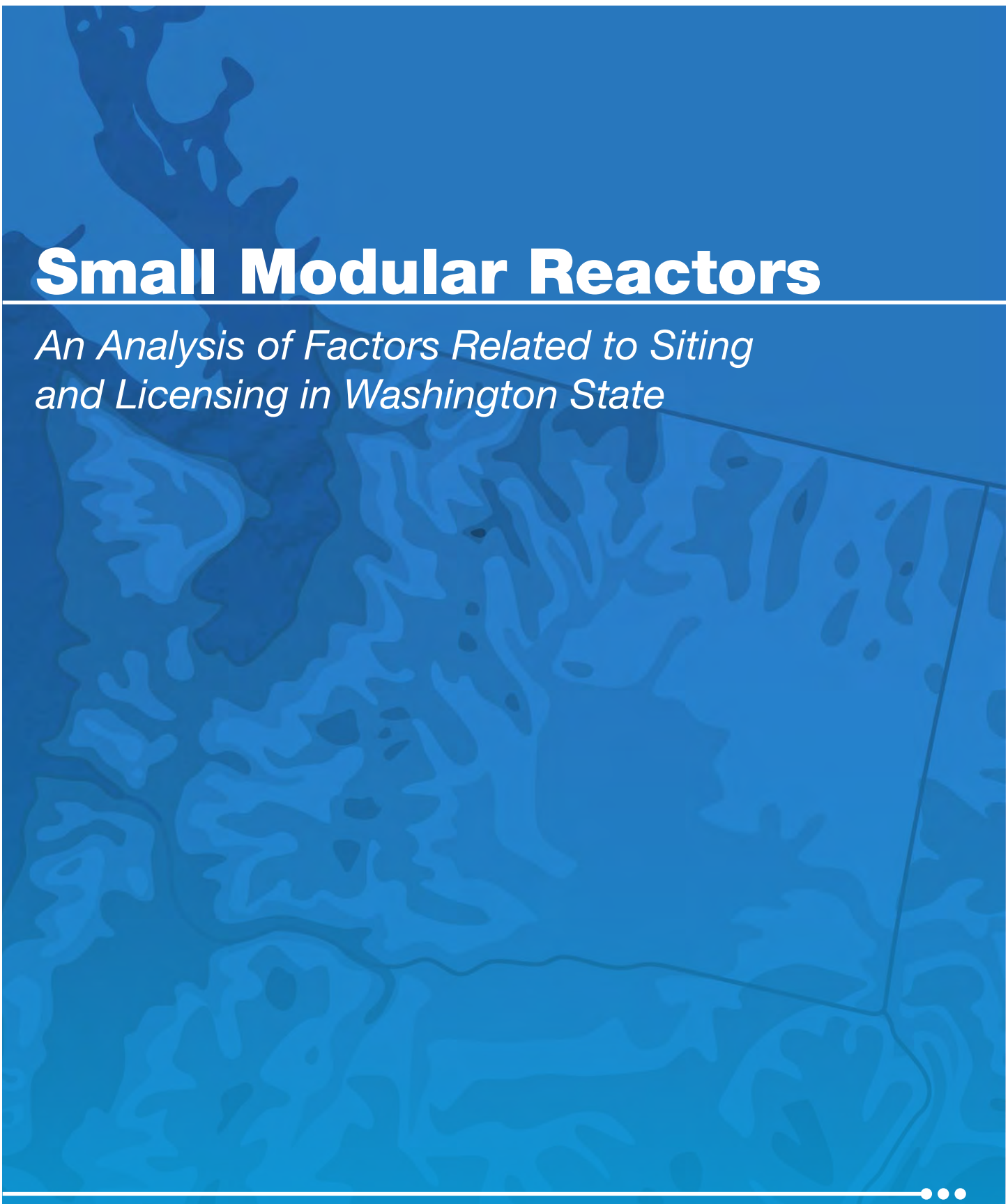
Small Modular Reactors

An Analysis of Factors Related to Siting and Licensing in Washington State



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Golder Associates

Executive Summary

This report investigates the potential for developing nuclear power generation in the state of Washington, focusing on one of the advanced nuclear reactor design technologies currently in development: Small Modular Reactors (SMRs). SMRs are defined by the US Department of Energy (USDOE) and others in the industry as nuclear power plant "modules" of 300 megawatts or less. Their concept includes offsite manufacturing, self-contained fuel, power generation and cooling, multiple module operation, and passive core failure protection that requires no action to ensure core integrity in the case of an accident.

This report looks at a range of potentially suitable locations for such a facility in Washington by applying selected site selection criteria on a statewide basis. It also considers the locations of past and present power plant sites, including past nuclear sites. The report discusses the many water supply options available to an applicant, and their constraints, and the lower water use options available for SMRs. It also describes the typical process likely to be followed to permit such a facility in Washington; makes recommendations for streamlining this permitting, mostly using existing rules and regulations; and suggests studies and/or activities that the State can implement, track, or investigate in the future.

The report describes the extensive licensing process that the US Nuclear Regulatory Commission (NRC) would apply in the siting of any SMR, and how the State could better coordinate with that process, recognizing that the NRC siting process is likely to be the critical path because it is longer than the State's process. The report also discusses the connected roles that the Federal Emergency Management Agency (FEMA) and the US Environmental Protection Agency (USEPA) have with the NRC licensing process, as well as the role of Washington's Energy Facility Site Evaluation Council (EFSEC) and other agencies.

Appendix A to this report provides a status update for many of the agencies, companies and research organizations who are involved in activities related to SMR development and related nuclear power development. This provides the reader with an understanding of current SMR technology and development, much of which would apply if an applicant proposes an SMR in Washington in the future. For example, industry groups and agencies such as USDOE have recommended a number of regulatory changes related to SMR licensing. The NRC is considering rule changes in response to those recommendations.

Finally, although many different SMR technologies are being examined around the world, the United States has 4-5 different designs in contention. The USDOE selected two of these designs as candidates for funding and development support. For this study, we developed a generic SMR design model that is an amalgam of the two finalists (NuScale and mPower). We used this model as the basis for our analysis of potential locations for SMRs in Washington. Since the USDOE selection, the mPower project has slowed down its rate of development and lost its USDOE funding, leaving the NuScale design as the apparent leader for the time being, although the Tennessee Valley Authority (TVA) is moving forward with a non-specific siting approach that may involve NuScale, mPower, or another technology in the near future. The mPower project is continuing, but at a slower pace. Our model SMR is a combination of the two and this report does not favor any SMR design. The status of these projects is also discussed in Appendix A.

This report focuses on siting, permitting, new developments, and future activities. It does not address public acceptance as a siting criteria, nor does it evaluate the implications of Initiative 394 (passed in 1981), which requires a public vote to approve the issuance of bonds to support the construction of any major public energy facility. Instead, we considered other siting factors, and discussed potential facility costs and schedules without defining the sources of funding.

The report is organized into the following chapters:

- Chapter 1 – Background, scope, and approach
- Chapter 2 – Small reactor history leading to today's technology
- Chapter 3 – The assumptions that went into the Model SMR used to evaluate site suitability in Chapter 4
- Chapter 4 – An overview of suitable locations for SMRs in Washington, recognizing that a nuclear plant siting study would need to incorporate site-specific factors and 1-2 years of study
- Chapter 5 – A discussion of the major permit requirements including considerable details about the NRC and related processes, so the State can evaluate opportunities for involvement
- Chapter 6 – Recommendations for streamlining and improving the permit process, and recommendations for further actions the State can consider to stay informed and be involved in the SMR siting and development process

The report includes suggestions on next steps the State might consider, and the timing of those steps, in preparation for the next Site Certification Agreement (SCA) to EFSEC for a nuclear power plant. The report discusses when the State may want to take actions if there was a desire to attract SMRs, attract their manufacturing, or pass legislative incentives. Such recommendations are entirely dependent on the State's direction and goals. Some other states have taken steps to address these goals already.

SMR development has the potential for significant improvements in nuclear plant siting associated with cost, safety, permitting schedule, generation flexibility, and site requirements. It also has the potential for significant carbon-free baseload generation. Public and agency concerns are still likely, related to waste disposal, fuel transport, and nuclear power, but the potential for advances in safety and licensing processes offered by SMRs have generated interest in Washington, the United States, and around the world.

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Acronyms and Abbreviations

Acronym	Description
ACHP	Advisory Council on Historic Preservation (US)
ACIRC	Advisory Council for Inter-Jurisdictional Regulatory Collaboration (WA)
AEC	United States Atomic Energy Commission
ALWR	advanced light-water reactor
ASC	Application for Site Certification
ASR	aquifer storage and recovery
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COL	Construction and Operation License (NRC); also termed Combined License
COLA	Construction and Operation License Application (NRC); also termed Combined License Application
Corps	United States Army Corps of Engineers
the Council	Energy Facility Site Evaluation Council
CZM	Coastal Zone Management Certification
DAHP	Department of Archaeology and Historic Preservation
DOD	Department of Defense
Ecology	Washington State Department of Ecology
EFSEC	Energy Facility Site Evaluation Council (WA)
EIS	environmental impact statement
EPZ	Emergency Planning Zone
ESA	Endangered Species Act
ESP	Early Site Permit (NRC)
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FNR	fast neutron reactor
GHG	greenhouse gas
GMA	Growth Management Act (WA)
HLNW	high-level nuclear waste
HPA	Hydraulic Project Approval
HTGR	high-temperature gas-cooled reactor
HTR	high temperature reactor
IGCC	integrated gasification combined cycle
ISG	Interim Staff Guidance
IAEA	International Atomic Energy Agency

ITAAC	Inspections, Tests, Analyses, and Acceptance Criteria
JARPA	Joint Aquatic Resources Permit Application (WA)
LWR	light-water reactor
MEI	Maximally Exposed Individual
MOU	Memorandum of Understanding
MRSC	Municipal Research and Services Center
MSR	molten salt reactor
MW	megawatt
MWe	megawatt of electricity
MWt	megawatt of thermal energy
NCSL	National Conference of State Legislators
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NFST	Nuclear Fuels Storage and Transportation Planning Project
NHPA	National Historic Preservation Act
NOAA Fisheries	National Oceanic and Atmospheric Administration
NOC	Notice of Construction
NOI	Notice of Intent (Ecology)
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NRDC	Natural Resources Defense Council
NSR	New Source Review
NMFS	National Marine Fisheries Service
NUREG	NRC Regulatory Guide
NWPPC	Northwest Power Planning Council
OFN	Office of Nuclear Energy (USDOE)
ORIA	Office of Regulatory Innovation and Assistance (WA)
PAGs	Protective Action Guides
PHWR	pressurized heavy water reactor
PM	particulate matter
PPE	Plant Parameter Envelope
PRA	probabilistic risk assessment
PSAR	Preliminary Safety Analysis Report
PSE	Puget Sound Energy
PSS	Potential Site Study
PWR	pressurized water reactor
RACM	Regulated Asbestos Containing Material
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
REP	Radiological Emergency Preparedness

RERT	Radiological Emergency Response Team (USEPA)
RIC	Regulatory Information Conference
ROD	Record of Decision
RPS	renewable portfolio standards
SCA	Site Certification Agreement
SDC	Standard Design Certification (NRC)
SEPA	State Environmental Policy Act (WA)
SHPO	State Historic Preservation Office
SMR	small modular reactor
SmrREC	Small Modular Reactor Research and Education Consortium
SWSLs	Surface Water Source Limitations
TDS	total dissolved solids
TMDL	total maximum daily load
the State	Washington State government, including EFSEC
TVA	Tennessee Valley Authority
UAMPS	Utah Associated Municipal Power Systems
UNF	used nuclear fuel
USDOE	United States Department of Energy
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VNECA	Virginia Nuclear Energy Consortium Authority
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WIN	Western Initiative for Nuclear
WPPSS	Washington Public Power Supply System

1.0 Introduction

1.1 Background

The Washington State legislature authorized funding for a study of small modular reactors (SMRs) in the biennial budget which was approved by the Governor on June 30, 2015. The study was to look at suitable locations for SMRs, evaluate permit streamlining options, and recommend studies for the future. It included consultation with the Washington Military Department, the Washington State Department of Ecology (Ecology), and the Washington State Department of Health. The bill was silent on US Nuclear Regulatory Commission (NRC) requirements, other than a recognition on the part of the bill sponsors that the NRC was moving forward at some level on this issue and that Washington State needed to collect more information on the topic. The budget authorization required the study to discuss permitting requirements for an SMR in Washington and required the state siting council (Washington State Energy Facility Site Evaluation Council [EFSEC]) to direct the required study. EFSEC selected Golder Associates of Redmond, Washington to conduct the study.

1.2 Scope

The legislation was brief but specific about the contents of the study. This report addresses topics beyond what was required in the authorization, that authors felt would contribute to the goals of the study and to its value in the future. The authorization required the following elements to be included:

- The study must identify possible locations in Washington where small modular reactors could be suitably located.
- The study must identify permits and studies that would be needed to facilitate such siting.
- The study must include recommendations on how the SMR siting and permitting process could be streamlined.
- The study must include recommendations for establishing general or programmatic permits or processes for SMRs in consultation with Ecology, the Washington Military Department, and the Washington State Department of Health.

1.3 Approach

Golder's approaches to elements within this report varied with the topics we were asked to investigate. To identify suitable locations for SMRs in Washington we used two approaches: a limiting factor screening analysis for the whole state to identify areas with more or less suitability, including exclusion areas; and identification of existing baseload power plant locations in the state, proposed, licensed or built, as likely sites for future consideration. To conduct this analysis and move forward with other sections, we defined our own generalized SMR description.

Our approach to the permitting analysis was to focus on the major decision-makers, EFSEC and the NRC, and to discuss in-depth a few of the more important permit requirements needed. We also listed other permits and approvals, recognizing that many are site-specific and not always applicable. We included the results from discussions with permitting agencies and staff from many state and federal agencies.

Details of the main elements of this study, and their locations within the report, are provided below.

Identification of Suitable Locations

Our approach to this element is to characterize the components and requirements of a typical SMR and to describe those requirements in the context of various attributes and resources in Washington. We did not conduct a quantitative risk-based or attribute-based statewide siting study intended to select specific sites for a facility for the following reasons:

- SMR technology is modular in design, which results in a project's size (defined here as electrical output) theoretically ranging from 50 to 1,800 megawatts of electricity (MWe). A site suitable for 50 MWe may not be suitable for a larger project due to a number of considerations.
- No one has proposed such a project, and its actual size, characteristics and resource requirements are likely to be different from anything we would assume here.
- The technology options, size requirements, and mitigation decisions for a project at any one site will determine the ultimate site suitability more than site characteristics alone.
- Site identification in 2015 may be limited in value by the time a site is actually proposed by a project sponsor 8-10 years from now.

In Section 3.0 we describe a typical SMR and its site requirements. In Section 4.0 we describe our analysis of suitable locations and the results of this analysis.

Permits and Studies

This report includes descriptions of the potential federal and state permitting requirements for an SMR (see Section 5.0). We discussed EFSEC's jurisdiction and a separate discussion of the extensive NRC regulatory process, and the NRC's role in developing the SMR concept for the United States. We also recommend various studies that would be helpful for this effort, including studies related to facility siting, the regulatory process, the technology development for SMRs, and other topics (see Section 6.0).

Streamlined Siting Process

This report offers recommendations to improve the future permitting process for SMRs (see Section 6.0). The implementation of such processes requires the support of all the agencies involved, and the underlying regulatory authority of each agency to implement such streamlining. Due to the ultimate review and approval authority of the NRC, improvements to the streamlining timeline may be limited by the NRC licensing schedule and procedures, including the NRC's process and current federal regulations.

Federal Agency Roles

Two federal agencies, the US Department of Energy (USDOE) and the NRC, have major roles in the development of nuclear power in the United States, including the development of SMRs. Although many of their activities are linked and/or coordinated (they are a result of reorganization of the US Atomic Energy Commission) their major roles are for energy and power development, including development of waste disposal sites (USDOE) and licensing of nuclear power facilities, and nuclear waste disposal sites (NRC). Both have a number of ancillary responsibilities. This report discusses the roles of those two agencies as they affect the development, schedules, guidance, feasibility and permitting requirements. See Sections 2.3 and 5.1 for discussion of these federal agency roles.

State Agency Consultation

The authors of this study contacted and met with the Military Department, Ecology, and the Department of Health to get their feedback on issues associated with siting. Although the legislation asks that these agencies comment on issues associated with their permitting requirements, they have no direct permitting authority over an SMR, because all siting authority for any nuclear power plant in Washington lies with EFSEC (RCW 80.50.020(12)(a)). They generally do, however, have permitting "responsibilities" to the extent that they are asked to comment upon or lead the analysis of permit requirements for EFSEC's plant license (Site Certification Agreement [SCA]) that would have been under their permitting purview, if it weren't for EFSEC sole authority for such site certification. They also have remediation responsibilities. See Section 5.2 for discussion of state agencies' potential roles in SMR permitting.

1.4 Consultation and Contacts

As part of this effort, team members scheduled conference calls or spoke with staff from the following agencies and organizations. In every case, staff contacted for this effort were helpful, open with information and suggestions, available for discussions and follow-up, and useful in providing as up-to-date information as possible about a process and technology that is developing at a rapid pace with multiple activities happening concurrently. We thank the following organizations for their support:

- Federal Government
  - US Department of Energy
  - US Nuclear Regulatory Commission
  - US Environmental Protection Agency
  - Federal Emergency Management Agency
  - Tennessee Valley Authority
  - Oak Ridge National Laboratory
- Washington State Government
  - Washington State Department of Ecology
  - Washington State Energy Facility Site Evaluation Council
  - Washington State Military Department, Emergency Management Division
  - Washington State Department of Health
  - Office of Regulatory Innovation and Assistance
- Research Organizations and Institutes
  - Electric Power Research Institute
  - Nuclear Energy Institute
- Private Corporations and Utilities
  - NuScale Power
  - BWX Technologies
  - Energy Northwest

2.0 History and Description of Small Modular Reactors

2.1 Nuclear Power in Washington and the United States

The Pacific Northwest has a long history of nuclear power development. Hanford's history began with the B reactor during WWII, and included other defense reactors. In 1987 nuclear power development in the state slowed with the shutdown of the Hanford N reactor. That same year, after 10 years of planning and research related to high-level nuclear waste disposal at Hanford (the Basalt Waste Isolation Project [BWIP]), Congress cancelled that program and selected Yucca Mountain, Nevada for nuclear waste disposal. During that same period and afterwards, the Hanford cleanup program grew, leading to the Tri-Party Agreement in 1989 that set timelines for the site's compliance with the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Hanford's cleanup program has been amended dozens of times, is far behind its original cleanup schedule and is still underway.

Nuclear power development in Washington started with a proposed coastal site in Puget Sound and a proposed site on the Skagit River which was transferred to a site at Hanford. The Hanford site for the Skagit/Hanford Nuclear Project (discussed below) was eventually cancelled due to questions of need for power. During the same period, Washington Nuclear Projects 1 through 5 were proposed at Hanford and Satsop. Units 3 and 5 at Satsop were cancelled before they were completed. Units 1 and 4 were eventually cancelled at Hanford and Unit 1 is being considered as a potential SMR site (Tri-Dec 2014). Currently, the Columbia Generating Station has been operating successfully at Hanford since 1984 and providing 1,200 MW of commercial power to the region. Thus, nuclear energy production and/or cleanup has been occurring at Hanford for more than 70 years. This brief history of nuclear successes and cancellations in Washington is included to emphasize the mixed history of nuclear power in the state and the importance of future public education, comparing the significant differences between these technologies and those offered by small modular reactors.

Regulations guiding the nuclear power industry have also experienced changes. Congress established the Atomic Energy Commission (AEC) in 1954 in support of commercial use of nuclear power. The AEC was split up in 1974 recognizing the challenging role the AEC had in promoting and also regulating nuclear power. In 1974, the Nuclear Regulatory Commission (NRC) was created and became the primary regulator of the industry. After the events at Three Mile Island nuclear plant in Pennsylvania in 1979, the NRC continued to strengthen their regulatory reviews of license applications and existing plants. That effort focused on existing plants because license applications for new commercial reactors slowed down considerably due to safety concerns and economic slowdowns. A few applications for commercial baseload power plants have been submitted since 1979. Currently, five reactors are under construction and the NRC is reviewing six more applications. The NRC has also reviewed (or is reviewing) many other applications submitted for smaller nuclear projects (e.g., for medical projects, research, etc.).

The last application for a commercial nuclear reactor in Washington was for the Skagit/Hanford Nuclear Project proposed by Puget Sound Energy and three other utilities to be located at the Hanford Reservation in 1982. During that same period, the Northwest Power Planning Council (NWPPC) was created. Both the National Environmental Policy Act (NEPA) environmental impact statement (EIS), being developed at the time by EFSEC and the NRC, and the new NWPPC load forecast concluded that the plant wasn't needed. Plans for the reactor were cancelled in 1983. However, the Columbia Generating Station, sited before the PSE project, has operated successfully since that time and continues to generate power.

As a result of the excessive costs and perceived risks of siting, permitting, design and construction of a new nuclear power plant, new applications to the NRC dropped significantly in the early 1980s. Among the issues were fears about health risk, continuing issues with siting the High Level Nuclear Waste Repository (which continue today) now on hold, and the complexity of starting construction on nuclear plants when they were still in design just to keep up with evolving design safety requirements. Thirteen states have significant restrictions or outright bans on new nuclear power plant development; some of these restrictions are related to the lack of a disposal site. If nuclear power were to have a future, it had to be through design improvements, advanced technologies, or a much simpler design, construction and operation process. This led to examination of simpler reactor options, with lower risk, and simpler operation and shutdown modes, although some large baseload facilities have gone through licensing.

2.2 SMR Development Worldwide

The World Nuclear Association (WNA) defines small modular reactors (SMRs) as nuclear reactors generally 300 MWe equivalent or less, that are designed with modular technology using module factory fabrication, and pursuing economies of series production and short construction times. This definition is based on definitions used in the International Atomic Energy Agency (IAEA), the NRC, USDOE, and the Nuclear Energy Institute (NEI).

SMRs are in various stages of development in many countries around the world. Of the four reactor design technologies in development—light water reactors (LWRs), fast neutron reactors (FNRs), graphite-moderated, high temperature gas reactors (HTGRs), and various kinds of molten salt reactors (MSRs)—LWRs are the most common in the United States. This report focuses on LWR technology.

A wide range of potential benefits are offered by the SMR concept:

- Their small size and modularity allows SMRs to be almost completely built in a controlled factory setting, and installed module by module. This improves construction quality and efficiency.
- Their small size and passive safety features make them suitable for use in countries with smaller grids and less experience with nuclear power.
- Their size, construction efficiency, and passive safety systems can reduce the overall cost, as these features allow for fewer redundant systems.
- Costs could be further reduced through multiple production design.
- The lower power of these plants would reduce the source term and would result in a smaller inventory of radioactive materials.
- Reactor units could be placed underground or potentially underwater, providing more protection from natural hazards (e.g., seismic or tsunami according to the location) or man-made hazards (e.g., aircraft impacts).
- Some designs have a lower requirement for access to cooling water, which would allow them to be sited in more remote regions, and could make them useful for specific applications such as mining or desalination.

Overseas, a few countries are moving ahead with SMR deployment; many of these international projects use technologies other than the LWR designs leading the US development. China has HTGR units in development. India and China also have PWR (pressurized water reactor) projects in development. Other countries with SMRs in design or construction include Russia, Argentina, and South Korea. Table 2-1 summarizes the status of a number of projects throughout the world, although the actual status of many of these is subject to change. Not all of these share the same safety features currently envisioned in US proposals.

Table 2-1. Small Reactors Constructed or Designed Worldwide (WNA 2015)

Small Reactors Operating

Name	Capacity	Type	Developer
CNP-300	300 MWe	PWR	CNNC, operational in Pakistan & China
PHWR-220	220 MWe	PHWR	NPCIL, India
EGP-6	11 MWe	LWGR	at Bilibino, Siberia (cogen)

Small Reactor Designs Under Construction

Name	Capacity	Type	Developer
KLT-40S	35 MWe	PWR	OKBM, Russia
CAREM	27 MWe	PWR	CNEA & INVAP, Argentina
HTR-PM, HTR-200	2x105 MWe	HTR	INET, CNEC & Huaneng, China

Small (>25 MWe) Reactors for Near-Term Deployment – Development Well Advanced

Name	Capacity	Type	Developer
VBER-300	300 MWe	PWR	OKBM, Russia
NuScale	50 MWe	PWR	NuScale Power + Fluor, USA
Westinghouse SMR	225 MWe	PWR	Westinghouse, USA*
mPower	180 MWe	PWR	Babcock & Wilcox + Bechtel, USA*
SMR-160	160 MWe	PWR	Holtec, USA
ACP100	100 MWe	PWR	CNNC & Guodian, China
SMART	100 MWe	PWR	KAERI, South Korea
Prism	311 MWe	FNR	GE-Hitachi, USA
BREST	300 MWe	FNR	RDIPE, Russia
SVBR-100	100 MWe	FNR	AKME-engineering, Russia

Small (>25 MWe) Reactor Designs at Earlier Stages (or Shelved)

Name	Capacity	Type	Developer
EM2	240 MWe	HTR, FNR	General Atomics (USA)
VK-300	300 MWe	BWR	RDIPE, Russia
AHWR-300 LEU	300 MWe	PHWR	BARC, India
CAP150	150 MWe	PWR	SNERDI, China
ACPR100	140 MWe	PWR	CGN, China
PBMR	165 MWe	HTR	PBMR, South Africa; NPMC, USA*
SC-HTGR (Antares)	250 MWe	HTR	Areva
Xe-100	48 MWe	HTR	X-energy, USA
Gen4 module	25 MWe	FNR	Gen4 (Hyperion), USA
IMR	350 MWe	PWR	Mitsubishi, Japan
TMSR-SF	100 MWt	MSR	SINAP, China
PB-FHR	100 MWe	MSR	UC Berkeley, USA
Integral MSR	32, 120, 288 MWe	MSR	Terrestrial Energy, Canada
Thorcon MSR	250 MWe	MSR	Martingale, USA
Leadir-PS100	36 MWe	lead-cooled	Northern Nuclear, Canada

** Well-advanced designs understood to be on hold*

In 2009 the IAEA assessed future SMR development under its Innovative Nuclear Power Reactors and Fuel Cycle (INPRO) program, and concluded that by 2030 there could be 43 to 96 SMRs in operation around the world (the assessment did not predict any SMRs in the United States by this date).

US Support of SMRs. In January 2012 the US Department of Energy (USDOE) called for applications from industry to support the development of one or two LWR designs, allocating $452 million over five years. Westinghouse, Babcock & Wilcox, Holtec, and NuScale Power all submitted applications; their proposed modular units ranged from 225 down to 45 MWe. The USDOE announced decisions in November 2012 to support the B&W 180 MWe mPower design, to be developed with Bechtel and TVA. And in December 2013, after another solicitation. The USDOE announced that a further grant would be made to NuScale on a 50-50 cost-share basis, for up to $217 million over five years, to support design development, NRC certification, and licensing of NuScale's 45 MWe small reactor design.

In March 2012 the USDOE signed agreements with three companies interested in constructing demonstration SMRs at the Department's Savannah River site in South Carolina. The three companies and reactors are: Hyperion with a 25 MWe fast reactor, Holtec with a 140 MWe PWR, and NuScale with the 45 MWe PWR. (In January 2014, Westinghouse announced that was suspending work on its small modular reactors.) The USDOE is discussing similar arrangements with four additional SMR developers; the USDOE aims to have a suite of small reactors providing power for the USDOE complex within 10 to 15 years.

2.3 Current SMR Siting in the United States

The lead federal agencies dealing with SMR research, development, design certification, and licensing are the NRC, USEPA, USDOE, and FEMA. Their current activities reflect the current and future status of SMR development in the United States.

The NRC is currently considering new rules that would address the significant differences between SMR design and construction and that of the major baseload plants of the past. This rulemaking is likely to affect future siting decisions. The NRC will be very involved in design certification and at least one Early Site Permit application for an SMR in the United States in 2016 and beyond.

USEPA and FEMA support the NRC's emergency planning and health exposure requirements. USEPA has two roles in the licensing process for SMRs. The first role is establishing the dose and environmental impact standards that the NRC must meet in their regulations. The second USEPA role under the National Environmental Policy Act (NEPA) is the responsibility for reviewing and approving the environmental impact statement prepared by the NRC as part of the Reactor Facility Construction and Operation License under 10 CFR Part 50 or Part 52. Section 5.1.3 of this report provides more details on USEPA's roles.

FEMA coordinates all federal planning for offsite impacts of radiological emergencies. FEMA takes the lead for assessing offsite radiological emergency response plans and preparedness, makes findings and determinations as to the adequacy and capability of implementing these plans, and communicates those findings and determinations to the NRC. Section 5.1.2 provides more details of FEMA's role.

USDOE's Role in SMR Siting. The USDOE has both direct and indirect roles related to SMR siting. One activity under the authority of the USDOE relates to the need for a high-level nuclear waste disposal site to store waste fuels from commercial reactors. This program was suspended in 2010 and the Office of Civilian Radioactive Waste Management was dissolved; new alternatives are now being considered (see USDOE discussion in Appendix A). A high-level nuclear waste repository for the nation's commercial wastes has not yet been sited. When a site is finally selected, the NRC will be responsible for reviewing and licensing its design, construction, and operation.

The USDOE is also responsible for helping the private sector develop energy and fuel technologies (including nuclear power) that will increase the amount of renewable energy alternatives under development, reduce our dependence on foreign oil, and support the reduction in greenhouse gas (GHG) emissions. Under the Energy Policy Act of 2005, (EPACT), the USDOE provides grants or loans to developers for research or for commercial scale deployment of projects meeting these criteria, depending on the program. The USDOE has supported biofuels, wind, carbon sequestration, and other renewable and/or non-fossil based energy technologies.

The USDOE has similar programs for nuclear power, including advanced alternatives such as SMRs. The USDOE's Advanced Nuclear Energy Projects program provides loan guarantees to support the construction of innovative nuclear energy and front-end nuclear projects in the United States that reduce, avoid, or sequester GHG emissions. The USDOE has identified four key technology areas of interest in the solicitation: advanced nuclear reactors, uprates and upgrades at existing facilities, and front-end nuclear projects, and SMRs. A total of $12.5 billion in loan guarantees is committed, with proposals solicited every 6 months. These loans are providing support and encouragement for further investigations into those technologies, including SMRs, with a goal of commercial operation in the future.

The USDOE also supports SMR development with their SMR Licensing Technical Support program under their Office of Nuclear Energy. This program's mission is to promote the accelerated deployment of SMRs by supporting certification and licensing requirements for US-based SMR projects through cooperative agreements with industry partners, and by supporting the resolution of generic SMR issues. The USDOE anticipates continuing efforts toward a 6-year, $452 million program. This program is currently supporting the NuScale project as discussed above.

2.4 Other Reactor Technologies

Although this report focuses on LWR designs being developed in the United States that were selected for support by the USDOE, other SMR and nuclear power technologies are being investigated in the United States and around the world that may also be successful. These other designs include high-temperature gas reactors like the PBMR, GT-MHR and Antares/ SC-HTGR reactors that were all competing for the Next Generation Nuclear Plant in the United States. Japan, China and South Africa all have their own designs, as do many other countries and organizations around the world. The Province of Ontario Canada is currently investigating the feasibility of a range of SMR technologies for Ontario. Other technologies and designs (Urenco U-Battery, ThorCon molten salt, Adams Engine HTR, fast atom neutron reactors, etc.) are not part of the USDOE's LWR SMR program at this time and were not evaluated to develop the model. The State would need to do their own technology assessment if they were interested in comparing the costs and feasibility of various proposals, or the USDOE could let the market decide. This study looks at those LWR designs that were selected by the USDOE and which are farthest ahead in the approval process in the United States.

3.0 The Model SMR Developed for the Location Suitability Analysis

Golder developed screening criteria to use when identifying suitable locations for small modular reactors in Washington. In order to define these criteria, we established a model SMR that represented technologies currently in development in the United States and supported by the USDOE. This section introduces SMR technology, describes how Golder developed this Model SMR, and discusses what attributes were deemed important for the location analysis.

3.1 Introduction to SMR Technologies

Small modular reactors are nuclear power plants that are smaller than the existing nuclear power generation fleet and nuclear power plants that are currently under construction in the United States. The USDOE Office of Nuclear Energy defines SMRs to be 300 MWe or less, unlike the current base load generation plants typically operating in the United States, which are 500-1,000 MWe or greater. As a further frame of reference, one MW of electricity can typically power 1,000 homes. Although there are some small versions of large reactors, using the older conventional designs, the small modular reactors discussed in this report have many updated safety features and are modular in design, which means the reactors can be manufactured in a factory under controlled and optimized conditions and then transported to a site by truck, rail, or barge. The module holds the reactor and steam generation system and electric turbine. The module can be installed at the site or combined with additional modules and other site infrastructure referred to as the balance of plant facilities, and then connected to the electrical grid or other energy demand source such as a manufacturing plant. SMR technology is used to generate heat which can produce steam, which can be converted to electricity in its steam turbine generator or used for district heating and cooling, or for desalination, water purification, or co-generation applications. The co-generation option offers the opportunity to meet the needs of industrial process heat. Where larger demand for power is required, multiple units can be connected to accommodate the needs of the industry or a community.

There are a number of SMR technologies currently being developed. These technologies possess some common attributes including electrical generation through the formation of steam from the heat transfer of a nuclear reactor cooling medium. Some other components are unique to a specific technology. Designs are being developed to target diverse energy applications and markets.

The following are primary technologies currently being developed, although there are others:

- Light Water Reactors (LWR). Of the new technologies, LWRs are the most compatible with the existing federal regulatory framework since LWR technology is used in all 100 of the existing US nuclear power reactors as well as the large reactors currently being built in Tennessee, Georgia, and South Carolina. Among other applications, small LWRs could replace older fossil-fired power plants of similar size, using existing infrastructure including cooling water, rail, and electrical transmission facilities. LWRs use normal water for nuclear reactor cooling and as the transfer medium to generate steam. Third and fourth generation LWR designs are also termed Advanced Light Water Reactors (ALWRs). LWR technology includes pressurized water reactors (PWRs).

- High-Temperature Gas-Cooled Reactors (HTGRs). HTGRs are well-suited to provide process heat for the industrial and transport sectors, with potential application for hydrogen production in the longer term. A current formation of this technology is based on a helium-cooled nuclear reactor and generates energy in the form of steam or high temperature fluid. The steam can be used to generate electricity in a steam turbine generator or used for a wide range of industrial processes.
- Liquid Metal Fast Reactors. Liquid metal fast reactors are cooled by metals such as sodium, lead, or lead-bismuth. Liquid metal reactors have a higher power density than water systems because metal coolants have higher density than the water used in most reactor designs. The other advantage of liquid metal reactors is that they don't operate at the high pressure of water systems, which can reduce safety and maintenance issues.

3.2 Developing a Model SMR

Golder developed a Model SMR description for this study that envelops certain technology characteristics to describe a generic project. To narrow the field of technologies, Golder focused on the technologies currently being supported by the USDOE. As described by the USDOE:

> *"The development of clean, affordable nuclear power options is a key element of the Department of Energy's Office of Nuclear Energy (DOE-NE) Nuclear Energy Research and Development Roadmap. As a part of this strategy, a high priority of the Department has been to help accelerate the timelines for the commercialization and deployment of small modular reactor (SMR) technologies through the SMR Licensing Technical Support program. Begun in Fiscal Year 2012, the DOE Office of Nuclear Energy's Small Modular Reactor Licensing Technical Support program will advance the certification and licensing of domestic SMR designs that are relatively mature and can be deployed in the next decade."*
>
> **Source: USDOE**

The USDOE has selected two modular LWR SMRs to support further development of the technologies: the mPower reactor design and the NuScale Power Module. Golder developed a plant parameter envelope (PPE) comprised of elements of the two technologies for use in this report.

3.3 SMR Model Attributes Used in the Location Analysis

For the purposes of this siting location analysis, the technology description of the Model SMR focuses on the following attributes:

- Facility Power Output
- Facility Components / Typical Plant Layout
- Operational Requirements and Resources Needs
- Operational Outputs

3.3.1 Facility Power Output

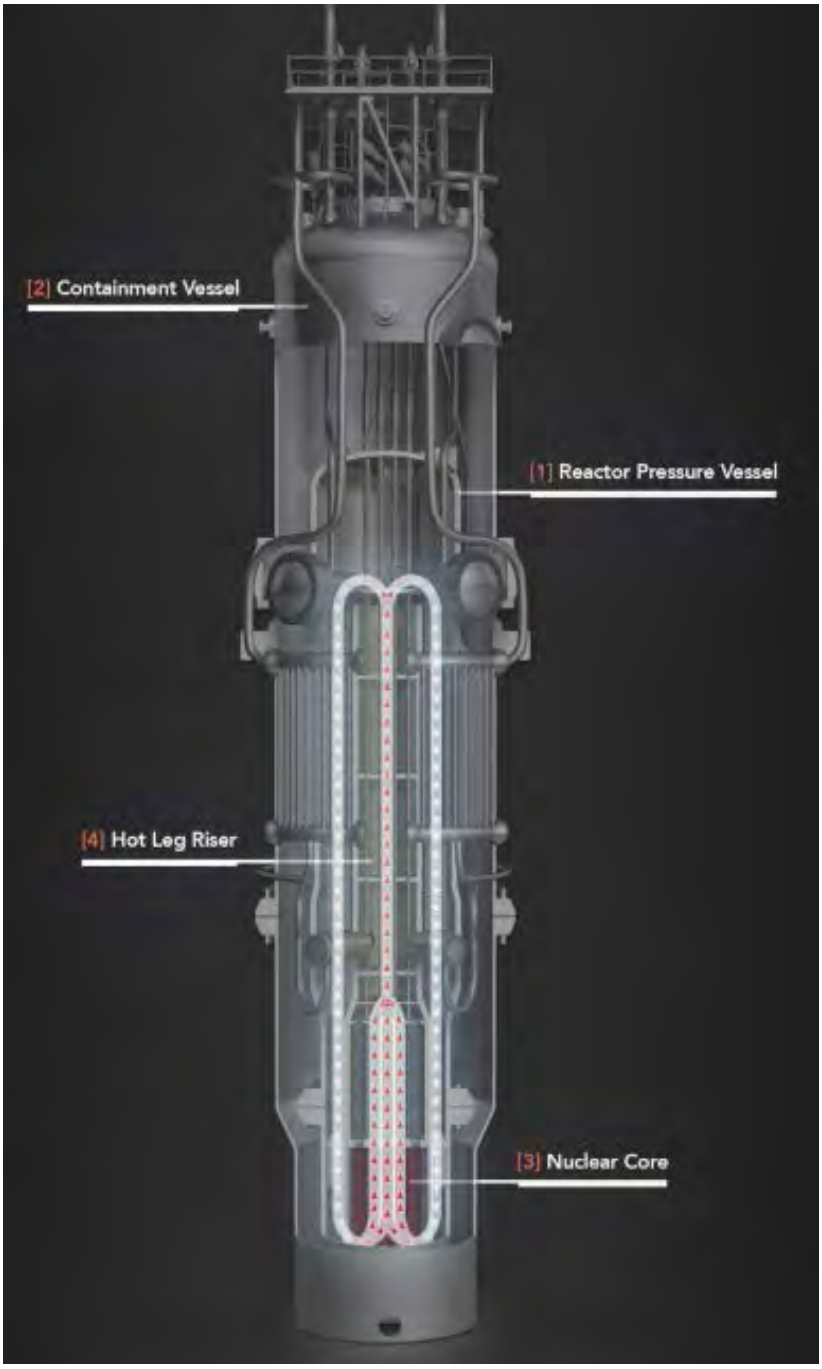
Both the mPower and NuScale reactor designs are scalable, modular, advanced light-water reactor (ALWR) systems in which the nuclear core and steam generators are contained within a single vessel.

