the same as for the existing CGS: 17,000 gallons per minute (gpm) (EN, 2010a). This is about half of the approximately 27,800 gpm (62 cfs) to 31,100 gpm (69 cfs) estimated for two AP1000 units proposed for the VCSNS in Fairfield County, South Carolina (SCE&G, 2009). Because the consumptive loss is about 0.05 percent of the minimum mean annual discharge of 80,650 cfs for the Columbia River (USGS 2010), the impact of surface-water use would be SMALL.

Assuming the plant operates within the limits of applicable water-quality permits, the impact from any cooling-tower blowdown, site runoff, and other effluent discharges on surface-water quality would be SMALL.

8.2.4 Aquatic Ecology

The NRC presumed that a new or replacement reactor would have closed-cycle cooling, and it would use the existing intake and discharge pipelines in the Columbia River and existing structures along the shoreline. The water withdrawal from the Columbia River for operation of the closed-cycle cooling system of a new AP1000 unit is approximately the same as that used for the existing CGS site. The number of fish and other aquatic organisms affected by impingement, entrainment, and thermal impacts would be equivalent to those associated with license renewal. A new or replacement reactor would use existing in-stream systems, and the impacts on the aquatic ecology of the Columbia River from construction of the new or replacement reactor would be SMALL because there would be no modifications in the river and no additional use. The level of impact on the aquatic ecology for the continued CGS operation is small, so NRC expects the levels of impact for impingement, entrainment, and thermal effects of the new or replacement reactor would also be SMALL.

8.2.5 Terrestrial Ecology

As stated in previous sections, the NRC presumes that a new nuclear alternative could be constructed on the existing CGS property. The 500 ac (200 ha) needed for the construction of the new nuclear alternative is available on the CGS site, but some fallow areas may be affected by the construction. Terrestrial ecology in these fallow areas would be affected, primarily resulting in habitat fragmentation and loss of food sources.

Operation of the existing cooling towers would continue to produce a visible plume and cause some deposition of dissolved solids on surrounding vegetation and soil from cooling-tower drift, but these impacts would be equal to or less than currently occurring impacts. Based on this information, impacts on terrestrial resources would be SMALL.

8.2.6 Human Health

The human health effects of a new nuclear power plant would be similar to those of the existing CGS. The NRC expects that operational human health effects would be SMALL. Human health issues related to construction would be equivalent to those associated with the construction of any major complex industrial facility and would be controlled to acceptable levels through the application of best management practices and Energy Northwest’s compliance with application, Federal, and state worker protection regulations. Human health impacts from operation of the nuclear alternative would be equivalent to those associated with continued operation of the existing reactors under license renewal. Both continuous and impulse noise impacts can be expected at offsite locations, including at the closest residences. However, confining noise-producing activities to core hours of the day (7:00 am–6:00 pm), suspending the use of explosives during certain meteorological conditions, and notifying potentially affected parties beforehand of such events would control noise impacts to acceptable levels. Noise impacts would be of short duration and would be SMALL. Overall, human health impacts would be SMALL.

8.2.7 Land Use

As discussed in Section 8.1.6, the GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land-use impacts focuses on the amount of land area that would be affected by the construction and operation of a new nuclear power plant at the CGS site.

Based on GEIS estimates, approximately 500 ac (200 ha) of land would be needed to support a new nuclear power plant to replace CGS. An area of sufficient size in the previously disturbed onsite industrial footprint is expected to be available for the nuclear plant, thus minimizing the amount of disturbance in undeveloped portions of the site. Onsite land-use impacts from construction would be SMALL.

Offsite impacts associated with uranium mining and fuel fabrication to support the new nuclear alternative would generally be no different from those occurring in support of the existing CGS reactor, although land would be required for mining the additional uranium. Overall land-use impacts from a new nuclear power plant would range from SMALL to MODERATE.

8.2.8 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region, especially resulting from the creation of new jobs. Two types of job creation would result: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts.

Based on GEIS estimates, a maximum construction workforce of 2,400 workers would be required. During construction of a new nuclear plant, the communities surrounding the power plant site would experience increased demand for rental housing and public services. The relative economic effect of construction workers on the local economy and tax base would vary.

After construction, local communities could be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. Since CGS is located near the Tri-Cities metropolitan area, these effects would be smaller because workers are likely to commute to the site instead of relocating to be closer to the construction site. Because of CGS's proximity to this large population center, the impact of construction on socioeconomic conditions could range from SMALL to MODERATE.

Based on GEIS estimates, the new nuclear power plant operations workforce could require approximately 840 workers. The number of operations workers could have a noticeable effect on socioeconomic conditions in the region; however, socioeconomic impacts associated with the operation of a new nuclear power plant at the CGS site would range from SMALL to MODERATE.

8.2.9 Transportation

During periods of peak construction activity, up to 2,400 workers could be commuting daily to the site. In addition to commuting workers, trucks would be transporting construction materials and equipment to the worksite, increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. Some plant components are likely to be delivered by train via the existing onsite rail spur. Nevertheless, transportation impacts would likely be MODERATE during construction.

Transportation traffic-related impacts would be greatly reduced after construction, but would not disappear during plant operations. Transportation impacts would include daily commuting by the operating workforce, equipment and materials deliveries, and the removal of waste material to offsite disposal or recycling facilities by truck.

Traffic-related transportation impacts would be no different during plant operations from those from the existing CGS plant. Overall, the new nuclear alternative would have a SMALL to MODERATE impact on transportation conditions in the region around the CGS site.

8.2.10 Aesthetics

The analysis of impacts on aesthetics focuses on the degree of contrast between the new nuclear alternative and the surrounding landscape and the visibility of the new nuclear plant.

The appearance of the power block for the new nuclear power plant would be virtually identical to the existing CGS plant. In addition, because the existing cooling system (including the mechanical draft cooling towers) would remain in use, the overall visual impacts of the new reactor alternative would be no different from those from the existing CGS facility. Overall, aesthetic impacts associated with the new nuclear alternative would range from SMALL during plant operations to MODERATE during construction.

8.2.11 Historic and Archaeological Resources

The same considerations, discussed in Section 8.1.11, for the impact of the construction of a natural gas-fired plant on historic and archaeological resources apply to the construction activities that would occur on the CGS site for a new nuclear reactor. As previously noted, the potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground-disturbing activities.

Surveys would be needed to identify, evaluate, and address mitigation of potential impacts prior to the construction of the new plant. Studies would be needed for all areas of potential disturbance (e.g., roads, transmission corridors, rail lines, or other ROWs). Areas with the greatest sensitivity should be avoided. Because Energy Northwest would conduct a survey and apply its established protection plan for future resources, the impact of a new nuclear plant alternative at the CGS site on historic and archaeological resources would be SMALL.

8.2.12 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new nuclear power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around CGS, and all are exposed to the same hazards generated from constructing and operating a new nuclear power plant.

Potential impacts to minority and low-income populations from the construction and operation of a new nuclear power plant at CGS would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of the Hanford Site and CGS could affect low-income populations. Given the close proximity to the Tri-Cities metropolitan areas, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information, and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a new nuclear power plant would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of CGS.

8.2.13 Waste Management

During the construction stage of the new nuclear plant, land clearing and other construction activities would generate waste that could be recycled, disposed of onsite, or shipped to the offsite waste disposal facility. Because the new nuclear plant would be constructed on or near the previously disturbed CGS site, the amounts of wastes produced during land clearing would be reduced.

During the operational stage, normal plant operations, routine plant maintenance, and cleaning activities would generate nonradioactive waste. Quantities of nonradioactive waste, discussed in Section 2.3.1 of this EIS, would be comparable to the existing CGS site.

According to the GEIS (NRC 1996), the generation and management of solid nonradioactive waste during the terms of a renewed license are not expected to result in significant environmental impacts. A new nuclear plant would generate waste streams similar to a nuclear plant that has undergone license renewal. Based on this information, waste impacts would be SMALL for a new nuclear plant located at CGS site.

8.2.14 Summary of Impacts of New Nuclear Generation

Table 8.2-1 summarizes the environmental impacts of the new nuclear alternative compared to continued operation of the CGS.