The mPower electric generation plant has a nominal 180 MWe per module with a four-year operating cycle without refueling, using standard pressurized water reactor (PWR) fuel similar to the NuScale system. A single mPower reactor is approximately 83 feet tall and 13 feet in diameter (Figure 3-1). It can generate 180 to 1,800 MWe using 1-10 modules at a suitable site.

Figure 3-1. mPower LWR SMR

The NuScale electric generation plant has a nominal 50 MWe (gross) output with a two-year operating cycle without refueling. The 50 MWe NuScale Power Module provides power in increments that can be scaled to 600 MWe (gross) in a single facility. A single reactor module is approximately 76 feet tall and 15 feet in diameter (Figure 3-2).

Figure 3-2. NuScale LWR SMR



Other power plants in the Northwest have been built or proposed in the 400-650 MWe range per unit. Our goals in selecting a model SMR size were to accomplish the following for the suitable location analysis:

- Select a generating capacity and site that was typical and reasonable compared to others in the Northwest.
- Select a capacity that could be met with a combination of today's SMR module designs including the two selected for this analysis.
- Select a model SMR size that wasn't so small that it could only fit into a small site without expansion potential; and not so big that sites would be limited by size and infrastructure capacity.

To evaluate facility siting considerations, Golder defined the Model SMR facility to have a nominal 600 MWe output. This output is within the output capabilities of both the mPower and NuScale technologies. While a single module of either technology vendor will produce less than the described Model SMR, it is unlikely that a site will be developed and permitted for the capacity of only one module (unless sited as a distributed generation concept with a much narrower siting focus). This is due to the high cost of site development for nuclear generation, the competitiveness with other electric power generation technologies, and social and political challenges. While SMR sites may initially construct and operate a single module, we assume that, for this siting evaluation, the permitting and site requirements will be more forward looking including provisions for future expansion up to a nominal 600 MWe plant.

3.3.2 Facility Components/ Typical Plant Layout

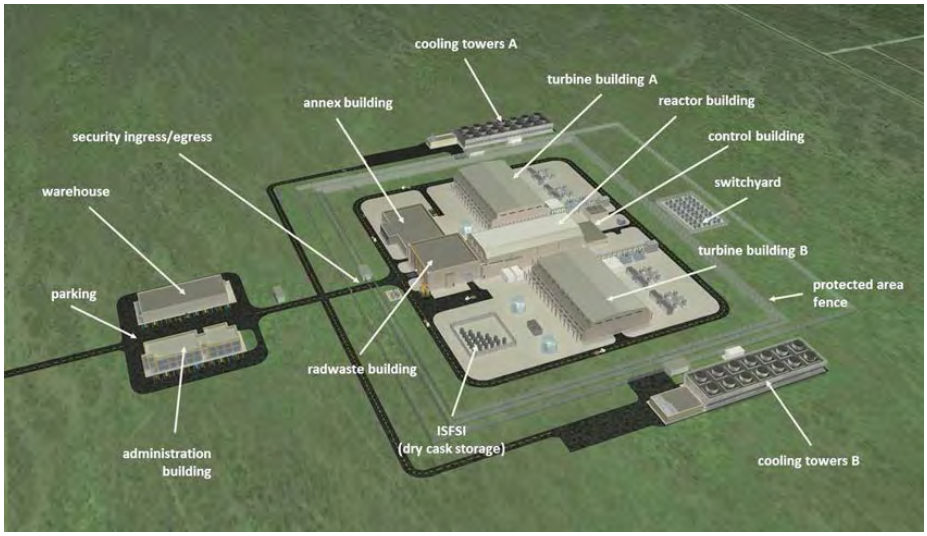
The primary component of a LWR SMR facility include the reactor building (see Figure 3-3 for a cross section depiction of NuScale reactor building), which contains a below-ground containment building including a steel-lined pool of water. The mPower reactor building uses a dry containment and relies on convection and conductive cooling. The NuScale example in Figure 3-3 shows a reactor building with five reactor modules (250 MWe).

Figure 3-3. NuScale Reactor Building Cross Section

The balance of plant facilities are similar to what you would find at any steam electric generation plant. The NuScale depiction of the overall facility (Figure 3-4) is representative of either technology vendor and includes the following main components:

- Perimeter security
- Administrative building with parking
- Warehouse for inventory storage, maintenance and repair
- Reactor building and control room
- Steam turbine buildings
- Interim radioactive waste building
- Ancillary equipment including fire protection
- Cooling towers
- Switchyard for electrical connection to the transmission grid

Figure 3-4. NuScale Example Layout for Plant Site



Facility site requirements include land for the reactor core and all balance of plant infrastructure, setbacks, buffer/site safety areas, and access. Per mPower, the land requirement for a 180 MWe facility is approximately 40 acres. As a conservative estimate for siting considerations, the mPower estimate is scaled up linearly for a 600 MWe facility resulting in a model SMR land requirement equal to approximately 130 acres. This is a conservative estimate as much of the facilities support structures and facilities would not change with added reactor modules.

A common attribute of ALWR SMR technology is the placement of reactor cores in the modules located underground. An inherent safety attribute of underground reactor cores is the use of gravity, convection, and conduction to cool the reactor in an emergency with a below-ground containment. Small reactors will also have long operating cycles between refueling (e.g., 4 years). Safety, security, and emergency planning are integrated into many aspects of SMR technology. Every nuclear power plant has multiple back-up safety systems, including automatic safe shutdown mechanisms. Because SMRs are smaller, they pose smaller risks, in the absence of site and adjacent area variables. The effects of this smaller size need to be studied to determine new Emergency Planning Zone (EPZ) sizes and resulting emergency response plans. The NRC is currently evaluating EPZ requirements for SMR technology.

3.3.3 Operational Requirements and Resource Needs

In identifying potential sites for the Model SMR it is important to understand the facility operation requirements and resource needs. Once the facility is constructed, fuel and water are the primary input needs required to operate the facility that may influence site selection (although dry cooling can be applied in arid climates). Electricity is the primary output unless steam or hot water is also a component of the project. For this study, we did not consider the proximity to fuel to be critical in site selection. However, the operation of the Model SMR does require water resources. If water is a limiting factor, an air-cooled or hybrid wet/dry condenser may be an option (see Section 4.4). However, the air-cooled option includes higher parasitic load to run the air-cooled condenser fans and also reduces the electrical output efficiency of the facility. Some designs include a pool surrounding the reactor containing millions of gallons of water, for use in the event of an emergency shutdown.

3.3.4 Operational Outputs

SMRs in development are incorporating designs based on decades of reactor operating experience and advancements in materials, design and digital controls. SMRs have fewer complex components like pumps and motors, instead relying on simpler, natural safety systems, such as use of gravity to circulate cooling water in the event that electrical power is lost and use of convection and conduction

to remove excess heat. These natural safety measures are intended to allow small reactors to remain safe during normal operation as well as many types of upset conditions.

Each of the leading small reactor designs uses an integrated approach in which the steam generators, pressurizer, control rod drive mechanisms, and cooling pumps (if used) are inside the reactor vessel. There are no openings below the top of the nuclear fuel, so the cooling water cannot leak out. These designs also place the reactor in underground containments, minimizing the surface exposure of the reactor and protecting it from aircraft impact or terrorist threats.

Under normal operation, the Model SMR will generate electricity from the steam generating unit, discharge waste heat and water vapor from the cooling towers, and create spent nuclear fuel for on-site storage until a depository is created. Particulate matter (PM) will be released from wet cooling towers as a result of total dissolved solids (TDS) contained in the cooling tower makeup water. However the PM resulting from the cooling towers is not considered a highly influential siting parameter, as only a fraction of the PM emissions resulting from wet cooling towers are in the form of Respirable or Fine Particulates (PM10 or PM2.5). Additionally, heat released from the wet cooling towers is not regulated and there are no known siting considerations to be evaluated. Moisture release from wet cooling towers can generate fog and icing under ambient conditions of saturated calm air and cold weather. Potential fogging and icing from the Model SMR should be considered in the siting process, though the extent of fog is generally quite localized. Spent nuclear fuel is stored at the facility on an interim basis and then, ultimately, shipped offsite for disposal when/if a high-level nuclear waste (HLNW) disposal site is licensed. The disposal location is not part of this siting evaluation. For transportation of new and spent fuel, the facility must have safe and secure access to highway, rail, or waterway (barge) for shipping.

The model facility includes an electrical switchyard for connection to high voltage electric transmission lines. Proximity to high voltage electric transmission lines that have available capacity for 600 MWe is also a siting consideration.

3.3.5 Facility Site Requirements

Regardless of the SMR technology being considered, the reactor core and balance of plant infrastructure requires access, roads for construction and operation personnel, and possible links to rail and/or ports for delivery of overweight and/or over-dimensional equipment and for fuel and waste transportation. Highway access also facilitates an adequate emergency response. SMRs will also require utility connections, including a source of water supply for plant operations as well as personnel, wastewater treatment and disposal infrastructure, and interconnection to deliver electricity or other forms of energy generated by the plant.

Of the two technologies that received funding, mPower developed a Vendor Information Worksheet that contained information that could be used to support the NRC's Early Site Permit (see text box). While acreages would vary based on the number of modules being installed and the existing site conditions, which are variable, the general scope and categories presented in the worksheet are reasonable guidelines for SMRs, including NuScale and mPower.

The discussion in Section 3.3.2 suggests 130 acres as an initial threshold to consider; this is consistent with the mPower metrics for site and operational needs. Construction needs would be more significant, but temporary.

Vendor Information Worksheet for mPower's Design

- Access routes – To be determined
- Acreage to support plant operations and the power block – 40 acres
- Office facilities, parking lots and permanent support facilities – To be determined
- Protected Areas – 8 acres
- Construction acreage – 355 acres
- Laydown areas and temporary construction facilities – To be determined
- Construction parking – 20 acres

4.0 Suitable SMR Locations in Washington State

4.1 Suitable Location Analysis

4.1.1 Introduction

One objective of this report is to identify suitable locations in Washington to site SMRs. The approach used herein to identify possible locations for future SMR technology (specifically, the Model SMR described in Section 3.0) consisted of a preliminary screening of data attributes for the state of Washington using publically available and private GIS databases. We also included a description of previously sited power plant locations because much more data collection and analysis effort was applied to the site selection and licensing efforts for those sites than for the general statewide screening analysis.

The screening criteria selected to allow for desktop state-wide analysis at a high level resulted in a preliminary evaluation. This approach is consistent with site screening methodologies historically adopted by the NRC.

Golder's suitable location analysis focuses on a combination of physical, biological and socio-cultural variables. Our screening criteria did not include project success factors such as energy supply and demand, or SMR competiveness with other power generation technologies. It did not include public acceptance, cost, or site-specific factors such as threatened and endangered species presence or cultural resource issues. These factors will eventually need to be considered by applicants, EFSEC, and the NRC when specific sites are proposed.

Final siting for purposes of an NRC Early Site Permit (ESP) Application (described in Section 5.0) will require consideration of these variables as well. The primary suite of variables that will factor into final siting include the following:

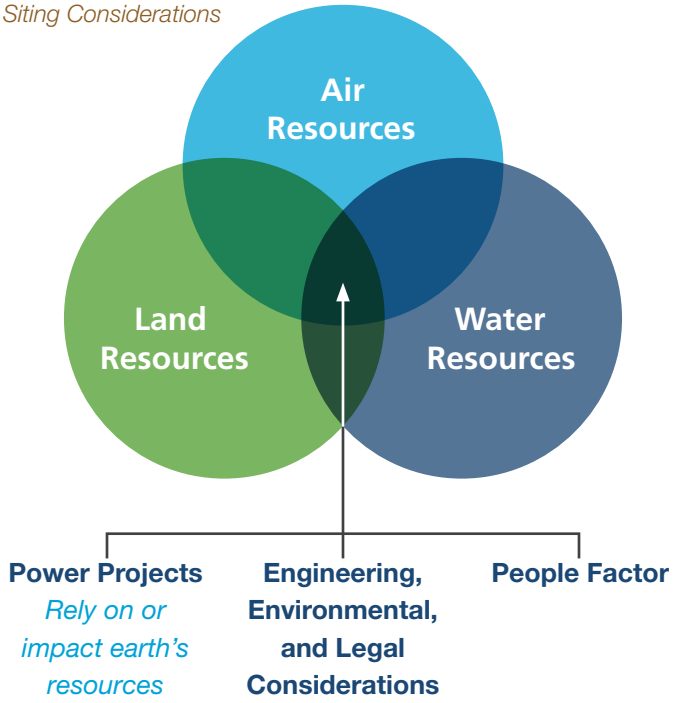
- Business objectives such as supply and demand for energy.
- A project's ability to comply with relevant federal, state and local environmental and land use laws and regulatory programs; this may include alternatives analysis that certain laws and programs require in order to meet applicable federal and state requirements.
- The proposed SMR's project resource needs including suitable land, and water availability.
- Selection of cooling technology, project size, and proximity to transmission.
- Infrastructure resources such as electrical interconnection and transmission, highway access, and offsite water and sewer (if applicable).
- Fuel availability and nuclear waste disposal availability.
- The acceptability of location by relevant stakeholders.
- Final decisions on regulatory changes.
- The acceptability of location as it relates to the safe construction, operation, and emergency response requirements.

Siting an SMR project requires the consideration of engineering, environmental, economic, regulatory, and social/political dynamics, as well as sound business objectives, in order to do the following:

- Determine the overall need for resources such as water supply for cooling, highway/rail/barge access for construction and operation, and electrical transmission with adequate capacity to meet the anticipated additional electrical load.
- Design and develop mitigation options meeting site constraints.

- Undertake site and design decisions for a planned facility to optimize resource supply and emergency planning responsiveness, and incorporate sustainability principles.
- Minimize environmental impact and maximize economic benefit.

Siting Considerations



Based on current SMR design development activities, it is clear that various SMR technologies (e.g., wet or dry cooling; power output [50 or 180 MW]; size and portability) have different site-related requirements; a site that is suitable for one SMR technology may not be suitable for all technologies or for multiple modules of a certain technology. Use of multiple modules can increase the needs for land and water. Larger facilities may affect the safety and security considerations associated with emergency planning and also may require significant transmission upgrades if the additional generation load cannot be accommodated by existing transmission infrastructure. Therefore, the preliminary screening provided herein provides an exploratory evaluation of the suitability of siting locations. It does assume a build-out of SMR modules to 600 MWe, and not just a 50 MW (single module) option, with the assumption that no utility would likely go through the rigors of an NRC siting process to select a site suitable for only the smallest module available—one 50 MW module. We did not assume the full mPower design buildout (1,800 MW) because we felt that size was unlikely and would unnecessarily limit location options to only larger sites.

4.1.2 Location Suitability Criteria

The criteria presented in this section are relevant to the siting of SMRs and must be considered in conjunction with other factors that include technology, market considerations, and the ability to bundle SMR modules to create more supply. NuScale's electric generation plant, for example, has a nominal 50 MWe (gross) output per module and the modules are being planned for combinations up to 600 MWe (12 modules) in a single facility. However, ten mPower modules could generate up to 1,800 MW with conventional cooling, or approximately 1,500 MW with dry cooling. The location suitability criteria presented herein are important considerations, regardless of size, but the criteria will need to be developed and candidate siting areas assessed for a specific size and technology. Anyone looking to site a sole 50 MW module would have many more site options.

Siting criteria included considerations of areas that are constrained (constrained areas) or should be avoided (avoidance areas), as well as areas that are attractive to site location due to their physical and biological characteristics and the area's relationship with land ownership and/or land development patterns (attraction areas). These categories are defined in more detail below.

Attraction Areas

Attraction areas represent potential locations favorable to SMR siting, construction and operation. Attraction areas fall into the following two broad categories:

1. Locations that already have infrastructure in place to facilitate project development.
2. Areas with suitable geophysical properties.

Attraction areas include the location of highways, rail, and port facilities that can support project construction, and high voltage transmission lines that will be required for any proposed SMR project. For the analysis, proximity to existing transmission lines greater than 69 kV was considered an attraction.

Attraction areas suitable from a geophysical perspective include seismically stable areas (limited shaking potential), areas with bedrock or soils with very low liquefaction potential, and areas that are flat or have shallow slopes. Areas that contain land that has been previously disturbed, have low habitat value, and lack the presence or potential of listed species of flora and fauna would also be considered attraction areas and these types of biological criteria should be considered in subsequent stages of siting studies.

Existing thermal power plant locations are also considered attractions, where new SMRs could share existing power plant and transmission infrastructure, or where SMRs could replace existing plants. (See Section 4.3 for descriptions of existing plant locations in Washington.) In Section 4.3, we also considered licensed facilities not yet constructed, as these sites have already been evaluated for power supply and resource needs.

Avoidance Areas

Avoidance areas represent locations that feature challenges to development. These areas can support SMR siting under certain circumstances, when balancing the environmental and regulatory aspects of development, construction, and operation with economic and technical considerations. Areas can possess more than one avoidance criteria (more than one limitation to development), but there may be engineering or other considerations to overcome these avoidance characteristics. The types of areas that, in the absence of other considerations, should be avoided relative to the other more favorable locational criteria include the following:

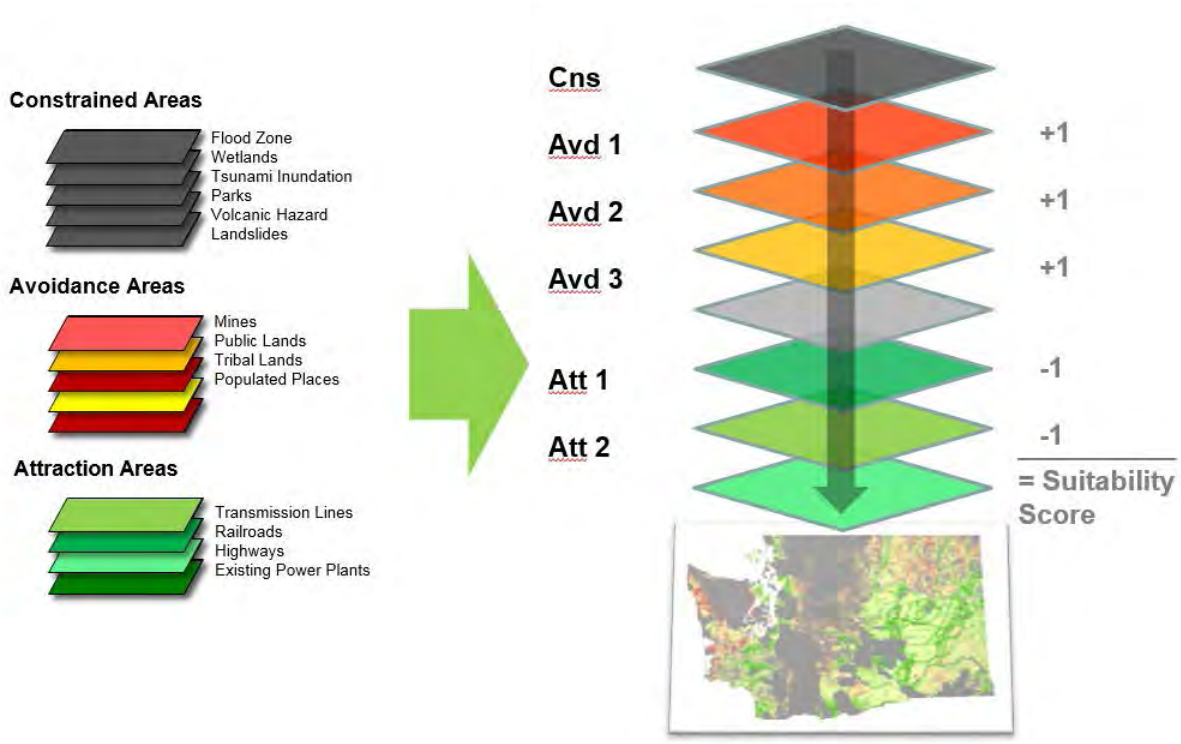
- Areas with low to moderate shaking potential
- Areas with bedrock or soils that have very low to low, low, and low to moderate liquefaction potential
- Areas with moderate slope
- Areas near landslides
- Inactive or abandoned mines
- Populated areas and airports
- Government-owned forest lands, watersheds, valuable wildlife areas, WDNR lands, and state university or tribal lands unless they are project sponsors or proponents

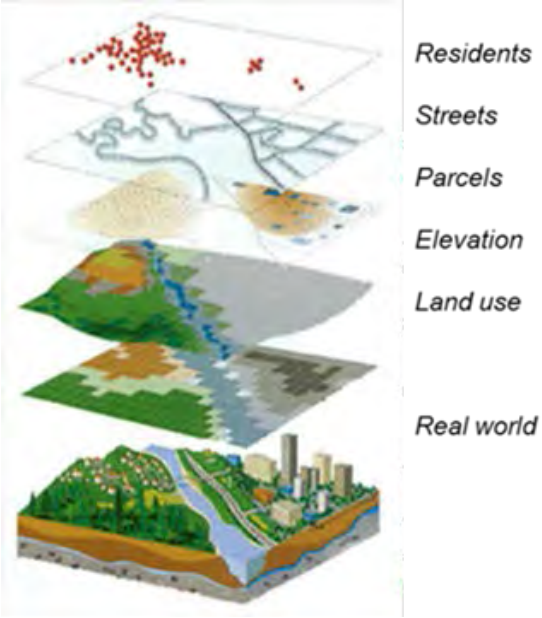
Constrained Areas

Constrained areas represent locations that have the most significant challenges in relation to siting due to significant engineering challenges and/or incompatibility with the site or surrounding areas. These could have been termed "Exclusion Areas" because the constraints shown may all but preclude siting; however, these sites may also possess qualities that could lead an applicant to take extraordinary steps (e.g., extensive design or mitigation) to site a facility at these locations. Constraints may be due to regulatory, physical, or technical barriers. For the purpose of this high-level screening, constrained areas include the following:

- Volcanic hazards, including lahars, blasts and pyroclastic flows
- Active faults
- Areas of moderate or higher earthquake liquefaction potential
- Known landslide areas, and areas of steep slope
- 100-year floodplains and tsunami inundation zones
- Dam inundation areas (within 100 year floodplains)
- Large wetland systems
- Public lands designated for preservation or conservation purposes such as state parks and wildlife refuges
- Certain land use types such as schools, landfills, and military reservations, unless the project sponsors or proponents are or are associated with a military entity

Single or multiple constraints may result in cost-prohibitive or infeasible engineering solutions.





4.1.3 GIS Database for Analysis

To facilitate the identification of suitable areas for SMR development, Golder established a GIS database to compile and evaluate publically available, geo-referenced data on the criteria listed above.

The data layers used for the analysis, including the types of data identified in the previous section, are summarized in Table 4-1. GIS data collected and evaluated included physical, biological, and certain land use data; existing and certain planned infrastructure that facilitates SMR development; and named or designated land, usually under government or Native American control. Table 4-1 identifies each criterion collected and analyzed, criteria classifications (attraction, avoidance or constrained), specifics on subcategories of criteria when applicable, and whether buffers were integrated into the screening process.

Table 4-1. List of Criteria Used in GIS Analysis of Suitable SMR Locations in Washington

Location Criteria	Criteria Classes	Criteria Classification	Description	GIS Feature Type[1]	Buffer
Volcanic Hazards	-	Constrained	Areas of volcanic lahars, blasts, and pyroclastics based on mapping from the US Geological Survey (USGS) 1996 and 2008	Polygons	None
Ground Shaking	>= 60% g	Avoidance	Percent ground acceleration (PGA) based on mapping from USGS 2014	Polygons	None
	< 60% g	Attraction			
Faults and Folds	-	Constrained	Quaternary faults and folds based on mapping from the Washington Department of Natural Resources (WDNR) 2010	Lines	5 miles
Liquefaction	Moderate, Moderate to High and High	Constrained	Liquefaction susceptibility based on mapping from WDNR, 2010	Polygons	None
	Ice, Peat and Water	Constrained			None
	Very Low to Low, Low, and Low to Moderate	Avoidance			None
	Bedrock and Very Low	Attraction			None
Landslides	Mapped landslides, mass wasting, or landforms	Constrained	Landslides, mass wasting, landforms and areas within 0.5 mile of these features, based on mapping from WDNR, 2013	Polygons	None
	Areas within a half mile of mapped landslides, mass wasting, or landforms	Avoidance		Polygons	0.5 mile
Slope	<15%	Attraction	Percent slope range calculated from US Department of Agriculture 30-meter Digital Elevation Models	Polygons	None
	15% - 30%	Avoidance			
	>30%	Constrained			
Inactive/Abandoned Mines	-	Avoidance	Inactive and abandoned mine locations based on mapping from WDNR, 2004	Point	500 feet
100-year Flood Zones	-	Constrained	Areas within the 100-yr flood zone from the Federal Emergency Management Agency (FEMA) Q3 insurance maps	Polygons	None
Tsunami Inundation areas	-	Constrained	Areas of potential tsunami inundation based on mapping from WDNR, 2010	Polygons	0.5 mile

Table 4-1. List of Criteria Used in GIS Analysis of Suitable SMR Locations in Washington (continued)

Location Criteria	Criteria Classes	Criteria Classification	Description	GIS Feature Type[1]	Buffer
Wetlands	-	Constrained	Wetlands, ponds, lakes, rivers, and marine areas based on mapping from the US Fish and Wildlife Service's National Wetlands Inventory, 2014	Polygons	None
Transmission Lines	-	Attraction	Operational transmission lines greater than 69kV based on mapping from McGraw-Hill – Platts Division, 2015	Lines	2 miles
Thermal Power Plants	-	Attraction	Operational, permitted, and proposed thermal power plants as listed on the Energy Facility Site Evaluation Council's website, 2015	Points	2 miles
Active Railways	-	Attraction	Railways based on mapping from the Washington Department of Transportation (WDOT), 2012	Lines	2 miles
Arterial Highways	-	Attraction	Arterial highways based on mapping from WDOT, 2015	Lines	2 miles
Marine Ports	-	Attraction	Marine port locations based on mapping from WDOT, 2015	Points	10 miles
Populated Places	-	Avoidance	Populated places as depicted through Urban Growth Boundaries based on mapping from the Washington Department of Ecology, 2013	Polygons	None
Public Lands	Airport	Avoidance	Public lands based on mapping from WDNR, 2007 and WDOT, 2013	Polygons	1 mile
	City Forest	Avoidance			None
	City or County Park/ Preserve/Natural Area/ Recreation Area	Constrained			0.5 mile
	City Public School	Constrained			1 mile
	City Science Center	Constrained			None
	City or County Watershed	Avoidance			0.5 mile
	County Forest	Constrained			None
	County Landfill	Constrained			None
	County Wildlife Area	Avoidance			None
	Military	Constrained			None

Table 4-1. List of Criteria Used in GIS Analysis of Suitable SMR Locations in Washington (continued)

Location Criteria	Criteria Classes	Criteria Classification	Description	GIS Feature Type[1]	Buffer
Public Lands *(continued)*	National Forest	Avoidance	Public lands based on mapping from WDNR, 2007 and WDOT, 2013	Polygons	None
	National Park/National Monument/National Historic Park/National Recreation Area	Constrained			1 mile
	National Wilderness Area	Constrained			0.5 mile
	National or State Wildlife Refuge/Wildlife Area/Fish Hatchery	Constrained			0.5 mile
	NOAA Research Facility, State Medical Facility	Constrained			None
	State DNR Land	Avoidance			None
	State Park	Constrained			0.5 mile
	State Penitentiary	Constrained			None
	State University	Avoidance			None
	Tribal Lands	Avoidance			None
	Unknown - Army Corps of Engineers	Avoidance			None
	Unknown City, County, State or Federal Lands	Avoidance			None

[1] *Point-single location or coordinate of data (e.g. earthquake epicenter)*
Polygon-area of variable dimensions (e.g. freshwater wetland)
Line-a narrow linear feature (e.g. 230 kV electrical transmission line

4.2 Results of Suitable Location Analysis

The results of the GIS screening process for the criteria identified above are provided in Figures 4-1 through 4-4. These figures represent the combination of the criteria for each classification as well as a composite of all criteria classifications. The criteria established here for this state-wide screening were combined to result in locations that are more suited for SMR development and locations that are less suitable to development. The criteria established above must be reconsidered, refined, and supplemented when exploring specific SMR technologies, specific sites, and as project size (single or multiple modules) and resource needs are determined. In general, the screening results depict the following:

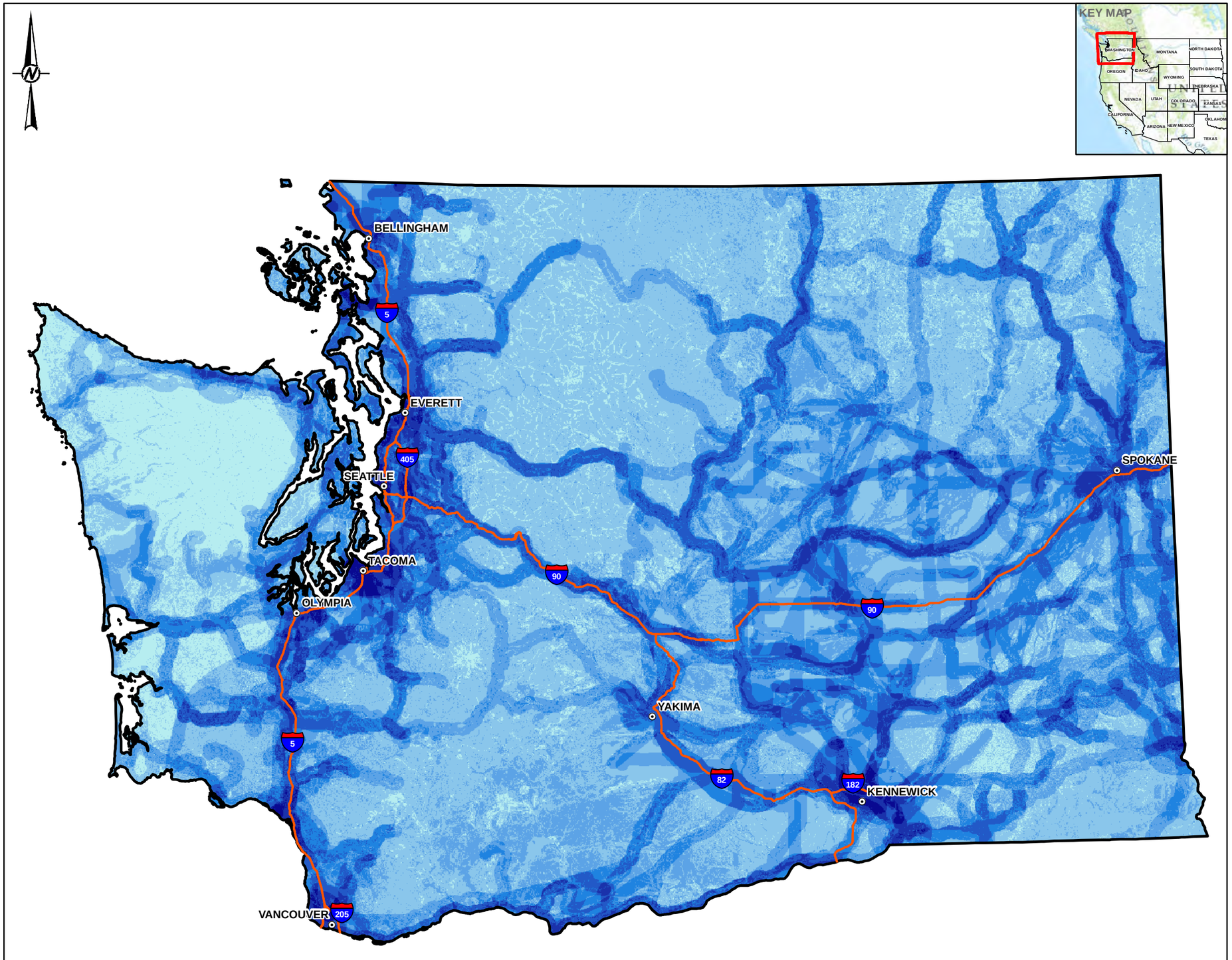
- Constrained Areas – These areas include the Cascade Mountains, due to volcanic activity, steep slope, and landslides. Coastal areas are also constrained due to tsunami inundation areas and named or designated lands, with the Olympic Mountains and the Coast Range also contributing to constrained areas. Land uses such as National Parks are included. The southeast quadrant of the state, including portions of the Columbia Basin, is constrained in certain areas due largely to active faults. Wetland and 100-year floodplain constraints are typically small in footprint compared to the other constraint criteria.
- Avoidance Areas – These areas are more uniformly distributed throughout the state, with particular reference to populated places (land within state-recognized urban growth boundaries), and certain named or designated lands such as wildlife areas and national forests. Some tribal reservations are likely to be constrained locations, depending on tribal culture and opinions. Instead of deciding that no reservation would allow an SMR, we rated them "avoidance" and left such decisions to future siting proposals.
- Attraction Areas – These areas are clustered around linear infrastructure, largely along the I-5 region and the southeast quadrant of the state, including the Columbia Plateau due to existing transmission, rail and highway networks.

The composite map, Figure 4-4, depicts the southeast quadrant of the state, including the Columbia Plateau, as more suitable for SMR development except for areas near active faults. The northeast quadrant of the state also has potential, as well as areas generally south of Olympia. The Cascade, Olympia, and Coast ranges are largely void of infrastructure and therefore, when combined with some of the geophysical criteria, less attractive for SMR development.

Based on the criteria and resulting screening analysis, areas of the state that are generally suitable for future SMR location considerations include rural areas that are geologically stable, located near existing infrastructure, and likely to contain low population density. Criteria also considered important to SMR siting include water supply for steam generation and cooling. The volume of water available for steam generation and wet cooling of SMRs depends on many variables including instream flow requirements, water rights limits, closed waters, and Endangered Species Act (ESA) considerations. A separate water supply discussion summarizing availability and the potential constraints for many of Washington's largest rivers is included. Because water as a siting factor is so dependent on site-specific and design factors, it was not used in the suitability analysis but instead is discussed separately.

General regional suitability for an SMR is summarized as follows:

- Northwest Coast – There is limited opportunity for SMR development in this remote and mountainous region, which has limited transmission infrastructure, not close to load centers; and significant area is also occupied by reservations and Olympic National Park.
- Coast and bays, between Ocean Shores and the Columbia River – This region is generally remote, with sensitive ecological resources along the coast and bays. SMR plant cooling by saltwater resources would be difficult to license.
- Central Plateau – Many areas of attractive land occur here close to infrastructure; however, water resource availability is generally limited except for the Columbia and Snake rivers, which still have limitations.



LEGEND

- MAJOR CITY
- INTERSTATE HIGHWAY
- WASHINGTON STATE BOUNDARY

SMR ATTRACTION AREAS

- MORE ATTRACTIVE
- LESS ATTRACTIVE

0 15 30 60

MILES

NOTE(S)

1. SEE TABLE 4-1 FOR DEFINITIONS OF SUITABILITY CRITERIA.
2. SEE REFERENCES CHAPTER FOR CRITERIA GIS SOURCE DATA CITATIONS.
3. ATTRACTION CRITERIA ARE ONLY ONE PART OF A HOLISTIC SUITABILITY MODEL AND SHOULD NOT BE USED TO INFORM SUITABILITY DECISIONS WITHOUT OTHER MODEL ELEMENTS.