Table 8.2-1. Summary of environmental impacts of the new nuclear alternative compared to continued operation of the CGS

Category	New nuclear generation	Continued CGS operation
Air quality	SMALL	SMALL
Groundwater	SMALL	SMALL
Surface water	SMALL	SMALL
Aquatic and terrestrial resources	SMALL	SMALL
Human health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL
Waste management	SMALL	SMALL

8.3 Combination Alternative

This section evaluates the environmental impacts of a combination of alternatives. This combination includes a portion of baseload capacity supplied by the natural gas-fired combined-cycle capacity identified in Section 8.1 (860 MWe) with an integrated renewable energy component of (175 MWe), a hydropower component (175 MWe), and an energy conservation and efficiency component (155 MWe). The integrated renewable energy component could include a variety of generation types such as biofuel-fired capacity and solar capacity. For the purpose of the comparison of impacts, this combination assumes wind power would be the renewable energy component, although distributed solar and smaller solar plants would also be reasonable choices for the renewable energy component.

Wind power is an intermittent resource, and to service its customer base, a source of power would need to be available to compensate for its periodic loss (EN, 2010a). For the purpose of evaluating the environmental impacts of this combination of alternatives, the NRC assumes that two new natural gas-fired units of the type described in Section 8.1 would be constructed and installed at the CGS site with a total capacity of 860 MWe. These plants would be operated from 685 MWe–860 MWe depending on the availability of wind power. When the wind power provides the assumed maximum of 175 MWe, the natural gas-fired plant will reduce the quantity of fossil fuel burning to achieve a power output of 685 MWe. During periods of no power generation from the wind component, the natural gas plant will operate at the assumed maximum production of 860 MWe. The appearance of a natural gas-fired facility would be similar to that of the full natural gas-fired alternative considered in Section 8.1, although only two units would be constructed. The NRC estimates that it would require about two-thirds of the space necessary for the alternative considered in Section 8.2, and that all construction effects—as well as operational aesthetic, fuel-cycle, air quality, socioeconomic, land use, environmental justice, and water consumption effects—would scale accordingly.

In 1998, DOE estimated that there were 238 developed hydroelectric sites in Washington State that were unpowered with a potential capacity of 3,373 MWe (INEEL 1998). Hydropower equal to 175 MWe would be developed by powering previously developed, but currently unpowered, hydroelectric sites. Wind turbines constructed at an offsite location, or multiple offsite locations, would account for roughly 175 MWe of CGS's current capacity. Wind turbine construction and repowering exiting hydropower sites at offsite locations would include the ROW for new transmission lines.As discussed in Section 8.1.3, load-management and energy-efficiency programs carried out by the Bonneville Power Administration and other utilities in Washington since 1982 have reduced demand by over 1,500 average megawatts. The NRC assumes that these programs would continue and that a portion of CGS's output—155 MWe—would be replaced by conservation. No major construction would be necessary for the conservation component of the combination alternative.

8.3.1 Air Quality

As discussed in Section 2.2.2.1, CGS is located in Benton County, Washington, which is part of the South Central Washington Intrastate AQCR (40 CFR 81.189). Benton County is designated as unclassified or in attainment for all NAAQS criteria pollutants; a portion of Benton County, which does not include the CGS site, became a maintenance area for PM_{10} on September 26, 2005 (40 CFR 81.348). Portions of Yakima County, which are also part of this AQCR, are also maintenance areas for PM_{10} as well as carbon monoxide (40 CFR 81.348). All other counties in this AQCR are designated as unclassified or in attainment with respect to the NAAQS criteria pollutants.

This alternative includes a combination of 685 MWe–860 MWe of natural gas-fired generation, 175 MWe of hydropower, 175 MWe of wind energy, and 155 MWe of energy conservation. The range in power for natural gas-fired generation is used to account for the power variability in wind generation.

The natural gas-fired generating component of this combination alternative would qualify as a new major-emitting industrial facility and would be subject to PSD under CAA requirements (EPA 2010). Washington State's EFSEC, which coordinates all evaluation and licensing steps for siting certain energy facilities in Washington State, has adopted WAC 173-400-720, which implements the EPA's PSD review. The natural gas-fired plant would need to comply with the standards of performance for electric utility steam-generating units set forth in 40 CFR Part 60 Subpart Da.

Subpart P of 40 CFR Part 51 contains the visibility protection regulatory requirements, including the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Federal Class I area. If the natural gas-fired component of this combination alternative were located close to a mandatory Class I area, additional air pollution control requirements would be required. As noted in Section 2.2.2.1, there are no Mandatory Class I Federal areas within 50 mi of the CGS site. The closest Mandatory Class I Federal area is Goat Rocks Wilderness Area, which is approximately 100 mi west of the CGS site (40 CFR 81.434).

The NRC projects the following emissions, assuming a maximum of 860 MWe power for the natural gas-fired component of this combination alternative based on data published by the EIA, EPA, and on performance characteristics and emissions controls:

- SO_x—65 T(59 MT) per year
- NO_x—206 T (187 MT) per year
- CO—43 T (39 MT) per year
- TSP—37 T (33 MT) per year
- PM_{10}—37 T (33 MT) per year
- CO_2—2,203,750 T (1,999,208 MT) per year.

A new natural gas-fired plant would have to comply with Title IV of the CAA (42 USC 7651) reduction requirements for SO_x and NO_x, which are the main precursors of acid rain and the major cause of reduced visibility. Title IV establishes maximum SO_x and NO_x emission rates from the existing plants and a system of SO_x emission allowances that can be used, sold, or saved for future use by the new plants.

There would be no operating emissions from the hydropower, wind, and conservation components of this combination alternative.

8.3.1.1 Sulfur Oxide, Nitrogen Oxide, Carbon Dioxide

As stated above, the new natural gas-fired component to this combination alternative would produce up to 65 T (59 MT) per year of SO_x and 206 T (187 MT) per year of NO_x based on the use of the dry low NO_x combustion technology and the use of the SCR to significantly reduce NO_x emissions.

The new plant would be subjected to the continuous monitoring requirements of SO_x, NO_x, and CO_2 specified in 40 CFR Part 75. The natural gas-fired plant would emit approximately 2.2 million tons (approximately 2.0 million MT) per year of unregulated CO_2 emissions. In

August 2008, the EFSEC proposed a new WAC chapter (463-90) for mandatory reporting of GHG emissions from large sources. EFSEC is working with the WDOE Air Quality Program to adopt the rule for sources or combination of sources that emit at least 10,000 MT of GHGs annually in the state.

8.3.1.2 Particulates

The new natural gas-fired alternative would produce 37 T (33 MT) per year of TSP, all of which would be emitted as PM_{10}.

8.3.1.3 Hazardous Air Pollutants

In December 2000, the EPA issued regulatory findings (EPA 2000a) on emissions of HAPs from electric utility steam-generating units, which identified that natural gas-fired plants emit HAPs such as arsenic, formaldehyde, and nickel, and stated that:

> Also in the utility RTC (Report to Congress), the EPA indicated that the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

8.3.1.4 Construction Impacts

Activities associated with the construction of the new natural gas-fired, hydropower, and wind-energy plants would cause some additional, temporary air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material-handling equipment. Emissions from workers' vehicles and motorized construction equipment exhaust would be temporary. It is expected that the construction crews would use dust-control practices to control and reduce fugitive dust. Therefore, the impact of vehicle exhaust emissions and fugitive dust from operation of the earth-moving and material-handling equipment would be SMALL.

Based on this information, the overall air-quality impacts of this combination alternative, which includes natural gas-fired generation, hydropower, wind energy, and energy conservation, would be SMALL to MODERATE.

8.3.2 Groundwater Use and Quality

The combination alternative would require about two-thirds the amount of the water consumption assumed for the natural gas-fired combined-cycle generation alternative. The NRC also assumed about the same ratio of groundwater use to surface-water use as that for the existing CGS; thus, the impact of the combination alternative on groundwater would be SMALL. The construction and operation of new wind-power projects and the installation and operation of power facilities at existing hydropower sites would have negligible impacts on groundwater.

8.3.3 Surface-Water Use and Quality

The combination alternative would require about two-thirds the amount of the water consumption assumed for the natural gas-fired combined-cycle generation alternative; thus, the impact of the combination alternative on surface-water use and quality were also designated as SMALL.