REFERENCE(S)

1. ESRI (CITIES)
2. WASHINGTON DEPARTMENT OF TRANSPORTATION (INTERSTATES)
3. WASHINGTON DEPARTMENT OF ECOLOGY (STATE BOUNDARY)
4. COORDINATE SYSTEM: NAD 1983 STATE PLANE WASHINGTON SOUTH FIPS 4602 FEET
5. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT
ENERGY FACILITY SITE EVALUATION COUNCIL

PROJECT
SMR SITING STUDY

TITLE
ATTRACTION AREAS MAP

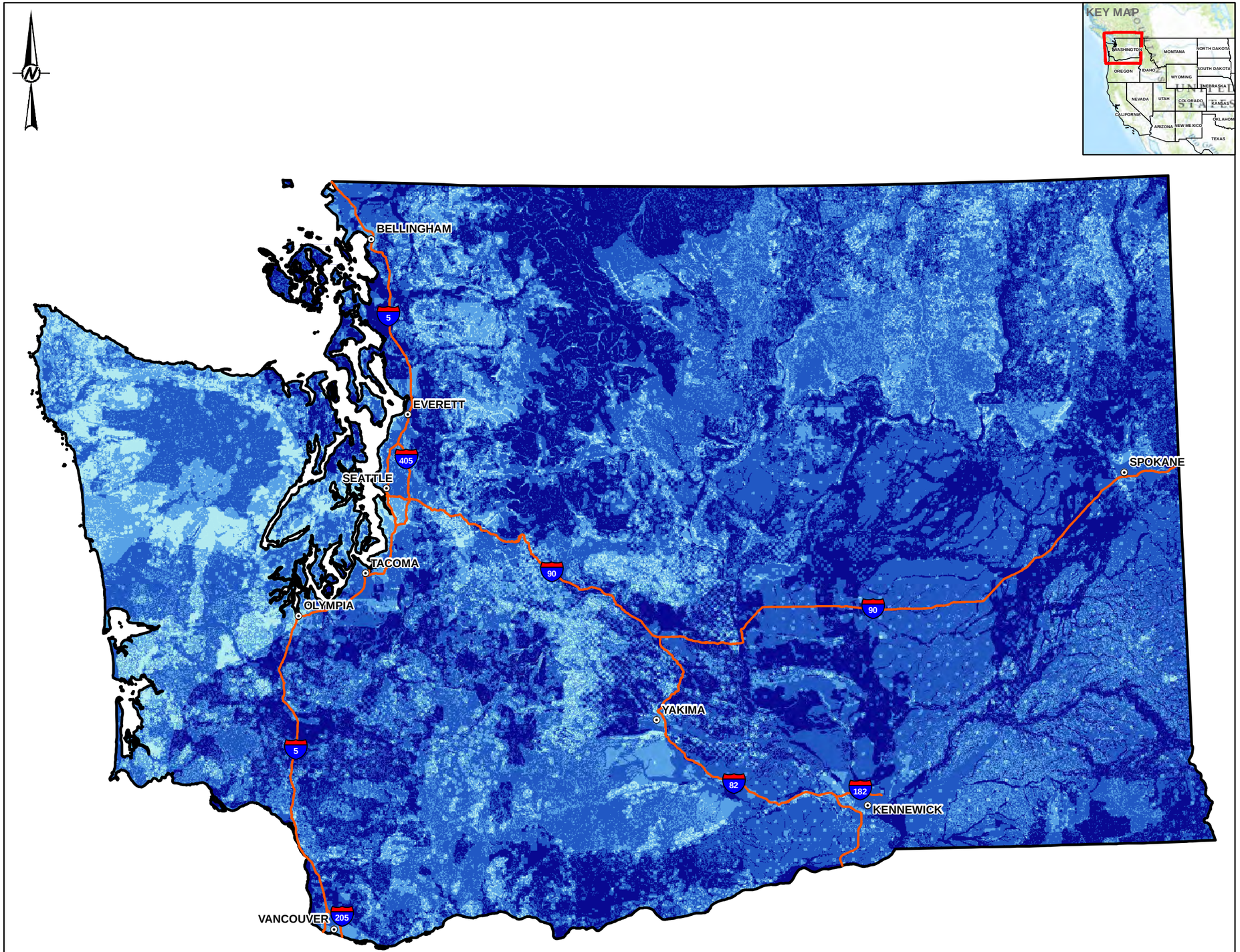
CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-10
DESIGNED	GL
PREPARED	BVJ
REVIEWED	RZ
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1539118	03	0	**4-1**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

PATH: G:\Energy\Facility\SiteEvaluationCouncil\SMR_Siting_Study\99_PROJECTS\1539118_SMR_Siting\02_PRODUCTION\MXD\FIGURES\Rev0\1539118_03\3_F1_Rev0_Attracted.mxd



LEGEND

- MAJOR CITY
- INTERSTATE HIGHWAY
- WASHINGTON STATE BOUNDARY

SMR AVOIDANCE AREAS

- MORE AVOIDANCE
- LESS AVOIDANCE

0 15 30 60

MILES

NOTE(S)

1. SEE TABLE 4-1 FOR DEFINITIONS OF SUITABILITY CRITERIA.
2. SEE REFERENCES CHAPTER FOR CRITERIA GIS SOURCE DATA CITATIONS.
3. AVOIDANCE CRITERIA ARE ONLY ONE PART OF A HOLISTIC SUITABILITY MODEL AND SHOULD NOT BE USED TO INFORM SUITABILITY DECISIONS WITHOUT OTHER MODEL ELEMENTS.

REFERENCE(S)

1. ESRI (CITIES)
2. WASHINGTON DEPARTMENT OF TRANSPORTATION (INTERSTATES)
3. WASHINGTON DEPARTMENT OF ECOLOGY (STATE BOUNDARY)
4. COORDINATE SYSTEM: NAD 1983 STATE PLANE WASHINGTON SOUTH FIPS 4602 FEET
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ENERGY FACILITY SITE EVALUATION COUNCIL

PROJECT
SMR SITING STUDY

TITLE
AVOIDANCE AREAS MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-10
DESIGNED	GL
PREPARED	BVJ
REVIEWED	RZ
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1539118	03	0	**4-2**

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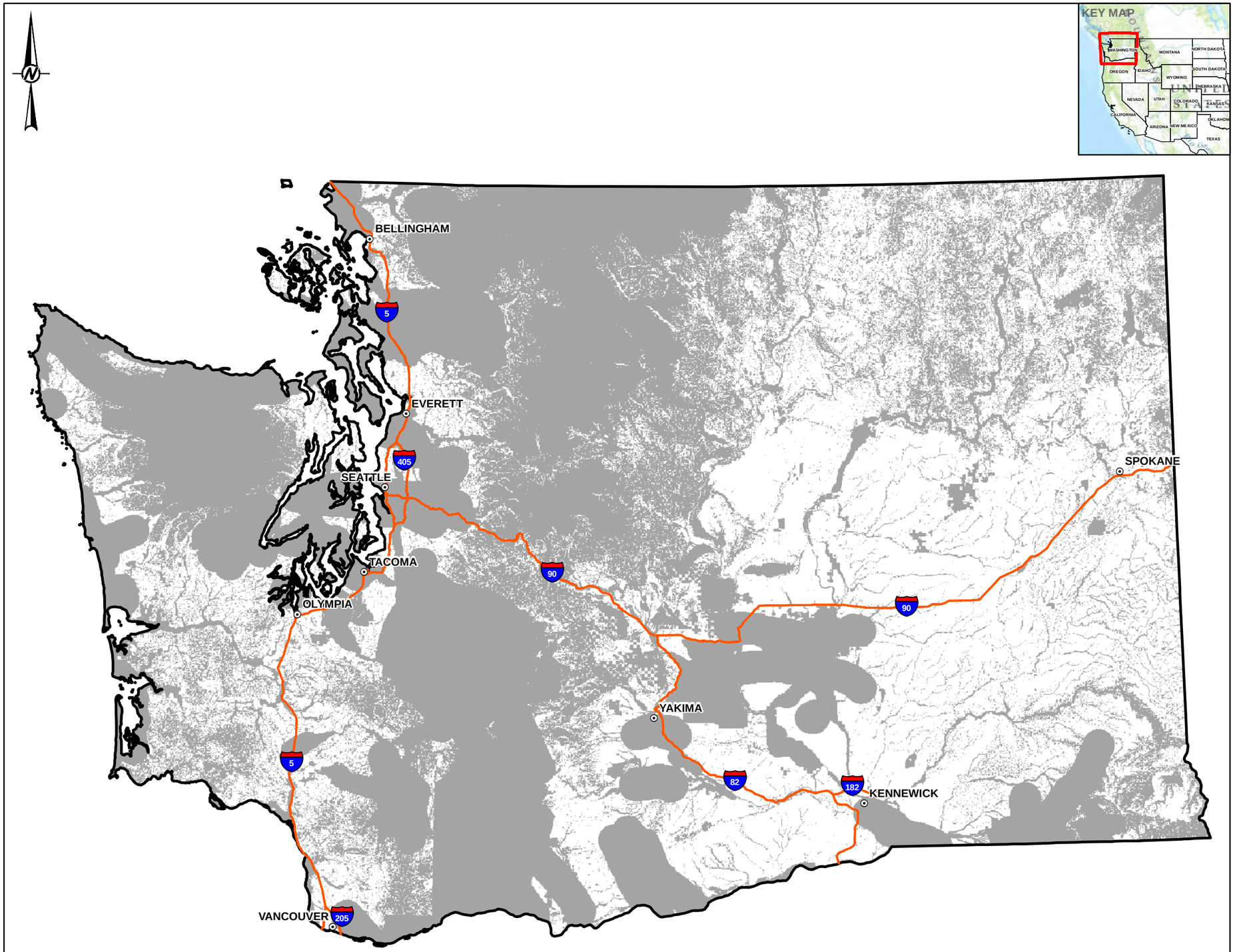

LEGEND

- MAJOR CITY
- INTERSTATE HIGHWAY
- WASHINGTON STATE BOUNDARY
- SMR CONSTRAINED AREA

0 15 30 60

MILES

NOTE(S)

1. SEE TABLE 4-1 FOR DEFINITIONS OF SUITABILITY CRITERIA.
2. SEE REFERENCES CHAPTER FOR CRITERIA GIS SOURCE DATA CITATIONS.
3. CONSTRAINED CRITERIA ARE ONLY ONE PART OF A HOLISTIC SUITABILITY MODEL AND SHOULD NOT BE USED TO INFORM SUITABILITY DECISIONS WITHOUT OTHER MODEL ELEMENTS.

REFERENCE(S)

1. ESRI (CITIES)
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3. WASHINGTON DEPARTMENT OF ECOLOGY (STATE BOUNDARY)
4. COORDINATE SYSTEM: NAD 1983 STATE PLANE WASHINGTON SOUTH FIPS 4602 FEET
5. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

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ENERGY FACILITY SITE EVALUATION COUNCIL

PROJECT
SMR SITING STUDY

TITLE
CONSTRAINED AREAS MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-10
DESIGNED	GL
PREPARED	BVJ
REVIEWED	RZ
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1539118	03	0	**4-3**

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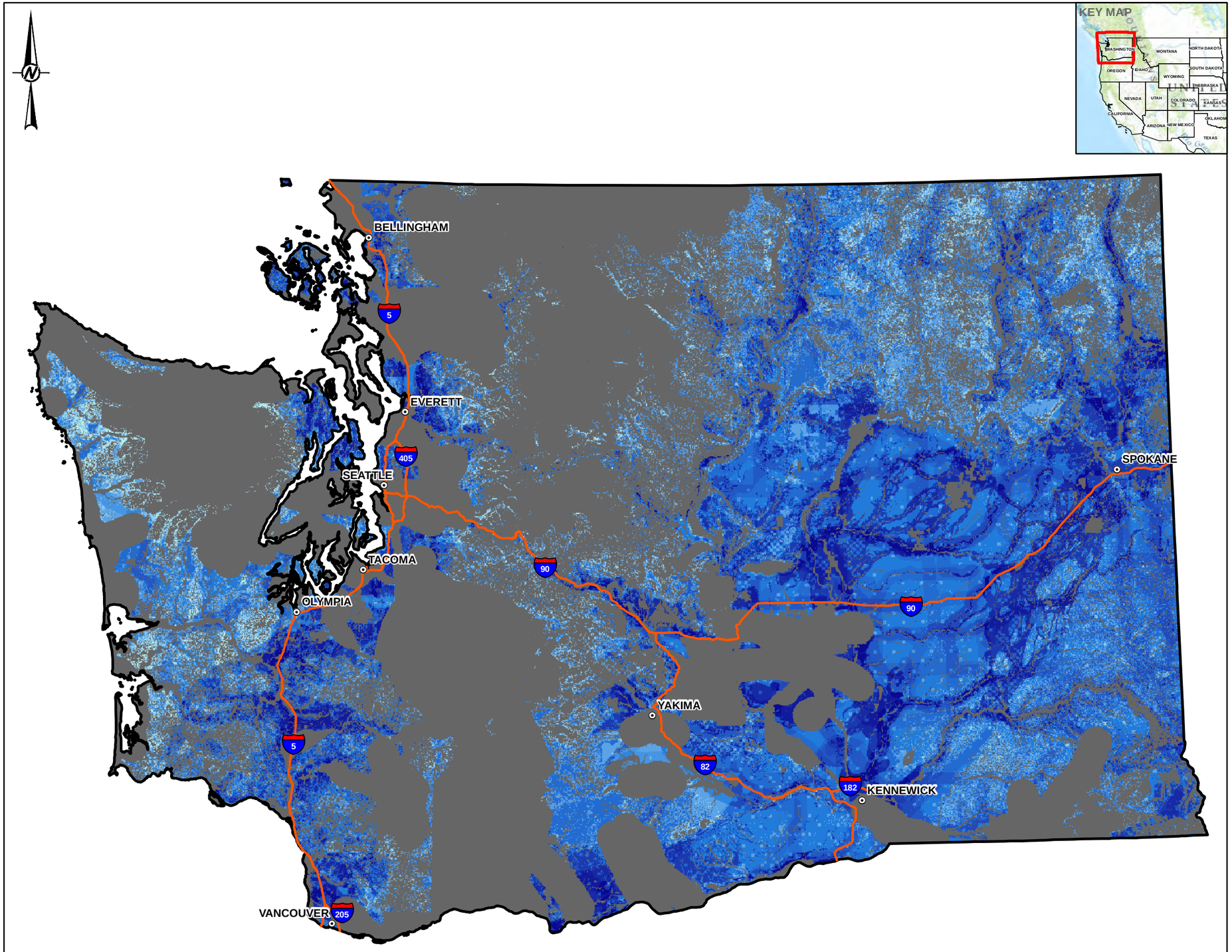

LEGEND

- MAJOR CITY
- INTERSTATE HIGHWAY
- WASHINGTON STATE BOUNDARY
- SMR CONSTRAINED AREA

SMR SUITABILITY

- LESS SUITABLE
- MORE SUITABLE

0 15 30 60

MILES

NOTE(S)

1. SEE TABLE 4-1 FOR DEFINITIONS OF SUITABILITY CRITERIA.
2. SEE REFERENCES CHAPTER FOR CRITERIA GIS SOURCE DATA CITATIONS.

REFERENCE(S)

1. ESRI (CITIES)
2. WASHINGTON DEPARTMENT OF TRANSPORTATION (INTERSTATES)
3. WASHINGTON DEPARTMENT OF ECOLOGY (STATE BOUNDARY)
4. COORDINATE SYSTEM: NAD 1983 STATE PLANE WASHINGTON SOUTH FIPS 4602 FEET
5. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT

ENERGY FACILITY SITE EVALUATION COUNCIL

PROJECT

SMR SITING STUDY

TITLE

SMR SUITABILITY MAP

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-11-10
DESIGNED	GL
PREPARED	BVJ
REVIEWED	RZ
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1539118	03	0	**4-4**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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- Hanford and the Tri-Cities area – This area is generally suitable for SMR development based on its licensing history and other factors, except on or near an active fault. The GIS screening composite was compared to candidates sited for SMR development at Hanford that were identified in a report commissioned by the Tri-Cities Development Council in 2014 (URS 2014). The review found that with one exception, the SMR sites at Hanford were suitable for development. Proximity to an active fault precluded inclusion in this analysis of one of the sites identified in the Tri-Dec study. Site-specific geotechnical investigations may determine that the sites precluded in this analysis may be suitable.
- Known industrial and/or power generation sites – Similar to the comparison undertaken for the SMR sites at Hanford, the GIS composite was compared to existing and permitted thermal power sites in Washington. The review found that the existing thermal power plants and permitted thermal power plant sites were located in areas that were generally suitable for development. These sites have been included as suitable, assuming that considerable analysis went into their selection, and confirmed by some sites that were licensed/certified.
- Far Eastern Washington – Similar to the Central Plateau, this area contains attractive land but these sites are far from major electric power load centers. Several high voltage transmission lines are proposed for the area, beyond those that exist, and SMR development may benefit by their ultimate development. Long transmission distances are a typical part of the transmission landscape (e.g., Puget Sound Energy receives some electricity from Colstrip, Montana) but the evolving safety characteristics and other SMR factors that may avoid the need for remote siting makes long distance transmission less desirable.
- Northeast Canadian border to Spokane – Though suitable land exists in this region, it is far from large electric power load centers and is dominated in land use by a reservation.
- I-5 Corridor (Vancouver, BC to Vancouver, WA) – This corridor is represented by existing power plants from Centralia/Chehalis to Sumas, and is close to loads; however, the corridor also includes slopes, environmentally sensitive areas, and population centers, and would require a very site-specific location to determine suitability.
- Columbia River and Snake River – The Columbia River, downstream to its mouth, and its Snake River tributary, are considered suitable and may contain specific locations for infrastructure where water use rights are available or might be procured. Water supply below Bonneville Dam has fewer constraints than other sites on the river.

4.3 Existing Power Plant Sites in Washington

We concluded that the location suitability analysis should include the identification of existing power plant sites in Washington as likely candidates for suitable locations. Golder reviewed sites that contain operating facilities, and also those with power plant facilities that are closed or partially completed. Additional sites were considered that were permitted or were well underway with the permitting process before they were cancelled, and never built. In these cases, the level of site analysis effort to get any of these sites to the permitting stage was far beyond the time and resources available to evaluate any specific sites for this report. For that reason, we suggest that any of these might be a suitable location for an SMR, subject to space availability, economics, public acceptance, and other site-specific factors we have not evaluated.

Some of the current sites may have space constraints for an additional plant; others may have land use or infrastructure capacity constraints that have changed since their licensing process was initiated and/or approved. Golder did not assess sites in terms of public acceptance, land availability, or other factors, other than brief descriptions of the sites identified, based on available information. The identified sites are reasonable starting locations for a siting study, but their actual suitability for an SMR depends on the SMR's size, purpose, and operating parameter requirements, which can only be determined by

some future applicant, and as affected by ongoing rulemaking activities at the NRC. The more likely sites may be those where nuclear plants were sited in the past, given their large size and historical suitability for nuclear power generation.

Neither the suitable location analysis nor this facility list considered the timing for the need for a facility, the current power surplus in the Northwest, SMRs' competitiveness against other electrical power generation technologies, or the need for power over the next 10-20 years. The NW Power Plan developed by the Northwest Power and Conservation Council does that. The 2015 draft of the power plan was issued in October 2015 and its position on SMRs is discussed in Appendix A.

Following is a brief description of the plants we have identified in Washington; these plants are shown in Figure 4-5.

BP Cherry Point Cogeneration. This gas-fired plant was never built, but did go through the siting process based on its site suitability and proximity to the refinery industry, which could utilize its heat and power output. Planned at 738 MW, a facility at this location could potentially support the aluminum industry as well, with nearby aluminum production. An SMR could support such production, even as distributed generation (without extensive transmission) if this application becomes feasible in the future. Recent (Q4, 2015) drops in aluminum prices have forced Intalco to cut production and staff by 30%, so economics would play a major role here, similar to other sites. The existing site is located about 2 miles south of Birch Bay.

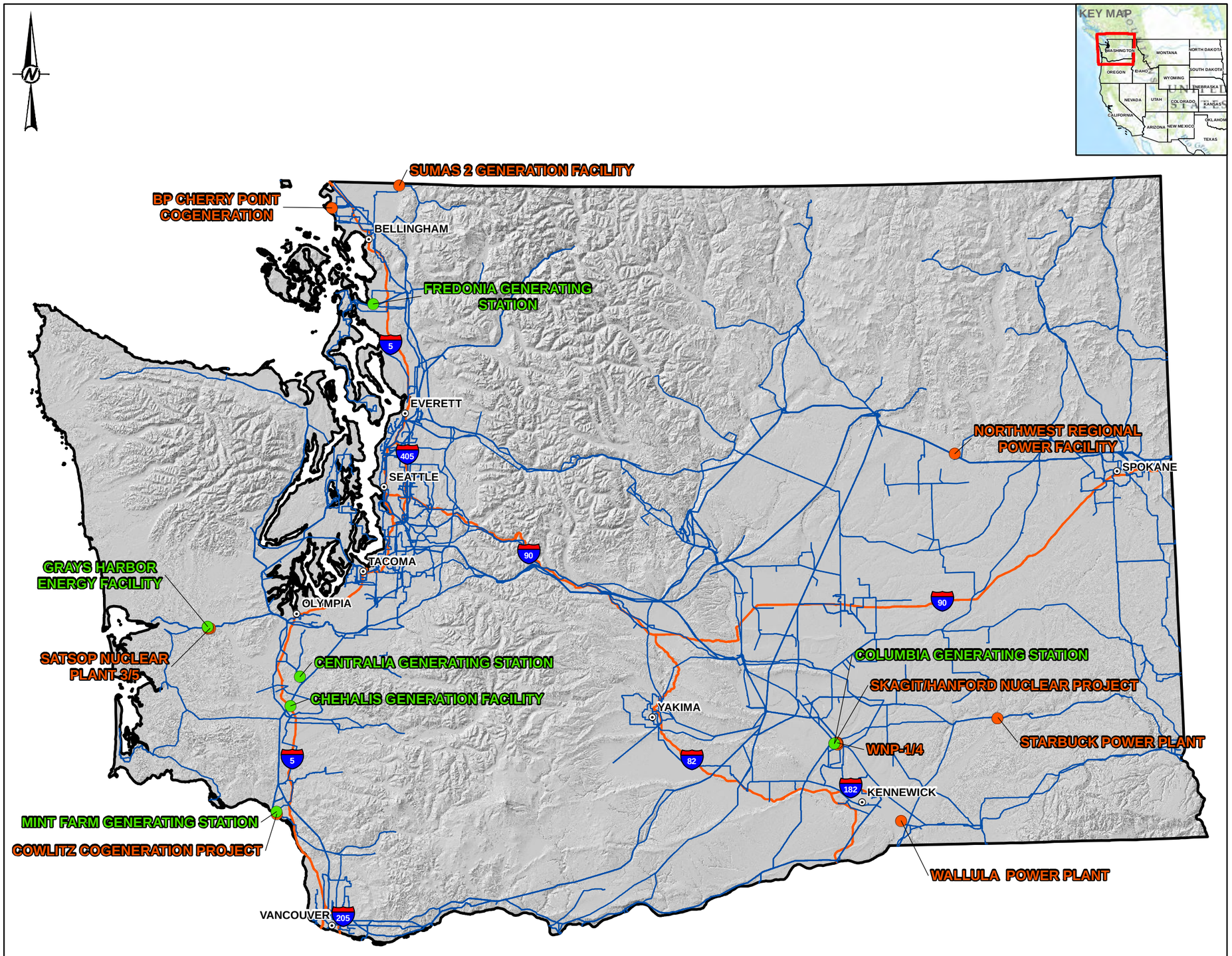
Centralia Coal Plant. This 1,350 MW coal-fired power plant is still operating and scheduled for gas conversion (or unit shutdown) over the next few years. If Trans Alta has a need to meet load demands for its customers, both existing units will need to be converted to another fuel and operating by 2025. The first conversion (half the facility) needs to be converted by 2020; the second by 2025. No such proposal is being considered, but this site was one of many mentioned by a legislative task force as a potential future SMR site. It was not suggested as part of unit shutdown process or schedule. The site has rail access, hundreds of acres of property at and adjacent to the existing coal plant, electrical transmission, and water supply. The existing plant is located about 3 miles south of Bucoda and 5 miles northeast of Centralia.

Chehalis Generating Facility. This 460 MW baseload combined cycle gas plant is located in a Chehalis business park near Interstate 5. The site is somewhat constrained by water supply, available land area, and any issues associated with proximity to populations. Benefits include proximity to transmission and load. Water is currently provided by the municipality due to summer flow constraints in the nearby Chehalis River. About 35 acres of open land is adjacent to the existing gas plant, which sits on a similar size property. No other vacant land is adjacent to the gas plant.

Columbia Generating Station. Obviously a suitable site for a nuclear plant, this facility has operated as a 1,100 MW nuclear power plant since 1984. Run by Energy NW, this site is already occupied and likely to continue operation at this site for many years. It is located about 10 miles North of Richland.

Cowlitz Cogeneration Project. This 300 MW gas plant was proposed by Weyerhaeuser for the Weyerhaeuser complex along the Columbia River, in partnership with Mission Energy. The plan was to replace up to 11 old boilers with the heat from gas generation and to sell the surplus power. With infrastructure in place, positive benefits would have included reduced emissions and increased power output but it was never built. The Weyerhaeuser facility, however, is adjacent to the city of Longview. Another gas-fired plant built nearby (Mint Farm Plant) is now providing power for the region.

Creston Generating Station/NW Regional Power Facility. This site was originally proposed as a coal-fired power plant, which included a new dam and reservoir for cooling water from the Columbia River. It was permitted and not built; years later it was proposed as a gas-fired baseload combined cycle power plant, and this second proposal was never built. The remote location may still be an advantage for this site.



LEGEND

- MAJOR CITY
- TRANSMISSION LINE (>69KV)
- INTERSTATE HIGHWAY
- WASHINGTON STATE BOUNDARY

THERMAL POWER PLANTS

- OPERATING
- PERMITTED OR PROPOSED

0 15 30 60

MILES

NOTE(S)

1. THERMAL POWER PLANTS THAT ARE CURRENTLY OPERATIONAL AND THOSE THAT HAVE BEEN PERMITTED BUT ARE NOT OPERATIONAL, OR NOT BUILT, ARE SHOWN ON THIS MAP. POWER PLANT LOCATION AND STATUS FROM ENERGY FACILITY SITE EVALUATION COUNCIL (EFSEC) WEBSITE.
2. ONLY OPERATIONAL TRANSMISSION LINES THAT HAVE GREATER THAN 69KV ARE SHOWN ON THIS MAP. TRANSMISSION LINE LOCATION AND VOLTAGE FROM MCGRAW-HILL.

REFERENCE(S)

1. ESRI (CITIES)
2. WASHINGTON DEPARTMENT OF TRANSPORTATION (INTERSTATES)
3. WASHINGTON DEPARTMENT OF ECOLOGY (STATE BOUNDARY)
4. ENERGY FACILITY SITE EVALUATION COUNCIL (POWER PLANTS)
5. MCGRAW-HILL, PLATTS (TRANSMISSION LINES)
6. U.S. DEPARTMENT OF AGRICULTURE (30M NED USED TO CREATE HILLSHADE)
7. COORDINATE SYSTEM: NAD 1983 STATE PLANE WASHINGTON SOUTH FIPS 4602 FEET
8. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT
ENERGY FACILITY SITE EVALUATION COUNCIL

PROJECT
SMR SITING STUDY

TITLE
THERMAL POWER PLANT SITES AND TRANSMISSION LINES IN WASHINGTON

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-10
DESIGNED	GL
PREPARED	BVJ
REVIEWED	RZ
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1539118	03	0	4-5

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Fredonia Power Plant. This is a small, four-unit gas-fired peaking facility run by Puget Sound Energy. It is at a small site in a relatively rural agriculture/residential area that might be suitable for a limited number of SMR modules but is currently a single cycle operation and not a baseload facility.

Grays Harbor Energy Facility. This 620 MW facility is comprised of two gas-fired combined cycle units located less than one mile from the Satsop site (below). It uses water from the Chehalis River. It is sited and operating. It's unknown whether there is room or demand for a new power plant here within the business park property itself, but there is plenty of vacant land surrounding the gas plant and the abandoned Satsop nuclear site. Grays Harbor is about 2 miles south of Satsop.

Satsop Nuclear Plants 3 and 5. Sited, permitted and partially constructed, these nuclear plants were cancelled because of issues with cost and need for power. The site remains, although much of the infrastructure has been removed. The history at this site may be an impediment to siting a nuclear plant there again, but even the NRC agreed it was a suitable location for a nuclear plant at one time, and that may still be correct. The area is about 3 miles south of Satsop.

Skagit-Hanford Nuclear Generating Station. This 1,275 MW nuclear generating station was proposed for the Hanford Reservation in Benton County in 1982. The license application was eventually cancelled about the time the final EIS was to be issued, but considerable data were generated at the site including development of an Application for Site Certification (ASC), Preliminary Safety Analysis Report (PSAR), and other documentation. The site is likely suitable for an SMR. The site data would need to be updated. Any new applicant at this site, or any site at Hanford, might benefit from a copy of the agreement between the NRC and EFSEC on joint processing of the applications and permitting, and the post-project report prepared by the NRC and EFSEC that documented the joint siting process and its successes.

Starbuck Power Plant. Proposed at the same time as the first Wallula gas-fired power plant, this similar facility was located a few miles from the Snake River and proposed to use Snake River water through a municipal water supply purchase agreement from the City of Starbuck. Another remote site, it is not known if a similar water supply agreement is available. The site was selected in part due to its proximity to natural gas and electrical transmission lines and the availability of city water.

Sumas II Power Plant. This proposed gas plant, proposed next to an existing plant, was never built for reasons that included included issues with local transmission capacity and vocal opposition from Canada. Any new nuclear plant proposal at that site, within a mile of the Canadian border, is likely to encounter the same issues. The site is small and lacks freeway access, although rail access is provided. Whatcom County has a prohibition against new transmission lines greater than 230 MW capacity in new corridors; this forced a previous applicant to propose transmission through Canada. The County's transmission line restrictions have not been tested in court.

Wallula Power Project/Wallula IGCC Project. The initial proposal for this site was a 1,300 MW gas plant followed a few years later by a proposed coal plant at the same site that was to be a coal-gasification project with CO2 sequestration. The second project, an integrated gasification combined cycle (IGCC) plant, was sited as a "clean coal" plant with almost no opposition, as the comments from all intervenors were addressed by the applicant. Transmission line upgrades were proposed that are currently under development by another sponsor. Neither project is currently active, and neither was built. Water was available through purchase of upstream water rights that may or may not be available in the future.

Washington Nuclear Projects (WNP) 1 and 4. One of two nuclear plants that were sited and permitted by the Washington Public Power Supply System on the Hanford Reservation, WNP1 has been partially dismantled and the site is available for future uses. It may be a suitable location for a future SMR and there may be local energy requirements that could help support the demand.

4.4 Rivers and Water Rights Availability in Washington

Golder evaluated water rights and availability issues throughout Washington, including consideration of major rivers in the state that could be likely cooling water sources for SMR modules. We did not include this factor in the suitability analysis because of the wide variability in water constraints and technology applications likely at specific sites. An individual site may have constraints on water supply within the local watershed, or within a certain season, or due to factors such as water rights or protected species issues in a specific river; however, no generalizations can be made on whether that site would be constrained or acceptable, because of the many options are available to an applicant to potentially solve these issues, and project economics will also play a role in what solutions can be employed. In this section, we provide detailed discussion on what options, and issues, an applicant might encounter when siting an SMR in Washington.

For any specific water source in Washington, the limitations and constraints on water withdrawals may include water rights limitations, closed waters, in-stream flow limits that could create intermittent supply issues, upstream vs. downstream rights and uses, available municipal supplies, changes of use or location, Endangered Species protection issues, and even Clean Water Act jurisdiction, which protects water quality from excessive withdrawals. Many of these topics have been litigated and others are subject to future litigation or interpretation, which can make a decision at any specific site too complex to discuss here. Likewise, this discussion is not a legal treatise on water rights in the state. But it does describe the general water availability, and a generalized description of water supply options and constraints.

Water Needs at Nuclear Power Plants

Future power plant owners will need water for potable, industrial and cooling water makeup uses. Conventional water consumption associated with the steam cycle can consume water in the combustion process itself, to improve turbine efficiency, through evaporation to remove waste heat, and through discharge of thermal wastewater (blowdown) into evaporation ponds (instead of treatment and discharge to the source).

A 600 MW power plant may consume approximately 11 million gallons of water per day, although this estimate is highly variable based on facility design, location, elevation and seasonal/climatic conditions, thermal efficiency, and other factors. The actual amount used also depends on the specific cooling technology employed.

Reactor Technologies and their Influence on Water Needs

- Dry Cooling – This technology uses air for cooling, which decreases water consumption considerably. Dry cooling still requires water but at much lower volumes. This technology incurs higher operating costs and produces less power, lower power outputs for the same fuel use, reducing efficiency. But it is included as an option and a benefit from some SMR designs that can operate with dry cooling. This option is generally offered when there is no water supply alternative.
- Wet/Dry Cooling – As described, this process uses more water than dry cooling and less water than wet cooling. A related option for this alternative is to operate under different modes based on water availability and/or season. (Dry cooling is less efficient in very hot weather).
- Cooling Towers – Cooling towers can be designed as mechanical draft, which uses fans that blow air vertically to strip heat from the water as the water trickles down from the top of the tower, or natural draft towers, which are large hyperbolic structures that pump the thermally laden water to the top of the tower and then discharge to the surface. Mechanical draft cooling seems to be preferred for SMRs using wet cooling.
- Cooling Ponds and Reservoirs – These are also possible alternatives for cooling; these methods take advantage of the thermodynamic effects of evaporation by using evaporation from the surface of the water bodies to consume heat. Evaporation can be accelerated by aerators to enhance the air-water surface exchange and increase the rate of evaporation.

Water Sources in Washington

In the following analysis of potential water sources for an SMR, we have assumed an SMR technology that uses combined cycle power generation with wet cooling using mechanical draft cooling towers. This technology uses the greatest amount of cooling water for a site, but is the most efficient mode of electrical generation as a result. Applicants seeking to reduce their water consumption requirements at a specific site can consider one of the other technologies as an option to reduce water consumption. And some SMR designs promote their dry cooling option.

There are a number of water supply options for any proposed power plant in Washington, and many rules and regulations that limit water availability. This section discusses some of these factors and the complexity of water source issues. We focus on rivers and not groundwater, although the two are often considered hydraulically connected. Here are the variables.

- Municipal Water Supply – Owners can buy water from local municipalities with available supply, and avoid a more complex water rights process. This simple regulatory solution generally has increased costs, if owners need to pay for treated water at municipal water supply rates. Alternatively, a mechanism might be possible to buy city water using city water rights and receive it under a wholesale pricing agreement.
- Water Rights – Water availability is comprised of physical ability and pre-existing rights, including administratively issued rights, valid water right claims, instream flows, and tribal treaty rights. If a water source is fully allocated, there are no new water rights available and a water rights application will be denied, unless suitable mitigation can be applied. In some cases seasonal rights may be available, but water may not be available for certain months.
- Water Right Acquisition – If new water rights are not available, one of the easiest solutions would be to take over water rights from an existing power plant user; this would require a relatively simple water rights change application to Ecology. A similar process might be the acquisition of irrigation water rights, generally upstream, which can then follow the same transfer process. If this process acquires enough summer flow rights to cover the whole year of operation, it can result in reduced summer flow withdrawals, with an environmental benefit. The one-time costs for such water can be a few thousand dollars per acre-foot.
- Water Rights Mitigation – Obtaining a new or existing water right may require mitigating impacts or impairment by replacing such water in kind, in place, and in time, which can be difficult. The State develops mitigation generally on a case-by-case basis, and is not always successful (Foster v. Yelm, October 8, 2015).
- Minimum Flow Requirements – Many rivers in Washington are subject to minimum instream flow requirements, that is, no withdrawals are allowed, even approved withdrawals, when a river is flowing at its legally designated low (minimum) flow. Users would need to shut down withdrawals or find other water under such conditions. Even streams without instream flow rules are administered to reduce withdrawals during low flow periods to protect habitat and water quality.
- Endangered Species Act Limitations – Although waters may be appropriated by the State, certain rivers have been designated by the US Fish and Wildlife Service (USFWS) and/or National Marine Fisheries Service (NMFS) as restricted to withdrawal or otherwise protected such that users will not withdraw water based on the presence of endangered species, and the potential for liability for Take by the State if they authorize more withdrawals from such rivers.
- Storage – Water for a new right is generally more available in the winter. Withdrawing winter water for summer use may address that. A hypothetical 8 million gallon a day demand, for example, would require approximately 9,000 acre-feet per year. Half that year would require 4,500 acre-feet. One solution is to build a storage river for seasonal use. If a reservoir was built with an average depth of 50 feet, it would need to be approximately 90 acres in size to hold 4,500 acre-feet. Costs and permitting issues for this solution can be expensive. They have been proposed in the past,

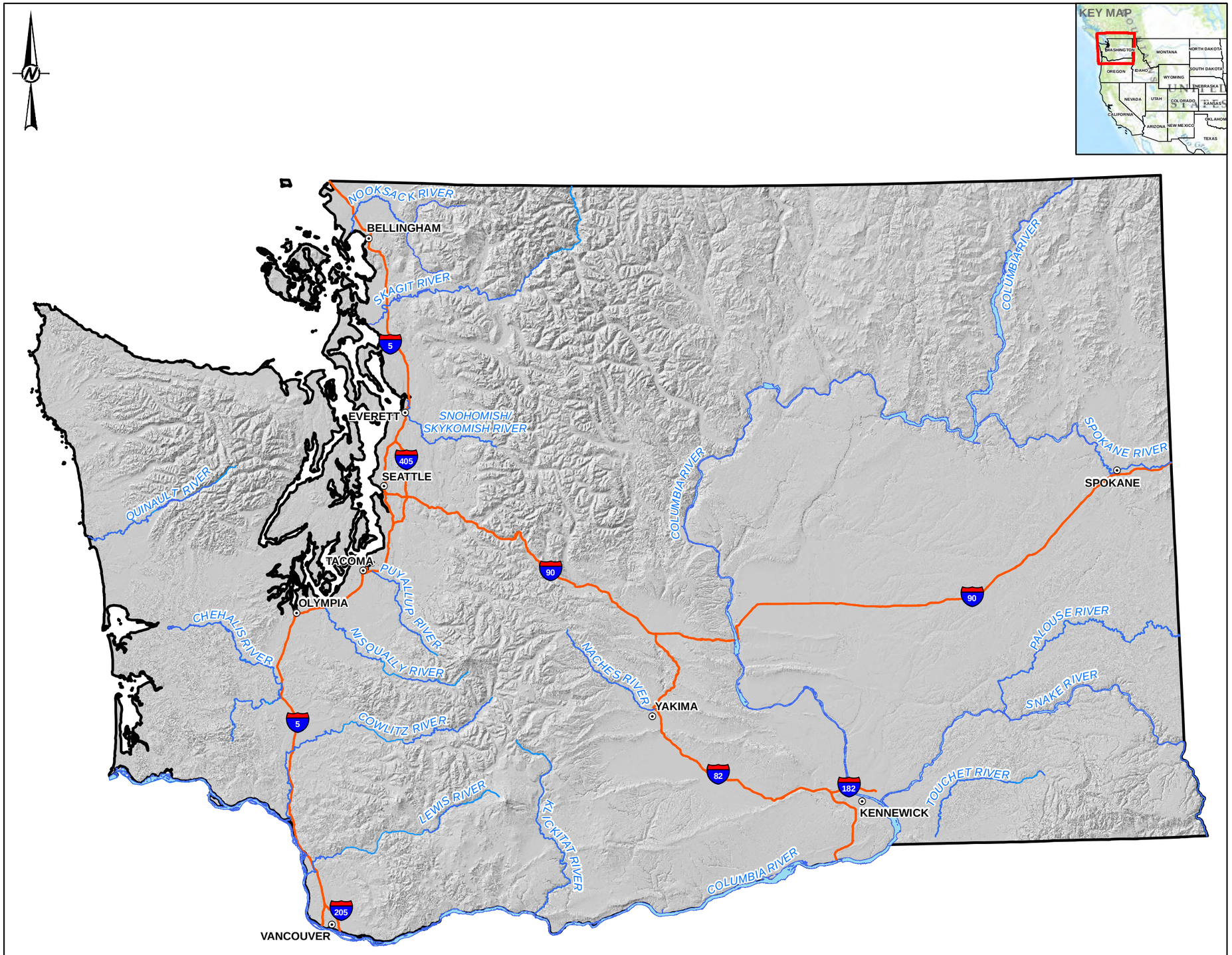
but never built. Aquifer storage via an aquifer storage and recovery (ASR) program allows such storage without a reservoir.

- TMDL Limits – Some Washington rivers do not meet desired water quality standards and are on an improvement path under the total maximum daily load (TMDL) program. Water withdrawals that exacerbated any TMDL condition (e.g., temperature) would be more difficult to approve, unless mitigation could be applied to improve the condition.
- Lake Roosevelt Incremental Storage Release Program – Withdrawals from the Columbia River, which is otherwise closed for new diversions, can tap into this program for future water supplies under the right conditions. For example, the State has developed a mitigation program to allow water from Lake Roosevelt to be available for municipal and industrial purposes, with power in a separate category. Of the 25,000 acre-feet of water designated for the program, only half remains uncommitted or not in the application process. A power plant would likely use at least half of that, and would be competing with municipal and industrial users that may demonstrate greater needs for population, jobs and economic growth.

Appendix B lists several of the largest rivers in Washington and discusses constraints created by one or more of the factors shown above (see also Figure 4-6). There are dozens more rivers in the state, but Table 1 in Appendix B demonstrates that many rivers have one or more restrictions to new water withdrawals and describes some of the factors influencing water availability across the state. Figure 4-7 shows mapped water rights in Washington for power generation and agricultural use which could potentially be considered for conversion to power generation. The figure also depicts surface water discharges to tidal waterbodies which could be captured and used as a grey water source for cooling water if quantity and quality were sufficient for cooling purposes. Buffers were established around the locations of place of use and the lower Columbia River, recognizing the feasibility to pipe the make-up water supply a reasonable distance to a future SRM site location.

In summary, an appropriate site from a watershed perspective would need to consider all of the potential constraints above, and evaluate the economics of various alternatives that are available. In some cases (e.g., ESA protection), an alternative may not be available. Solution options can include successful use of acquired irrigation rights, some of which may only be available during summer flows. In such cases, spreading the total withdrawal across all 12 months creates the environmental benefit of lower withdrawals in the summer; or acquiring summer rights only while applying for new winter rights may be a solution. These and other options may be available at otherwise constrained locations.

If an easy solution can't be developed, then project size or cooling technology options as discussed above can be considered.



LEGEND

- MAJOR CITY
- INTERSTATE HIGHWAY
- WASHINGTON STATE BOUNDARY
- RIVER

0 15 30 60

MILES

NOTE(S)

1. SEE TABLE 4-2 FOR A DISCUSSION ON WATER RIGHT AVAILABILITY IN THESE RIVERS.

REFERENCE(S)

1. ESRI (CITIES)
2. WASHINGTON DEPARTMENT OF TRANSPORTATION (INTERSTATES)
3. WASHINGTON DEPARTMENT OF ECOLOGY (STATE BOUNDARY)
4. WASHINGTON DEPARTMENT OF NATURAL RESOURCES (RIVERS)
5. U.S. DEPARTMENT OF AGRICULTURE (30M NED USED TO CREATE HILLSHADE)
6. COORDINATE SYSTEM: NAD 1983 STATE PLANE WASHINGTON SOUTH FIPS 4602 FEET
7. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT
ENERGY FACILITY SITE EVALUATION COUNCIL

PROJECT
SMR SITING STUDY

TITLE
MAJOR WATERWAYS IN WASHINGTON

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-10
DESIGNED	GL
PREPARED	BVJ
REVIEWED	RZ
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1539118	03	0	**4-6**

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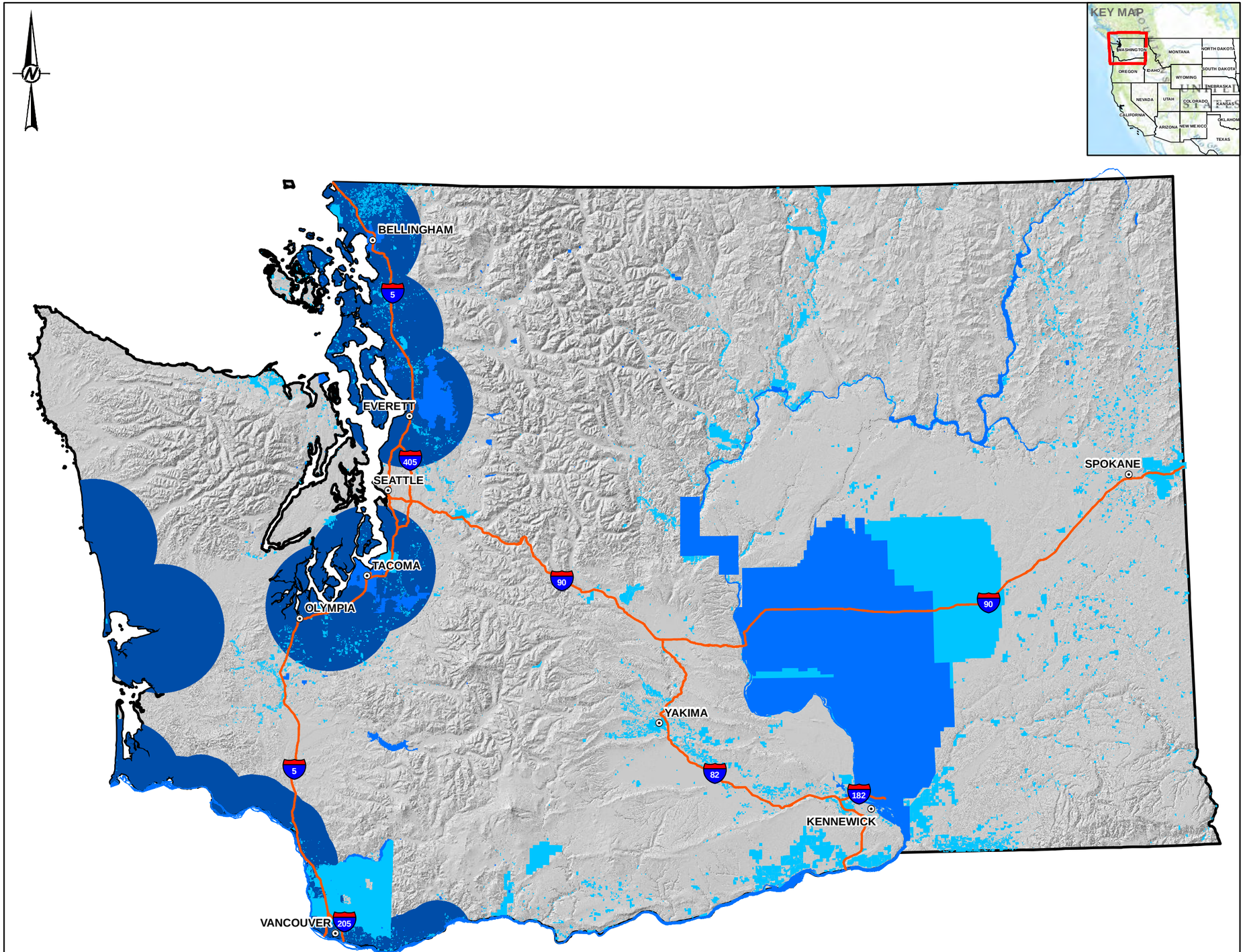

LEGEND

- MAJOR CITY
- INTERSTATE HIGHWAY
- WASHINGTON STATE BOUNDARY
- WATER RIGHT PLACE OF USE - ACTIVE CERTIFICATE OR PERMIT FOR POWER GENERATION
- WATER RIGHT PLACE OF USE - ACTIVE CERTIFICATE OR PERMIT FOR IRRIGATION
- SURFACE WATER DISCHARGE PROXIMATE TO TIDAL WATERBODIES

0 15 30 60
MILES

NOTE(S)

1. WATER RIGHTS PLACE OF USE POLYGONS INCLUDE ONLY THOSE THAT HAVE BEEN MAPPED BY WASHINGTON DEPARTMENT OF ECOLOGY AS OF NOVEMBER 6, 2015.
2. ONLY WATER RIGHTS PLACE OF USE POLYGONS THAT HAVE ACTIVE PERMITS OR CERTIFICATES FOR THE PURPOSE OF POWER GENERATION OR IRRIGATION (WHOLLY OR PARTLY) ARE SHOWN.
3. COLUMBIA RIVER 10 MILE BUFFER DEPICTED BONNEVILLE DAM TO DOWNSTREAM CONFLUENCE WITH TIDAL WATERBODIES.

REFERENCE(S)

1. ESRI (CITIES)
2. WASHINGTON DEPARTMENT OF TRANSPORTATION (INTERSTATES)
3. WASHINGTON DEPARTMENT OF ECOLOGY (WATER RIGHTS, STATE BOUNDARY)
4. U.S. DEPARTMENT OF AGRICULTURE (30M NED USED TO CREATE HILLSHADE)
5. WASHINGTON DEPARTMENT OF NATURAL RESOURCES (RIVERS)
6. COORDINATE SYSTEM: NAD 1983 STATE PLANE WASHINGTON SOUTH FIPS 4602 FEET
7. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, DELORME, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), SWISSTOPO, MAPMYINDIA, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT
ENERGY FACILITY SITE EVALUATION COUNCIL

PROJECT
SMR SITING STUDY

TITLE
MAPPED WATER RIGHTS PLACE OF USE - ACTIVE PERMITS AND CERTIFICATES FOR THE PURPOSE OF POWER GENERATION OR IRRIGATION

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-11-16
DESIGNED	GL
PREPARED	BVJ
REVIEWED	RZ
APPROVED	GB

PROJECT NO.	CONTROL	REV.	FIGURE
1539118	03	0	4-7

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5.0 Permits and Approvals For SMRs

This section describes the permits and approvals required for small modular reactors in Washington State and the processes needed to acquire them. The specific responsibilities of the NRC, EFSEC, the Federal Emergency Management Agency (FEMA), and the US Environmental Protection Agency (USEPA) are discussed in detail, due to their significant responsibilities. The roles of selected federal, state and local agencies are discussed as well. Table 5-1 lists the majority of relevant federal permit and approval requirements. Section 5.2 and the permits table within lists non-federal permits, many of which are site-specific or routine, and not discussed beyond the discussion offered in Table 5-2. And none are directly required, as EFSEC is the sole non-federal permitting agency.

The Energy Facility Site Evaluation Council has statutory authority (Chapter 80.50 RCW and Title 463 WAC) over all state and local permits and approvals to site any commercial nuclear power plant in Washington State, including any SMR facility (where their jurisdiction doesn't overlap with that of the NRC). Before permits are issued, review under the State Environmental Policy Act (SEPA) must occur. EFSEC would be the lead agency for an SMR facility siting under SEPA review. This report includes a brief discussion of EFSEC's application process.

Likewise, the NRC is the lead federal agency in charge of licensing commercial nuclear power plants, including their design, construction and operation. The NRC would be the lead agency under the National Environmental Policy Act (NEPA). These two agencies would lead site licensing and SEPA/NEPA compliance. Their roles, and the role of other federal and state supporting agencies, are discussed below.

5.1 Federal Permits and Approvals

Table 5-1 lists the most likely permits, authorizations, and approvals from federal jurisdictions that may be applicable for construction and operation activities associated with the siting of an SMR facility in the state of Washington. Additional discussion is provided for the principal agencies involved in nuclear plant siting, and their roles. The table doesn't list funding agencies (e.g., USDOE) or property managers (e.g., the Bureau of Land Management [BLM]) that may be brought in for non-routine decisions, but focuses on those who would be directly involved in permitting regardless of the site.

Table 5-1. Potential Federal Permits, Authorizations, and Approval Requirements

Federal Permit/ Approval	Regulatory Agency	Timeline	Trigger
National Environmental Policy Act (NEPA)	Nuclear Regulatory Commission (NRC)	3-4 years to issue a design certification; another 3-4 years to issue a construction and operating license before construction can begin. Alternatively, an Early Site Permit license could be issued for a site – pending a future project application – 3-4 years.	Submitting Project License Application (under Part 50 or 52,as revised), and an Environmental Report.

Table 5-1. Potential Federal Permits, Authorizations, and Approval Requirements (continued)

Federal Permit/ Approval	Regulatory Agency	Timeline	Trigger
NEPA Adequacy review under Section 309 of the Clean Air Act; Health exposure review with NRC under 40 CFR 190	Environmental Protection Agency (USEPA)	EPA works with NRC during the licensing process on exposure issues. NRC reviews USEPA findings and determinations in the NRC NEPA Process; see NEPA.	Federal Action: NRC License.
Safety response zone planning	Federal Emergency Management Agency (FEMA)	NRC reviews FEMA findings and determinations in NRC NEPA Process; see NEPA.	Memorandum of Agreement (MOA) with NRC for all offsite nuclear emergency planning and response.
Clean Water Act, Section 404 Permit	US Army Corps of Engineers (Corps)	60 days (Regional or Nationwide) to 120 days (Individual) or longer; concurrent with NEPA/SEPA process and Endangered Species Act (ESA) Section 7 consultation (if not NRC).	Working within ordinary high water mark (OHWM) of a water of the US Excavating, land clearing, or discharging dredged or fill material into a water of the US (wetlands fill).
Clean Water Act, Section 10 Permit	Corps	60 days (Regional or Nationwide) to 120 days (Letter of Permission or Individual) or longer; concurrent with NEPA/SEPA process and ESA Section 7 consultation.	Working in, over, under, or affecting a navigable water of the US, such as the Columbia River or other rivers so designated by the Corps in Washington.
ESA Section 7 Consultation (Biological Assessment)	US Fish and Wildlife Service (USFWS); National Oceanic and Atmospheric Administration (NOAA Fisheries)	6 to 12 months.	Federal action requires assessment of project impacts on federally-listed species; lead entity for consultation would be NRC or the Corps.

5.1.1 Nuclear Regulatory Commission (NRC)

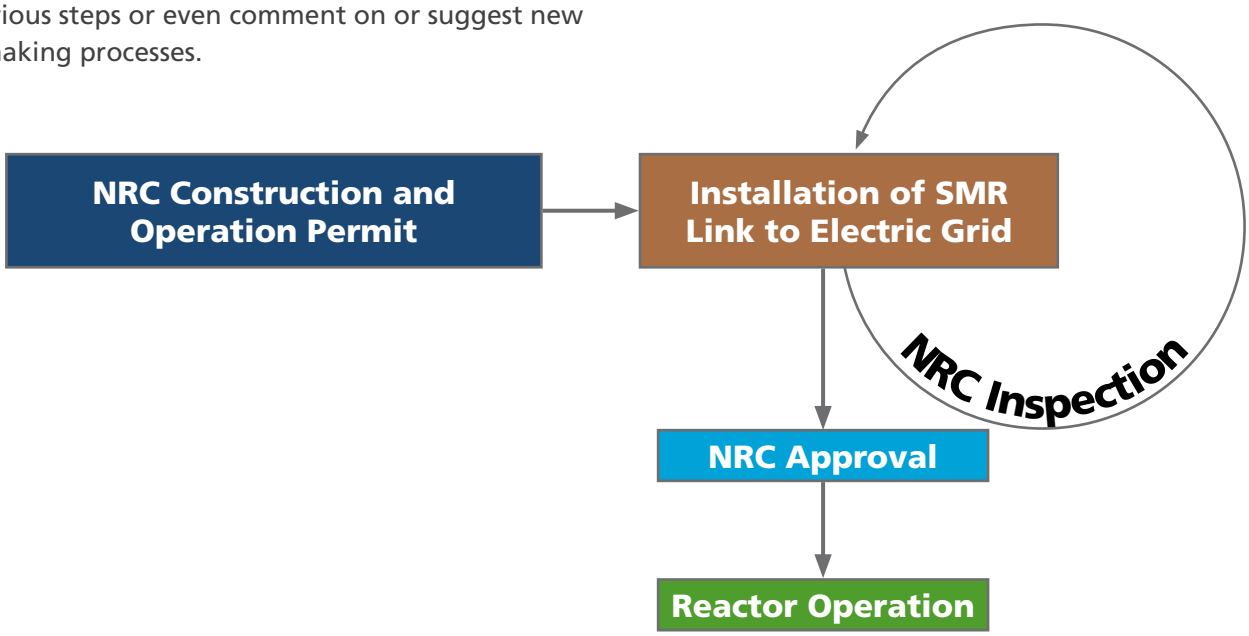
Overview

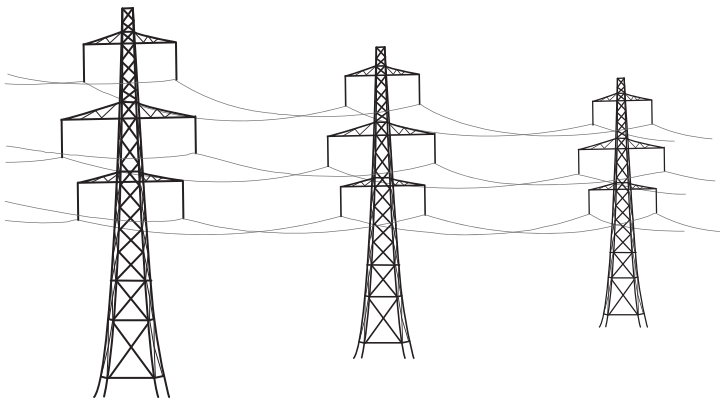
One focus of this analysis is the NRC's role in siting SMRs. The NRC's history, responsibilities, and authorities are so significant to the successful siting of any nuclear facility that we have provided this separate NRC section in the permitting discussion. The NRC's regulations have been developed over the past 30-40 years and have been applied to license the large baseload nuclear plants that are operating or are under construction in the United States. Few changes have been made in those regulations to address the potential differences between SMRs and older baseload technologies, although some interested parties are suggesting such changes. A thorough description of the NRC's permitting process informs the State about their decision processes and opportunities to work with the NRC at various steps or even comment on or suggest new rulemaking processes.

This section summarizes the current NRC licensing process, changes currently underway to address SMRs, and nuclear industry proposals to address SMR siting and regulatory compliance in the future.

The NRC has developed two alternative regulatory approaches for reactor licensing:

- 10 CFR Part 50 DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES (Part 50)
- 10 CFR Part 52 LICENSES, CERTIFICATIONS, AND APPROVALS FOR NUCLEAR POWER PLANTS (Part 52)





Both of these regulatory frameworks were developed to implement 10 CFR Part 51,"Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." License applicants have the option of working under either of these license frameworks. For the most part, these two approaches have identical technical requirements. The difference between these is primarily in the process followed. In Part 50, licensing is split between an initial construction permit and an operating license granted later, after the facility is constructed. Part 52 provides a single license, the "Construction and Operation License" (COL; also called a "Combined License"). Part 52 NUREG-1789 describes a requirement for construction inspection called ITAAC (Inspections, Tests, Analyses, and Acceptance Criteria), which is required even after the COL is approved, and before construction begins. The ITAAC process has the potential to add significant time to the steps of loading fuel and the start of operations, even after NRC licenses have been granted.

Although some potential applicants are considering the Part 50 approach, most are considering Part 52 and it is discussed in detail here.

Recognizing the complexity of reactor licensing, the NRC provides various types of guidance (e.g., "Interim Staff Guidance" [ISG]) to assist the license applicant in meeting the regulatory requirements. Guidance typically clarifies rather than changes regulatory requirements, but can include Regulatory Guides, Standard Review Plans, and even NRC Regulatory Guide (NUREG) documents. The NRC has issued ISG on combined licenses and Early Site Permits (ESP)—COL/ESP-ISG-027 and COL/ESP-ISG-028—specifically to address SMR licensing. Regulatory Guide 1.206 provides guidance for combined license applicants; NUREG-0800 provides guidance to NRC staff on reviewing design certification and license applications, and guides applicants and other reviewers on expectations. This guide would help EFSEC and their consultants in Site Certification Agreement (SCA) reviews. The NRC also provides design-specific review standards, when requested, such as those that will be used to review SMR design certifications.

Within this framework, SMRs are currently obligated to the same NRC regulations, policies, and procedures as larger reactors. However, the NRC has recognized that there are differences in how SMRs can meet these regulations. Rather than re-writing the regulations in 10 CFR Part 52, the NRC provides staff guidance in selected areas to create some flexibility for SMRs. For example, the NRC provides the following:

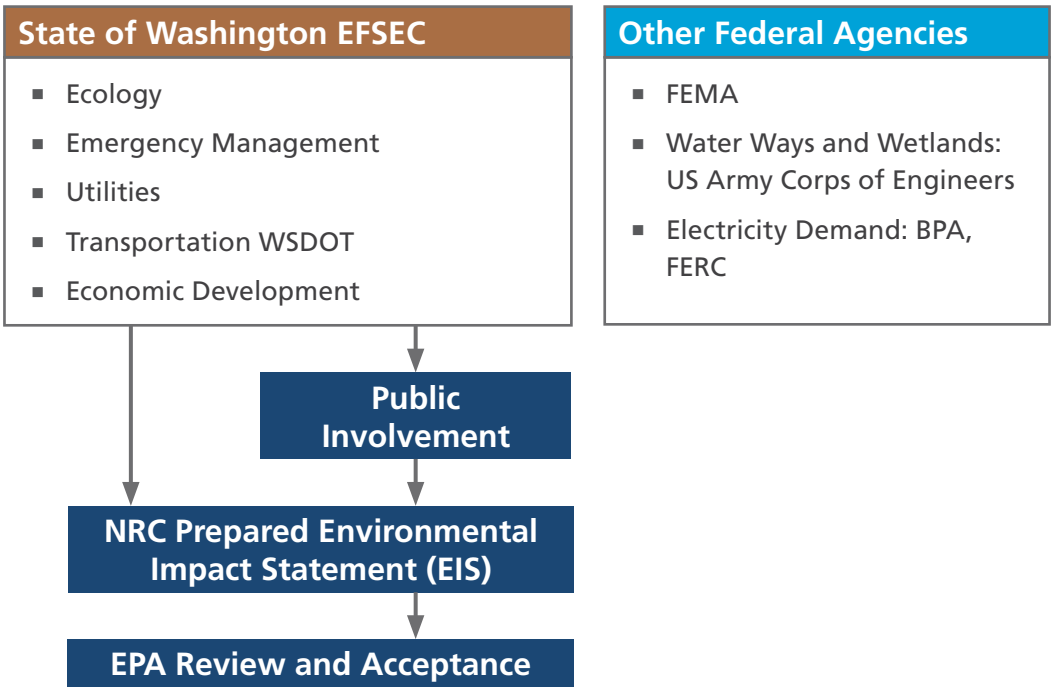
- Interim Staff Guidance on topics of general concern that are also relevant to SMR licensing
- Interim Staff Guidance specific to SMRs
- Exemption request procedures, when the license applicant wishes to meet the intent of 10 CFR Part 52 through alternative approaches

NRC Licensing Procedure – 10 CFR Part 52

NRC Environmental Impact Statement Licensing Framework

The NRC licensing procedure for new reactors is built around an environmental impact statement (EIS) prepared by the NRC staff (and their consultants). This process would overlap EFSEC's SEPA process by involving NRC staff to prepare a NEPA\SEPA EIS. The NRC licensing procedure requires that the applicant provides the input required for the 10 chapters of the EIS. The process for NRC's new reactor facility application review is specified in NUREG 0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," as follows:

- Chapter 1 provides the specification and requirements for the new reactor, including schedules, locations, and technical specifications.
- Chapter 2 describes the site, with detail sufficient to support evaluation of environmental impact.
- Chapter 3 describes all physical changes that will occur before, during, and after installation of initial and future planned modules.
- Chapter 4 details the impacts of pre-construction and construction activities.
- Chapter 5 details the impacts from operation of the facility during its proposed license period.



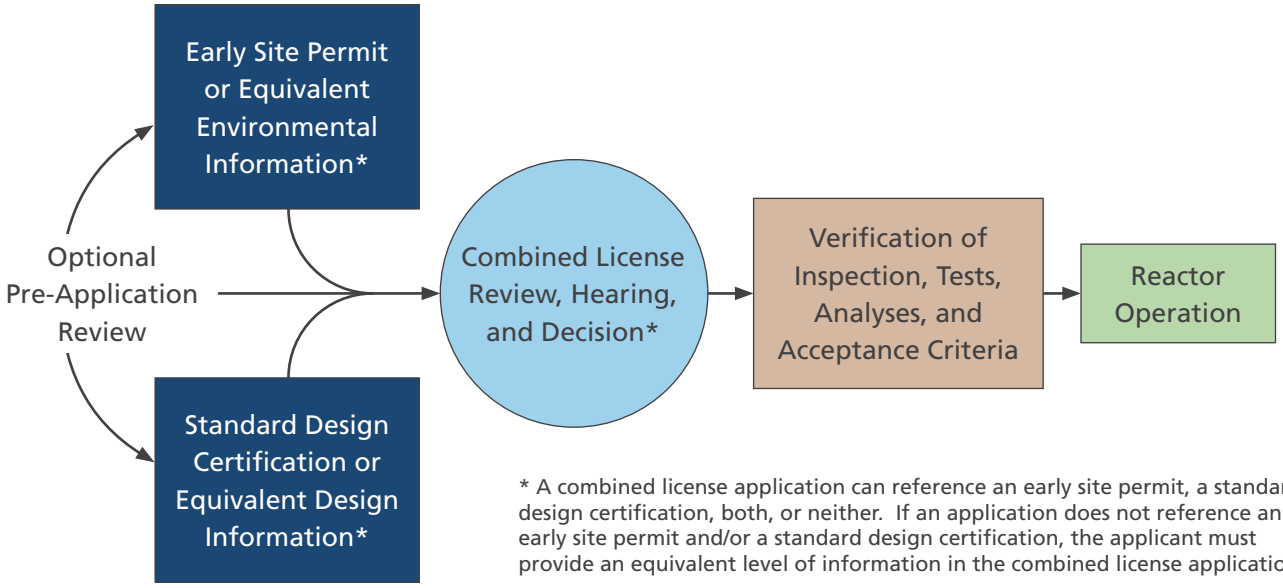
- Chapter 6 details the impacts related to the fuel cycle, including transportation and decommissioning.
- Chapter 7 details the cumulative impacts from pre-construction, through construction, operation, and closure, including foreseeable future impacts.
- Chapter 8 describes the electric demand forecasts justifying the project.
- Chapter 9 presents options to the project to meet the requirements.
- Chapter 10 synthesizes the analysis as cost-benefit, and presents NRC staff recommendations.

If an applicant were to submit an EFSEC Application for Site Certification (ASC) at the same time as their Preliminary Safety Analysis Report (PSAR), EFSEC could begin direct involvement with the licensing, starting with an application review and continuing through the EIS.

In addition to input from the applicant, the NRC new reactor licensing procedure requires input from other agencies including the Federal Energy Regulatory Commission (FERC), FEMA, USEPA, the US Department of Transportation (USDOT), and the US Army Corps of Engineers (Corps), as well as state environmental, electric utility, transportation, and emergency response agencies as discussed herein.

The Part 52 procedure provides for three types of applications: 1) Design Certification (DC); 2) Early Site Permit (ESP), and 3) a Construction and Operation License (COL). Not all owners will submit an ESP. The general permitting procedure is illustrated in Figure 5-1. With an ESP, the site is licensed separately from the nuclear reactor itself, with a "Parameter Envelope" providing the interface between the two. This provides flexibility in situations where, for example, SMR designs are still evolving and the applicant wishes to establish site suitability to expedite permitting, construction, and operation once the project's design is certified. The Tennessee Valley Authority (TVA) is currently following this procedure for their SMR proposal at the Clinch River site.

Figure 5-1. NRC Licensing Process, 10 CFR Part 52 (source: NRC 2004e [NUREG/BR-0298, Rev 2])



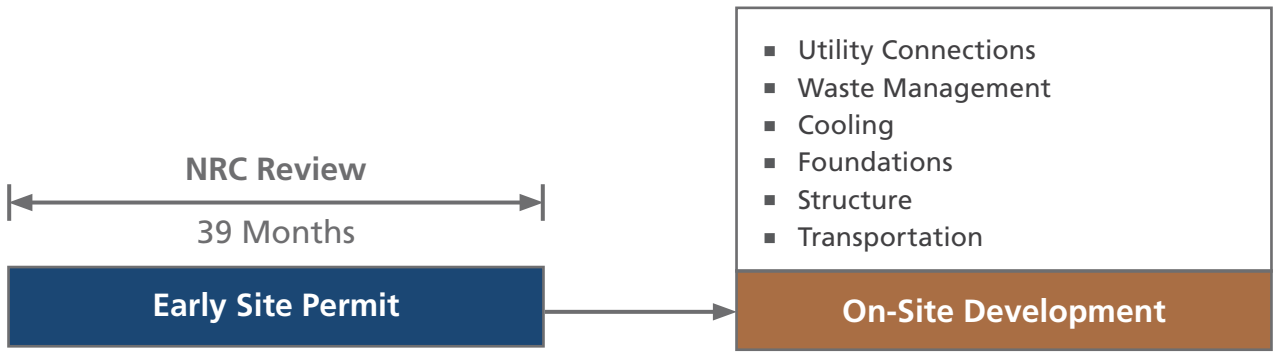
Early Site Permit (ESP)

10 CFR Part 52 provides a mechanism by which one or more nuclear power facility sites can be approved, either within the context of a defined reactor specification, or by using a "Parameter Envelope" to describe the interface between the facility and the site. The parameter envelope is the same concept used in this study to define a model SMR, which combines a set of variable parameters (power output, size, water consumption, fuel type, etc.) to use as the basis for siting discussions. By issuing an Early Site Permit, NRC approves one or more nuclear power facility sites, contingent on future project facilities meeting the technical requirements of the parameter envelope. The ESP can therefore be issued before, after, or coincident with an application for a Construction and Operation License (COL).

NRC has set the validity of ESPs to 10 to 20 years from the date of issuance, with an option to renew for an additional 10 to 20 years. If an ESP license were issued for a site in Washington, any project facility falling within the parameter envelope defined in that site license could then proceed to a COL application. This process provides two options for the State through EFSEC, discussed in Section 5.2.1.

The requirements of the ESP application are as follows (NUREG/BR-0298, Rev 2, July 2014):

- The boundaries of the site, including a discussion of the exclusion area for which the applicant has the authority to remove or exclude persons or property.
- Characteristics of the site, including seismic, meteorological, hydrologic, and geologic data.
- The location and description of any nearby industrial, military, or transportation facilities and routes.
- The existing and projected future population of the area surrounding the site, including a discussion of the expected low-population zone around the site and the locations of the nearest population centers.
- An evaluation of alternative sites to determine whether there is any obviously superior alternative to the proposed site.
- The proposed general location of any plant on the site.
- The number, type, and power level of the plants, or a range of possible plants planned for the site.
- The maximum radiological and thermal effluents expected.



- The type of cooling system expected to be used.
- Radiological dose consequences of hypothetical accidents.
- Plans for coping with emergencies.

Each of these requirements would be tailored to conditions in Washington State, including the power supply and demand, site, plant design, and possible alternative sites. The NRC would compare a site in Washington to possible sites elsewhere in the Pacific Northwest. Although an ESP may be for a site alone, extensive information about the range of characteristics of any future facility on that site must be known and presented.

Standard Design Certification (SDC)

A critical element to the successful development of SMRs for nuclear power generation is the ability to receive NRC design certification, leading into eventual construction of modules than can be reproduced and delivered to sites. NRC provides Standard Design Certification as a rule issued according to 10 CFR Part 52.54 to define the reactor facility design. This certification defines the circumstances under which the NRC would provide a Construction and Operation License. The SDC includes the following:

- A parameter envelope defining design characteristics, site requirements, and any additional issues that need to be addressed for safe construction and operation.
- Conclusions regarding the radiological safety of the design, if constructed and operated on a site with the defined parameter envelope.
- Specification of required inspection, test, analyses, and acceptance criteria.
- Requirements of the quality assurance program.

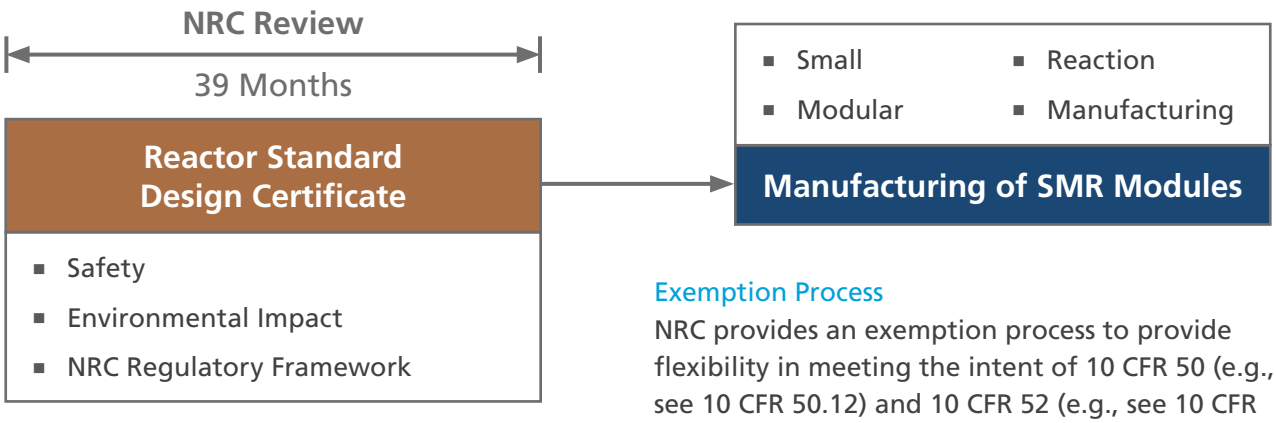
For a site in Washington State, the requirements of a Construction and Operation License would be that this SDC parameter envelope be consistent with the ESP parameter envelope. Thus, the SDC can be defined independently from any Washington State siting or site development process. However, once the parameter envelope for a site in Washington State is known, the information can be used to support reactor and facility design as part of the SDC process. This could ensure that Certified SMR designs could be sited in Washington.

Construction and Operation License (COL)

As illustrated in Figure 5-1 above, under 10 CFR Part 52, NRC will issue a Construction and Operation License (also called a "Combined License" in NRC terminology) based upon an EIS prepared by its staff, considering a pre-approved ESP and SDC. This EIS needs to ensure that the parameter envelope required by the ESP and SDC is consistent. (As discussed elsewhere, we assume this EIS would be a joint NEPA/SEPA EIS with EFSEC.)

The NRC has established that a COL can be issued contingent on a parameter envelope, even before a specific ESP has been granted (10 CFR Part 52). Consequently, the review process for the COL can to some extent be coincident with the review period for an ESP, as the Tennessee Valley Authority has planned for their site.

According to a spokesperson for the TVA, they are submitting an ESP application in the first quarter of 2016, and plan on submitting a project license application in 2018, before the ESP license is granted. The TVA has not yet selected their technology. The NuScale and mPower designs are among those under consideration.



Public and Stakeholder Review Process

NRC requires that all applications, including COL and ESP, have public and stakeholder review meetings, including public meetings near the sites. These meetings are held during NRC's EIS preparation processes, and following issue of the Draft EIS. NRC holds the standard NEPA scoping and Draft EIS hearings meetings, and EFSEC could participate in this effort through a joint NEPA/SEPA process as they have in the past. The NRC usually goes beyond the minimum required meetings and holds others.

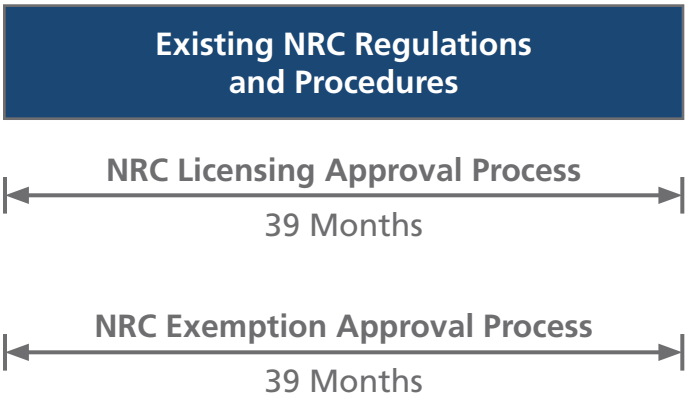
NRC Licensing Timescale

The NRC has established a time scale of 39 months for Standard Design Certification and approximately 30 months for evaluation of an Early Site Permit. The estimated approval time for a Construction and Operation License is 30 months, not including the time required for public hearings. This timescale can be longer if there are issues that the NRC does not feel have been sufficiently addressed in the applications, or if the application contains information that the NRC considers unexpected. These ESP and SDC licensing processes can be carried out independently, either consecutively or in parallel. As a result, provided that the parameter envelopes are consistent, sites and reactors can be licensed on independent time scales. Thus, no site is required for a licensee to apply for a SDC and no reactor design is required for a licensee to apply for an ESP. However, an initial parameter envelope for a site in Washington State would be useful to those designing SMRs. An initial parameter envelope of possible reactor designs would be useful in evaluating what sites in Washington State might be suitable for development of an ESP application.

Exemption Process

NRC provides an exemption process to provide flexibility in meeting the intent of 10 CFR 50 (e.g., see 10 CFR 50.12) and 10 CFR 52 (e.g., see 10 CFR 52.93). The exemption process is expected to be used to address differences between SMR and larger facilities, particularly given the length of time needed for NRC to prepare updated rules and procedures specific to SMR. The exemption process provides specific requirements to ensure that the intent of the regulations are met, and the NRC estimates the approval of an exemption request will take 39 months.

The specific exemption processes that would be required for an SMR site in Washington State depends in part on what rules the NRC updates. NRC is considering rulemaking for several key issues, including source terms, Emergency Planning Zones (EPZ), facility security, and decommissioning. The timeframe for rulemaking is generally about 60 months. Of these potential new rules, only the EPZ process has been initiated by NRC.



ITAAC Inspection during Construction and Operation

10 CFR Part 52.99, Inspection during Construction is currently an essential part of the NRC licensing process, and can have a significant effect on schedules and cost. The NRC carries out a sequence of inspections during construction, operation, and decommissioning, starting no later than 1 year after issuance of the Construction and Operation License or at the start of construction as defined at 10 CFR 50.10(a), whichever is later. The ITAAC process is designed to ensure that, after the ESP, SCD, and COL have been granted, the facility continues to meet the goals and intents of 10 CFR Part 52. The ITAAC process would occur well after the Governor's approval of a Site Certification Agreement. Compliance conditions in the SCA can consider this as an option.

Given the nature of ITAAC, it is difficult to predict the costs or delays in operation that may occur, even following approval. NRC states in 10 CFR Part 52.99 that an applicant for a combined license may proceed at its own risk with design, procurement activities construction, and preoperational activities, considering the effect of activities subject to ITAAC, even though the NRC has already granted an ESP and/or SCD. Some limited site work can begin, before the NRC grants a COL. The benefit of an SMR is that one of the ITAAC inspection targets—the design and reactor construction—is pre-approved; the reactor delivered on site as an approved module. However, all the other project considerations still require extensive ITAAC review. The COL holder cannot load fuel and start commercial operation until the NRC finds that the acceptance criteria for all ITAAC have been met (10 CFR 52.103(g)). This would be well after EFSEC has granted an SCA, so conditions in the SCA would likely refer to this activity and its approval.