The construction of utility-scale wind-power projects would require installation of access roads and support facilities. The NRC assumes that state and local agencies would require erosion-control measures that would prevent any degradation of the quality of surface waters on or downstream from wind-power development sites. In addition, the NRC assumes that new hydropower installations at operating sites (dams) would be in accordance with state and Federal regulations on surface-water impoundments and dam operations and that surface-water quantity and quality would not be affected. For these reasons, the impact of the Combination Alternative on surface-water quality and quantity would be SMALL.

8.3.4 Aquatic Ecology

Impacts on the aquatic ecology of the CGS site for the combination alternative of wind power, natural gas-fired units, and hydropower would be associated with activities in and use of the water. Wind-power systems on the CGS site would not require water; thus, construction of the systems would not disturb the aquatic ecology of the site. The NRC assumes that the cooling systems for the two new natural gas-fired units would use the existing intake and discharge systems. Water consumption for the cooling systems of the natural gas-fired units would be less than for the CGS. Air emissions from the natural gas-fired units would be a new source of pollutants that would deposit on the river's surface; however, due to fast flows in the river, exposure of the pollutants to the aquatic resources would likely be minimal. Alterations in water flow from operation of previously developed but currently unpowered hydroelectric sites would result in several types of impacts on the aquatic ecology of the river system, including alteration of aquatic habitat and impacts from interaction with the hydropower structure. Hydropower in the Columbia River basin has adversely affected aquatic endangered species (e.g., Chinook salmon), and these impacts are currently being mitigated as directed by the biological opinion for the Federal Columbia River Power System (NMFS 2010). Because of the potential habitat disturbances and impacts on endangered species from the additional use of hydropower, impacts on aquatic resources from the combined alternative would be MODERATE.

8.3.5 Terrestrial Ecology

A combination alternative of a two natural gas-fired units, a system using wind energy, and energy conservation would make use of existing disturbed land at the CGS site for the natural gas units and the existing mechanical draft cooling towers. This alternative would also require land offsite for the gas pipeline and would require additional land offsite to accommodate the number of turbines necessary in a wind farm to offset the power generated by the CGS.

This alternative would use a portion of the existing plant site land, switchyard, and transmission-line system for construction of the natural gas-fired unit. Impacts on terrestrial ecology from onsite construction of two natural gas-fired units would be less than the impacts described for the three-unit natural gas-fired alternative. Impacts on terrestrial ecology from offsite construction of the 15 mi-long (24-km-long) gas pipeline for the two natural gas-fired units would be the same as for the three natural gas-fired unit alternative previously discussed.

Based upon data in the GEIS, the wind farm component of the combination alternative producing 175 MWe of electricity would require approximately 4,000 ac (1,600 ha) spread over several offsite locations, with approximately 16 ac (6.5 ha) in actual use. The remainder of the land would remain in agriculture. Additional land may be needed for construction of transmission-line corridors to connect to existing transmission-line corridors.

Impacts on terrestrial ecology from construction of the wind farm portion of the combination alternative and any needed transmission lines could include loss of terrestrial habitat, an increase in habitat fragmentation, and corresponding increase in edge habitat, and may affect threatened and endangered species. The GEIS notes that habitat fragmentation may lead to declines in migrant bird populations. Bird mortality would increase from construction of the wind farm, although proper site selection for the wind farm could help to reduce bird strikes. The GEIS noted that wind farms typically do not cause significant adverse impacts on bird populations, although thousands of acres of wildlife habitat or agricultural land could be affected, and wildlife migratory routes could be disrupted (NRC 1996).

Based on this information, impacts on terrestrial resources would be MODERATE.

8.3.6 Human Health

The human health risks from a combination of alternatives include the effects already discussed in Section 8.2.6 for the NGCC plant, and they were found to be SMALL. For the environmental impacts of alternatives including conservation and demand-side management, the GEIS (NRC, 1996) notes that the environmental impacts from these alternatives are likely to be centered on indoor air quality, with radon as a potential health risk. This is due to increased weatherization of the home in the form of extra insulation and reduced air turnover rates from the reduction in air leaks. However, based on the assumption that a member of the public has implemented mitigative measures to minimize levels of indoor radon, the staff concludes that the human health risks to members of the public from the conservation portion of this alternative would be SMALL. For wind capacity, the GEIS notes that construction and routine operations would not affect human health because the construction and operation of the facilities are expected to comply with Federal and state safety standards to protect the workers and the public.

The NRC considers the human health risks from the combination of alternatives to be SMALL.

8.3.7 Land Use

The analysis of land use impacts for the combination alternative includes impacts from the amount of land area required for the construction and operation of a two-unit natural gas-fired combined cycle power plant at the CGS site, an offsite wind energy generating facility, offsite hydropower, and the effects of implementing energy conservation and efficiency.

The GEIS generically evaluates the impact of natural gas power plant operations on land use, both on and off each power plant site. Based on GEIS estimates, approximately 92 ac (37 ha) of land would be needed to support the two-unit natural gas-fired portion of the combination alternative. Because of the availability of land, land use construction impacts at CGS would be SMALL.

In addition to onsite land requirements, land would be required offsite for natural gas wells and collection stations. Scaling from GEIS estimates, approximately 7,900 ac (3,200 ha) would be required for wells, collection stations, and pipelines to bring the gas fuel to the power plant. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside the U.S. and be delivered as liquefied gas.

The wind farm component of the combination alternative producing 175 MWe of electricity would require approximately 4,000 ac (1,600 ha) spread over several offsite locations, with approximately 16 ac (6.5 ha) in actual use. Although the wind farm would require a large amount of land, only a small component of that land would be in actual use. In addition, the elimination of uranium fuel for CGS could partially offset offsite land requirements. Scaling from GEIS estimates, approximately 1,150 ac (465 ha) would not be needed for mining and processing uranium during the operating life of the plant.

The land use impacts of the energy conservation and efficiency component of this combination alternative would be SMALL. The rapid replacement and disposal of old energy inefficient appliances and other equipment would generate waste material and could increase the size of landfills; however, given the time for program development and implementation, the cost of replacements, and the average life of equipment, the replacement process would probably be gradual. More efficient appliances and equipment would replace older equipment (especially in the case of frequently replaced items, such as light bulbs). In addition, many items (such as home appliances and industrial equipment) have recycling value and would not be disposed of in landfills. Overall land use impacts from the combination alternative could range from SMALL to MODERATE.

8.3.8 Socioeconomics

As previously discussed, socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new natural gas-fired power plant could affect regional employment, income, and expenditures. Two types of jobs are created by this alternative: (1) construction related jobs, which are transient, short in duration, and less likely to have a long term socioeconomic impact; and (2) operation related jobs in support of power plant operations, which have the greater potential for permanent, long term socioeconomic impacts. Workforce requirements of power plant construction and operations for the natural gas-fired power plant alternative were determined in order to measure their possible effect on current socioeconomic conditions.

Impacts from this alternative would include the types of impacts discussed for socioeconomics in Section 8.1.8 of this SEIS. Section 8.1.8 states that the socioeconomic impacts from the construction and operation of three natural gas-fired units at CGS would be SMALL to MODERATE. Based on GEIS projections, and a workforce of 1,200 for a 1,000 MWe plant, the two-unit gas-fired portion of the combination alternative at CGS would require a peak estimated construction workforce of 1,075 workers. Accordingly, the socioeconomic impacts from the natural gas-fired component of the combination alternative would be SMALL to MODERATE.

An estimated additional 350 construction workers would be required for the wind farm. These workers could cause a short-term increase in the demand for services and temporary (rental) housing in the region around the construction site.

After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. However, these effects would likely be spread over a larger area, as the wind farms may be constructed in more than one location. The combined effects of these two construction activities would range from SMALL to MODERATE.

Additional estimated operations workforce requirements for this combination alternative would include an estimated 124 operations workers for the gas-fired power plant and 50 operations workers for the wind farm. Given the small number of operations workers at these facilities, socioeconomic impacts associated with operation of the natural gas-fired power plant at CGS and the wind farm would be SMALL. Socioeconomic effects of an energy conservation and efficiency program would be SMALL. As noted in the GEIS, the program would require additional workers.