NRC Licensing Issues Specific to SMRs

It is generally assumed that SMR facilities will be licensed according to 10 CFR Part 52, and that is therefore the focus of the following discussion. Potentially significant differences between licensing procedures for conventional 1,000 MW+ plants and SMRs, which can be as small as 50 MW, are as follows:

1. SMRs will be manufactured off site, and may be licensed separately from the site through the SDC and ESP process. This requires specification of the "Parameter Envelope" interface between Reactor and Site.
2. Multiple reactor modules may be located at a single site, and may be licensed on separate time frames.
3. Radiological contamination source terms are expected to be significantly different for SMRs, based on lower anticipated exposure scenarios.
4. Reactor safety features are expected to be significantly different for SMRs, resulting in different Emergency Planning Zone requirements.
5. Cooling requirements are expected to be lower for SMRs.
6. Control Room Operator Requirements will reflect a changing safety regime and project size.
7. Insurance requirements, and some other requirements now in place per (1,000 MW) reactor may now be per site, recognizing the trend toward multiple small SMRs.

Off-Site and On-Site Facility Development

While a small modular reactor in Washington State would require considerable site work to develop cooling systems, waste management, foundations, and site infrastructure, the size of the site would be significantly less than that required for the reactors built in the 1970s when reactor facilities were custom-designed and licensed on site. NRC regulations are already established to consider offsite and onsite development activities. However, the State of Washington will need to consider the additional aspects of transportation to and from the site, including module and fuel rod transport, and the potential for offsite manufacturing facilities within the state.

Multiple Reactors per Site

Most SMR approaches are based on an assumption that multiple reactor units will be installed on a single site. This has been addressed by NRC COL-ISG-022, "Interim Staff Guidance on Impact of Construction (under a Combined License) of New Nuclear Power Plant Units on Operating Units at Multi-Unit Sites," which provides specific additional requirements for such systems.

The NRC has identified four alternative scenarios for environmental licensing at an SMR site (NRC ESG-ISP-027):

- Scenario 1: A single license application for all reactors at the site.
- Scenarios 2 and 3: Two or more license applications at the site, with or without site expansion.
- Scenario 4: Early Site Permit and Construction and Operation License for groups of modules as they are to be installed.

For each of these scenarios, the NRC has established a license application procedure describing how the approval process would proceed, and how "Performance Envelopes" would be preserved between ESP and SDC to the COL approval and ITAAC. EFSEC might issue an SCA for modules submitted in an application, and consider an amended application to cover future modules and new site conditions.

Source Term

The potential radiological contamination due to reactor operation depends on the combination of the amount and type of radiation at the reactor (the "source term") and the pathway from the radioactive source to the environment. SMR facilities are significantly smaller than conventional power reactors, and therefore are expected to provide different radiological contamination source terms. The NRC has not yet initiated preparation of licensing guidance for these smaller source terms. Consequently, it is anticipated that the use of a smaller source term for safety calculations will be addressed through the exemption process. The source term is required both for the safety assessment portion of EIS, and for establishment of the Emergency Planning Zone (EPZ).

The size of the EPZ, and its potential reduction, could be a significant cost and technical issue for SMR licensing. If, for example, a site has a small EPZ (e.g., a 2-mile radius), that zone could substantially avoid major population centers, transportation routes, and critical infrastructure such as ports and universities. However, for a large EPZ (e.g., 50-mile radius), the population and infrastructure to be considered is likely to be much larger. And the larger the area, the greater the cost of analysis, planning, infrastructure development, public involvement and mitigation.

Reactor Safety

NRC document DC/COL-ISG-028, "Assessing the Technical Adequacy of the Advanced Light-Water Reactor Probabilistic Risk Assessment for the Design Certification Application and Combined License Application," provides guidance for the safety assessment of SMRs, as required by the NRC's application process. This document was originally designed to address the technical adequacy of the probabilistic risk assessment (PRA) needed for an application for design certification of an advanced light-water reactor (ALWR) according to 10 CFR 52.47(a)(27) and 10 CFR 52.79(a)(46), (ASME 2009).

The NRC uses a PRA Standard for Safety Assessment to reflect the combined risk of all reactor systems, and their interaction with the site and environment over time. The NRC considers this approach appropriate for SMR facilities. However, the way that the NRC has specified PRA makes assumptions that cannot yet be met because the SMR safety concept relies significantly on the separate Early Site Permit and Standard Design Certification of the reactor facility. The NRC has therefore stated a need to adapt these procedures so that PRA can be carried out for small modular reactors. However, the NRC has not yet initiated this process.

Emergency Planning Zone (EPZ) Requirements

One of the areas in which the NRC has made some progress in establishing guidelines for SMRs is in the Emergency Planning Zone Requirements. The NRC document SECY-15-0077 proposes a "consequence-based approach to establishing requirements," which is potentially more flexible than the prescriptive approach assumed in 10 CFR Part 52. The zone size is defined based on upon projected offsite dose in case of severe accident. The current EPZ framework for the governing EPZs for light-water reactors is based on USEPA's Protective Action Guides (PAG). The PAG manual contains radiation dose guidelines that would trigger public safety measures, such as evacuation or staying indoors, to minimize or prevent radiation exposure during an emergency. The USEPA develops PAGs to help responders plan for radiation emergencies, and would work with the State's Department of Emergency Management in response planning.

The NRC has provided procedures under which an exemption to the prescriptive EPZ requirement can be modified. Note that this ISG is still under development, and when finalized will still require an exemption process for approval.

Cooling Requirements

Operational and emergency reactor cooling is critical safety issue, and is therefore addressed in detail in NRC regulations (e.g., 10 CFR 50.46 and 10 CFR 50.54). These regulations are generally based on the design assumptions of Gigawatt-scale reactor facilities. The NRC is not currently considering revision of these requirements for SMRs (Grenci and Haemer 2010). Consequently, SMR licensing would require an exemption process for approval.

Control Room Operator Requirements

Control room operator requirements for SMRs are expected to be significantly different than for conventional large reactors. Instead of a control room for each one or two reactors, SMR control rooms may run several modules. The NRC has not yet initiated preparation of revised regulations for these requirements, and therefore does not expect such regulations to be available within the next several years. Consequently, it is anticipated that Construction and Operation Licenses for SMRs will address control room operator requirements under the exemption process until new regulations are adopted.

NRC's Guidance

In conclusion, there are a few changes in the NRC licensing process that might be in place by the time a nuclear project is proposed for Washington. Assuming the regulations and policies under review or consideration are proposed as regulatory guidance changes, and no inordinate delays occur to their development process; and NRC decides to move them from exemption status to part of the SMR standard license approach, these new changed may be in place. The available schedule to develop these changes is approximately as follows, based generally on the UAMPS schedule:

- NRC licenses an SMR technology – 2016 to 2020
- NRC licenses a project for construction and operation – 2018 to 2020
- SMR is constructed and operated – 2020 to 2023
- Application is developed and submitted for an SMR in Washington – 2024 or later

This schedule assumes a future Washington applicant will await results of the Idaho project, or won't start siting until the design certification is issued in 2020 or so.

Washington State SMR Licensing Scenario

Here is a description of how an SMR baseload electric generating station might be sited in Washington through the NRC. Steps marked with an asterisk indicate opportunities for public comment.

1. Applicant selects site and takes 1-2 years assembling a project license application for NRC (Under Part 52 as revised above).
2. License application and Environmental Report are submitted to NRC for review and comment*. ASC submitted to EFSEC if project is included.
3. NRC issues its deficiency analysis and comments to applicant. (as does EFSEC)
4. Applicant addresses deficiencies and NRC accepts it as a complete document; Begins license review*.
5. NRC Prepares NEPA EIS (NEPA/SEPA with EFSEC) and License Application Review and Presents licensing case to the Commission*.
6. Commission holds hearings and makes a decision*.

5.1.2 Federal Emergency Management Agency (FEMA)

On December 7, 1979, the President, in response to the recommendations of the Kemeny Commission on the Accident at Three Mile Island, directed that the Federal Emergency Management Agency assume lead responsibility for all offsite nuclear emergency planning and response. The following provides a summary of the 44 CFR Part 353 Appendix A, "Memorandum of Understanding between NRC and FEMA Related to Radiological Emergency Planning and Preparedness." This discussion focuses on FEMA activates related to NRC licensing and does not include a detailed discussion of responsibilities related to radiological emergency and incident response.

On January 14, 1980, FEMA and the NRC entered into a Memorandum of Understanding (MOU), since updated, that establishes a framework of cooperation in radiological emergency response planning matters. The MOU establishes this framework so that the two agencies' mutual efforts will be directed toward more effective plans and related preparedness measures at and near nuclear reactors and fuel cycle facilities which are subject to 10 CFR Part 50, Appendix E, and certain other fuel cycle and materials licensees that have potential for significant accidental offsite radiological releases. The general principles agreed to in the MOU are as follows:

- FEMA coordinates all federal planning for offsite impact of radiological emergencies, takes the lead for assessing offsite radiological emergency response plans and preparedness, makes findings and determinations as to the adequacy and capability of implementing offsite plans, and communicates those findings and determinations to the NRC.
- The NRC reviews those FEMA findings and determinations in conjunction with NRC onsite findings to make determinations on the overall state of emergency preparedness. The NRC uses these overall findings and determinations to make radiological health and safety decisions in the issuance of licenses and the continued operation of licensed plants to include taking enforcement actions as notices of violation, civil penalties, orders, or shutdown of operating reactors.
- The NRC and FEMA have earlier MOUs dealing with radiological emergencies, response, and preparedness.

FEMA coordinates all federal planning for offsite impact of radiological emergencies and takes the lead for assessing offsite radiological emergency response plans and preparedness, makes findings and determinations as to the adequacy and capability of implementing offsite plans, and communicates those findings and determinations to the NRC.

The NRC reviews those FEMA findings and determinations in conjunction with NRC onsite findings for the purpose of making determinations on the overall state of emergency preparedness. The NRC uses these overall findings and determinations to make radiological health and safety decisions during licensing and the continued operation of licensed plants, including taking enforcement actions such as notices of violation, civil penalties, orders, or shutdown of operating reactors.

Early Site Permit (ESP) Applications

As described in the NRC permitting discussion above, an ESP is issued by the NRC for one or more sites for a nuclear power facility, independent of a specific nuclear plant design. An ESP is valid for 10 to 20 years. In reviewing an ESP application, the NRC will address site safety issues, environmental protection issues, and plans for coping with emergencies.

FEMA will receive ESP information from the NRC provided by the applicant and review for significant impediment to the development of offsite emergency plans. FEMA will determine whether major features of offsite emergency plans submitted by the applicant are acceptable. FEMA's review will include an assessment as to whether these plans meet the standards and criteria of NUREG-0654/FEMA-REP-1. FEMA findings will indicate one of the following three conclusions:

1. Plans are adequate and there is reasonable assurance that they can be implemented with only limited or no corrections needed.
2. Plans are adequate, but before a determination can be made as to whether they can be

implemented, corrections must be made to the plans, or supporting measures must be demonstrated (e.g., adequacy and maintenance of procedures, training, resources, staffing levels and qualifications, and equipment).

3. Plans are inadequate and cannot be implemented until they are revised to correct deficiencies.

NRC Licensing Reviews

The NRC rules (10 CFR 50.33, 50.34, 50.47, 50.54, and Appendix E to 10 CFR Part 50, and 10 CFR Part 52) include requirements for the licensee's emergency plans. Specifically, the NRC responsibilities for radiological emergency preparedness are as follows:

1. Assess licensee emergency plans for adequacy. This review will include organizations with whom licensees have written agreements to provide onsite support services under emergency conditions.

2. Verify that licensee emergency plans are adequately implemented (e.g., adequacy and maintenance of procedures, training, resources, staffing levels and qualifications, and equipment).

3. Review the FEMA findings and determinations as to whether offsite plans are adequate and can be implemented.

4. Make radiological health and safety decisions with regard to the overall state of emergency preparedness (i.e., integration of emergency preparedness onsite as determined by the NRC and offsite as determined by FEMA and reviewed by the NRC) such as assurance for continued operation, for issuance of operating licenses, or for taking enforcement actions (e.g., notices of violations, civil penalties, orders, or shutdown of operating reactors).

FEMA provides support to the NRC for licensing reviews related to reactors, fuel facilities, and materials licenses with regard to the assessment of the adequacy of offsite radiological emergency response plans and preparedness. This includes timely inclusion in NRC safety evaluation reports. If an applicant started the licensing process for an SMR in Washington State, FEMA would review the project's offsite emergency plans to determine the level of compliance with the standards and criteria of the joint publication NUREG-0654/FEMA-REP-1. The NRC would review the FEMA findings under its responsibilities for radiological emergency preparedness. The NRC will grant a license only if the health and safety of the public are determined to be adequately protected.

5.1.3 US Environmental Protection Agency (USEPA)

The USEPA has two supporting roles in the licensing process for SMRs. The first role is establishing the dose and environmental impact standards that the NRC must meet in their regulations. These requirements are codified as 40 CFR 190, "Environmental Radiation Protection Standard for Nuclear Power Operations." These standards define the maximum allowable dose regarding human health (in milliSieverts [mSv]), and also the maximum radiological release to the environment (in millicuries [mCi]). These standards were issued in 1977. Since 2013, USEPA has been engaged in a proposed rulemaking for updating this standard to reflect current science. This proposed rulemaking includes consideration of whether any changes would be appropriate for specific technologies (such as SMRs and advanced light-water reactors). The public comment period for this proposed rulemaking closed in August 2014.

The second USEPA role under NEPA is the responsibility for reviewing and approving the EIS prepared by the NRC as part of a power facility's Construction and Operation License under 10 CFR Part 50 or 10 CFR Part 52. For an SMR site in Washington, this review would be carried out by USEPA District 10, Office of Compliance and Enforcement (OCE), with technical support from the USEPA Headquarters in Washington, DC. The USEPA issued a guidance document for this review in 2008 (USEPA 2008). The ongoing rulemaking effort at USEPA referenced above also involves consideration of what changes, if any, would be appropriate to this review procedure for SMRs.

5.1.4 Other Federal Agencies

Any federal agency with a decision to make may have some role in permits or approvals for an SMR. The role might be funding, in terms of a grant or loan, such as those issued by the US Department of Energy (USDOE); a permit decision or approval by USEPA such as a National Pollutant Discharge Elimination System (NPDES) permit if the project is on federal land (e.g., if a wastewater discharged to surface or ground waters, NPDES is triggered); or a federal land ownership decision and approval , including NEPA compliance, would be presumed if the project occurs on a US Fish and Wildlife Service reserve, on Bureau of Land Management lands, or other federal property.

National Environmental Policy Act compliance would be accomplished with the NRC as the lead agency for the NEPA process. The NRC would review their site screening analysis procedure, although that might be revised for SMRs as analytical techniques may have been developed for larger baseload regional power plants. The NRC would be responsible for scoping, purpose and need definition, alternatives, and oversight of the EIS process. They would issue a Draft and Final EIS, hold commission hearings on the project. This would follow the normal licensing process of applicant submittals, adequacy reviews and requests for information, and applicant responses.

A likely alternative process, which is also preferred, is a joint federal/state EIS with NRC as the federal lead agency and EFSEC as the State's SEPA lead, leading to a NEPA/SEPA EIS process. If this is done, as it has been done successfully in the past, the NEPA/SEPA EIS would start with an extensive dataset in the form of an Application for Site Certification submitted to EFSEC and an Environmental Report and Preliminary Safety Analysis Report submitted to the NRC. The independent consultant selected for the EIS could prepare the draft EIS after a successful adequacy and completeness review, and then complete the final EIS based on comments. This could be done in approximately one year if the submittals were adequate; this possible timeframe is based on the schedule achieved by the NRC and EFSEC during preparation of the Skagit/Hanford Project NEPA/SEPA EIS.

Because of the complexity and relative newness of an SMR EIS (there are no precedents), and the process differences and logistics constraints of joint agencies on opposite coasts, the success of a joint federal/state NEPA/SEPA EIS would probably be contingent on a well- crafted Memorandum of Understanding between the agencies, and potentially involving other agencies if they have a decision to make (Corps, FEMA, USEPA, Bureau of Indian Affairs, etc.). Details about what might be included in the MOU are discussed in Section 7 – Recommendations.

5.2 State and Local Permits and Approvals

State and local jurisdictions do not have direct regulatory authority over siting an SMR facility or any project in Washington that is under EFSEC regulatory authority. EFSEC coordinates all evaluation and licensing steps and can use state and local agencies to support their review process, but EFSEC is the single, sole permitting authority for the state. No state or local permits are required, but the applicant must demonstrate compliance with all other state and local permits/approvals, or ask for a waiver from them; alternatively, EFSEC can ask local jurisdictions to proceed. The state and local permits/approvals listed in Table 5-2 are those that the applicant would need to show consistency with to receive a Site Certification Agreement (SCA). Following Table 5-2 is a detailed discussion of EFSEC and a brief discussion of other state-level permits or approvals listed in the table. If an SMR project is approved, EFSEC issues an SCA in lieu of any other individual state or local agency permits.

Table 5-2. State and Local Permits and Approvals with which Applicants Must Show Consistency

Permit/Approval	Regulatory Agency[1]	Timeline[2]	Trigger
State			
State Environmental Policy Act (SEPA)	Energy Facility Site Evaluation Council (EFSEC)	12 months or longer; usually concurrent with NEPA environmental review	Submitting Application for Site Certification
Site Certification Agreement	EFSEC	12 to 14 months from application submittal to recommendation to Governor	Completion of EFSEC consistency determination, adjudicative proceedings, and SEPA review
Clean Water Act Section 401 Water Quality Certification	Washington State Department of Ecology (Ecology)	Usually 3 months, but can take up to 1 year; concurrent with Corps Section 404 permit process; up to 6 months after public notice to issue 401 Certification	Applying for a federal license or permit to conduct any activity that might affect water quality
Clean Water Act National Pollutant Discharge Elimination System (NPDES) Permit	Ecology	3 to 6 months and issued at least 60 days prior to construction	Disturbance of 1 or more acres of land; regulates stormwater discharges
Clean Water Act Individual or Industrial NPDES Permit (Wastewater Discharge Permit)	Ecology, Water Quality Program	6 to 12 months	Discharge of wastewater to the ground or industrial wastewater to municipal treatment plant
Water Right Change Permit	Ecology, Water Resources Program	Indefinite, averaging more than 5 years but expedited through an applicant paid program, the actual time will vary according to location, complexity, and the number of other applications competing for the same source of water	Changing or adding new places of use, diversion or withdrawal, or change use of existing water right
New Water Right	Ecology, Water Resources Program	Indefinite, averaging more than 14 years	Project use of groundwater or surface water
Aquatic Use Authorization (Aquatic Lands Lease)	Washington Department of Natural Resources (WDNR)	6 months to a year after DNR receives complete application	Activity on state-owned aquatic land
Hydraulic Project Approval (HPA)	Washington State Department of Fish and Wildlife (WDFW), Habitat Program	Maximum 45 calendar days after receipt of complete application; (complete application includes SEPA decision)	Applicable if using, diverting, obstructing, and changing the natural flow or bed of state waters

Table 5-2. State and Local Permits and Approvals with which Applicants Must Show Consistency (continued)

Permit/Approval	Regulatory Agency[1]	Timeline[2]	Trigger
State			
Air Quality Minor Source Registration Program	Ecology or one of seven Regional Clean Air Agencies (Benton, Northwest, Olympic, Puget Sound, Southwest, Spokane, Yakima)	Varies	Operation that emits any of the criteria pollutants above the levels identified in WAC 173-400-102(5) or toxic air pollutants above levels identified in WAC 173-460-150
Air Quality Notice of Construction (NOC) Permit	Ecology or one of seven Regional Clean Air Agencies	60 to 90 days, up to 6 months	Construction of a new source of air pollution (or modification of an existing source of air pollution)
Air Quality (Demolition/Removal Notification Form)	Ecology or one of seven Regional Clean Air Agencies	10 day notice	Demolition or removal of any structures
National Historic Preservation Act Section 106 Consultation Archaeological Site Alteration and Excavation Permit	Washington State Department of Archaeology and Historic Preservation (DAHP)	Variable for Section 106 consultation; 45 to 60 days for alteration or excavation permit	Federal action requires assessment of potential project impacts on cultural resources
Radioactive Air Emission License to Operate New Facility Approval to Construct	Department of Health, Office of Radiation Protection	30 to 60 days or longer based on complete information after receipt of NOC	Potential to emit radionuclides into the air
Resource Conservation and Recovery Act (RCRA) Site Identification Number (RCRA Site ID)	Ecology, Hazardous Waste and Toxics Reduction Program	2 weeks	Applies if project will generate waste that may be designated as a dangerous waste. Ecology has cleanup jurisdiction
Notice of Intent to Construct or Decommission a Well Well Construction and Operator's License	Ecology, Water Resources Program	2 weeks	Drilling activities (water wells, monitoring wells, geothermal heat pump borings, or geotech soil borings)
Coastal Zone Management Certification (CZM)	Ecology	60 days (federal project); 180 days for licenses, permits	Federal action within any of the state's 15 coastal (abutting marine and marine influenced waters) counties
Washington Forest Practices Permit	Washington Department of Natural Resources (WDNR)	60 days	Timber harvest in eastern or western Washington

Table 5-2. State and Local Permits and Approvals with which Applicants Must Show Consistency (continued)

Permit/Approval	Regulatory Agency[1]	Timeline[2]	Trigger
Local			
Building Permit	County Planning Department	Varies	Construct permanent facility or addition to existing facility
Critical Areas Ordinance (CAO)	County Planning Department	Varies, concurrent with Shoreline and SEPA process	Proposing a project in, or near critical areas or in protective buffer zones as defined by the County
Shoreline Management Program Permit Shoreline Conditional Use (CUP)/ Substantial Development (SSDP) (or Variance or Exemption)	County Planning Department; Approved by Ecology	2 to 4 months; up to 18 for complex project, concurrent with SEPA process (Ecology's decision within 30 days)	Project proposed within 200 feet of a stream, lake, or associated wetlands and floodplains (SSDP for all non-exempt development and uses exceeding $6,416 fair market value)
On-site Sewage System Permit	County Planning Department	Varies	Installing, repairing, or expanding an onsite sewage treatment (septic) system and drainfield with less than peak daily flows of 3,500 gallons of residential-strength sewage

[1]*EFSEC is still the only state permit authority*

[2]*Not applicable under EFSEC authority and schedule*

5.2.1 EFSEC

Under Revised Code of Washington (RCW) 80.50.020 (12)(a), EFSEC has siting authority over any nuclear power facility whose primary purpose is to produce and sell electricity. Thus, any nuclear power plant, regardless of size, that is proposed to be operated in Washington State to generate electricity is under EFSEC's jurisdiction, including an SMR. Jurisdiction is not limited to plants larger than 350 MW, like other thermal plants under EFSEC jurisdiction. An exception might include a federally sponsored research reactor under exclusive control of the Department of Defense or the USDOE, but no such reactors are anticipated under this study. Like other qualified energy facilities, this means that only one non-federal permit decision is made for a permit application: the approval or denial of a Site Certification Agreement (SCA) under EFSEC's rules.

The EFSEC process is well known to the sponsors of this document so we do not go into a detailed discussion of compliance requirements, application content, or the adjudicatory process. In summary, after the submittal of a license application, (Application for Site Certification [ASC]) under EFSEC's Rules (Title 463 WAC), the application is reviewed by EFSEC's independent consultant, an EIS is prepared, and hearings are held. The only submittal required of an applicant is a complete ASC, which is consistent with EFSEC's siting regulations in Chapter 463-60 WAC. Part of that consistency is providing enough project design to describe all aspects of the project, including construction and operation; showing that the requirements of all permits and approvals have been met, including the permit requirements described in a Joint Aquatic Permit Application (JARPA); and providing sufficient information to move forward

with a NEPA and/or NEPA EIS. The WAC does not specifically ask for any actual permit applications besides air and water permit applications in WAC 463-60-536 and 537, although the applicant is responsible for compliance with other permits.

At the end of the application review, adjudicatory and environmental review process, EFSEC makes a recommendation to the Governor, who makes the decision to approve or deny the project. The recommendation follows the findings of fact and conclusions of law determination by the administrative law judge who administered the hearing(s) and the Council generally follows those findings. There is a remand option available to the Governor, but the approval/denial requirement remains.

Applicants need to demonstrate compliance with all local and state laws and regulations, or request a waiver from them. SEPA compliance is satisfied by EFSEC as the Lead Agency, generally with an EIS on large new projects. The applicant also applies for applicable federal permits to construct and operate the facility. The federal permits are required for the project to proceed with construction and operation, but are generally limited to parts of the facility (wetlands fill, ESA compliance, floodplain issues, etc.) and are ancillary to the construction and operating permit incorporated into EFSEC's SCA. Federal permits require NEPA compliance, but some federal permits are for relatively minor portions of the project (e.g., a 2-acre wetlands fill) that may not individually trigger an EIS. There is an exception when a federal agency feels that their decision is critical to the feasibility of the project, and also feels that there is a likelihood of significant impacts or controversy, and requires an EIS as a result. In such a case, the federal agency looks at many impacts, often those outside of their permitting purview. A nuclear project, for example, brings on a federal agency (the NRC) with a significantly expanded regulatory role whose decision is absolutely critical to the design, construction and operation of the project. Thus, it can be assumed that the NRC would require a NEPA EIS with an SMR, and that EFSEC will play a major decision-sharing role with the NRC for it.

In both cases, the agency's decision on the EIS influences the project decision and other permits and approvals.

In addition to the process described above, another option available to an applicant to EFSEC under this process is a Potential Site Study (PSS). The benefits and options under this separate study option, conducted before an application submittal, are discussed in the Recommendations section.

The other permitting roles and responsibilities associated with nuclear siting in Washington are discussed elsewhere in this section. With regard to EFSEC, the NRC has federal responsibility over the design, construction, and operation of a nuclear power plant. Following the federal supremacy clause, and related federal regulations, the State's role in siting a nuclear project can be to regulate those activities not already regulated by the federal government (NRC) or delegated to the State (e.g., NPDES). This report is not a legal regulatory standing analysis of the NRC versus EFSEC. Suffice to say that the NRC has considerable authority over the transport, use and disposal of nuclear fuels, and the design, construction and operation of nuclear plants. EFSEC has authority over all plant elements that the NRC does not deem critical to the nuclear cycle. Instead of trying to define them all here, and making jurisdictional determinations, we summarize how the NRC and the State handled these responsibilities on a previous occasion when a commercial baseload nuclear power plant was proposed for Washington State.

Between 1979 and 1983, Puget Sound Energy (now PSE) was proposing a nuclear power plant in Skagit County (the Skagit River nuclear plant), and went through a range of actions. The facility was the subject of a county-wide straw vote when 72% of the voters agreed that plans for the plant should be stopped. Puget Sound Energy submitted new applications (to EFSEC and the NRC) for the project to be located on the Hanford Reservation (the Skagit/Hanford Project). They sponsored a Draft and Final EIS for the project. They ultimately cancelled the project after neither the Final EIS nor the Northwest Power Planning Council saw a clear need for the project.

When the applications were submitted to the NRC and EFSEC, the two agencies agreed to split their project review and authorization responsibilities by signing an MOU that designated the NRC as the lead and the analyst for all nuclear-related aspects of the project, and all nuclear related impacts and risks, while EFSEC took responsibility for all non-nuclear aspects. The NRC took responsibility for their alternatives analysis process as well, and EFSEC incorporated this analysis. Joint application reviews were conducted and the NRC staff chaired meetings discussing adequacy comments on the application.

This joint review and NEPA/SEPA process went well, and resulted in a Final NEPA/SEPA EIS that was ready to publish, except that the NRC could not publish the NEPA/SEPA final EIS with the Need in question. Without a final EIS, the NRC didn't proceed with hearings and a Record of Decision (ROD).

We assume that any future SMR submittal will trigger a similar process, with the NRC and EFSEC coordinating their respective reviews and separate responsibilities, and that would be the NRC/EFSEC permitting process. This will result in a coordinated review and permitting process, and mutual decisions by both parties. Details about the NRC's permitting process are discussed elsewhere in this permitting section.

The NRC and EFSEC hearings may go in different directions, but both will result in an open discussion of project impacts, security, health risk, mitigation, and final agency decision. If both agencies approve the project(s) we assume that similar shared oversight roles could carry into construction and operation. This effort combines the considerable staff resources and expertise that can be brought to bear on nuclear power projects by the NRC, and the diverse and local expertise and public accountability offered by EFSEC, and by any independent third party consultant selected by EFSEC (and confirmed by the NRC as the NEPA EIS consultant).

5.2.2 Other State and Local Permits and Approvals

Clean Water Act 401 Certification

The federal Clean Water Act allows states to approve, condition, or deny projects proposed in waters of the United States, including wetlands. Projects that may result in a discharge to these waters must first receive a permit or license from one of several federal agencies.

EFSEC issues a 401 Certification when the Washington State Department of Ecology (Ecology) has reasonable assurance that the applicant's project will comply with state water quality standards and other aquatic resources protection requirements under Ecology's authority. The 401 Certification can cover both the construction and operation of a proposed project. Conditions of the 401 Certification become conditions of the federal permit or license.

To request a 401 Certification, applicants would normally submit a Joint Aquatic Resources Permit Application, along with any additional information applicable to the project (for example: mitigation plan, restoration plans, etc.) to Ecology's Federal Permit Unit. In this case, JARPA-related conditions would need to be met in license submittals to EFSEC and/or the NRC. Typical requirements addressed in a JARPA permit include the following (Ecology 2015b):

- Federal
  - US Army Corps of Engineers Section 10 Permit
  - US Army Corps of Engineers Section 404 Permit
  - US Coast Guard Private Aids to Navigation Permit
- State
  - Ecology 401 Water Quality Certification
  - Washington Department of Fish and Wildlife Hydraulic Project Approval
  - Washington Department of Natural Resources Aquatic Use Authorizations for State Owned Aquatic Land
- Local (City or County)
  - Shoreline Conditional Use Permit
  - Shoreline Substantial Development Permit
  - Shoreline Variance
  - Shoreline Exemption
  - Shoreline Revision

National Pollutant Discharge Elimination System (NPDES) Stormwater and Industrial Wastewater

Mandated by Congress under the Clean Water Act, the National Pollutant Discharge Elimination System is delegated by the USEPA to the State of Washington for implementation. The adequacy of meeting the requirements of this permit is required in an Application for Site Certification for any disposal of wastewater material into "waters of the state," which include rivers, lakes, streams, and all underground waters and aquifers. Ecology would review ASCs for adequacy in responding to the requirements of NPDES permits for municipal stormwater discharges, as well as for construction and industrial-related discharges. The water quality standards for surface waters of the State of Washington are defined in Chapter 173-201A WAC.

New Water Right and Water Right Change Permit

The waters of Washington State collectively belong to the public and cannot be owned by any one individual or group. Instead, individuals or groups may be granted rights to use them. A water right is a legal authorization to use a predefined quantity of public water for a designated purpose. This purpose must qualify as a beneficial use, which involves the application of a reasonable quantity of water to a non-wasteful use, such as irrigation, domestic water supply, or power generation.

State law requires certain users of public waters to receive approval from the State prior to using water, in the form of a water right permit or certificate. Any use of surface water (lakes, ponds, rivers, streams, or springs) that began after the state water code was enacted in 1917 requires a water-right permit or certificate.

Most of the water rights in Washington State are already allocated.

A permit is the first step towards securing a perfected water right. A water right is "perfected" when all of the terms and conditions associated with it have been fully accomplished. (Until then it is "conditional" or "unperfected.") Permit holders are allowed to start construction of the water system and begin using water. With few exceptions, permits are required if the holder plans to withdraw water for any use from either surface waters or groundwater.

Ecology issues a certificate when the agency confirms that the water right being developed is perfected. A Certificate of Water Right is the final legal record of the permit holder's water right. Once a certificate is issued, the water right is considered "appurtenant" or attached to the land on which the water is used (Ecology 2015a). EFSEC would likely issue any required water authorization for an SMR.

As with other permits and approvals, an applicant needs to demonstrate that Ecology's requirements have been met, in order to receive EFSEC's authorization. Under the Attorney General's Opinion letter AGO No. 10 1975, EFSEC has sole authority to issue water rights authorizations just as they do for other permits and approvals (Washington State 1975). This authority is also based on RCW 80.50.110, which is a part of the state code enabling EFSEC and stating that this chapter governs and supersedes other law or regulations, as follows:

1. *If any provision of this chapter is in conflict with any other provision, limitation, or restriction which is now in effect under any other law of this state, or any rule or regulation promulgated thereunder, this chapter shall govern and control and such other law or rule or regulation promulgated thereunder shall be deemed superseded for the purposes of this chapter.*

2. *The state hereby preempts the regulation and certification of the location, construction, and operational conditions of certification of the energy facilities included under RCW 80.50.060 as now or hereafter amended.*

Water Rights and Availability for Power Generation.

Washington State has a long and sometimes convoluted set of permitting and approval options for those wanting to acquire water for cooling. Specific discussion about how these options may affect siting are described in detail in Section 4.4. Various water supply options for SMRs are discussed in the siting analysis.

Aquatic Use Authorization

An Aquatic Use Authorization or Aquatic Lands Lease is required for most private activities taking place on state-owned aquatic lands. The application for Aquatic Use Authorization on Washington Department of Natural Resources (WDNR) managed aquatic lands is contained in Attachment E of the JARPA and compliance should be demonstrated in an ASC.

Hydraulic Project Approval (HPA)

Anyone planning certain construction projects or activities in or near state waters is required to obtain a Hydraulic Project Approval permit. The Washington Department of Fish and Wildlife (WDFW) usually administers the HPA program under the state Hydraulic Code, and would review any ASC for compliance.

Radioactive Air Emission License to Operate New Facility

To ensure compliance with the standards for radioactive air emissions set by the Ecology, the Washington State Department of Health has been delegated federal authority to issue Radioactive Air Emissions Approvals to Construct, and Radioactive Air Emissions Licenses to Operate. The Radioactive Air Emissions Licenses to Operate are included in Air Operating Permits issued by Ecology. As with other permits, once an applicant can demonstrate to Department of Health staff that requirements are met, EFSEC issues the approval.

A Notice of Construction application contains the following information:

- Facility information
- Chemical and physical processes
- Abatement technology description and efficiencies including conceptual drawings
- Contributing radionuclides and annual possession quantities/release rates
- Effluent monitoring system description
- Potential-to-emit
- Total Effective Dose Equivalent (TEDE) to Maximally Exposed Individual (MEI) calculations
- Cost factors or Best Available Radionuclide Control Technology/As Low as Reasonable Achievable Control Technology (BARCT/ALARACT) demonstrations as applicable
- Control technology standards

Air Quality Notice of Construction (NOC) Permit and Air Quality Minor Source Registration Program

Businesses that are new, replacing or modifying emission control equipment, or are increasing their air pollutant emissions must undergo New Source Review (NSR). NSR requires businesses that emit air pollution in Ecology-regulated counties to get Notice of Construction Order of Approval. A NOC regulates the business's air pollutant emissions. It is also called a "pre-construction permit" because the business owner must get this permit before starting construction of the facility. Consistency with these requirements should be demonstrated in an application.

National Historic Preservation Act Section 106 Consultation and Archaeological Site Alteration and Excavation Permit

The State Historic Preservation Office (SHPO), in Washington maintains a database of historic properties, and is mandated by the National Historic Preservation Act (NHPA) to represent the interests of the State when consulting with federal agencies under Section 106 of the NHPA. This cultural resource compliance is included in the ASC and evaluated in the NEPA/SEPA document. In addition to the views of the agency, the SHPO, and the Advisory Council on Historic Preservation (ACHP), input from the general public and Native American tribes is also required.

Resource Conservation and Recovery Act (RCRA) Site Identification Number (RCRA Site ID) and State Radiation Control

The required Resource Conservation and Recovery Act Site ID Number is an identifying number used for tracking wastes from their point of generation to final disposal. The Uniform Hazardous Waste Manifest system (USEPA Form 8700-22) is the primary mechanism to ensure that wastes reach their intended destination. The transporter and the receiving facility signatures on the manifest provide assurance that the waste has been properly handled.

The Washington State Department of Health is designated as the state radiation control agency and is the state agency having sole responsibility for administration of the regulatory, licensing, and radiation control provisions as defined in Chapter 70.98 RCW. The Waste Management Section licenses and regulates the commercial low-level radioactive waste disposal sites in the state of Washington to ensure the health and safety of site employees, the public, and protection of the environment. The NRC would retain all licensing authority over the storage or eventual disposal of high level wastes such as spent nuclear fuel rods.

The Radiological Emergency Preparedness (REP) section is responsible for assuring that the Department of Health is prepared to respond to radiological emergencies. This is accomplished by maintenance of the radiological emergency response plans and procedures, providing training, and developing exercises to ensure the state is prepared for an emergency.

Coastal Zone Management Certification (CZM)

The State of Washington, through the Department of Ecology, participates in the nationwide Coastal Zone Management Program. The CZM program is a voluntary state-federal partnership that encourages states to adopt their own management programs in order to meet the federal goals of protection, restoration, and appropriate development of coastal zone resources. The states have broad latitude to adapt federal goals to state and local circumstances, needs, and legal traditions.

Washington's program defines the state's coastal zone to include the 15 counties with marine shorelines: Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Pacific, Pierce, San Juan, Skagit, Snohomish, Thurston, Wahkiakum, and Whatcom counties. The CZM program applies to activities within the 15 counties as well as activities outside these counties that may impact Washington's coastal resources. Most, but not all, activities and development outside the coastal zone are presumed to NOT impact coastal resources. SMR applications will need to demonstrate CZM consistency in their ASC, or demonstrate lack of applicability.

Under Washington's Program, federal activities that affect any land use, water use or natural resource of the coastal zone must comply with the enforceable policies within the six laws identified in the Program document. The six state laws are as follows:

- Shoreline Management Act (including local government shoreline master programs)
- State Environmental Policy Act
- Clean Water Act
- Clean Air Act
- Energy Facility Site Evaluation Council
- Ocean Resource Management Act

Activities and development affecting coastal resources which involve the federal government are evaluated through a process called "federal consistency". This process allows the public, local governments, Tribes, and state agencies an opportunity to review federal actions likely to affect Washington's coastal resources or uses. Three categories of activities trigger a federal consistency review:

1. Activities undertaken by a federal agency.
2. Activities that require federal approval.
3. Activities that use federal funding.

An SMR project would trigger CZM review if located in the any of the 15 counties identified above, including CZM review adjacent to surface waters discharging to the coastal resources. If a project falls into one of the three categories above AND is either in the coastal zone or it impacts coastal uses or resources, then the federal consistency process is triggered.

6.0 Recommendations

This section describes a variety of actions that, if taken, could benefit development, permitting, and siting of small modular reactors in Washington State. These recommendations are provided in two groups: actions that could help streamline the SMR permitting process (Section 6.1), and recommended studies or other activities (Section 6.2) that could support the SMR analysis, including surveys and research that could eventually contribute to facility siting, the regulatory process, or public education and involvement.

EFSEC's timelines for application processing are discussed in limited detail in their Rules. For example, in the case of Expedited Processing (EP), the Council must approve or deny EP within 120 days of submittal of an application (WAC 463-43-050). During that time, the application must be reviewed for content and completeness, a land use hearing must be scheduled and held, and a land use determination made. In the next 60 days, the Council must prepare a Site Certification Agreement (SCA) and forward it to the Governor (unless denied).

In the case of a full application, under Washington Administrative Code (WAC) 463-64-020, the Council must submit its recommendation to the Governor within 12 months of submittal of an application. This assumes that the application review, land use hearing, applicant responses, draft EIS, adjudicated hearings, and final EIS and SCA have all been completed in that 12-month period. Shortening this 12-month process is not recommended here; we do provide other recommendations on permitting and related activities.

The timing of implementing the recommendations we have provided to prepare for future SMR activities are very sensitive to goals of the State, and to the current anticipated schedule for SMR permitting in Washington. Goal definition is critical to deciding on the best time to implement some of these recommendations. For example, if the goal is to be prepared for an SMR application submitted to EFSEC, the State does not need to do anything for at least five years, or perhaps can wait even eight to ten years, as no application is anticipated before that time. If the State's goal is to encourage SMR development in Washington, for economic or carbon reduction reasons, or to encourage their manufacturing in the state, such encouragement should start immediately. Several other states have already initiated such action. Whether and when to act on the recommendations presented here depends on the State's goals and desired outcomes.

6.1 Streamlining The Siting and Permitting Process

6.1.1 Introduction

Due to the length of NRC permitting requirements for SMRs (adequacy reviews, NEPA compliance, license application processing, hearings, and decision), a Washington State streamlined permitting process is not likely to reduce the overall time for permitting/operation approvals for an SMR. Certainly, if the two permitting processes (Washington State and federal) were conducted consecutively, and not concurrently, every month saved during the state process would save a month in the schedule. But this is unlikely and is discouraged. We assume that the state and federal review and approvals will be done concurrently and with considerable coordination, as has been previously accomplished. With the NRC permitting process expected to take almost four years under current licensing protocols, it is unlikely that a faster state process would be able to shorten the permit approval timeline, as EFSEC's state permitting process

almost always takes less than that. In this report, we identify some of the steps that can still be taken to improve any permitting process, potentially avoiding unexpected delays in the future, and better informing the process itself.

Both the NRC and EFSEC have pre-application process options available, although these processes are quite different. The NRC considers the possibility of site banking via an alternative licensing process referred to as an Early Site Permit (ESP) that was established in 1989 (see Section 5.1.1 for more details). This is much more detailed than EFSEC's Potential Site Study and actually results in a permit. An ESP allows an applicant to obtain approval for a reactor site (not for a project) and "bank" it for future use. The Tennessee Valley Authority (TVA), for example, is going through an ESP process now, with plans to submit their ESP application to the NRC in the first quarter of next year (Q1 – 2016), followed by the selection of a project/design and full license application (Construction and Operation License Application [COLA]) in 2018. TVA's approach is not actually site banking, because their project application will be submitted before the ESP process is complete. But they will be able to get the siting process underway without a defined project. The NRC's ESP process can bank a site for 10 years or more.

Another "pre-application" process available from the NRC for SMRs is a certified standard plant design process. This eventually will allow a pre-approved "off-the-shelf" design for use in future applications, but is not approval for a project at a site. This avoids part of the lengthy design review process, which has been part of NRC licensing due to the complexities of nuclear power plant siting, design, construction and operation; a shorter design review process is one of the intended benefits of SMRs. Various licensing options require separate license decisions along the way. The certified SMR design option allows an applicant to apply for a site and operating license with the plant design certification already issued. EFSEC has no design certification process, so that is not a state licensing option.

The implementing legislation for this report included a request to evaluate programmatic permitting as an option for streamlining. We considered programmatic permitting, and concluded that we do not think programmatic permitting for an SMR is an effective tool for the following reasons, in order of importance:

- Siting issues for an SMR are potentially controversial, uncertain, detailed, and so expensive and broad in scope that a programmatic approach would require as much if not more time and money than a project approach.
- The local city or county considering an SMR does not have the authority to site the facility.
- Most of the issues related to SMR permitting would be under NRC jurisdiction.
- EFSEC has no authority over a programmatic proposal.
- The proposal, issues and analysis would need to consider so many "worst case" or reasonably possible scenarios, based on variable SMR designs, under each discipline, that the potential impacts would be far more than from a project analysis alone.

While programmatic permitting may not be beneficial to SMR siting, it could be of value for manufacturing facilities related to SMRs. If the State decided to encourage SMR manufacturing, then a programmatic approach to pre-permit a business park or port site could be effective, and would be under the authority of a local government.

The existing EFSEC early siting process is represented by the Potential Site Study, a pre-application process that can remove siting uncertainties and create a focus on major issues. This is discussed in more detail in Section 6.1.2. A pre-application process is suggested as well.

Although it may be difficult for any state licensing procedures to shorten the overall SMR permitting process, because of the length of the federal (NRC) permitting schedule, there are actions any applicant can take, using existing processes in Washington, that can avoid unnecessary delays and perhaps even improve the NRC permitting process. There are also

actions that can be taken by the State. These applicant and State actions recommended here include the following techniques and tools:

- EFSEC Potential Site Study
- Pre-application meeting
- Office of Regulatory Innovation and Assistance (ORIA) support
- Site Banking process
- NRC/EFSEC cooperation and coordination
- Land Use Hearing change
- EFSEC Criteria Document development
- Joint NEPA/SEPA EIS agreement
- Programmatic permitting
- Completeness review

For each topic, we present an analysis of the process or element, and one or more recommendations that the State or an applicant could implement.

6.1.2 EFSEC Potential Site Study

Analysis – EFSEC Potential Site Study (PSS)

A successful Application for Site Certification (ASC) requires considerable investigation, planning and effort. Early identification of issues is an important part of these efforts. A thorough application needs to meet EFSEC staff expectations, permitting requirements, NEPA and SEPA requirements, and third party consultant expectations.

EFSEC has a Potential Site Study (PSS) process under WAC 463-22 that allows a future applicant to request and fund a study of a project and its proposed site, to provide an early identification of issues needing analysis in the ASC, and to investigate any other topics brought up by the potential applicant and EFSEC. The study can examine any topic of particular interest to EFSEC and the applicant, and can highlight topics for extra focus in the pending ASC. This process currently exists, although not commonly used, and can succeed as a permit streamlining tool by providing the applicant with information that they may not otherwise have, which can lead to a better application. Ironically, one major rationale for doing a PSS—saving license processing time—may be the reason why future applicants choose not to do them. Its primary purpose is to uncover information about the site and the project that the applicant may not have known or for which the applicant did not have an appropriate response. Detecting these issues early can save time and money. In considering whether to incur the costs and time of doing a PSS before submitting an ASC, the applicant generally feels they know everything needed, because they may have studied the site in detail. Based on what the applicants feel they know, the PSS may represent nothing more than cost and delay.

Only when the study is underway or completed does the applicant know whether the Potential Site Study had value (although the additional public involvement offered by the process generally offers a public interest value of its own). This is a time and cost risk that some applicants are not willing to take. A completed PSS does not offer a guarantee that all potential issues are known. But it does give the applicant the opportunity for considerable interaction and feedback from interested parties and EFSEC staff, and their consultant. One particular value of the study that the applicant can't satisfy on their own is for the consultant author to provide direction on how to respond to these issues. The process is intended to move forward as described below.

Potential Site Study Process. After receiving an applicant request to study a potential (preliminary) site, EFSEC can discover and analyze potential environmental issues with the proposed site and investigate any topics and issues that EFSEC and the applicant believe are essential to an adequate appraisal of the potential site, and the project. As part of the study, EFSEC cooperates with the following:

- Local government with jurisdiction over the potential site.
- Any federal, state, or local governmental agency that might be requested to comment upon the potential site.
- Any municipal or public corporation having an interest in the project.
- The public.

EFSEC holds open meetings to ask the public to identify issues that should be addressed in the application. Subject to any limitations that might be created by concerns about ex parte communication, the PSS provides the applicant and staff, if not the Council, the opportunity to describe initial plans and concerns; planned scopes and studies; alternatives, mitigation, or any other topics the applicant or EFSEC may feel would benefit from early identification. The goal is to develop a more complete application. The study is prepared by an independent consultant hired by EFSEC to evaluate these and any other issues, and to identify focus areas for the application. The content, goals, process and mechanics of the process are flexible, and can be a valuable pre-application tool. There are certain steps in the PSS process that can be particularly valuable, if implemented.

Recommendation – Potential Site Study

We recommend that EFSEC applicants go through the PSS process for large and controversial projects, and that EFSEC staff encourage it, although the final decision is the applicant's. Regardless of whether it uncovers new issues , it can provide the applicant with considerable guidance on expected content requirements in the application. The value of addressing issues or specific responses to the requirements that otherwise would have been minimized or omitted can be significant. The study can have the following benefits:

- If an unknown issue is discovered, it is generally less expensive to address it correctly in the initial application than to revise and redo the analysis.
- The process expands opportunities for public involvement, which is generally a good thing for the applicant, public, and agency alike.
- The process allows the applicant direct and detailed access to EFSEC staff (and potentially Council members) before submitting an application. This can help to get EFSEC's issues and priorities across. The process should not be hindered by ex parte communication concerns that may arise after an application has been submitted.
- The PSS itself is an opportunity for a well-informed independent environmental consultant working for EFSEC to raise issues, make suggestions, solve problems, set requirements, and provide significant guidance to the applicant on what needs to go into the application, and provide comments on what has been presented to date. The independent consultant will review the ASC for adequacy in meeting the Washington Administrative Code. A PSS offers that consultant the opportunity to provide specifics on requirements (develop criteria for the rules) to which the ASC can then respond.
- A PPS doesn't just identify issues, it can tie them to WAC requirements and potentially SEPA and NEPA requirements, and identifies how they should be addressed to the future applicant. EFSEC has adopted SEPA guidelines, so an application must address SEPA issues as well.
- Without the PSS, the process of submitting an application to EFSEC staff involves relatively minimal pre-project discussions and analysis and no external input to the applicant. Upon submitting the application, the applicant immediately enters into a condition of strict ex parte rules that restrain future communication opportunities and reduces the potential for a more complete application.

6.1.3 Pre-Application Meeting

Analysis – Pre-Application Meeting

The pre-application meeting is another common tool used by the US Army Corps of Engineers and other agencies to hear about a proposal, the applicant's plans and studies, and possible permitting plans. Alternatives and other regulatory requirements are discussed. The meeting is also a forum for providing feedback to the applicant about many elements that will affect the future permit application, permit decision, and project. The Corps typically has a permit decision to make, too, yet they have no problems meeting with applicants to discuss requirements and expectations. The Corps often asks other agencies to attend, as does an informed applicant. This pre-application meeting is used (by the Corps) when a significant Individual Clean Water Act permit application is expected. However, it needn't be limited to the Corps permit process. Permit applicants meet with agencies before submitting permit applications as a matter of course at all regulatory levels: federal, state and local. A pending applicant could hold one with EFSEC.

Any applicant for any permit can assemble a group of involved agencies for a pre-application meeting. The general goal of any such meeting is to find out what the agencies will be expecting in an application, based on the project described at the meeting. NEPA, SEPA and local permitting requirements can be discussed, as well as the applicant's proposed approach. Agencies can suggest data requirements, studies, alternatives, related approval requirements (ESA, NHPA, Shoreline Management Act, 401, etc.), which can all be addressed, for example, in a future Joint Aquatic Resources Permit Application (JARPA) within the ASC. An application submitted after a pre-application meeting should be better than one submitted without this meeting. The actual logistics of the meeting can be managed by the applicant, the applicant's consulting firm, a representative from the Governor's Office of Regulatory Innovation and Assistance, or EFSEC staff. EFSEC should be contacted for their preference.

A pre-application meeting is generally a formal, 2- to 4-hour multi-agency (state/federal) meeting in which members of the applicant's team ask questions of agency staff. The meeting can be held with or without a formal PSS, involving a project presentation and solicitation of agency comments. Although suggestions and thoughts are exchanged, no one is bound by comments made during the meeting. More than one such meeting may be warranted.

Currently, parties may be concerned about some communication due to ex parte communication restrictions. But prior to submitting the ASC, there is no application. Thus, a request for a PSS should not change the ability for the applicant to talk to an agency member or council member at any time, as they are not a party before the Council. Just as EFSEC has a preapplication process for transmission lines in WAC 463-61-010, including public review a similar process of staff and public interaction before ASC submittal could help all projects and enhance communication. Once an application is submitted, EFSEC becomes the reviewer and communication is limited.

Recommendation – Pre-Application Meeting

We recommend providing a mechanism for informal communication between EFSEC and the applicant, similar to WAC 463-61-060, before an ASC is submitted so that the applicant can be clear on what is expected in applications, to reduce the extent of application amendments submitted after the application review process is initiated.

The pre-application meeting should be extensive enough to go over each WAC requirement for an application; should include expert-to-expert discussions so there is a clear understanding; and should involve the independent consultant in all meetings, as they are the ones who will be evaluating the application for completeness.

6.1.4 Office of Regulatory Innovation and Assistance (ORIA)

Analysis – ORIA

The Office of Regulatory Innovation and Assistance was established by Governor Gary Locke and retained under its revised name by Governor Inslee. The purpose of the office is to support the permitting process for businesses in the interest of a healthy economy, jobs, and environmental protection. The office is not there to support a project; it is there to support a decision, encouraging communication and timely feedback so that an appropriate and timely decision can be made. In that way, ORIA staff members encourage accountability, responsiveness, attendance, and feedback. Among their activities is scheduling pre-application meetings, when their support is requested, and ensuring that the key decision-makers attend. The ORIA website includes a questionnaire that allows an applicant to describe a project and location to get a list of potential permits and approvals for any project. Although some corrections must usually be made after the process, the web-based workbook tells applicants what requirements they must meet. In the case of an SMR, or any project under EFSEC jurisdiction, the EFSEC decision is the only one; however, the applicant needs to demonstrate compliance with all other regulations, or ask for an exemption. The questionnaire tool is a very elementary method of identifying those requirements.

ORIA offers four Regional Assistance Leads based on project location. The leads are available to offer the following services:

- Coordinate between project proponents and local, state and federal agencies to build projects providing jobs, alternative energy, and economic development while protecting the environment.
- Help government agencies and citizens develop innovative, collaborative solutions to environmental problems such as balancing the needs of farms and fish or development issues such as green shorelines.
- Work with rural communities to address development issues by connecting local government with state and federal regulators.

Although a future applicant can get direction from EFSEC staff, the ORIA leads may be able to provide more site-focused guidance as well as guidance on local contacts and issues.

Recommendation 1 – ORIA

We suggest the applicant consider discussions with ORIA staff about their project and site to see if they have any specific thoughts or insights. Thereafter, we assume that EFSEC staff can serve in that role, and provide specific input to EFSEC requirements as well. The applicant can encourage ORIA to schedule and encourage participation in a pre-application meeting with federal representatives to discuss all federal permits and approvals if, for some reason, the meeting scheduled by EFSEC staff is not attended by all federal decision makers.

Washington's New ACIRC Process. The Governor announced his support in September 2015 for a new multi-agency advisory/review committee to meet quarterly to address large, controversial or important projects of statewide interest and with the potential for significant economic impacts, to ensure that agency decisions are made in a timely and coordinated fashion, in the interest of efficiency and to avoid delays in the decisions. This committee, the Advisory Council for Inter-Jurisdictional Regulatory Collaboration (ACIRC), is setting up their regulatory framework to enhance statewide coordination for permit processing to achieve the following:

- Reduce time and costs in reviewing and permitting projects.
- Increase the predictability of the review and permit processes.
- Align requirements of state and federal agencies to improve efficient use of resources to benefit both, when possible and appropriate.
- Support improved community outcomes.
- Sustain environmental stewardship.

The ACIRC intends to implement a streamlined approach to the regulatory review and permitting process by identifying projects of statewide significance through a scoping process, then working with the project proponent and all permitting and regulatory agencies to facilitate the development of project timelines and environmental review (NEPA and SEPA) schedules with assumptions, and when necessary troubleshoot priority projects to remove unnecessary barriers to the environmental review and permitting process based on shared policy objectives.

Agencies involved to date include ORIA, Ecology, WDFW, WDNR, the Washington State Department of Archaeological and Historical Preservation; federal agencies including the Corps, BLM, USFWS, USFS, and NOAA Fisheries; and affected Tribes.

This process is too new to assess its effectiveness, potential, or even its role in processing a project under the one-stop permitting process of EFSEC, which already has a project approval process direct to the Governor. Encouraging the state agency members to coordinate permitting on a project already before EFSEC (and when EFSEC has sole jurisdiction) may be redundant, if not conflicting.

Recommendation 2 – ORIA

It is the applicant's choice whether to bring in ORIA to support activities such as the pre-application meeting (discussed above) and agency discussions. If EFSEC staff are available and willing to hold such meetings, ORIA staff would not be needed. Therefore, we have no recommendation on the use of ORIA staff to enhance planning and communication for EFSEC projects.

6.1.5 Site Banking

Analysis – Site Banking

From the days of the initial creation of EFSEC (originally TPPSEC), the idea of site banking has been discussed to save the time and costs and uncertainty associated with licensing new baseload power plants. Part of this need was created by the enormous size of power plants being proposed in the 60s, 70s and 80s, and the size of the issues these plants created. A baseload of 1,000-2,000 MW has considerable resource needs and impacts, and a power plant "island" of multiple generating stations has even more. The discussed concept at that time was whether or not to pre-license sites, so they were ready when the need for a plant came along. This would avoid all the siting delays by addressing them all without a project waiting to be permitted.

Along with the calls for banking as a solution was the reality of the issues associated with this solution. First, who would do the banking? Who would spend the millions of dollars to select a site, secure access rights to the property, conduct required studies, get public input, prepare and submit a license application, go through SEPA and NEPA, and get a site authorized when there was no immediate project pending? Second, what site is suitable to be frozen in land use and availability for 5-10 years or more pending a future site application that may not arrive? How good is land use planning when a site of perhaps 500 acres or more cannot be used for other uses, has no available potential benefits, and affects land use planning on adjacent lands, and is not providing property taxes to local government without improvements for anything beyond pre-existing land value? Third, what guarantee is there that an energy developer will come forward with a technology and project that fits all the assumptions made in the banking studies and permits? Would a site banked for nuclear power support wind turbines? Will it work for an emerging technology 10 years from now? Will an SMR-based site be able to support a fusion reactor or other facility 5-10 years later? Fourth, another cost item might be Public Utilities Commission approval. Will any state's utilities commission allow such costs into the rate base when no generation may ever be built? And the fifth issue is regulatory uncertainty. There is no guarantee that the technology envisioned in 2020 will be accepted in 2030. What if new listed species occupy the site, or new regulations are passed, incompatible land uses are constructed next door (e.g. an airport expansion)? Consider, for example, the scenario of a banked coal plant site in the year 2000 in Washington, and its likely value today for a new coal plant site.

There are a number of pros and cons associated with site banking, and many depend on location. For example, at a location like Hanford, with considerable nuclear siting history and broad land use controls, the following pros and cons may exist for a banking alternative looking at long term future use of the site.

PROS

- Large sites are already under the control of existing landowners or managers.
- The public in the vicinity may be more open and accepting of nuclear technology than other parts of the state or country.
- Adjacent land use developments can probably be contained, ensuring consistent land uses for necessary distances without buying additional land.
- Land use consistency is likely, even with evolving technologies, because the Hanford site is involved in the nuclear industry from research to cleanup to commercial power generation, and already has nuclear generation.

CONS

- Any bank sponsor who created a banked site would have no assurance of any return on the investment.
- Even an accepting public might fight an unknown future project.
- At any site, if a proponent comes forward with something that is significantly different than the assumed prototype, they risk a new siting process.
- The sponsor would need to hire a developer to create a range of SMR options large enough to cover the range of future applicants, yet specific enough to create a project-level EIS. This would

be a costly exercise for any commission or board to commit to, especially with no applicant in the wings, and no sponsor for the study.

- If the data available are too general, and only a programmatic EIS can be completed, the future applicant would have to have a project-level EIS later, with a potential 1-2 year delay and loss of the banking benefit. In our opinion, a site banking EIS could be bigger and more controversial than a project EIS, as it would need to cover more project options than a simple project proposal, with many more public unknowns, and with no one available to fully commit to solving or mitigating the issues raised by the EIS.
- In the case of EFSEC, there is no site banking option in their current siting regulations. A specific project can be permitted and not built for a while, but EFSEC cannot certify a site without a project and an applicant. The legislature could change EFSEC's authority to certify a banked site, go through the SEPA process while doing so, and save future processing time and attract applicants. But for the reasons stated above, we do not recommend that the State create a site banking process. Alternatively, providing support to the NRC's ESP process may be useful. This process is generally closer in time between a site license and project operating license, and has been in use for a while. In fact, TVA is using it now with a plan for an ESP in 2016 followed, before approval, with a plan for an operating facility license application in 2018.

Recommendation – Site Banking

If the State wishes to support a site banking process for SMRs, we suggest waiting for an Early Site Permit application to the NRC, and becoming active in that review process. The ESP, if used successfully in Washington by an applicant and the NRC, may shorten the State's site permitting process, because some of the federal siting process would be complete at the outset (e.g., when EFSEC receives an application). However, for the ESP to work, there must be an applicant. EFSEC cannot currently permit a site, only a project facility application at a site. Details of the NRC's ESP process are discussed in the NRC permitting section (Section 5.1.1.), and recommendations on how to work with the NRC during their early site permitting process are discussed below in Section 6.1.6.

While the CGS EIS and WNP-1 EA documents can provide considerable data to support any future analysis, we do not suggest that the State look at site banking as an option to attract an SMR.

6.1.6 NRC/EFSEC Cooperation/Coordination

Analysis – NRC/EFSEC Cooperation/Coordination

One of the best opportunities to improve the permitting process is for EFSEC and other representatives of the State to work closely with the NRC and to take steps to ensure that coordination happens as soon as it is useful. This may include interaction with Region 10 USEPA and with FEMA as well. In fact, the State may want to initiate early coordination at this time and work with the NRC to ramp up the level of interaction over time as SMR technology development proceeds. The Task Force is already on this path. Some of this interaction may include commenting on new NRC rules subject to public comment, exploring future Memorandum of Understanding (MOU) possibilities, or coordinating activities of the Washington Department of Health and the Washington Military Department with NRC counterparts. The more aware the State is of risk, economic potential, benefits, and costs, of the technology, the more informed they can be when making comments on proposed regulations.

Various opportunities for this coordination exist, and are discussed under separate headings in these recommendations. They include attendance at and/or tracking meetings and conferences, commenting on rulemaking, participating in an ESP process, jointly preparing an EIS, and coordinating application processing.

Recommendation 1 – NRC/EFSEC Cooperation/Coordination

We recommend consolidating any Application Review/EIS Process between the NRC and EFSEC. An applicant desiring to build and operate an SMR in Washington must submit applications to both agencies. (EFSEC will allow the Preliminary Safety Analysis Report/Environmental Report as an application.) The submittals and application review processes for each agency are discussed in the permitting section. To help streamline the permitting process, we suggest that EFSEC and the NRC sign an MOU at the outset of the licensing process, or earlier, and before any applications are submitted. The MOU would define authorities, responsibilities, schedules, responsible parties, review times, deliverables, and shared and independent activities, and name responsible parties for each agency including their authorities and responsibilities. This would include coordinating activities of the Washington Department of Health and the Washington Military Department with their NRC counterparts.

This would be informative to applicants and agencies alike. The MOU would focus on activities that need to be coordinated for maximum effectiveness and efficiency, such as NEPA Scoping, document reviews, respective agency responsibilities, and the NEPA/SEPA EIS. It would not need to coordinate independent hearings, such as the EFSEC and NRC hearings, agency deliberations, or other agency decisions, other than including their anticipated timelines into the overall decision schedule. Each MOU is different and affected by agency priorities, agency staff, current regulations, the project and its location, and other agency involvement. But some of the elements of the MOU intended for NEPA/SEPA compliance might include the following:

- Roles and Responsibilities of the Lead Agencies and Cooperating Agencies
- Coordinated NEPA/SEPA scoping process, locations and attendance
- Agreement on Purpose and Need, Alternatives, and No Action
- Agreement on responsibilities for EIS Sections (e.g., in the Skagit/Hanford application and EIS the NRC lead all nuclear issues while EFSEC lead all non-nuclear issues).
- Technical responsibilities for review of ASC sections and Preliminary Safety Analysis Report (PSAR) sections
- Agreement on due dates and turnaround times for review comments
- Joint NEPA/SEPA Draft EIS hearing and open houses
- Agreement on what EIS comment topics are assigned to which agencies
- Agreements on roles of FEMA, USEPA, and state agencies

This shared responsibility approach will enhance coordination and support state decision making while recognizing the authority of the NRC, USEPA and others.

Recommendation 2 – NRC/EFSEC Cooperation/Coordination

We recommend that EFSEC's consultants prepare the EFSEC portions of the EIS. EFSEC has, in the past, either allowed their independent consultant to prepare their EIS independently from the outset, or used the applicant's ASC as the basis for the EIS, subject to consultant comments but still largely in control of the applicant and their consultant. We recommend that the former process be implemented for SMRs, and that the independent consultant preparation process be the only process considered for SMR application reviews. We recommend this for the following reasons:

1. Recognizing that applicants may prefer the latter approach to save money and assert more control, we feel the risks outweigh those benefits. Applicants can vary considerably in background and culture. Public applicants from the Northwest, for example, might be very sensitive to local issues and attitudes, and in many cases may be less focused on extreme cost-control methods and schedule compared to a private applicant from outside the region using private capital and unfamiliar with Washington's environmental laws. Despite hiring local consultants, an ASC/EIS written by a private applicant from outside the region may not be suitable. Using a local environmental consultant to determine the scope, content, and approach of the EIS keeps the SEPA approach consistent and unbiased.
2. A thorough application and thorough responses to comments generates the basis for a good EIS process and future hearings and decisions. In such cases, the independent consultant can use much of the analysis, confirmed in the Application Review process, and not incur major "reanalysis" costs. Analysis in the application that is supported and reasonable can be incorporated at low cost. On the other hand, unreasonable or unsupported analysis can be redone, resulting in an adequate document. Put another way, the excessive cost of a third party EIS can be reduced or avoided with a good application.
3. Any SMR will need a SEPA EIS and a NEPA EIS. The NRC will need to participate in the selection of the EIS consultant to meet NEPA procedures. They will not allow the applicant's consultant to prepare the EIS. So giving EFSEC's consultant sole responsibility over the content of the EIS, with the NRC's concurrence, will meet both NEPA and NRC requirements for SMRs.

6.1.7 Land Use Hearing

Analysis – Land Use Hearing

One element of EFSEC's permitting process may have become obsolete and creating more permitting issues than is it solving: the requirement for a land use consistency hearing and its required findings and decision for every application and expedited application request.

At EFSEC's inception in 1970, they were authorized to overrule local land use regulations, if needed and requested by an applicant , and in the public interest, when siting an energy facility at a site where the energy project was not consistent with local land use designations, zoning, or ordinances. The concept was to prevent a local jurisdiction from making a local decision that would deny a large project with obvious statewide interest and benefits. The current process involves identifying land use consistency at the start of the ASC review process as envisioned in the rules, to determine at the outset if there is a land use conflict (these conflicts are usually based on zoning and comprehensive plan designations).

Land use and zoning interpretations have changed since EFSEC's inception. In 1970, land use was essentially defined by zoning, and/or possibly a comprehensive plan designation (or no designation at all). A power plant was either consistent or inconsistent with local land use designations and zoning. Today, land use consistency is more complex, and considers wetland buffers, setbacks, mitigation, variance procedures, and project impacts that are consistent with SEPA goals, Growth Management Act (GMA) concurrency, and definitions of an essential public facility. Local government officials testifying at the required land use hearing often say they cannot make a land use determination because they don't know the project impacts, and there is no SEPA compliance available. Land use consistency now goes far beyond zoning and is generally tied to impacts.

Also, because the Land Use Consistency Hearing is required under the rules to be held within 30 days of application submittal, local officials must scramble to acquire and read significant EFSEC applications to make whatever determination they have to make, to testify hurriedly in front of the council on a subject they cannot have an opinion on at this early stage. The council is forced to receive this testimony and make a land use finding for a project that they will not make an SCA decision on for another year.

Another issue with the Land Use Hearing is its limited testimony, public hearing. Public involvement in Washington is a critical decision element, and its citizens are actively involved in the process. Responding to a public notice, preparing for it by gathering information, leaving their homes to drive to the meeting, and then being told they can only make comments on land use unnecessarily alienates the public. They have to repeat the process to get their other, more significant comments heard, and are unhappy with the applicant and lead agency who sent them to the first unrewarding meeting.

Fortunately, the applicant, EFSEC, and its consultants have managed to pull together joint Land Use and SEPA scoping meetings on the same date on some occasions. This process is rushed due to the limited schedule, potentially compromising the value of the scoping meeting, but does address the public involvement issue described above. (Incorporating the federal NEPA scoping into the same meeting further risks schedule/quality issues). Even if the meetings are held jointly, this doesn't solve EFSEC's challenge to write up conclusions from the land use hearing, which will almost always be unresolved for the reasons mentioned above. Since it is almost impossible to get the NOI published in time, this risks the need to have separate NEPA and SEPA scoping meetings for the same project, another alienation of the public.

Recommendation – Land Use Hearing

Overall, many land use regulations passed since the inception of EFSEC have diluted the value of any Land Use Hearing. We recommend that it be eliminated, and that land use consistency be part of the EIS analysis, with all other impacts, and the adjudicated hearing after all the data is in, if anyone wants to adjudicate it. Eliminating the 30-day time limit and ensuring that land use consistency be part of the scoping meeting would be an improvement to the current process. But EFSEC would still be required to write up a Land Use Consistency conclusion that would often say that any such conclusion is premature without more time for review and quantify impact analysis. Although still required to meet timing requirements of Expedited Processing requests, eliminating this step for full applications would be a convenience to EFSEC and to the local agencies, cities, counties and Port Districts who in the past have had to prepare and present testimony that is so often uncertain and incomplete.

6.1.8 EFSEC Criteria Document

Analysis – EFSEC Criteria Document

The EFSEC Rules for the content of an ASC (WAC 463-60) are succinct. While they have been reorganized and regrouped in the past for clarity, they are brief and their interpretation is left up to the applicant, and then up to the third-party independent consultant who must review the resultant application for adequacy. One set of the WAC Guidelines applies to all projects, ranging from oil terminals to wind farms and nuclear plants. Other WAC users may develop their own interpretations (agencies, the public, intervenors, etc.). If there were more details available to applicants and others as to what the rules are actually calling for, applicants would have a better chance of hitting the target in their applications. There are always limits to the effectiveness of siting criteria because all projects are different. But it may be more effective for an applicant to ignore a non-applicable specific criteria (if some were developed) than to interpret a broad guideline.

Another aspect of a criteria document is to consider the pending requirements for NEPA and SEPA compliance. Although the ASC guidelines are largely organized in EIS format and content, they do not cover all NEPA and SEPA requirements. It is not productive for a consultant's review to conclude that an application is complete under EFSEC guidelines (Rules) when sufficient information does not exist to write an EIS; in these cases, a separate data request is required, one that should have been made initially as part of the Application Review.

At least one consultant-prepared application review of an ASC was organized into two comment sections per WAC guideline: the ASC and EIS adequacy. Both had to be addressed by the applicant, and EFSEC knew when ACS requirements had been met and the application was complete. Another such review prepared specific criteria for an applicant, interpreting the guidelines to let the applicant know what they expected to see in an application, for their specific project, beyond the simple WAC language.

Here's an example of the potential brevity of existing guidelines:

WAC 463-60-225 – Emission Control

1. The application shall describe and quantify all construction and operational air emissions subject to regulation by local, state or federal agencies.
2. The application shall identify all construction and operational air emissions that are exempt from local, state and federal regulation, and the regulatory basis for the exemption.
3. The applicant shall demonstrate that the highest and best practicable treatment for control of emissions will be utilized in facility construction and operation.
4. The application shall identify all state and federal air emission permits that would be required after approval of the site certification agreement by the governor, and the timeline for submittal of the appropriate applications for such permits.
5. In the case of fossil-fuel fired energy plants, the application shall describe and quantify all emissions of greenhouse gases.
6. In the case of a nuclear-fueled plant, the applicant shall address optional plant designs as these may relate to gaseous emissions.

The guideline above is fairly informative, but, for instance, it is unclear on whether an applicant should submit any of the following:

- Ship, rail or tugboat emissions even though they are not subject to regulation
- Backup/emergency diesel generation capacity and emissions assuming 100% operation
- Separate emission calculations for all valves, connections, floating tank storage lids
- Emissions for commuting workers or deliveries
- Potential upsets
- Particulate fugitive emissions from cooling tower drift, evaporation pond dust, storage piles, ash disposal, or coal car transport
- Fugitive emissions of volatile organic compound emissions (VOCs) from ship cargo holds during fueling, or flaring, or liquefied natural gas (LNG) gas bleed
- Offsite emissions associated with potentially cumulative impacts, connected actions, and alternatives

A detailed analysis and recommendation of how best to respond to a WAC requirement for a specific project, location and time should be very helpful to applicants.

Recommendation – EFSEC Criteria Document

There are three ways for an applicant to improve the content of an Application for Site Certification leading to a complete application (besides other communication suggestions included herein):

1. Review all related previous applications and application reviews and the comments provided.
2. In particular, review previous ASC reviews that included NEPA/SEPA compliance as a review criteria.
3. Review any Potential Site Studies that developed guidelines criteria as one of their products.

The State could achieve a similar objective by doing the following for SMR applications or others.

1. Develop criteria for the guidelines that are focused on a specific project/technology type (e.g., SMRs).
2. Have the Potential Site Study consultant develop such criteria as part of their product (if a PSS is undertaken).
3. Inform the applicant that the ASC must meet NEPA and SEPA requirements as well (if a NEPA EIS is anticipated), and encourage them to go beyond the ASC guidelines to meet them.

The permitting process for any nuclear power plant will be dominated by the NRC permitting and approval review process. Thus, the State is limited on how much it can do to reduce the overall permitting time for a nuclear plant in Washington. The NRC siting timeline exceeds that of most permitting scheduled for any facilities in Washington. There are some steps the State can take to avoid delaying the NRC process any longer than it normally takes. These related steps and activities are described below.

6.1.9 Joint NEPA/SEPA EIS

Analysis – Joint NEPA/SEPA EIS

This permit streamlining procedure is applicable to any proposed project permitting/licensing decision requiring both a federal (NEPA) and a state (SEPA) EIS. Under no condition should EFSEC allow separate EISs be developed for SMRs by the State and the NRC. There are many reasons to prevent this situation from occurring:

- There is always an acceptable alternative that incorporates both needs.
- Separate EISs can create confusion as they eventually take on different schedules and describe the project in different stages of development if the applicant modifies the project during the EIS process, or one lead agency move in a different alternatives or mitigation direction than the other.
- Separate EISs force the public to work on, comment on, and review the same project twice, which is an unnecessary waste of citizen and agency time.
- Separate EISs create different alternatives based on different Need statements of the separate lead agencies, potentially looking at different impacts and geographies, which can further confuse the public and weaken the analysis.
- Writing and reviewing two EISs doubles the amount of agency time committed (since all but one agency would be involved in both documents), increasing state and federal funding costs, applicant costs, and limited staff time.
- Both NEPA and SEPA contain provisions that allow format changes to EISs, so any NEPA/SEPA EIS can meet all state and federal requirements, even if reformatted.
- Due to the likely differences among two documents, written at different times about the same project, this could provide opponents with opportunities to point these out and increase the response burden, if not provide grounds for appeal.
- Any decision maker would need to be familiar with both documents to ensure consistency with impacts, conditions, and project details.

Recommendation – Joint NEPA/SEPA EIS

Regardless of what process is selected for permit streamlining, if there is to be a federal EIS and a State EIS (and merely adopting a NEPA document does not work), our recommendation is to only accept a joint document process that meets both agency requirements. The NRC and EFSEC worked well together in the past on a NEPA/SEPA document when they produced the Skagit/Hanford project EIS. This cooperation should be repeated.

Immediately upon receipt of applications to EFSEC and the NRC, if not before, the two agencies should develop an MOU to jointly accomplish their licensing processes, and to clarify how the two agencies, and any cooperating agencies, will prepare the NEPA/SEPA EIS. This MOU should include mutually agreeable elements to move forward jointly in a way that is consistent with their application content requirements, public involvement requirements, NEPA/SEPA requirements, hearings requirements, schedules, reviews, decision makers, dispute resolution, and other facets of delivery. Based on past experience, this will include the selection of an independent NEPA/SEPA consultant.

6.1.10 Programmatic Permitting

Analysis – Programmatic Permitting

Various options are available and have been used to plan for future project development via the Planned Action process under Washington's Growth Management Act, or SEPA compliance for zoned business parks for future applicants, or combined SEPA/GMA planning activities and energy overlay zones, which have worked in rural areas for renewables. In a 2011 report, the Washington Department of Commerce concluded that planned actions and more SEPA integration

with GMA planning could be successful for local government to move forward with projects on a more streamlined basis, including renewable energy projects (Washington Department of Commerce 2011a). In another 2011 report, the Department discussed streamlined permitting options such as Energy Overlay Zones, Planned Action SEPA Reviews, Pilot Project Permitting, and Energy Technology Test Zones (Washington Department of Commerce 2011b). We reviewed these permitting options, and suggest that while they have been proven to be effective for local Planned Action and similar pre-project planning efforts, implementing a system like this for nuclear power plant siting would present much greater challenges. While it is beyond the scope of this report to develop a statewide regulatory Planned Action plan for SMRs, we identified several hurdles that such an action would need to overcome if it were initiated in Washington. These challenges include the following:

- There are statewide and national policy concerns over nuclear power development and its waste disposal plans.
- Any adequate analysis of planned action for a nuclear plant would be expensive; the source of funds would need to be identified.
- The scope for any generalized Planned Action or Programmatic approval for a site capable of accepting an SMR could not avoid the foreseeable impacts associated with a nuclear plant which, in our opinion, would make the effort as large and controversial as siting the project itself.
- State jurisdiction over such a facility lies exclusively with EFSEC when planned actions are typically a locally sponsored activity.
- The 2012 Washington State Energy Strategy analysis and its permit streamlining recommendations, do not address nuclear power or SMRs.
- EFSEC has no ability to permit a site without a project.
- The NRC dominates the licensing requirements and process, and would be the controlling decision for site suitability, regardless of a state or local process.