8.3.9 Transportation

Construction and operation of a natural gas-fired power plant and wind farm would increase the number of vehicles on the roads near these facilities. During construction, cars and trucks would deliver workers, materials, and equipment to the worksites. The increase in vehicular traffic would peak during shift changes resulting in temporary levels of service impacts and delays at intersections. Transporting components of wind turbines could have a noticeable impact, but is likely to be spread over a large area. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact. Traffic-related transportation impacts during construction could range from SMALL to MODERATE depending on the location of the wind farm site, current road capacities, and average daily traffic volumes.

During plant operations, transportation impacts would not be noticeable. Given the small numbers of operations workers at these facilities, the levels of service traffic impacts on local roads from the operation of the gas fired power plant at CGS and at the wind farm would be SMALL. Transportation impacts at the wind farm site or sites would also depend on current road capacities and average daily traffic volumes, but are likely to be small given the low number of workers employed by that component of the alternative. Any transportation effects from the energy efficiency alternative would be widely distributed across the state and would not be noticeable.

8.3.10 Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the surrounding landscape and the visibility of the power plant. In general, aesthetic changes would be limited to the immediate vicinity of the CGS site and the wind farm facilities.

Aesthetic impacts from the natural gas-fired power plant component of the combination alternative would be essentially the same as those described for the natural gas-fired alternative in Section 8.1.10. Power plant infrastructure would be generally smaller and less noticeable than CGS containment and turbine buildings. Mechanical draft cooling towers would continue to generate condensate plumes and operational noise. Noise during power plant operations would be limited to industrial processes and communications. In addition to the power plant structures, construction of natural gas pipelines would have a short-term impact. Noise from the pipelines could be audible offsite near compressors. In general, aesthetic changes would be limited to the immediate vicinity of CGS and would be SMALL.

The wind farm would have the greatest visual impact. The 105 wind turbines (assuming an average size of 1.67 MW) at over 300 ft (100 m) tall and spread across multiple sites covering 4,000 ac (1,600 ha) would dominate the view and would likely become the major focus of attention. Depending on its location, the aesthetic impacts from the construction and operation of the wind farm would be MODERATE to LARGE.

Impacts from energy conservation and efficiency program would be SMALL. Some noise impacts could occur in instances of energy conservation and efficiency upgrades to major building systems, but this impact would be intermittent and short lived.

8.3.11 Historic and Archaeological Resources

The same considerations, discussed in Section 8.1.11, for the impact of the construction of a natural gas-fired plant on historic and archaeological resources apply to the construction activities that would occur on the CGS site for a new natural gas-fired power-generating plant. As previously noted, the potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground-disturbing activities.

As described in Section 2.9, much of the CGS site has been previously disturbed by the partial construction of Units 1 and 4 and CGS. In addition, the CGS site has been surveyed for cultural resources, resulting in the identification of archaeological sites within the vicinity of the pumphouse and intake structure. There is a low potential for cultural resources to be located in previously undisturbed portions of the CGS site.

Surveys would be needed to identify, evaluate, and address mitigation of potential impacts prior to the construction of any new power-generating facility. Studies would be needed for all areas of potential disturbance (e.g., roads, transmission corridors, rail lines, or other ROWs). Areas with the greatest sensitivity should be avoided. Because Energy Northwest would conduct a survey and apply its established protection plan for future resources, the impact of a new natural gas-fired power plant at the CGS site on historic and archaeological resources would be SMALL.

Depending on the resource richness of the site chosen for the wind farm, the impacts could range between SMALL to MODERATE. Therefore, the overall impacts on historic and archaeological resources from the combination alternative could range from SMALL to MODERATE.

Impacts to historic and archaeological resources from implementing the energy efficiency and conservation program would be SMALL and would not likely affect land use or historical or cultural resources elsewhere in the state.

8.3.12 Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new natural gas-fired power plant at CGS, wind farm, and Energy Conservation and Efficiency Program. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around the a power plant, and all are exposed to the same hazards generated from constructing and operating a natural gas-fired power plant and wind farm.

Low-income families could benefit from weatherization and insulation programs. This effect would be greater than the effect for the general population because (according to the Office of Management and Budget (OMB)) low-income households experience home energy burdens more than four times larger than the average household (OMB, 2007). Weatherization programs could target low-income residents as a cost-effective energy efficiency option since low-income populations tend to spend a larger proportion of their incomes paying utility bills (OMB, 2007). Overall impacts to minority and low-income populations from energy conservation and efficiency programs would be nominal, depending on program design and enrollment. Potential impacts to minority and low-income populations from the construction and operation of a natural gas-fired power plant at CGS and wind farm would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of the Hanford Site and CGS and the wind farm could affect low-income populations. Given the close proximity to the Tri-Cities metropolitan area, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information, and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a natural gas-fired power plant and the wind farm (depending on its location) would not have a disproportionately high and adverse human health and environmental effects on minority and low-income populations.

8.3.13 Waste Management

During the construction stage of this combination of alternatives, land clearing and other construction activities would generate wastes that could be recycled, disposed of onsite, or shipped to the offsite waste disposal facility. During the operational stage, spent SCR catalysts, which control NO_x emissions from the natural gas-fired plants, would make up the majority of the waste generated by this alternative.

There would be an increase in wastes generated during installation or implementation of conservation measures, such as appropriate disposal of old appliances, installation of control devices, and modifications of buildings. New and existing recycling programs would help to minimize the amount of generated waste.

The NRC concludes that overall waste impacts from the combination of the natural gas-fired unit constructed onsite, hydropower, a renewable energy component other than hydropower (i.e., wind capacity), and conservation would be SMALL.

8.3.14 Summary of Impacts of the Combination Alternative

Table 8.3-1 summarizes the environmental impacts of the combined alternative compared to continued operation of CGS.

Table 8.3-1. Summary of environmental impacts of the combination alternative compared to continued operation of CGS

Category	Combination alternative	Continued CGS operation
Air quality	SMALL to MODERATE	SMALL
Groundwater	SMALL	SMALL
Surface water	SMALL	SMALL
Aquatic and terrestrial resources	MODERATE	SMALL
Human health	SMALL	SMALL
Socioeconomics	SMALL to LARGE	SMALL
Waste management	SMALL	SMALL

8.4 <u>Alternatives Considered but Dismissed</u>

This section presents alternatives to license renewal that were eliminated from detailed study due to technical reasons, resource availability, or current commercial limitations. The NRC believes that these limitations would continue to exist when the existing CGS license expires. Under each of the following technology headings, the NRC explains why it dismissed each alternative from further consideration.

8.4.1 Offsite New Nuclear and Natural Gas-Fired Capacity

While new natural gas-fired and nuclear power-generating facilities like those considered in Sections 8.1 and 8.2, respectively, could be constructed offsite rather than at the CGS site, the impacts would be far greater than constructing these facilities and making use of existing infrastructure at the CGS site. Additional impacts would occur from the construction of new water intake and discharge structures, as well as other support infrastructure including new transmission lines, roads, and railway spurs that are already present on the CGS site. Furthermore, the community around the Hanford Site and CGS is already familiar with the appearance of a power facility, and it is an established part of the region's historic and aesthetic character. Workers skilled in power plant operations may not be as readily available in other locations. Remediation may be necessary at other industrial sites to make the site ready for redevelopment. In short, an existing power plant site would present the best offsite location for a new generation facility with a new nuclear reactor or natural gas-fired power plant.

8.4.2 New Coal-Fired Capacity

Coal-fired generation accounts for a greater share of U.S. electrical power generation than any other fuel (EIA 2009a). Furthermore, the EIA projects that new coal-fired power plants will account for the greatest share of capacity additions through 2030—more than natural gas, nuclear, or renewable generation options. Integrated-gasification combined-cycle technology is an emerging coal option that uses coal gasification technology and is substantially cleaner than conventional pulverized coal plants due to the removal of major pollutants from the gas stream before combustion. While coal-fired power plants are widely used and likely to remain widely used, the NRC acknowledges that future additions to coal capacity may be affected by perceived or actual efforts to limit GHG emissions.