Recommendation – Programmatic Permitting

Should any applicant decide on a future Early Site Permit application for a nuclear technology such as SMRs, the State could offer whatever resources, planning, cooperation, suiting guidance and direction desired, in a partnership with the NRC, to help the NRC pre-approve a site under their regulations. This supports programmatic permitting under existing regulations, with an external funding path, consistent with federal regulations, and possibly consistent with local interests. Such a process could achieve the State's goals while minimizing risks, costs, and premature decisions on siting until more certainty is available on the technology, its costs and acceptance.

However, the only state agency with the jurisdiction required to pre-license the site has no authority to do so; no funds to do so; and no particular time-saving incentive to do so, as the NRC licensing time would likely consume any potential time savings. And once completed, there is no assurance than an applicant would submit an application in the future.

Therefore, we recommend that the State provide whatever support is appropriate in coordinating with the NRC should they receive an ESP for a site in Washington. Funding for such support may still be needed, but if lead by a non-licensing entity in the state, it could support the effort and keep future independent permit decisions free of conflict.

6.1.11 Completeness Review

Analysis – Completeness Review

EFSEC's Rules are not sufficiently definitive to ensure that their schedule requirements can be met. For example, the Rules assume that a 12-month timeline requirement can be met, based on the assumption that an application will be complete before it is reviewed. The issue here is that the required timeline doesn't change when ASC content requirements aren't met. This situation could be improved, as discussed below. Although the 12-month timeline is prescribed, there is no prescribed schedule for all the actions (except for the land use hearing) that have to be completed within that timeline.

EFSEC's 12-month timeline for application processing can be lengthened if an extension is agreed to by the applicant and EFSEC (WAC 463-64-020). Applicants generally agree to requested extensions, faced with the potential for denial or no decision if EFSEC needs more data to make a positive recommendation. EFSEC essentially always grants Applicant extension requests. But applicants could demand that the 12-month timeline be met, regardless of conditions.

When applications are thorough and detailed, prepared by experienced corporations or by consultants who are experienced, and appropriate funding and effort is applied, applications are complete, or close to complete upon submittal, and deficiencies can be addressed by the applicant or EFSEC's EIS consultant quickly to remain essentially on schedule. This has happened often.

However, when an application falls far short of requirements, a series of requests and responses will occur. In these situations, there is no definitive end point or defined process as to when the application is complete, or adequate, or even sufficient to proceed with the EIS process, application processing, contested case hearings, or other analysis. Under this delayed scenario, there is no official change in the one-year timeline expectation. The Rules do not address this important element of the licensing process.

WAC 463-60-116 states that "applications to the council for site certification shall be complete…" And under the Revised Code of Washington (RCW) 80.50.100(1), the council is required to evaluate the application to determine compliance with Chapter 80.50 RCW and WAC 463-60. These rules clearly state that EFSEC has the authority to review applications for completeness and that applications must be complete. It is logical to assume that the 12-month timeline is based on the receipt of a complete application, as required in WAC 463-60-116 and could be implied that this timeline starts when EFSEC has a complete application. However, the Rules have no language that defines when the Council can determine that an application is "complete" (at which point the 12-month timeline would commence). Without this definition, the 12-month timeline must be met even with an incomplete application.

Past Councils were hesitant to have their independent consultant make an adequacy call, or determine whether an application was complete, feeling that this should be a Council determination, decided during the adjudicatory process . The potential for this issue has always been present.

If there were a formal completeness review step between the date of submittal and the start of the one-year timeline, then a better commitment by both parties (EFSEC and Applicant) might be more likely. This step is used by other licensing agencies; the NRC and California's energy commission (CEC) each have a completeness review step. In many cases, the staff can review an application, submit a review response to the applicant, and eventually determine whether the application is complete. The completeness determination is a decision to move forward with the processing based on sufficient information. It is not a reflection of the suitability of the project to be licensed, or that any element of the project is adequate for permitting, approval or other conclusion. Applications can proceed with processing after being deemed complete, and the one-year timeline starts.

A Completeness Review step in the ASC processing is not necessarily a permit streamlining step. It can even take extra time over the assumed 12-month period from the date of application submittal, especially if multiple reviews are required. A typical review round might be 60-90 days, with 30 days each for the review, response, and re-review, although actual lengths of these phases depends on content. Regardless of length, all parties would be working under the same process and with the same expectations. The existing application review process follows a similar course of review and comments, but the outcome is not as definitive, and the 12-month clock isn't tied to a completeness review date. Following a revised process, with all parties knowing what to expect, a completeness review step should result in an application suitable to meet a 12-month processing time once the completeness determination is made.

Recommendation 1 – Completeness Review

The State should add a completeness review process to the 12-month timeline commitment. This review could be implemented within a 90-day window but would not be limited to that in the event that applicants were unresponsive. The process should allow 45 days for the initial review by the third-party consultant; 15 days for post-review discussions to clarify requests, discuss alternative solutions, or point out discrepancies; and 30 days for the applicant to respond. The one-year timeline starts the day that EFSEC and/or their independent consultant determines that the application is complete.

We suggest the following text:

WAC 463-60-118 Completeness Review

1. Applications shall be submitted for review by EFSEC and its third-party consultant to make a completeness review under the requirements of RCW 80.50.100(1) and other requirements for permitting and processing (NEPA, SEPA) and as prescribed by EFSEC.
2. After review of the application and comments to the applicant, the applicant shall provide any additional information as requested, or demonstrate why it is not appropriate.
3. After receipt of this information, EFSEC and its third-party consultant shall review responses and, if sufficient, issue a Determination of Completeness. If the information is not sufficient, the review process described in (1) above should be repeated.
4. The 12-month timeline required by WAC 463-64-020 starts with the issuance of the Determination of Completeness by EFSEC.

Recommendation 2 – Completeness Review

We suggest that the completeness review conducted by the third-party environmental consultant be followed by a specific process to document and clarify the review comments and the applicant's response, and tie both to a schedule, as follows:

- EFSEC completes and submits a Completeness Review document to the applicant and applicant's consulting team for review.
- After review, both teams hold an all-day meeting to go over comments, agree on needs, defer or explain review comments, and commit to specific information responses.
- The applicant provides responses in the form of information or an amended application that includes explanation of changes from the review versions, or, if there is still missing information, the applicant provides a response document with detailed analysis to support the changes.
- EFSEC's consultant briefly reviews responses to affirm the concurrences, and proceeds with the NEPA/SEPA document.

This is a formal process that can be done in one room, or in breakout sessions, so that discipline leaders can have time to discuss and work out needs.

6.2 Recommended Studies

6.2.1 Introduction

Listed below are recommendations for the State to consider related to siting, permitting, agency coordination, public education and involvement, and other topics associated with SMR siting in Washington. The scope of our effort was to recommend studies that can be considered for the future. We have also added actions that might be taken by the State, beside studies. In some cases, we know that the NRC is already underway with investigations and regulatory revisions, and our recommendations include tracking or commenting on them. We also recommend that representatives of the State attend or track key meetings that will be held in the future, as a potential investment/cost to the State. These meetings can provide the latest updates on SMR developments including regulations, technology, licensing activities, and related events that will continue to provide information.

SMR development is underway in the United States, at a limited scale, and will be facing potential barriers of funding, technology risks, licensing schedules, public acceptance, political will and acceptance, regulatory change, and uncertainties in construction and operation. The entities engaged in SMR development are confident in the technology's future success, and they and the agencies have a general timeline tied

to the success of each step, based on history. These schedule assumptions may be correct, and many parties are committed to make SMR development happen. However, each of these steps (e.g., spending funds to attract industry, changing legislation to expedite permitting, preparing sites, setting up advisory groups, and working with the NRC), with a known history for other projects, is new for SMRs, which raises some element of uncertainty. As each step is completed, the uncertainty is reduced. The content of the study recommendations below is not tied to this uncertainty. However, the timing of them is. Deciding when to take any action requires a balance between the time needed to accomplish specific goals, and the time required to successfully develop and operate an SMR. Once the various goals of the State are decided, the time available to achieve those goals will need to be determined, based on confident predictions about successful SMR design, certification, licensing, construction and operation.

6.2.2 SMR Cost/Benefit Study

Analysis – Cost/Benefit Study

Costs, benefits and issues associated with SMR siting in Washington are potentially significant, and the status of design and licensing is in a very dynamic state at this time, as discussed in this report. The State should be well informed about costs and benefits, using the most current information tied to the time of any major commitments. This will inform the state decision makers and the public at large. The range of cost and revenue factors may be tied to SMR development or even SMR manufacturing development (which was not evaluated in this report) and will include siting, permitting, design/construction, operation, and indirect effects associated with these. The certainty associated with any such study will improve with time as permitting and siting advances are achieved. For these reasons, we suggest that a comprehensive cost/benefit analysis be conducted, at the appropriate time, as discussed below.

Some of the issues associated with such a study have been examined already by Missouri S&T University. The Small Modular Reactor Research and Education Consortium (SmrREC) has been set up by Missouri S&T University to investigate the economics of deploying multiple SMRs in the country. SmrREC has constructed a comprehensive model of the business, manufacturing and supply chain needs for a new SMR-centric nuclear industry.

Recommendation – SMR Cost/Benefit Study

The State should consider a study of potential costs and benefits of an SMR in Washington, once greater certainty is available about design and operation parameters. Considerable costs analysis in the Tri-Dec Hanford Siting Analysis (Tri- Tri-Cities Development Council (Tri-Dec). 2014) to compare Hanford-specific site options can provide some data here. The study should include typical economic effects of construction and operation jobs, potential long-term replacement benefits of coal/gas emissions and greenhouse gas reduction, and economic benefits and costs related to the modular siting process. It should discuss cost overrun and operational cost risks; fate and costs of nuclear waste handling, transport, and disposal (or onsite storage); and costs and potential of evacuation or other upset costs. The study should note the potential for insurance or legislation to cover these costs. The study should also evaluate state and local governmental and infrastructure costs and compare revenues and expenditures associated with construction and operation, including sales and use tax, Business and Occupation (B&O) taxes, property taxes, and other sources of government income compared to unanticipated costs of public services and utilities, to the extent they need to be expanded due to SMR development.

Because of the significant development and construction costs anticipated, the analysis should evaluate all documented indirect effects, with their associated probabilities, including secondary growth multipliers and the potential for specific industries that might arise to support SMR development (services, manufacturing, etc.). To the extent that some of these activities could occur and be developed out of state, we suggest that the in-state documented effects be the basis for the analysis, and that potential development from SMR technology that could occur out of state be discussed separately. In that way, only the more certain costs and revenues can be compared; and the State can make a separate decision on whether to commit resources to attract other industries, and how likely it will be for them to come to Washington.

We suggest that this study be prepared by a team representing a range of opinions and backgrounds, if possible, to ensure that there is a balanced analysis or a report with an appropriate range of opinions/conclusions or ranges of outcomes, and that the study cite various similar studies, such as the Missouri S&T study, to demonstrate a range of conclusions. We feel that a report authored by only one sector of economists and scientists may only be followed by an opposing sector view with differing conclusions; this could create a confusing message to the public.

One suggested approach to this report is to develop a 30 year forecast representing a range of potential effects and outcomes (high and low), similar to that done by the NW Power Planning Council in their load forecast. In looking forward 30 or more years, the report should consider various carbon management strategies that may be in place in the future. The economics of SMRs versus other thermal generation options could change considerably as GHG concerns become more prominent in energy planning, and as strategies such as carbon taxes and carbon trading are considered. The report could consider scenarios such as carbon trade costs.

Any such report should start with a literature review of similar or related studies and some confirmation of their results. For example, the report could look into the URS study done for Tri-Dec and the NERA study done for the Nuclear Energy Institute, or other feasibilities done for utilities or utility groups.

6.2.3 SMR Facilities Construction

Analysis – SMR Facilities Construction

While this report did not evaluate the market for construction of SMR modules and related infrastructure, there has been an interest in such an industry in Washington and elsewhere. The Tri-Dec study (URS 2014) alluded to this potential and similar studies in other states have encouraged their states to attract and/or establish such an industry.

Recommendation – SMR Facilities Construction

As part of the State's preparation for the possibility of future SMR development, and the State's overall opinion of that possibility, we recommend a study to look at the infrastructure, design, manufacturing, service, and related industries that are likely to be required to support the construction and operation of SMRs in Washington (and the Northwest) and whether those needs can be met with current businesses, by new businesses inside or outside of the region, or would be best met by local businesses. The timing of such a study may be affected by the availability of funding and the level of interest in the State to attract businesses. No SMR design certification has been issued by the NRC. It will likely be at least 5 years before one is certified and a site licensed, and perhaps close to 10 years before one operates. The State will need to balance the resultant uncertainties. For instance, if planning an industry analysis in 2016, the State should also consider the time it would take to mount a campaign to attract industries, if industry attraction is desired.

The industry analysis should, in particular, address timing, if the State wishes to support an SMR construction industry or the siting of modules in Washington. For instance, if we assume that SMR license applications in Washington (and across the country) will start being submitted in a certain year, when will Washington need to start a program to ensure that manufacturing capability is in place once there is demand for SMR construction? In this example, pertinent programs could include marketing, tax incentive legislation, or permitting support. As of 2015, some very basic schedule assumptions have been made, but more certain dates will need to be in place before government or industry commits to major funding efforts for that purpose.

6.2.4 Public Involvement

Analysis – Public Involvement

The citizens of Washington have had an extremely diverse set of experiences dealing with nuclear power and nuclear waste handling and disposal, perhaps more than any other state. After one of the largest bond defaults in history and one of the largest radioactive waste remediation projects in history, both tied to nuclear power and nuclear waste disposal, many Washington residents are cautious about nuclear power. There are also residents across the state and in the Tri-Cities area in particular who support the economic benefits of nuclear-related activities. These experiences are in addition to the nationwide concerns that have been raised by

events at the Three Mile Island nuclear plant, at the Fukushima plant in Japan, and the current suspension of high-level nuclear waste disposal siting at Yucca Mountain, Nevada. These experiences have molded positions and opinions that may change with time, but which currently have the potential for widely diverse opinions on nuclear power. More recently, the worldwide recognition of the need to reduce greenhouse gas emissions while continuing to develop new baseload energy options looks at nuclear power as a resource alternative to achieve that. Yet the overall awareness of the potential for safety advances associated with SMR development is probably low. Some of the past and current actions that various populations in Washington are aware of include the following:

- A county-wide straw poll (Skagit County) on siting a nuclear power plant that voted against siting the plant in the county.
- General concerns about the issues and risks posed by the Three Mile Island incident in Pennsylvania.
- The Washington Public Power Supply System (WPPSS) bond default and resultant abandonment of nuclear power plants under construction in Grays Harbor County and at Hanford.
- Ongoing issues with radionuclide cleanup at the Hanford Reservation
- The current suspension of development of the Yucca Mountain High Level Nuclear Waste Repository.
- Nuclear radiation exposure and response at the Fukushima nuclear plant in Japan.
- Successful implementation of new technology AWLRS in the United States.
- An increasing sensitivity and awareness about greenhouse effects on climate, and ways to reduce greenhouse gas emissions through use of nuclear power.
- The level of experience in the Tri-Cities area related to the nuclear industry.

Compared to the incidents above, and general awareness of facts related to Washington's nuclear industry, some going back 30 years and some going on continuously since then, very little information has been provided to the public on SMRs, their design elements, development, risks and benefits. And since none have been built and operated in the United States, no US data on licensing and operating conditions have been developed or presented. Although this study did not assess public opinion, the events above may have created a mixed opinion of nuclear power siting in some sectors in Washington.

Before siting an SMR, or encouraging their operation in Washington, the State may wish to determine what Washington citizens know or are currently thinking about new nuclear technologies. A nationwide survey done by an independent survey group (Bisconti Research 2014) and sponsored by a pro-nuclear organization (the Nuclear Energy Institute [NEI]) found that nationwide public opinion on nuclear power development was favorable, and 75% of the respondents felt that nuclear energy was an important source of power for the future. Respondents felt that licenses of existing nuclear plants should be renewed (83%) and new nuclear plants should be built (61%). These are nationwide statistics based on 1,000 interviews and are not necessarily representative of Washington.

The citizens themselves might benefit from more information about SMRs, especially as potential licensing dates approach; and might then generate more informed opinions based on current and future technology and not just the technology and experiences of the past. Ironically, as proponents discuss the potential safety improvements and cost benefits associated with SMR developments, this might prompt opponents to raise concerns about the uncertainties associated with new designs, new technology and new unknowns. Predictions of improved safety will not be as effective as demonstrated effectiveness.

In response to these possible public concerns, we recommend the following studies be considered, including some that can be done after successful operation is demonstrated in other states. Considering the number of years likely to be required before the first licensing application is submitted in Washington, sponsors of these studies will need to determine the most effective time to assess public opinions and provide educational opportunities.

Recommendation 1 – Public Involvement

We recommend conducting a poll of Washington citizens on their acceptance of nuclear power and their understanding of past and current technologies, including SMRs. The poll should be sufficient to identify geographic difference, specific siting concerns, and information/educational needs of the public, to the extent they display misunderstandings or lack of knowledge. The poll should not only address opinions and knowledge about nuclear power, but should specifically address the concepts offered by SMR technology (e.g., safety, size, flexibility, licensing certainty) to the extent those are known, and the public's knowledge and concerns about SMRs. The poll should also assess the public's confidence in siting agencies to make the right decisions, including the NRC, the USEPA, and EFSEC.

Recommendation 2 – Public Involvement

After receiving the public opinion poll results, the State should provide an opportunity for public involvement and education related to SMR design development, certification and siting. Such an effort may be tied to the goals and positions of the Governor's office at the time of the education process, and whether it would be best to start now, during the future design certification process, or after an SMR is permitted and sited elsewhere. All information should be factual and unbiased, including a discussion of the uncertainties created by a new technology development.

The public should continue to be involved as uncertainties are reduced. The public involvement and education program would continue to include education related to the operation of any US facility. This will require an educated balance between the benefits of early and continuous education and involvement, and better and more accurate data that can only come later. The eventual program should provide a permanent and unbiased source of information to the public about the technology, the licensing, costs and benefits, risks, and other information of interest, ranging from waste disposal issues to GHG reduction benefits. If an information website is selected as a tool in support of this effort, we suggest that links to all responsible views be provided, from the NRC and the Nuclear Energy Institute to the USDOE, Union of Concerned Scientists, and the Natural Resources Defense Council (NRDC). The nuclear energy issue creates an interesting debate between greenhouse gas reduction advocates and nuclear power opponents, some of whom come from the same organization.

6.2.5 Additional Recommended Studies and Activities

The following recommended actions include information gathering, outreach, and conference participation that the State could consider to understand the latest developments in SMR regulations, technology, licensing activities, and related subjects.

Recommendation – Create Nuclear Assessment Advisory Group

We recommend that the State set up an appropriate advisory group or office to continue to track the progress and status of SMR development and the State's interests and concerns related to siting and operation. Alternately, the existing Joint Select Task Force on Nuclear Energy could be continued. The title "Nuclear Assessment Advisory Group" is a suggestion; the actual title should reflect the mission of the group (education, legislation, promotion, etc.) Such a group would not be similar to the Nuclear Waste Advisory Board, who were given a project to evaluate (Hanford Cleanup and the Repository) and funds to operate with. But the group would be an independent office to educate and inform, ask questions and provide fact-finding about SMRs, their costs and benefits, and the public education and involvement activities associated with them. This office would not be a decision maker—EFSEC has the only siting authority—but would serve as a coordination point for many of the recommendations included in this section. This would allow the State to move forward with an assessment program while avoiding any one state agency from taking a position for or against the technology, or appearing to, before an actual application is submitted. Alternatively, this or another board, office or task force could serve as a proponent for SMR development, overall nuclear energy development, and related economic development, including the potential for SMR manufacturing. We do not discuss a proponent role further here, as this is somewhat

outside of the scope of this report. However, the recommendation to establish a development-focused entity is within the scope.

For example, such an entity was established in 2013 in Virginia, however, the Virginia Nuclear Energy Consortium Authority (VNECA) was established to make the state a national and global leader in nuclear energy, while serving as an interdisciplinary study, research, and information resource for nuclear energy issues. It represents the state of Virginia, institutions of higher education, nuclear energy companies, suppliers, and local organizations that support the advancement of the nuclear industry. Thus, the Virginia Authority was given not only an educational role, but a promotional one. Various other state initiatives have been created and are summarized in NEI's June 15, 2015 report, "State Legislation and Regulations Supporting Nuclear Energy" (NEI 2015).

The time to create any office, council or authority is tied to the optimum time to gather and disperse information about SMR development, and to the goals of the effort, knowing that early public involvement and education is essential to good decision making. Much more will be known about licensing issues and progress in the next 2-3 years. Possible action options for the office might include the following:

- Organize a gathering place or web library with information for the public.
- Sponsor public surveys on knowledge and opinions.
- Provide a source for public education and involvement.
- Regularly update a source for technology and regulatory developments.
- Sponsor public workshops and meetings across the state.
- Be a grant applicant for federal funds to implement above.
- Attend and track major conferences.
- Provide a direct connection with NRC Counterparts.
- Liaison with USEPA and FEMA on their activities.
- Attract speakers from industry, environmental organizations and agencies.
- Sponsor a symposia on current status and trends of SMR development in the Northwest, to be held in Seattle, Tri-Cities or Spokane, perhaps biannually. Alternately, attend related symposia if sponsored by others.

If the prime function of the organization was to be for education and preparation for the first SMR ASC, there may be little urgency for intense activity for a few years, assuming the first application is eight to ten years out. On the other hand, if the goal is to attract industry and SMR manufacturing, an earlier start may be warranted. The economic studies, tax incentive legislation, marketing programming and results, site selection and permitting, design and construction of future manufacturing facilities, may take many years, potentially requiring more immediate actions, such as the recent Tri-Dec report prepared by URS.

Recommendation – Conduct a Direct Cost Risk Analysis

Actual costs leading up to the operation date of a small modular reactor are considerable, potentially in excess of $2 billion. Especially in light of past economic consequences of nuclear power development in Washington, the State should commission a study at an appropriate time to evaluate the costs of SMR development to the citizens of Washington, including the potential cost of future power to ratepayers. How much will the federal government commit to cover some of the cost risks of this new technology? Such a study should consider a cost range analysis, similar to the load forecasting used by the NWPPC, with risks and uncertainties reflected in the range. The study should also consider and make decisions on the following factors at a minimum:

- Schedule and uncertainty
- Federal funding involved
- Agreed-upon contingency funds
- Design/construction uncertainty tied to the date of the study, and status of SMR operation at that time
- Interest rate variability and effects on costs
- Permitting delays and effects

- Rate approval delays and costs (to the rate base)
- Construction delays and effects
- Costs of likely alternatives over the same time frame (gas, wind, solar, other) for those energy sources offering baseload power equivalents
- Insurance considerations

The TriDec SMR report (URS 2014) includes a number of economic recommendations; these should be reviewed as well to see if any should be adopted.

Recommendation – Attend 2016 Regulatory Information Conference (RIC)

As part of any public education and awareness program, the State should review the proposed agenda for the next NRC sponsored Regulatory Information Conference (RIC), which will occur on March 8-10, 2016. Registration starts in January 2016. This event is an overview of NRC regulatory updates and is attended by numerous NRC staff and a large number of private industry representatives. SMRs are likely to be on the agenda and, even if not, the NRC staff with the answers on SMR status will be there. We suggest that the legislature review the agenda, talk with the NRC, and decide if there is value in sending 1-2 members of the legislature, or state agency representatives, to attend this in 2016 and on a regular (annual) basis thereafter, or use nationwide representatives to states and legislatures as a means to attend and report findings.

Recommendation – Continue Western Initiative for Nuclear (WIN) Involvement

The State should continue to be involved in activities associated with the Western Initiative for Nuclear (WIN). While this activity is sponsored by a single provider (NuScale), it has received broad acceptance among many states and interested parties, and provides a good platform for information sharing, including schedules and implications for siting in Washington.

Recommendation – Track Activities of National Conference of State Legislators (NCSL) Committees

While we are certain that members of the Washington State Legislature are involved with the NCSL, and their committees or task forces, we encourage tracking committee and task force activities that may involve nuclear siting and/or SMRs, or even encourage a task force to focus on that issue specifically. SMRs are already one of the NCSL's focus areas, and the conference provided a status report for SMR development as recently as August of 2015.

Recommendation – Take Steps if there is a Desire to Attract Manufacturing

If the State desires to attract SMR manufacturing industry to Washington, the State should work with the Municipal Research and Services Center in Seattle to develop processes for site banking, early site permitting, pre-application meetings and processes, etc., that they have either developed or received from Washington cities and counties. The State should also consider the processes set by legislation as summarized in the NEI study references below.

Recommendation – Track the USDOE Nuclear Fuels Storage and Transportation Planning Project (NFST)

Lack of a permanent or interim storage facility for waste fuels is one of the biggest unsolved issues related to SMRs. The State should track the USDOE to be aware of processes being considered for interim storage of nuclear fuels, and encourage movement in this area. Whether Washington wants to be a candidate site is another issue and no decision has been made to solicit them, but getting a high level nuclear waste facility sited, even an interim facility, is important to the success of any other phase of nuclear power development. Some states, for example, have tied their acceptance of nuclear power to the confirmation of a licensed repository.

Recommendation – Review Other States' Legislation

Many states have proposed or passed legislation to promote nuclear power or other forms of new energy technologies. This legislation, and how it affected state decisions, is worth reviewing if there are sponsors in Washington who are interested in similar legislation. Instead of recommending any specific legislation, we suggest reviewing these legislative summaries for their applicability to Washington's political climate, regulatory authority, and their effectiveness in other states. The NEI, for example, issued a June 2015 report on state regulations supporting nuclear energy that is a good source for

possible legislation or policy changes in Washington. Some regulations included language on nuclear power as an accepted and/or designated source to meet state goals for emissions, new generation, etc. Other language mentioned nuclear development costs as eligible for rate-based cost recovery determinations, including transmission line costs, and other named cost recovery options. One resolution (Illinois) asked the state and federal government to find ways to protect the state's nuclear plants from shutdown and to evaluate the societal, greenhouse gas, and economic costs of closing plants.

Because the range of options is so broad, our recommendation is for potential sponsors to review the legislation passed by other states for applicability and value, rather than making legislative recommendations of our own.

Recommendation – Track/Comment on NRC Rulemaking

While we are not in a position to recommend that the NRC do anything, we do recommend the State encourage the NRC to initiate and move forward with the processes for updating the exemption process for the Emergency Planning Zone, Source Term, and Decommissioning. We also suggest encouraging the NRC to initiate dialog regarding insurance coverage for SMRs. This might be a topic for the Western Governor's Association to take a position on as a whole, to develop a common policy and carry more weight in the recommendation.

When appropriate and as available, we suggest that the State, on its own or through the Western Governors' Association, provide the NRC with state input to regulatory and proposed rule-making processes.

We recommend that the State track the NRC meetings website, as this website is continually announcing public, project and internal meetings with their topics and sometimes agendas. This is an opportunity to stay current with all the activities associated with SMRs with which the NRC (and occasionally USDOE) is involved.

Recommendation – Investigate Distributed Generation Facilities

A smaller module at the right location could satisfy the requirements of a major industrial/commercial user without the need for transmission. With an evolving policy for exposure, risk, evacuation, population density, and other parameters associated with health risks from operation and/or accidents, it would be useful to know the likelihood of distributed generation application siting for SMRs. There may even be opportunities for a distributed generation SMR at Hanford. Will costs and risks be sufficiently low to proceed? Are distributed generation SMRs strictly for high load, low population areas such as a remote aluminum plant or mine operation? Will costs be sufficiently low to generate a return in a high-energy use industry in Washington? Although distributed generation is one of the future markets for SMRs, it may be too early in the licensing and regulatory process to investigate this option. We did not include a one-module distributed generation option in our model SMR. However, we did want the legislature to be aware of its potential and use the mechanisms discussed elsewhere in this section to monitor distributed generation potential.

6.3 Recommendation Timing

This section includes many recommendations. Most can be implemented or at least initiated immediately, or can be initiated whenever the legislature or others want to expand the role of SMRs in Washington. Some recommendations simply provide opportunities for further involvement and education. Some might improve various permitting processes regardless of whether SMRs are sited in Washington. And some are entirely tied to the readers' goals, ranging from immediate action to future activities. This section tries to attach some measure of timeliness to the recommendations, and describes the factors that may influence immediate action versus waiting until 2025.

6.3.1 SMR License Application Preparation

An SMR application to EFSEC isn't likely for at least eight to ten years. At that time, perhaps 2023 or later, an SMR application may be submitted to EFSEC and the NRC. EFSEC would then hire their third-party consultant, the NRC would start their 3-4 year

licensing process, and the applicant would have met with state and federal agencies and the NRC in preparation for this event. To prepare staff for this, EFSEC and state agencies expecting to be directly involved could probably wait until 2020 to begin training, staffing, and otherwise preparing for an application. Efforts to inform and involve the public may not need to be initiated until closer to the time (within two years perhaps) of the first application (recommendations on educating the public on SMR benefits and issues are discussed in Section 6.2.4).

6.3.2 Rulemaking Influence

Should the State desire to be involved in public input related to NRC rulemaking, they should become involved now, as NRC rulemaking is currently taking place. Input from the State could include providing direct comments, attending conferences and hearings, tracking the NRC website, and being involved with industry organizations like NEI. The state could assign someone to do this and seek input where needed, or could hire a specialist consultant for specific review assignments. This is an immediate activity.

6.3.3 SMR Attraction Planning

If the State decides to encourage SMR technology, or even to investigate whether to encourage it, planning for this should be a near-term activity. For example, an economic study to determine costs and benefits could be done after a potential facility is defined. One was conducted by TriDec (URS 2014) that focused on cost savings at Hanford. If these two activities took two years, the State could decide what actions to take to encourage the industry in the third year, and in the fourth year could decide on the legislation needed to implement this encouragement (legislation could include tax benefits, education programs, establishing an oversight agency, etc.). Following this legislation, in years 5 and 6, the State may see the results of such activities, as industry starts reacting and planning based on these legislative changes. Perhaps in Year 7, pre-permitting could be initiated to site a future manufacturing facility. These approximate dates add up to approximately 7 years. This timeline could be shortened if the State created a nuclear siting committee to expedite some of these activities.

A thorough public education and involvement program would need to be implemented in parallel, as the public's opinions will influence the success of these activities.

6.3.4 SMR Construction Planning

Should the State decide to invest in attracting SMR manufacturing, or related industry and technology, many of the steps outlined in Section 6.3.3 may be needed. In particular, the State will need to focus on many future planning activities, including the following:

- Conduct cost/benefit analysis
- Characterize existing resources
- Identify acquisition team
- Investigate tax incentives or similar incentives
- Introduce and pass legislation
- Consider site pre-permitting
- Conduct marketing

Construction planning will require considerable lead time and should start soon, so that the State can decide what investment and schedule should be followed.

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8.0 Glossary

advanced light-water reactor (ALWR)	Advanced designs of LWRs, also called third or fourth generation reactors. Some third generation reactors are in operation (in Japan) or under construction. Fourth generation designs are still in development and will not be operational until 2020 at the earliest (WNA website). The mPower and NuScale SMR designs (upon which this report's Model SMR is based) are ALWRs.
advanced gas-cooled reactor (AGR)	A type of gas-cooled nuclear reactor developed in Britain that uses graphite as the moderator, carbon dioxide as a coolant, and enriched uranium as fuel. This reactor operates at high temperatures for improved thermal efficiency compared to first generation designs, but requires stainless steel fuel cladding to withstand these temperatures.
Application for Site Certification (ASC)	License application EFSEC would require for SMR siting in Washington.
aquifer storage and recovery (ASR)	The process of injecting water into an aquifer, where it is stored for use at a later time. Requires permits from Washington State Department of Ecology in Washington.
attraction areas	One of three criteria used during this analysis. Attraction areas represent potential locations favorable to SMR siting, construction and operation, such as locations that already have infrastructure in place to facilitate project development, and areas with suitable geophysical properties.
avoidance areas	One of three criteria used during this analysis; represents locations that feature challenges to development. These areas can support SMR siting under certain circumstances, when balancing the environmental and regulatory aspects of development, construction, and operation with economic and technical considerations.
constrained areas	One of three criteria used during this analysis. Constrained areas represent locations that have the most significant challenges for siting SMRs due to significant engineering challenges and/or incompatibility with the site or surrounding areas.
Construction and Operation License (COL) (also termed Combined License)	An NRC-issued license that authorizes a licensee to construct and (with certain specified conditions) operate a nuclear power plant at a specific site, in accordance with established laws and regulations. A COL is valid for 40 years (with the possibility of a 20-year renewal). (NRC website glossary)
Design Certification	Certification and approval by the NRC of a standard nuclear power plant design independent of a specific site or an application to construct or operate a plant. A design certification is valid for 15 years from the date of issuance but can be renewed for an additional 10 to 15 years. (NRC website glossary)

Early Site Permit (ESP)	A permit through which the NRC resolves site safety, environmental protection, and emergency preparedness issues, in order to approve one or more proposed sites for a nuclear power facility, independent of a specific nuclear plant design or an application for a construction permit or combined license. An ESP is valid for 10 to 20 years, but can be renewed for an additional 10 to 20 years. (NRC website glossary)
Emergency Planning Zone (EPZ)	Emergency zones around each nuclear power plant, established to facilitate a preplanned strategy for protective actions during an emergency. EPZs are site-specific, and include a plume exposure pathway zone and an ingestion exposure pathway zone.
fast neutron reactor (FNR)	A nuclear reactor in which the fission chain reaction is sustained by fast neutrons. Plutonium is usually used as the fuel.
gas-cooled reactor (GCR)	A nuclear reactor in which the coolant is a gas, such as carbon dioxide or helium.
high-temperature gas-cooled reactor (HTGR)	Gas-cooled nuclear reactors that operate at higher temperatures and efficiency than GCRs. A current design is a helium-cooled reactor that generates energy using steam or high temperature fluid. HTGRs with coolant outlet temperatures over 1000°F are termed very high-temperature reactors (VHTR).
high temperature reactor (HTR)	A nuclear reactor whose temperatures are high enough (at least 660 degrees Fahrenheit) for efficient generation of mechanical power.
Interim Staff Guidance (ISG)	Documents issued by the NRC to clarify or address issues not discussed in standard review plans.
Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)	A combined license from the NRC enables the licensee to construct a plant and operate it once construction is complete if certain standards (ITAAC) identified in the combined license are satisfied. The majority of ITAAC are from the design certification for the reactor's technology; the remaining ITAAC are site-specific.
light-water reactor (LWR)	Nuclear reactors that use ordinary water for coolant. LWRs include boiling water reactors (BWRs) and pressurized water reactors (PWRs). LWR technology is used in all 100 existing US nuclear power reactors. (NRC website glossary). See also ALWR definition.
lahar	Mudflow or debris flow composed of a slurry of volcanic material, rocky debris, and water.
liquid metal fast reactor	Reactor design that is cooled by metals such as sodium, lead, or lead-bismuth. These reactors have a higher power density than water systems.
liquefaction	A phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading.
Maximally Exposed Individual (MEI)	A hypothetical individual who -- because of proximity, activities, or living habits -- could receive the maximum possible dose of radiation or of a hazardous chemical from a given event or process.
Model SMR	The generic design model created for this report's analysis of possible siting locations for SMRs in Washington. It is an amalgam of SMR attributes of the two finalists selected by USDOE as candiates for support (NuScale and mPower designs).

moderator	A material, such as ordinary water, heavy water, or graphite, that is used in a reactor to slow down high-velocity neutrons, thus increasing the likelihood of fission.
molten salt reactor (MSR)	Nuclear reactor using a fluid fuel such as very hot fluoride or chloride salt instead of the solid fuel used in most reactors. The fuel can also function as the coolant. One type of MSR is the LFTR (liquid fluoride thorium reactor).
mPower Design	One of two SMR designs chosen by USDOE for additional funding and support. 180 MWe.
New Source Review (NSR)	NSR permitting protects air quality when factories, industrial boilers and power plants are newly built or modified. NSR also assures that new or modified industries are as clean as possible.
NuScale Design	One of two SMR designs chosen by USDOE for additional funding and support. 45 MWe PWR design.
Protective Action Guides (PAGs)	USEPA-developed guidelines on radiation doses that would trigger public safety measures, such as evacuation or staying indoors, to minimize or prevent radiation exposure during an emergency.
pressurized heavy water reactor (PHWR)	Reactor design that uses heavy water under high pressure as a coolant. As heavy water is an efficient moderator, the reactor can use unenriched uranium as fuel. A secondary circuit uses steam from the coolant to drive the turbine.
Plant Parameter Envelope (PPE)	The set of postulated design parameters that bound the characteristics of a reactor that might later be built at the selected site.
Potential Site Study (PSS)	A study that a prospective applicant may request form EFSEC, prior to submitting an application for certification. A PSS can help determine if there are any environmental, regulatory, or social "hurdles" that cannot be overcome, which would render the project unsuitable.
pressurized water reactor (PWR)	Type of LWR reactor that uses ordinary water as both coolant and moderator. Very pure water is heated to a very high temperature by fission, kept under high pressure (to prevent it from boiling), and converted to steam by a steam generator (rather than by boiling, as in a boiling-water reactor). The resulting steam is used to drive turbines, which activate generators to produce electrical power. About 2/3 of nuclear power plants operating in the US are PWRs.
Site Certification Agreement (SCA)	A license to build and operate a qualifying energy facility in the state of Washington. Prepared and issued as a recommendation by EFSEC, it is denied or approved and signed by the Governor.
Standard Design Certification (SDC)	A Rule issues under 10CFR 52.54 that formalizes an approved and certified design.
small modular reactor (SMR)	Nuclear power plant modules that produces 300 megawatts of energy or less (Office of Nuclear Energy definition).
source term	Types and amounts of radioactive or hazardous material released to the environment following an accident.
total maximum daily load (TMDL)	The maximum amount of a pollutant that a body of water can receive while still meeting water quality standards.

Appendices

Appendix A

Status & Trends – SMR Development Activities

Appendix B

Water Availability in Washington Rivers

Appendix A

Status and Trends – SMR Development Activities

Introduction

Small Modular Reactor (SMR) development is a worldwide effort operating at the advanced edge of design and technology, where some of the very first concepts are currently being built, or in design, or in the stages of design certification or licensing. As a result, advances and new developments are occurring rapidly and continually. This appendix to the report "Small Modular Reactors – An Analysis of Factors Related to Siting and Licensing in Washington State" offers a brief summary of the status of SMR development, including a discussion of some of the major participants in government and industry who are involved in the technology, their current activities, and the current status of these participants as of end-of-year (EOY) 2015. As discussed below, some substantial developments are scheduled for 2016 and 2017 in the United States. New information and new activities in design, certification, licensing, construction, and testing are all pending or scheduled. As these activities occur and are processed, and as their results are known, the knowledge base associated with this technology and its regulations will continue to expand. Readers who are interested in the evolution of SMR technology are encouraged to follow the activities of these participants.