Energy Northwest has considered constructing new coal-fired generating capacity in its service territory. In particular, in 2006, Energy Northwest submitted an application for the Pacific

Mountain Energy Center, a 680-MW, two-unit electrical generation facility, proposed to operate on synthetic gas produced from coal or petroleum coke, at a site in Kalama, Washington. However, with the passage of Washington State Senate Bill 6001 in July 2007, Washington State now requires new coal-fired power plants to include provisions for carbon capture and storage. In November, 2007, the Washington State EFSEC concluded that Energy Northwest's proposed GHG reduction plan for the Pacific Mountain Energy Center failed to meet the requirements of the statute, and was rejected. Energy Northwest considered converting the proposed plant to a gas-fired plant, but determined that financial and economic conditions do not support a 680-MW project. By letter dated May 5, 2009, Energy Northwest requested that its application for the Pacific Mountain Energy Center be terminated.

Although coal-fired generation is technically feasible and can supply baseload capacity similar to that supplied by CGS, the technology required for economic carbon capture is not expected to be available in time to include as part of a new coal plant to replace CGS when its license expires. It is also uncertain whether a utility would pursue a permit in the State of Washington due to uncertainties in the permitting process. For these reasons, the NRC does not consider the construction of a large, base-load coal-fired power plant in Washington State as a reasonable alternative to continued CGS operation.

8.4.3 Energy Conservation and Energy Efficiency

Although often used interchangeably, energy conservation and energy efficiency are different concepts. Energy efficiency means deriving a similar level of services by using less energy, while energy conservation shows a reduction in total energy consumption. Both fall into a larger category known as demand-side management. Demand-side management measures address energy end uses—unlike energy supply alternatives discussed in previous sections. Demand-side management can include measures that do the following:

- Shift energy consumption to different times of the day to reduce peak loads
- Interrupt certain large customers during periods of high demand
- Interrupt certain appliances during high-demand periods
- Replace older, less efficient appliances, lighting, or control systems
- Encourage customers to switch from gas to electricity for water heating and other similar measures that utilities use to boost sales

Unlike other alternatives to license renewal, the GEIS notes that conservation is not a discrete power-generating source; it represents an option that states and utilities may use to reduce their need for power-generation capability (NRC 1996). Since 1982, the Bonneville Power Authority and regional utilities, including Energy Northwest, have developed and carried out a variety of energy conservation programs designed to reduce both peak demands and daily energy consumption. These load-management and energy-efficiency programs have reduced demand by over 1,500 average megawatts. The Northwest Power and Conservation Council estimates that future cost-effective energy efficiency improvements will meet a substantial portion, but not all, of projected demand growth through 2030 (NWPCC, 2010). Although these programs will continue, NRC does not consider that future energy savings will be a reasonable offset to the CGS baseload capacity. Because of this, the NRC has not evaluated energy conservation and efficiency as discrete alternatives to license renewal. They have, however, been considered as components of the combination alternative.

8.4.4 Purchased Power

In its ER, Energy Northwest stated that purchased electrical power is, in theory, a potential alternative to CGS license renewal. Washington State typically exports surplus power through the Pacific Intertie, which was established to transmit electricity south to California during peak summer months. During periods of low hydroelectric generation in the Pacific Northwest, energy is also sometimes purchased and imported to Washington. However, for the 2023–2043 time frame of CGS's renewal, there are no guaranteed available power sources to replace the 1,150 MWe of baseload capacity that CGS supplies. Because of the lack of assured availability of purchased electrical power, the NRC has not evaluated purchased power as an alternative to license renewal. However, purchased power can be considered as a component of the combination alternative, as a replacement for a renewable power component when it is not available.

8.4.5 Solar Power

Solar technologies use the sun's energy to produce electricity. Southeastern Washington receives approximately 4.0–4.5 kWh per square meter per day (EERE 2008). Energy Northwest currently operates the 30-kW White Bluffs Solar Station on the IDC site east of the CGS site. Similar small solar projects may be developed near the CGS site as part of the planned energy park on the Hanford Site or as part of other utility generation development.

While it is theoretically possible to replace CGS's capacity with solar photovoltaic technology, land requirements for such a facility would be significant. Energy Northwest estimates that flat-plate photovoltaics would require 7.4 ac/MWe and concentrating systems would require 4.9 ac/MWe. Therefore, replacing the installed capacity of CGS would require from 8.75 square miles (mi^2) to more than 13 mi^2 for a similar capacity solar plant. Because solar plants tend to be roughly 25-percent efficient, a solar-powered alternative would require at least 35 mi^2 of collectors to provide an amount of electricity equivalent to that generated by CGS. Space between parcels and associated infrastructure would increase this land requirement. The Hanford Site, at over 500 mi^2, is theoretically large enough for a facility of this size.

NUREG-1437, Section 8.3 (NRC 1996, 1999) describes the potential environmental impacts associated with a large-scale solar generation facility and transmission lines. The construction impacts for a 35-mi^2 facility would likely be significant and would include impacts on sensitive areas and loss of productive land. The operating facility would also have considerable continuing aesthetic impact. In addition, in the GEIS, the NRC noted that, by its nature, solar power is intermittent (i.e., it does not work at night and cannot serve baseload when the sun is not shining), and the efficiency of collectors varies greatly with weather conditions. A solar-powered alternative would require energy storage or backup power supply from other sources to supply equivalent electric power at night. Given the significant environmental impacts and the challenges in meeting baseload requirements, the NRC did not evaluate a large-scale solar power plant as an alternative to CGS license renewal.

Installations of solar panels on residential and commercial rooftops are referred to as "distributed solar power," and it is theoretically possible to replace CGS's annual generation with these types of solar installations. Assuming a 90-percent capacity factor, CGS produces over 9 million mWh annually. Based on an average house size of 139 m^2 (1,500 square feet (ft^2)) with a usable roof space of 70 m^2 (753 ft^2) and a conversion efficiency of 15 percent, over 500,000 new or existing homes would have to be fitted with solar panels to replace the generation from CGS. With a population of just over 1.3 million, this alternative would likely require installations on nearly every residence in eastern Washington. Without significant government or utility incentives, installation of distributed solar panels on this scale in either commercial or residential applications is unlikely. In addition, as with larger-scale solar plants, this solar alternative would require energy storage or backup power supply from other sources at night to supply baseload generation equivalent to that of the CGS. For these reasons, NRC did not evaluate distributed solar as an alternative to CGS license renewal.

8.4.6 Wind Power

The American Wind Energy Association (AWEA) reports that a total of 25,369 MW of wind energy capacity was installed in the U.S. at the end of 2008, with 8,545 MW installed just in 2008 (AWEA 2009). Texas is by far the leader in installed capacity with 2,671 MW, followed by Iowa (1,600 MW), Minnesota (456 MW), Kansas (450 MW), and New York (407 MW). The National Renewable Energy Laboratory (NREL 2010) estimates that Washington State has a wind energy potential of over 18,000 MW of installed capacity with annual generation of over 55,000 Gigawatt hours (GWh) (considering sites with capacity factors greater than or equal to 30 percent at 80-m height). The Northwest Power and Conservation Council identified utility-scale wind power as a generating resource with up to 5,000 MWe new potential capacity in the region west of the Continental Divide (NWPCC 2005), although the potential power output from developable sites would likely be less.

At the current stage of wind energy technology development, wind resources of Category 3 or better[1] are required to produce utility-scale amounts of electricity. There are locations meeting this criterion in eastern Washington, west and south of the Hanford Site in the Columbia River basin. Six wind projects with a combined capacity of 568 MW have been constructed and are operating within 50 mi of the CGS site. Four additional projects with a combined capacity of 1,700 MW have been proposed in the same region. In total, these projects would generate 2,268 MW of electricity (DOE 2009; EFSEC 2010; NWPCC 2010, BPA 2011).

Land-based wind turbines have individual capacities as high as 3 MW, with the 1.67-MW turbine being the most popular size to have been installed in 2008 (offshore wind turbines have capacities as high as 5 MW). At these sizes, many hundreds of turbines would be required to meet the baseload capacity of the CGS reactor. Further, to avoid inter-turbine interferences in wind flow through the wind farm, turbines must be located well separated from each other, resulting in utility-scale wind farms requiring substantial amounts of land.[2] Energy Northwest estimates that 270 mi^2 of land would be necessary to generate 1,150 MWe of power. In addition, because prime wind areas are often located on ridgetops and other areas far from transmission facilities, utility-scale development would have significant economic and environmental costs.

The capacity factors of wind farms are primarily dependent on the constancy of the wind resource and while offshore wind farms can have relatively high capacity factors due high-quality winds throughout much of the day (resulting primarily from differential heating of land and sea areas), land–based wind farms typically have capacity factors typically less than 40 percent. For example, although three large wind power projects installed in Washington

[1] By industry convention, wind resource values are categorized on the basis of the power density and speed of the prevailing wind at an elevation of 50 m, from Category 1 with wind power densities of 200 to 300 W/m^2 (typically existing with constant wind speeds between 12.5 to 14.3 mph [5.8-6.4 m/s] through Category 7 with power densities of 800-1800 W/m^2 (wind speeds of 19.7 to 24.8mph [8.8-11.1 m/s]). Category 3 wind has a power density of 300 to 400 W/m^2 with wind speeds of 15.7 to 16.8 mph (7.0 to 7.5 m/s).

[2] However, the permanent components of wind farms, the individual turbines, electrical substations, and maintenance/control/storage buildings occupy roughly 5 percent of the area of a typical wind farm with the remaining land areas available for most other non-intrusive land uses once construction is completed.

have a combined potential capacity of 369 MWe, these projects averaged only 113 MWe from October 2007–October 2008 (EN, 2010a), or 31-percent capacity. Even assuming 40 percent as a capacity factor, a wind farm would require an installed capacity of roughly twice CGS's capacity to produce the same amount of electricity. To be considered baseload power, the majority of this energy would have to be stored for use when wind is not available. However, energy storage options available to overcome wind intermittency and variability are limited and expensive.

Because of the intermittent nature of wind power and substantial land requirements of large wind farms, the NRC does not consider a utility-scale wind farm, by itself, as a reasonable alternative to the renewal of the CGS operating license. However, the Northwest Power and Conservation Council (NWPCC) does anticipate that wind power additions will be important new generation sources in the license renewal period, with a 100-MWe plant being considered as the reference plant (NWPCC 2005). Accordingly, the NRC considered smaller-scale wind farms as renewable energy components of the combination alternative.

8.4.7 Biomass Waste

Eastern Washington has many biomass fuel resources including forest, mill, agricultural, animal waste, and municipal waste, as well as energy crop potential. The Pacific Region Bioenergy Partnership estimates that Washington State's annual production of 16.9 million dry tons of biomass per year has an energy potential of 15.9 terawatt hours of electricity (http://www.pacificbiomass.org/WABiomassInventory.aspx). In its ER, Energy Northwest stated its intention to pursue one or more 50-MWe wood waste projects in the Pacific Northwest with two industrial partners (ADAGE, 2009), (EN, 2010a). Forestry waste comprises about half of the biomass inventory in Washington State.

Walsh et al. (2000) note that estimates of biomass capacity contain substantial uncertainty, and potential availability does not mean biomass will actually be available at the economic prices shown or that resources will be usably free of contamination. Some of these plant wastes already have reuse value and would likely be more costly to deliver because of competition. Others, such as forest residues, may prove unsafe and unsustainable to harvest on a regular basis, or may prove uneconomic if significant transportation is required to bring the waste to the plant. Because the wood waste technology is relatively inefficient and expensive, and because economic operation relies on siting near fuel sources, plant sizes are generally small relative to CGS. To replace the CGS, 23 plants of the size Energy Northwest is considering would have to be constructed. The NRC also acknowledges that perceived or actual efforts to limit GHG emissions may affect biomass-fired generation. As a result, the NRC has not considered a biomass-fired alternative to CGS license renewal.

8.4.8 Hydroelectric Power

According to researchers at Idaho National Energy and Environmental Laboratory, Washington State has an estimated 2,539 MWe of technically available, undeveloped hydroelectric resources at 551 sites throughout the state (INEEL 1997). This potential capacity is greater than the capacity of CGS and, if fully developed, could theoretically replace CGS's baseload generation. However, given that the average nameplate capacity of installed hydroelectric projects in Washington is about 100 MWe, it would take more than 12 individual projects to replace the baseload generation of CGS, considering hydropower availability. Hydroelectric projects require individual licenses and permits to operate, which can often be difficult to obtain due to environmental constraints. The NRC did not consider it reasonably foreseeable that 1,150 MWe of new hydroelectric baseload generating capacity could be permitted, developed, and made available during the license renewal period. Therefore, the NRC did not evaluate hydropower, separately, as an alternative to license renewal. However, the NRC did consider hydropower installed at developed, but unpowered, sites as part of the combination alternative.

8.4.9 Wave and Ocean Energy

Wave and ocean energy has generated considerable interest in recent years. Ocean waves, currents, and tides are often predictable and reliable. Ocean currents flow consistently, while tides can be predicted months and years in advance with well-known behavior in most coastal areas. The Washington Coast and the Puget Sound have many potential wave and tidal energy development sites. However, most of these ocean energy technologies are in relatively early stages of development, and while some results have been promising, they are not likely to be able to replace the baseload capacity of CGS by the time its license expires. Accordingly, the NRC did not consider wave and ocean energy as an alternative to CGS license renewal.

8.4.10 Geothermal Power

Geothermal electric generation is limited by the geographical availability of geothermal resources (NRC 1996). Southeastern Washington has several known and potential geothermal regions which, according to the U.S. Geological Survey, have the potential to produce 127 MWe. However, many areas are inaccessible for development and transmission lines because they are located on Federal property or in national parks. In addition, many of these areas, including reservoirs in the Columbia River basin, do not have the potential for high temperatures. The NRC concluded that geothermal energy is not a reasonable alternative to CGS license renewal.

8.4.11 Municipal Solid-Waste

Municipal solid-waste combustors use three types of technologies—mass burn, modular, and refuse-derived fuel. Mass burning is used most frequently in the U.S. and involves little sorting, shredding, or separation. Consequently, toxic or hazardous components present in the waste stream are combusted, and toxic constituents are exhausted to the air or become part of the resulting solid wastes. Currently, approximately 89 waste-to-energy plants operate in the U.S. These plants generate approximately 2,700 MWe, or an average of 30 MWe per plant (Michaels 2007). In 2005, 4 percent of Washington State’s municipal solid waste was burned for energy production. More than 38 average-sized new municipal solid waste combustion plants would be necessary to replace the CGS baseload capacity.

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant would be approximately the same as that for a coal-fired power plant. In addition, waste-fired plants have the same or greater operational impacts than coal-fired technologies have (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at coal-fired facilities or at wood-waste facilities because of the need for specialized waste separation and handling equipment (NRC 1996).

The need for an alternative to landfills, rather than energy considerations, drives the decision to burn municipal waste to generate energy. The use of landfills as a waste disposal option is likely to increase as energy prices increase; however, municipal waste combustion facilities may become attractive again.

Regulatory structures that once supported municipal solid-waste incineration no longer exist. The Tax Reform Act of 1986 made capital-intensive projects such as municipal-waste combustion facilities more expensive relative to less expensive waste-disposal alternatives such as landfills. Also, the 1994 Supreme Court decision C&A Carbone, Inc. v. Town of Clarkstown, New York, struck down local flow control ordinances that required waste to be delivered to specific municipal waste combustion facilities rather than landfills that may have had lower fees. In addition, environmental regulations have increased the cost to construct and maintain municipal waste combustion facilities.

Given the small average installed size of municipal solid-waste plants and the unfavorable regulatory environment, the NRC does not consider municipal solid-waste combustion to be a feasible alternative to CGS license renewal.

8.4.12 Biofuels

In addition to wood and municipal solid-waste fuels, there are other concepts for biomass-fired electric generators, including conversion to liquid biofuels and biomass gasification. In the GEIS, the NRC states that none of these technologies progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as CGS. After re-evaluating current technologies, the NRC finds other biomass-fired alternatives are still unable to reliably replace the CGS capacity. For this reason, the NRC does not consider other biomass-derived fuels to be feasible alternatives to CGS license renewal.

8.4.13 Oil-Fired Power

EIA projects that oil-fired plants will account for very few of plants for new generation capacity constructed in the U.S. from 2008–2030. Furthermore, EIA does not project that oil-fired power will account for any significant additions to capacity (EIA 2009a).

The variable costs of oil-fired generation are found to be greater than those of nuclear or coal-fired operations, and oil-fired generation has greater environmental impacts than natural gas-fired generation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive (EIA 2009a). The high cost of oil has prompted a steady decline in its use for electricity generation. Thus, the NRC does not consider oil-fired generation an alternative to CGS license renewal.

8.4.14 Fuel Cells

Fuel cells oxidize fuels without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and passing air (or oxygen) over a cathode and then separating the two by an electrolyte. The only byproducts (depending on fuel characteristics) are heat, water, and CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

Presently, fuel cells are not economically or technologically competitive with other alternatives for large-scale electricity generation. EIA projects that fuel cells may cost $5,374 per installed kilowatt (total overnight costs[3]) (EIA 2009a), or 3.5 times the construction cost of new coal-fired capacity, and 7.5 times the cost of new, advanced natural gas-fired, combined-cycle capacity. In addition, fuel cell units are likely to be small (the EIA reference plant is 10 MWe). While it

[3] Overnight cost is the cost of a construction project if no interest were incurred during construction.

may be possible to use a distributed array of fuel cells to provide an alternative to CGS, it would be extremely costly to do so. Accordingly, the NRC does not consider fuel cells to be an alternative to CGS license renewal.

8.4.15 Delayed Retirement

Energy Northwest has stated in its ER that it is not aware of any combination of planned retirements that could replace CGS's baseload capacity. As a result, delayed retirement is not a feasible alternative to license renewal.

8.5 No-Action Alternative

This section examines environmental effects that would occur if the NRC took no action. No action in this case means that the NRC does not issue a renewed operating license for CGS and the license expires at the end of the current license term, in December 2023. If the NRC takes no action, the plant would shutdown at or before the end of the current license. After shutdown, plant operators would initiate decommissioning according to 10 CFR 50.82.

This section addresses only those impacts that arise directly as a result of plant shutdown. The environmental impacts from decommissioning and related activities have already been addressed in several other documents, including the "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, Supplement 1 (NRC 2002); Chapter 7 of the license renewal GEIS (NRC, 1996); and Chapter 7 of this SEIS. These analyses either directly address or bound the environmental impacts of decommissioning whenever Energy Northwest ceases operating CGS.

Even with a renewed operating license, CGS will eventually shut down, and the environmental effects addressed in this section will occur at that time. Since these effects have not otherwise been addressed in this SEIS, the impacts will be addressed in this section. As with decommissioning effects, shutdown effects are expected to be similar whether they occur at the end of the current license or at the end of a renewed license.

8.5.1 Air Quality

When the plant stops operating, there will be a reduction in emissions from activities related to plant operation, such as use of diesel generators and employee vehicles. Since it was determined that emissions during the renewal term would have a SMALL impact on air quality, if emissions decrease, the impact on air quality would also decrease and would be SMALL.

8.5.2 Groundwater Use and Quality

With plant shutdown and decommissioning, there will be a reduction in groundwater use over that of continued plant operation. Based on the discussion in Section 4.3, groundwater use by CGS would have a SMALL impact on groundwater use and quality during the renewal term; therefore, if groundwater use decreases, the impact on groundwater use and quality would also decrease, having a SMALL impact.

8.5.3 Surface-Water Use and Quality

Shutdown and decommissioning would result in a reduction in surface-water use over that of continued plant operation. Since it was determined that continued plant operations would have a SMALL impact on surface-water use and quality during the renewal term (see Section 4.3), the impacts of shutdown and decommission on surface-water use and quality would also be SMALL.

8.5.4 Aquatic Ecology

If the plant were to cease operating, impacts on aquatic ecology would decrease because the plant would withdraw and discharge less water than it does during operations. Shutdown would reduce the already SMALL impacts on aquatic ecology.

8.5.5 Terrestrial Ecology

If the plant were to cease operating, the terrestrial ecology impacts would be SMALL, assuming that no additional land disturbances on or offsite would occur during decommissioning activities or waste disposal.

8.5.6 Human Health

Human health risks would be smaller after plant shutdown. The plant, which is currently operating within regulatory limits, would emit less gaseous and liquid radioactive material to the environment. In addition, after 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 Chapter 4 of this SEIS, the NRC concluded that the impacts of continued plant operation on human health would be SMALL. In Chapter 5, the NRC concluded that the impacts of accidents during operation would be SMALL. Therefore, as radioactive emissions to the environment decrease, and as likelihood and variety of accidents decrease after shutdown, the NRC concludes that the risk to human health following plant shutdown would be SMALL.

8.5.7 Land Use

Plant shutdown would not affect onsite land use. Plant structures and other facilities would remain in place until decommissioning. Most transmission lines connected to CGS would remain in service after the plant stops operating. Maintenance of most existing transmission lines would continue as before. The transmission lines could be used to deliver the output of any new power-generating capacity additions made on the CGS site. Impacts on land use from plant shutdown would be SMALL.

8.5.8 Socioeconomics

Plant shutdown would have an impact on socioeconomic conditions in the region around CGS. Should the plant shut down, there would be immediate socioeconomic impacts from loss of jobs (some, though not all, of the approximately 1,100 employees would begin to leave); and tax payments may be reduced. These impacts, however, would not be considered significant on a regional basis given the close proximity to the Tri-Cities metropolitan area and because plant workers' residences are not concentrated in a single community or county. Revenue losses from CGS operations would directly affect Benton County and other local taxing districts and communities closest to, and most reliant on, the plant's tax revenue. The socioeconomic impacts of plant shutdown would (depending on the jurisdiction) range from SMALL to MODERATE. An additional discussion of the potential socioeconomic impacts of plant decommissioning is provided in Appendix J to NUREG 0586, Supplement 1 (NRC, 2002).

8.5.9 Transportation

Traffic volumes on the roads near the Hanford Site and CGS would be greatly reduced after plant shutdown due to the loss of jobs at the facilities. Deliveries of materials and equipment to CGS would also be reduced until decommissioning. Transportation impacts from the termination of plant operations would be SMALL.

8.5.10 Aesthetics

Plant structures and other facilities would likely remain in place until decommissioning. The plume from cooling towers would cease or greatly decrease after shutdown. Noise caused by plant operation would cease. Aesthetic impacts of plant closure would be SMALL.

8.5.11 Historic and Archaeological Resources

Impacts from the no-action alternative on historic and archaeological resources would be SMALL. A separate environmental review would be conducted for decommissioning. That assessment would address the protection of historic and archaeological resources.

8.5.12 Environmental Justice

Impacts to minority and low-income populations when CGS ceases operations would depend on the number of jobs and the amount of tax revenues lost by the communities in the immediate vicinity of the power plant. Closure of CGS would reduce the overall number of jobs (there are currently 1,100 employed at the facilities) and tax revenue for social services attributed to plant operations. Minority and low-income populations in the township vicinity of CGS could experience some socioeconomic effects from plant shutdown, but these effects would not likely be high and adverse.

8.5.13 Waste Management

If the no-action alternative was carried out, the generation of high-level waste would stop and the generation of low-level and mixed waste would decrease. Impacts from carrying out the no-action alternative are expected to be SMALL.

8.5.14 Summary of the Impacts of No Action

Table 8.5-1 summarizes the environmental impacts of the no-action alternative compared to continued operation of the CGS.

Table 8.5-1. Summary of environmental impacts of no action compared to continued operation of CGS

Alternative	Impact area						
	Air quality	Groundwater	Surface water	Aquatic and terrestrial resources	Human health	Socioeconomics	Waste management
Continued operation of CGS (license renewal)	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
No-action alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

8.6 Alternatives Summary

In this chapter, the following alternatives to CGS license renewal were considered: natural gas combined-cycle generation, new nuclear generation, and a combination alternative. The no-action alternative and its effects were also considered. Table 8.6-1 summarizes the impacts for all alternatives to CGS license renewal.

Table 8.6-1. Summary of environmental impacts of proposed action and alternatives

Alternative	Impact area						
	Air quality	Groundwater	Surface water	Aquatic and terrestrial resources	Human health	Socioeconomics	Waste management
Continued operation of CGS (license renewal)	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Natural gas-fired alternative at the CGS site	SMALL to MODERATE	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to MODERATE	SMALL
New nuclear alternative at the CGS site	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Combination of alternatives	SMALL to MODERATE	SMALL	SMALL	MODERATE	SMALL	SMALL to LARGE	SMALL
No-action alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

The environmental impacts of the proposed action (issuing a renewed CGS operating license) would be SMALL for all impact categories, except for the Category 1 issue of collective offsite radiological impacts from the fuel cycle, high-level waste, and from spent fuel disposal. Significance levels for these impacts have not been determined, but the Commission determined them to be Category 1 issues nonetheless.

The natural gas-fired alternative is not an environmentally favorable alternative due to air quality impacts from NO_x, SO_x, PM_{10}, CO, and CO_2, (and their corresponding human health effects) as well as the construction impacts on terrestrial resources. The combination alternative would have lower air emissions and waste-management impacts than the natural gas-fired alternative; however, the combination alternative would have relatively high construction impacts on terrestrial resources and potential historic and archaeological resources due mainly to the wind turbine component. The new nuclear alternative would result in impacts from construction activities, but, although these and operational impacts would be SMALL, they would be larger than the impacts associated with continued operation of CGS.

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

8.7 References

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9.0 CONCLUSION

This final supplemental environmental impact statement (SEIS) contains the environmental review of the Energy Northwest application for a renewed operating license for Columbia Generating Station (CGS), as required by the *Code of Federal Regulations* (CFR), Part 51 of Title 10 (10 CFR Part 51), the U.S. Nuclear Regulatory Commission's (NRC) regulations that implement the National Environmental Policy Act (NEPA). This chapter presents conclusions and recommendations from the site-specific environmental review of CGS and summarizes site-specific environmental issues of license renewal that were noted during the review. Section 9.1 summarizes the environmental impacts of license renewal; Section 9.2 presents a comparison of the environmental impacts of license renewal and energy alternatives; Section 9.3 discusses unavoidable impacts of license renewal, energy alternatives, and resource commitments; and Section 9.4 presents conclusions and NRC staff (staff) recommendations.

9.1 Environmental Impacts of License Renewal

The staff's review of site-specific environmental issues in this SEIS leads to the conclusion that issuing a renewed license would have SMALL impacts for the eight Category 2 issues and the two uncategorized issues applicable to license renewal at CGS.

Mitigation measures were considered for each Category 2 issue, as applicable. Additionally, the staff identified several measures that could mitigate potential impacts to historic and archaeological resources. Energy Northwest could reduce the risk of potential impacts to these resources located on or near CGS by following their Cultural Resources Protection Plan and by providing staff cultural resource awareness training to ensure that informed decisions are made before any ground-disturbing activities. Substantive revisions to the Cultural Resources Protection Plan should be developed in coordination with the Washington State Historic Preservation Officer and consulting tribes. In addition, lands not surveyed should be investigated by a qualified archaeologist prior to any ground-disturbing activity. Given the potential for discovery of subsurface archaeological material within the culturally sensitivity zone, Energy Northwest needs to ensure that these areas are considered during future plant operations and maintenance activities.

The staff also considered cumulative impacts of past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes them. The staff concluded in Section 4.11 that cumulative impacts of CGS's license renewal would be SMALL to LARGE depending on the resource. However, the incremental contribution from CGS during the period of extended operation would be SMALL.

9.2 Comparison of Environmental Impacts of License Renewal and Alternatives

In the conclusion to Chapter 8, the staff considered the following alternatives to CGS license renewal:

- natural gas combined-cycle generation
- new nuclear generation

- a combination alternative that includes a portion of the natural gas combined-cycle capacity, a conservation component, a purchased power component, a hydropower component, and a wind power component
- no action (not renewing the CGS operating license)

The NRC staff concluded that the combination alternative and the natural gas combined-cycle alternative would have greater overall adverse environmental impacts than new nuclear generation. The new nuclear alternative would have SMALL environmental impacts in most areas with the exception of socioeconomic impact. Continued operation of CGS would have SMALL environmental impacts in all areas. The NRC staff concluded that continued operation of the existing CGS is the environmentally preferred alternative.

9.3 Resource Commitments

9.3.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out any of the energy alternatives considered in this SEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with Environmental Protection Agency (EPA) emissions standards, though the alternative of operating a fossil-fueled power plant in some areas may worsen existing attainment issues. Chemical and radiological emissions would not exceed the National Emission Standards for hazardous air pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to radiation and hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste would also be unavoidable. In comparison, hazardous and nonhazardous wastes would also be generated at non-nuclear power generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and state regulations. Due to the costs of handling these materials, power plant operators would be expected to carry out all activities and optimize all operations in a way that generates the smallest amount of waste possible.

9.3.2 The Relationship between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment, as described in Chapters 4, 5, 6, 7, and 8. "Short-term" is the period of time that continued power generating activities take place.

Power plant operations require short-term use of the environment and commitment of resources and commit certain resources (e.g., land and energy), indefinitely or permanently. Certain short-term resource commitments are substantially greater under most energy alternatives, including license renewal, than under the no-action alternative because of the continued generation of electrical power and the continued use of generating sites and associated infrastructure. During operations, all energy alternatives require similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Air emissions from power plant operations introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but they are not expected to impact air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired.

Continued employment, expenditures, and tax revenues generated during power plant operations directly benefit local, regional, and state economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste requires an increase in energy and consumes space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities are committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

9.3.3 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitment of resources that have been noted in this SEIS. Resources are irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitment 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 commitment of capital, energy, labor, and material resources are also irreversible.

The implementation of any of the energy alternatives considered in this SEIS would entail the irreversible and irretrievable commitment of energy, water, chemicals, and in some cases, fossil fuels. These resources would be committed during the license renewal term and over the entire 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. These resources are readily available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

9.4 Recommendations

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

- the analysis and findings in NUREG-1437, Volumes 1 and 2, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants"
- the Environmental Report submitted by Energy Northwest
- consultation with Federal, state, local, and tribal government agencies
- the NRC's environmental review
- consideration of public comments received during the scoping process and on the draft Supplemental Environmental Impact Statement.

10.0 LIST OF PREPARERS

Members of the Office of Nuclear Reactor Regulation (NRR) prepared this supplemental environmental impact statement (SEIS) with assistance from other U.S. Nuclear Regulatory Commission (NRC) organizations and with contract support from Pacific Northwest National Laboratory (PNNL).

Table 10-1 provides a list of NRC staff that participated in the development of the SEIS. PNNL provided contract support for alternatives, aquatic ecology, historic and archaeological resources, air quality, hydrology, and the severe accident mitigation alternatives (SAMA) analysis, presented primarily in Chapters 2, 4, 5, 8, and Appendix F.

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12.0 INDEX

NRC FORM 335 (12-2010) NRCMD 3.7 — U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET** *(See instructions on the reverse)*	1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) NUREG-1437, Suplement 47, Vol. 1
2. TITLE AND SUBTITLE Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS) Supplement 47 Regarding Columbia Generating Station Final Report	3. DATE REPORT PUBLISHED MONTH: March — YEAR: 2012 4. FIN OR GRANT NUMBER
5. AUTHOR(S) See Chapter 10 of the report	6. TYPE OF REPORT Technical 7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.)

same as above

10. SUPPLEMENTARY NOTES

Docket Number 50-397

11. ABSTRACT (200 words or less)

This final supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Energy Northwest to renew the operating license for Columbia Generating Station (CGS) for an additional 20 years.

The final SEIS includes the NRC staff's analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from new natural gas-fired combined-cycle generation; new nuclear generation; a combination alternative that includes some natural gas-fired capacity, energy conservation, a hydropower component, and a wind-power component; and not renewing the license (the no-action alternative).

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

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)	13. AVAILABILITY STATEMENT
Columbia Generating Station CGS Energy Northwest Supplement to the Generic Environmental Impact Statement SEIS FSEIS GEIS National Environmental Policy Act NEPA	unlimited 14. SECURITY CLASSIFICATION *(This Page)* unclassified *(This Report)* unclassified 15. NUMBER OF PAGES 16. PRICE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

OFFICIAL BUSINESS

NUREG-1437,
Supplement 47, Vol. 1

Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Columbia Generating Station

April 2012