Although there are still concerns about the risks and uncertainties associated with nuclear power, and nuclear waste disposal in particular, the potential benefits of SMR development include the opportunities for simpler design, construction, licensing process, and operation, as well as improvements in safety associated with the power generation cycle. Despite the lack of a permanent repository for spent fuel rods, the technology offers a major zero-carbon emission source of baseload power. As these concepts move forward in the United States, and with the support of the US Department of Energy (USDOE), the Nuclear Regulatory Commission (NRC) is proceeding cautiously with plans for a few rulemaking changes to the licensing process (such as the Emergency Planning Zones [EPZ] revisions discussed in the NRC permitting section of the report). The EPZ rulemaking and other proposed changes will evolve over the next few years.

As SMR technology advances and regulations are revised in response, some state policies in the US are evolving as well. From minor steps like removing policies that prohibit nuclear power, to setting up economic commissions to encourage it, these states are evolving in economic, environmental, and regulatory considerations, such as carbon emissions, and in political and policy trends.

The following discussion summarizes the roles, responsibilities and current status of selected participants in the industry, including recent and ongoing activities by these participants.

Federal Agency Activities

The US Department of Energy (USDOE)

As part of their role in energy research and development in the United States, and supplemented by the administration's policies on energy security and reducing oil imports and reducing greenhouse gas (GHG) emissions, the USDOE has encouraged the development of new advanced technologies for nuclear power generation, including the development of SMRs.

The US fleet of nuclear power plants currently provides approximately 60% of the country's zero-carbon emission energy production. US energy demands are predicted to increase 28% from 2011 to 2040, and

most of the current fleet of nuclear power plants is scheduled for retirement or relicensing well before then. Without a nuclear replacement solution, today's technologies suggest that the retired plants will be replaced with natural gas, yielding a net increase in CO2 emissions of 200 to nearly 300 million metric tons per year (USDOE 2014). Those reactors that do proceed with gas conversion as part of the license renewal process will be committing their existing plants to 60 more years of operation and CO2 emissions. Many were first built in the 1970s and 1980s.

Another aspect of USDOE's interest in SMRs (and other low/zero emission technologies) is the aging of the nation's coal-fired power plant fleet. Almost all of the coal-fired power plants in the United States greater than 300 megawatts (MW) in size are over 50 years old. Today's most likely replacement scenario for these plants is also natural gas, with some renewables/gas combinations that reduce emissions overall, but still rely on fossil fuels for firm baseload power. Each conversion probably results in a commitment of another 30 to 50 years of emissions from fossil fuel combustion.

USDOE is looking for ways to make nuclear power and other technologies viable for the future. For example, among their many offices and initiatives, the Office of Nuclear Energy (OFN) runs their Light Water Reactor Sustainability Program (LWRS) providing research in areas designed to extend the life of existing nuclear plants. The OFN also supports new SMR technology through their SMR licensing Technical Support Program, which was started in 2012.

To help the SMR technology move forward (USDOE is also supporting other advanced nuclear design technologies), USDOE issued a request for proposal (RFP) in 2012 for applications for funding support to any sponsor willing to proceed with SMR development who could meet USDOE selection criteria for qualifications, business status, engineering progress, and other factors. Two designs were eventually selected as the program evolved: the NuPower project, whose major sponsor is Fluor Engineers, operating in Oregon and other states; and the mPower project proposed by Babcock and Wilcox in Tennessee and Virginia (now BWX Technologies) with Bechtel and the Tennessee Valley Authority (TVA) as partners.

Both of these designs offered the following benefits to improve nuclear power generation safety:

- Safety systems are self-contained, passive, and automatic, requiring no external input or controls, and cooling occurs via convection.
- The units' fuel, water, and power generation are contained in a single vessel.
- More water volume (for safe shutdown) is available compared to the core size and the heat produced.
- Facilities are underground, reducing earthquake effects and risk, and increasing security.

In both the NuPower and mPower designs, USDOE committed to more than $200 million in matching funds to help each of the two companies in their R&D efforts and eventual design and licensing schedules, with a goal toward an eventual design certification submittal to the NRC as a major first step. Since the selections were made, the mPower project has cut back on funding to the extent that USDOE withdrew its own funding. The mPower project continues, but at a reduced level of investment (see the TVA discussion below) although mPower asked NRC to stop conducting a design review in November, 2015. The NuScale project has continued, and NuScale plans to submit an application to NRC in late 2016 to get their design certified, followed by a project license application. This design certification may be a 3-4 year process but the two processes may overlap. Future SMRs are aided by the President's March 19 Executive Order to have federal agencies get 15% of their power from alternative energy sources, including SMRs.

Additional USDOE activities that are focused on SMRs include working on source term evaluations, security, testing support, economic modelling of SMRs, technology assessment, fuels testing, regulatory revisions, insurance requirements, and instrumentation, as well as collaborating with the Electric Power Research Institute (EPRI) on a Utility Requirements Document.

USDOE and Nuclear Waste Disposal. The USDOE has a nuclear waste disposal responsibility that relates to SMRs because it will eventually lead to a program and location(s) to receive their waste. Considering USDOE's activities in this field, many different states may be involved in the solution. For that reason, we summarize their ongoing investigations in nuclear waste management.

The commercial nuclear power plant industry has no long-term permanent location to dispose of nuclear waste (e.g., spent fuel rods from nuclear reactors). Although utilities have been paying billions of dollars into a repository fund under requirements of the Nuclear Waste Policy Act, the proposed high level nuclear waste repository licensing process at Yucca Mountain has been suspended. The nuclear industry is still storing spent nuclear fuel rods on their power plant sites, and continues to support a repository or at least an interim repository. Some interim HLNW repository concepts are actually being proposed by local government and industry.

Recognizing the need for a better solution to high-level nuclear waste disposal, the US Secretary of Energy, in 2010, chartered the Blue Ribbon Commission on America's Nuclear Future (BRC) to conduct a comprehensive review and recommend a plan of action for the back end of the nuclear fuel cycle: namely the management and disposal of the nation's used nuclear fuel (UNF) and high-level nuclear waste (HLNW). In January 2012 the BRC issued its final report, which included the following recommendations, among others:

1. A consent-based approach should be utilized to site future nuclear waste management facilities.
2. One or more consolidated interim storage facilities should also be promptly developed to provide a secure storage capability away from the nuclear reactor sites, including those that have ceased operation.
3. One or more geologic disposal facilities should be promptly developed to provide permanent disposal in a location that is isolated from humans and the environment.
4. Preparations should be undertaken for large-scale transport of spent nuclear fuel and high level waste to the interim storage and disposal sites.

In January 2013, the USDOE released the Administration's Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste (Strategy) in response to the BRC's recommendations. The Strategy endorses the concept of a consent-based siting process and prioritizes the development of a pilot interim storage facility to be followed by a larger facility with sufficient capacity to significantly reduce the inventory of spent nuclear fuel stored at reactor sites. The Strategy also includes a plan to develop and open a geologic repository by 2048.

Since late 2012, the USDOE's Office of Nuclear Energy (DOE-NE) has been conducting planning activities within the Nuclear Fuels Storage and Transportation Planning Project (NFST) to lay the groundwork for implementing interim storage, including associated transportation, per the Administration's Strategy, within existing legislative and budgetary authorizations. The goal of this effort is to identify, select, and develop one or more interim nuclear waste disposal facilities that can be used until a final long-term repository is opened and fully operational. In the past, USDOE has sought out sites, applied the expertise of their national laboratory program to evaluate sites, or solicited site locations from others. These are among the options under consideration in the search for interim storage options.

US Nuclear Regulatory Commission (NRC)

This section discusses the current activities at the NRC in response to the growing interest in SMR development. The actual permitting and regulatory roles of the NRC are discussed in the main body of the report. Additional details about NRC regulations are provided in the SMR Hanford Site Analysis report commissioned by the Tri-Cities Development Council (URS 2014).

The NRC has a long, institutionalized regulatory process and culture—one known for careful documentation, scientific review, and a methodical process—all tied to safety and security. As a result, when new technologies arise, the NRC is cautious about revising the associated permitting and approval processes. The commission is hearing many suggestions about how parts of regulatory compliance, insurance, or other process could be changed for SMRs. These suggestions, from industry groups, utilities and others, including the NRC's own staff, are under discussion and may lead to future changes. One significant change is actually in process, based on NRC staff recommendations: to revise the Emergency Planning Zone requirements for siting. Other changes are in process as well.

In August 2015, the Commission approved (SECY 15-0077) the staff's recommendation to initiate a rulemaking to revise regulations and guidance for emergency preparedness (EP) for SMRs, noting the potential benefit of a performance-based emergency preparedness regimen for these smaller reactors. Until the rulemaking is complete, all applicants would use the existing exemption processes.

There are currently two Emergency Planning Zones around today's nuclear reactors: a 10-mile plume radius and a 50-mile ingestion radius. New rulemaking accepted by the NRC proposes to examine changes in these EPZs, including looking at site boundaries and 2-mile distances from the plants. The rulemaking process is likely to take 3-4 years to be finalized.

The NRC commission paper SECY 15-044 is another rulemaking effort focused on SMRs. The document is more administrative than technically substantive, but it is intended to avoid the issue of separate annual fees for each reactor module in an SMR chain that would occur if fees were charged per reactor like today's large baseload units. The NRC is also looking into assigning insurance requirements to a site, rather than to each reactor as is done today. Because SMRs are intended to be multiple integrated modules, insuring each one separately may not be appropriate.

Tennessee Valley Authority (TVA)

Although not a regulatory agency, the TVA is contributing to the advancement of SMR technologies and siting. The TVA is a federal agency, headquartered in Tennessee, that is responsible for electrical transmission and natural resource management. It is similar to the Bonneville Power Administration (BPA) in function, but has a slightly different purpose, focusing also on economic development. The TVA was on track to help develop an SMR facility at their Clinch River Breeder Reactor (CRBR) site in Oak Ridge, Tennessee. The TVA was developing the facility as a partner on the mPower project, which was supported by USDOE funding as a partner with Babcock & Wilcox (now BWX Technologies) and Bechtel Corporation. When the mPower project went to a much-reduced level of funding, as it is operating under today, the TVA decided to continue moving forward with an SMR at the site via a different path.

The path selected by the TVA is to submit an Early Site Permit (ESP) application to USDOE to get the site permitting underway, and initiate the project permitting later, following 10 CFR Part 52 siting regulations. This allows the TVA to keep moving on their project siting goals, without a project. The TVA is now considering at least four possible technologies, including mPower's design, and has developed a Plant Parameter Envelope (PPE), which is a list of minimum/maximum factors comprised of the input and outputs (infrastructure requirements and impacts) of all the technologies they are considering. In that way, a site approved by the NRC can accept any future project that falls within the confines of that envelope (height, thermal discharge, water use, accident source term, etc.). For example, TVA is considering only light-water reactor (LWR) technologies, and has a site under 1,000 acres, assuming a combined MW output greater than any of the current technologies available, in case it is needed.

The TVA plans to submit the ESP application in early 2016 to begin the 3-4 year approval process. But TVA does not intend to wait for that approval before selecting a technology and submitting an actual project license application (Combined Construction and Operation License Application [COLA]) in 2018. By that date, they hope a technology will be available for selection, and a new course can be plotted involving the design certification, ESP process, and COLA process that incorporates all three activities. If successful, the 2018 COLA may result in a construction and operation license (to build) in 3-5 years, or possibly sooner if SMR licensing timelines are reduced by then. With 5 years for permitting and 3 years for construction (a very uncertain estimate), the TVA SMR could be constructed by 2026. Uncertainties with these estimates are all affected by funding, power supply, regulatory changes, public perception, unknown risks, and agency review processes.

Utah Associated Municipal Power Systems (UAMPS)

UAMPS is an association of utilities that is a political subdivision of the State of Utah; UAMPS provides wholesale electric-energy, on a nonprofit basis, to community-owned power systems throughout the Intermountain West. The UAMPS membership represents 45 members from Utah, Arizona, California, Idaho, Nevada, New Mexico, Oregon and Wyoming. The association is currently considering developing a NuScale design SMR at a location in Idaho. For its part, NuScale is already planning to submit a design certification application to the NRC in 2016. This and the TVA project described above are two of the most active SMR proposals underway at this time (see Energy Northwest and NuScale below).

International Governments and Agencies

United Kingdom (UK) National Nuclear Laboratory (NNL)

The UK is interested in SMRs and sponsored an SMR Feasibility Study (National Nuclear Laboratory 2014) only one year ago to determine if the technology is viable, and if it is a technology the UK may want to sponsor. The NNL's mission is to profitably deploy nuclear technology to a broad range of national and international markets and provide independent, authoritative advice on nuclear issues.

The NNL study evaluated technologies, including mPower and NuScale, and assessed markets, innovations, costs, and commercial opportunities. One conclusion from this study was that there is a significant market for SMRs and the UK has a "narrow window of opportunity" to participate in a joint development with a partner country.

The NNL conclusions on NuScale were that it was a well-developed design with potential challenges in operating up to 12 units installed sequentially. The NNL concluded that the mPower system is a more traditional pressurized water reactor (PWR) concept with similar multi-module concerns expressed. NNL described both mPower and NuScale technologies as investment opportunities for the UK. The mPower group has since offered to partner with the UK. A UK-only development option was considered feasible, but constrained by investment, schedule, marketability overseas, and market timing.

The report evaluated alternatives with seven criteria and selected NuScale, Westinghouse, mPower, and the Chinese ACP100+ reactor plans as worthy of further review.

The NNL identified public perception as an important factor. The report cited UK citizen support at 42% in the March, 2014 survey, which was lower than in the United States where a survey found that most respondents were in favor of nuclear power overall (NEI 2014).

In December 2015, the UK government committed another $350 million in SMR development with a plan to solicit technology proposals in 2016. Westinghouse has proposed to partner with them.

International Atomic Energy Agency (IAEA)

The IAEA was established by member nations as the world's center for cooperation in the nuclear field, to promote the safe, secure and peaceful use of nuclear technologies. The IAEA's Department of Nuclear Energy has been evaluating SMR technologies and released their 2014 investigation, "Advances in Small Modular Reactor Technology Developments." The investigation examines the status of all technologies under way worldwide, and is one of the most comprehensive analyses of the industry available. The IAEA recognizes and discusses the many potential advantages of SMRs, while also discussing some of their potential issues, many of which are being worked on at many levels. Issues identified in the 2014 investigation include the following:

- Operability performance/record
- Technology maturity
- Human factor engineering; operator staffing for multiple-module plants
- Post-Fukushima action items on design and safety
- Economic competitiveness
- First of a kind cost estimates (i.e., cost uncertainty)

Province of Ontario – Ministry of Energy

The province is currently conducting a SMR feasibility study.

State Agencies/Entities/Utilities

Washington State Legislature, Joint Select Task Force on Nuclear Energy

This task force was established by the legislature to examine many aspects of nuclear power development in 2014. The task force voted to extend their activities into 2015 including a meeting held in October of 2015. Its December 15, 2014 Final Report consisted of a summary of meetings, presentations, and task force member comments on nuclear energy (Joint Select Task Force on Nuclear Energy 2014). The report offered the following views:

- Nuclear power should play a key role in the state and offers many benefits, including jobs and clean energy.
- State actions in support of this industry might include education and awareness, formal promotion, including nuclear power under I-937.
- Siting opportunities and site identification activities should be improved.
- A solution to radioactive waste disposal should be encouraged.
- Costs and economic benefits of SMR production should be developed, including costs and benefits of displacing other fuels and local power sources.

Washington State Department of Commerce

Among the many responsibilities of the state's Department of Commerce are to develop programs in support of the state's economy and its energy future. Reports on permit streamlining and energy planning, under the State Energy Office, have been summarized in the contents of main body of this report. The department works to support the Governor's Executive Order 14-04 and Clean Energy plans, which encourage investment in emissions reduction and consumption and emphasis on renewables; however, the plans and goals are silent on direct actions specific to nuclear generation. The Department's Deputy Director stated in a November 2015 interview that the State's energy strategy was silent on electrical generation, and that they rely on the direction of the NW Power Planning Council (NWPPP) for their 20-year resource plan. (See the section on NWPPP below.)

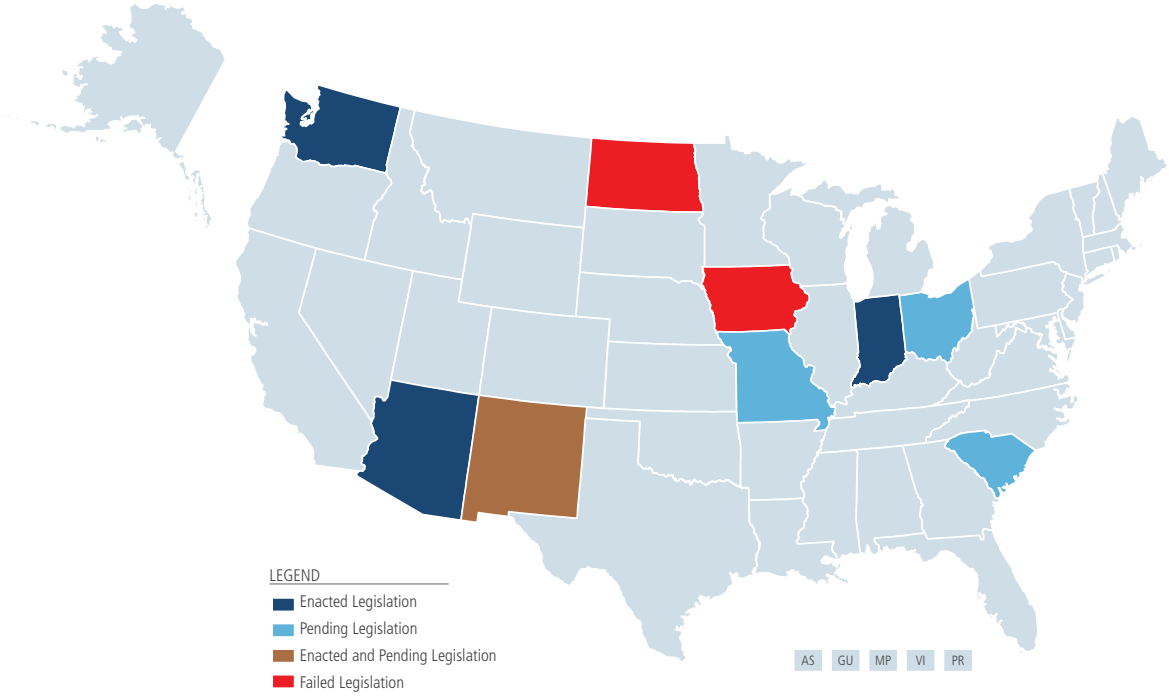
The Department of Commerce works to support the goals of Washington's Energy Independence Act including renewable portfolio standards (RPS) that are overseen by the Utilities and Transportation Commission.

National Conference of State Legislators (NCSL)

This organization of state legislators across the United States includes members from Washington and is involved in all topics of interest to US citizens and the legislators who govern them. SMRs are among the topics this organization covers, and the NCSL has provided considerable information to its members and on its website about the technology, risks, benefits, and state regulations that have been proposed for SMRs. The following figure shows the status of legislation in recent years across the United States. Some of this legislation might provide a model for Washington regulations dealing with financing, tax incentives, permitting, and related issues and is a good resource for those interested in creating legislation to encourage SMRs, their manufacture, or the nuclear industry. Whether or not the topic and language of another state's law could be effective in Washington depends on the topic, other regulations and policies, legislative history, tax policies, and other factors. The legislation that triggered Washington's presence on this map was the $500k support to Tri-Dec for SMR investigations. Some of the suggested legislation in other states included the following:

- A Missouri bill requiring utility electricity sales to include 2% SMR generation
- A New Mexico bill creating a Task Force to promote nuclear supported economic development, and encouraging SMRs, including another bill to look at economic benefits from SMRs
- An Arizona bill to provide R&D funding for two SMR reactor designs
- Bills in Iowa, Indiana and Missouri to encourage SMR development in various ways

2010-2014 State Legislation on SMR Technologies



Energy Northwest

Energy Northwest (ENW) is public power agency created by the Washington State Legislature. They are comprised of a consortium of 27 public utility districts and municipalities that own and operate energy facilities in the Northwest, including the Columbia Generating Station, a nuclear plant located on the Hanford Reservation. Other generating facilities owned by the agency include the White Bluffs Solar Station, Packwood Lake Hydroelectric Project and Nine Canyon Wind Project. They also provides operations and maintenance services for generating facilities owned by other utilities, and develops new power generation facilities to meet growing demand. The operations and maintenance capability of ENW is responsible for their current connection to SMR development.

ENW is a partner with NuScale and UAMPS for the proposed NuScale design SMR that will start the design certification process with the NRC in 2016. If the project goes ahead as envisioned, the consortium will submit a license application to the NRC for a site in Idaho. If that site and project are licensed and built, ENW is slated to operate the facility and all the modules that would be constructed there. According to ENW's 10 year planning horizon , they have no plans in the next 10 years to submit an application for an SMR in Washington (ENW 2015).

Northwest Power and Conservation Council

The Pacific Northwest Electric Power and Conservation Planning Council, also known as the Northwest Power and Conservation Council (Council), was authorized on December 5, 1980 by Congress in the Pacific Northwest Electric Power Planning and Conservation Act, Public Law 96-501. Although federally authorized, it is listed under state organizations in recognition of its role as an interstate agency, established April 28, 1981, by agreement among the states of Idaho, Montana, Oregon and Washington to provide planning and policy leadership on regional electric power and fish and wildlife issues. The Council develops a plan to help ensure the region of a safe, reliable, and economical power system with due regard for the environment. The Council's Plan, issued every five years, is instrumental in shaping and authorizing power generating options in the Northwest. The latest draft plan was released October 20, 2015, and its relationship to SMR technology is summarized here.

Draft Seventh Northwest Conservation and Electric Power Plan (Plan).

As described in the Plan's Chapter 1, Executive Summary:

> *"The Pacific Northwest power system faces a host of uncertainties, from compliance with federal carbon dioxide emissions regulations to future fuel prices, resource retirements, salmon recovery actions, economic growth, a growing need to meet peak demand, and how increasing renewable resources would affect the power system. The Council's Seventh Power Plan addresses these uncertainties and provides guidance on which resources can help ensure a reliable and economical regional power system over the next 20 years."*

The Council classified generating resource technologies into three categories: primary, secondary, and long-term. Their long-term evaluation includes SMRs as a viable emerging technology, if needed for a zero-carbon future. The plan stated that SMRs are intended to reduce capital cost and investment risk by utilizing a greater degree of factory assembly, shortening construction lead time, and better matching plant size to customer needs and finances through scaling of multiple units. The smaller plant size of SMRs may also permit greater siting flexibility, load following capability, and cogeneration potential and can benefit system reliability through reduction in "single shaft" outage risk. Also, SMRs have lower construction and reliability risks than conventional plants. The Council provides the following resource strategy guidance related to SMR technology:

> *"Future Resources: In the long term, the Council encourages the region to expand its resource alternatives. The region should explore other sources of renewable energy, especially technologies that provide both energy and winter capacity; new efficiency technologies; new energy-storage techniques; smart-grid technologies and demand-response resources; and new or advanced low-carbon generating technologies, including advanced nuclear energy. Research, development, and demonstration funding should be prioritized in areas where the Northwest has a comparative advantage or where unique opportunities emerge."*

Private Corporations

NuScale Power

NuScale Power is one of the recipients of the December, 2013 USDOE funding competition, and is on their way to a design certification submittal with the NRC in 2016. NuScale Power is proceeding with their SMR module project from offices in Portland and Corvallis, Oregon; Rockville, Maryland; and Charlotte, North Carolina. Fluor Corporation is the major sponsor. The NuScale module is a self-contained light-water reactor design with a 50 MW capacity. Each module is approximately 15 feet in diameter and 76 feet high, containing the fuel, heat exchange system, and generators. Although each module is compact enough to ship via barge, rail or specially permitted truck, the surrounding infrastructure is still considerable, requiring a few dozen acres for substations, cooling towers, administrative facilities, buffers, and other infrastructure. The module is enclosed in a reactor building filled with sufficient water to self-cool and shut down the system in an emergency with no additional support or additional water, and no power.

NuScale has an advisory board comprised of more than a dozen utilities, including Energy Northwest. Their planning started years before the USDOE solicitation, and today they are responding to USDOE'S need and to the needs expressed by the Western Governors Association in the last few years, to find ways to incorporate SMRs into the marketplace. Part of NuScale's plan in the United States is to proceed with siting an SMR, probably in Idaho. This site is tied to the UAMPS Carbon Free Power Project (CFPP). Currently on schedule, the plan is to submit the design certification application late in 2016, and to follow that with an NRC project application (COLA) to receive license approval in 2020. If construction begins immediately, up to 12 modules would be delivered in 2023 and 2024 and operation would occur over the same time frame. NuScale's cost estimate for this effort in 2014 dollars is just under $3 billion, or approximately $5,000 per kilowatt. The SMR plant would replace coal-fired power generation.

NuScale is working with Energy Northwest and the UAMPS on siting the first SMR at the Idaho National Laboratory in Idaho Falls, Idaho. Assuming key design certification and development milestones are met along the way, Energy Northwest and the UAMPS intend to submit a COLA to the NRC by early 2018. To aid in this application, the USDOE recently awarded NuScale and UAMPS $16 million to complete the COLA. It is estimated that the first module will be operational in 2023 and the full 12-module, 600 MW SMR plant will be operational in 2024. Energy Northwest and UAMPS estimate that the capital cost of this first plant will be around $2.9 billion, with a full plant levelized cost of electricity around $75 per megawatt-hour.

NuScale SMR Features at a Glance:

- **Thermal capacity** – 160 MWt
- **Electrical capacity** – >50 MWe (gross)
- **Capacity factor** – >95%
- **Dimensions** – 76' x 15' cylindrical containment vessel module containing reactor and steam generator
- **Weight** – ~ 700 tons as shipped
- **Transportation** – Barge, truck or train
- **Cost** – <$5,000/KW
- **Fuel** – Standard LWR fuel in 17 x 17 configuration, each assembly 2 meters (~ 6 ft.) long; 24-month refueling cycle with fuel enriched less than 4.95%

mPower

BWXT mPower, Inc. is currently in the development, licensing and deployment process for small modular reactors. The BWXT mPower™ reactor, an initial winner in USDOE's competition for federal government funding support, is an SMR design concept that is designed to have the capacity to provide output in increments of 180 MWe (megawatts of electricity) per module for a four-year operating cycle without refueling. The mPower project is operating at a much lower level of funding than during its initial startup after the USDOE funding, but it is still moving forward. Initial sponsors included Babcock & Wilcox (reorganized in June, 2015 into the BWXT business unit), Bechtel Corporation, and the Tennessee Valley Authority. Their original schedule was to submit a construction permit application to the NRC by 2015 for approval by 2018. This has been delayed by the funding reductions but the TVA has proceeded on an alternate course to keep their project moving forward (see the discussion on the Tennessee Valley Authority, above).

Mpower Attributes at a Glance:

- Thermal output: 530 MWt
- Electrical output: 155 - 180 MWe
- Air-cooled condenser; water-cooled condenser
- Vessel diameter: 13 feet
- Height: 83 feet
- Vessel weight: 628 tons (w/o fuel), 716 tons at power
- Fuel assemblies: 17x17 fuel pin array
- Refueling cycle: 4+ years
- Land requirements: ~40 acres (2 pack)
- Passive design
- Steam Generator
- Emergency Power DC only

Features of the BWXT mPower reactor include integral nuclear system design, passive safety systems, underground siting, and one to ten or more modules at one site. They still intend to be among the future SMR technology choices available to utilities and developers, and are one of the options TVA is still considering for their Savannah River site. NRC suspended their review of critical design code information of the mPower design on November 19, 2015.

Holtec International Company (HIC) – SMR Development

SMR Inventec, LLC, is a wholly owned subsidiary of Holtec International Company; the company has developed the SMR-160, a pressurized water reactor (PWR) SMR, designed with passive cooling. It is a light-water reactor with the reactor, steam generator, and spent fuel pool located in containment. The reactor core is located below grade. The SMR-160 has a rated electrical output of 160 MWe.

Holtec International Company (HIC) – Interim Storage Facility

Holtec is working with a partnership in Eddy and Lee Counties, New Mexico to develop an interim storage facility for high-level nuclear waste. Holtec makes the storage containers and plans on licensing a facility. Their plans are to submit an application for the facility in 201, submit a Safety Analysis Report in 2018, receive their NRC license approval in early 2019 to begin construction, and start operation in 2020. This Holtec schedule does not discuss the completion of a National Environmental Policy Act (NEPA) environmental impact statement (EIS) for the facility or how long that would take, but the EIS would have to be complete before a license was issued. This update is provided here because a Holtec division has an SMA design, and because future waste disposal is an issue related to SMRs.

Westinghouse Electric Company

Westinghouse Electric Company has developed their own SMR design for a 225 MW unit and is moving forward with a program to develop it where there is interest. Their design requires 15 acres of land. They received approval to test their design from the NRC in early 2015. The decision by the USDOE to support mPower and NuScale has slowed the Westinghouse SMR development schedule, but it still in development.

Westinghouse SMR Features at a Glance:

- Electric Output: >225+ MWe
- Reactor Power: 800 MWt
- Design Life: 60 years
- Fuel Type: 17x17 RFA, <5% enriched UO2
- Total Site Area: ~15 acres
- Passive Safety Systems
- Rail, Truck or Barge Shippable
- Simplified System Configuration, Standardized, Fully Modular Approach
- 24 Months between Refueling

Trade, Government and Industry Associations

Electric Power Research Institute (EPRI)

EPRI is a utility-sponsored research institution founded to assist member utilities with common issues in the industry. Operating in five states and the District of Columbia, EPRI sponsors research in dozens of areas, including nuclear power plant siting and advanced nuclear technologies. They recently updated their nuclear power plant siting guide (EPRI 2015), which is based on NRC siting regulations and is used in nuclear plant siting. The guide is available to non-members for $150,000. EPRI sponsors a Small Modular Reactor Staff Optimization Technical Advisory Group. EPRI has also issued a 2002 siting guide for Early Site Permit applications, for utilities considering the ESP process as TVA is currently doing. They also issued a utility requirements document for SMRs in 2014 (EPRI 2014). EPRI will continue to develop guidance documents, conduct research, and provide data to their member utilities.

Nuclear Energy Institute (NEI)

NEI is a pro-nuclear power organization in Washington DC. They act as a proponent for the nuclear industry and provide technical support and analysis to the NRC and others about many issues, including SMRs. NEI's mission, as stated on their own website, is to foster the beneficial uses of nuclear technology before Congress, the White House and executive branch agencies, federal regulators, and state policy forums; proactively communicate accurate and timely information; and provide a unified industry voice on the global importance of nuclear energy and nuclear technology. This role includes outreach to the public and to state and local government on issues and information associated with nuclear power. They could be an information resource to anyone in Washington wishing to get more information on these topics.

NEI's objective is to ensure the formation of policies that promote the beneficial uses of nuclear energy and technologies in the United States and around the world.

For example, NEI submitted a new Source Term proposal to the NRC in December 2012; the NRC issued a number of questions in response, and these questions are currently under discussion. They are supporting the use of SMRs as part of a carbon-free strategy and are also supporting the NRCs proposal to consider revised rules associated with Emergency Planning Zones and has lobbied for an alternative process for design certification submittals for SMRs (in 2013-2014).

World Nuclear Association

The World Nuclear Association (WNA) is an international organization that promotes nuclear energy and supports its representatives from uranium mining, conversion, enrichment and fuel fabrication; all reactor vendors; major nuclear engineering, construction, and waste management companies; and the majority of world nuclear generation and related services. A WNA 2015 report on SMR standardization of licensing and harmonization of regulatory requirements said that the enormous potential of SMRs rests on a number of factors:

- SMRs could almost be completely built in a controlled factory setting and installed module by module, improving the level of construction quality and efficiency.
- Their small size and passive safety features lend them to countries with smaller grids and less experience of nuclear power.
- Size, construction efficiency and passive safety systems (requiring less redundancy) can lead to easier financing.
- Building multiple units for a specific SMR design will reduce costs further.

International Framework for Nuclear Energy Cooperation (IFNEC)

The International Framework for Nuclear Energy Cooperation was developed from the former Global Nuclear Energy Partnership (GNEP). The IFNEC is a partnership of countries aiming to ensure that new nuclear energy initiatives meet the highest standards of safety, security, and non proliferation. It involves both political and technological initiatives, and extends to financing and infrastructure. One of the IFNEC's goal is to accelerate the development and deployment of advanced nuclear fuel cycle technologies. The GNEP was initiated early in 2006, but picked up on concerns and proposals from the International Atomic Energy Agency (IAEA) and Russia. The vision was for a global network of nuclear fuel cycle facilities all under IAEA control or at least supervision. The group is interested in new generation technologies and waste disposal and reuse options.

Appendix B

Water Availability in Washington Rivers

Water Availability in Washington State Rivers

Golder evaluated factors related to the availability of water throughout Washington, including major rivers in the state that could be considered as likely cooling water sources for small modular reactor (SMR) modules. Table B-1 lists several of the largest rivers in Washington and discusses constraints created by one or more factors. There are dozens more rivers in the state, but this table demonstrates that many of the larger rivers have one or more restrictions to new water withdrawals and describes some of the factors influencing water availability across the state.

Table B-1. Water Availability Considerations in Selected Large Rivers in Washington

River	Considerations for Water Right Availability
Quinault River	There may be limited water available for new uses, especially given that river levels need to be maintained to ensure adequate water quality and fish migration. The Quinault Indian Tribe is very concerned about maintaining flows and fish habitat in the watershed and water right applications and mitigation plans are routinely sent to the Tribe for their review. Some areas located near the Pacific Ocean may have the potential for seawater intrusion. Applicants seeking new water appropriations may need to develop a mitigation plan and mitigate for the impacts their use of water will have on surface water bodies. Proximity to the reservation and national park and distance from load centers make this source unlikely.
Chehalis River	This watershed is one of the most intensely farmed basins in western Washington, and much of the water has already been spoken for. There is limited water available for new uses in the Chehalis watershed, especially given that river levels need to be maintained to ensure adequate water quality and fish migration. Increased demands from population growth, naturally low summer and early fall streamflow levels, and impacts from climate change add to the challenge of finding new water supplies. One power plant uses the Chehalis as a source and another close to the river uses municipal supply due to limited Chehalis water availability. Applicants seeking new water appropriations will likely need to provide mitigation to offset the impacts their use of water will have on surface water bodies. This is unlikely to be suitable for further withdrawals except during winter flow conditions. Summer supplies would need mitigation, storage or an alternative supply or cooling technology application. Both the Chehalis and Quinault Indian Tribes are very concerned about maintaining flows and fish habitat in the watershed. By request, the Washington State Department of Ecology (Ecology) notifies the tribes of all new water right applications and decisions.

Table B-1. Water Availability Considerations in Selected Large Rivers in Washington (continued)

River	Considerations for Water Right Availability
Nooksack River	An Instream Resources Protection Program rule for the Nooksack watershed was adopted in 1985. The purpose of the rule is to protect senior water rights, to maintain a healthy ecosystem, and to meet future water resource management objectives. Such rules are required by state law (RCW 90.54). The rule establishes minimum instream flows for rivers and creeks in the watershed and requires all lakes and ponds to be retained in their natural condition. Water rights issued after the date of the rule for surface water or groundwater connected to surface water are subject to these established instream flows. In many instances, this means that Ecology is unable to issue new water rights in the watershed because the new right will either impair a senior water right holder or the established minimum instream flow. Power plants subject to instream flows would need to curtail withdrawals at low flows which makes any significant new cooling withdrawal unlikely to be practicable. Future water diversions or withdrawals that are shown to negatively affect the minimum instream flows or the natural state of the lake or pond cannot be approved without a mitigation plan. As such, it is likely that new water right applicants will need a mitigation plan to secure a new water right.
Skagit River	Much of the water in the Lower and Upper Skagit Watershed is already legally spoken for. Increasing demands for water from population growth, declining groundwater levels in some areas, and the impacts of climate change have added to the challenge of finding water for new uses. The Lower Skagit Watershed lacks water when and where it is needed, particularly during the summer months. All water uses established after April 14, 2001 in the Skagit River basin and its tributaries are junior to the instream flows and are subject to curtailment when instream flow levels are not met. All new water uses requiring a continuous and reliable source of water, including permit-exempt wells, must be mitigated to prevent impairment of the instream flows. Water for non-consumptive uses (such as hydropower generation) and water uses that can be interruptible may be approved, subject to interruption during low flows of the Skagit River and designated tributaries. The interruptible condition, combined with the countywide vote against the Skagit plant many years ago suggests that the Skagit River would not be a likely source for a new plant.
Skykomish and Snohomish Rivers	Most water in the watershed is already legally spoken for. The Snohomish Watershed increasingly lacks water when and where it is needed, particularly during the summer months. WRIA 7 has an Instream Resources Protection Program rule (WAC 173-507) to protect senior water rights, maintain a healthy ecosystem and to meet future water management objectives. Such rules are required by state law (RCW 90.54). All new water withdrawals in the Snohomish River watershed are subject to the instream flows established in the rule. Therefore any new water rights will be interrupted when instream flows in the Pilchuck, Skykomish, Snohomish, Snoqualmie, Sultan and Tolt rivers are not met. Obtaining a new non-interruptible (year-round) water right in this area will likely be a very difficult, and expensive process due to potential adverse impacts on these protected streams and rivers. It is likely that applicants will need to mitigate to secure a non-interruptible supply or convert to a different cooling technology at low flows.

Table B-1. Water Availability Considerations in Selected Large Rivers in Washington (continued)

River	Considerations for Water Right Availability
Puyallup River	This watershed is one of the most intensely populated and farmed basins in western Washington, and much of the water in the Puyallup-White Watershed has already been spoken for. There is limited water available for new uses, especially because river levels need to be maintained to ensure adequate water quality and fish migration. Increased demands from population growth, naturally low summer and early fall stream flow levels, and impacts from climate change add to the challenge of finding new water supplies in WRIA 10. This is an unlikely source for new cooling water demands. WRIA 10 has an Instream Resources Protection Program rule (WAC 173-510). The rule establishes instream flows on the Upper and Lower Puyallup River and the Carbon River, including all tributaries. All future water withdrawals are subject to the instream flows.
Nisqually River	There is limited water available for new uses in WRIA 11, especially given that river levels need to be maintained to ensure adequate water quality and fish migration. Additionally, Tacoma Power has senior water rights to maintain reservoir levels in Alder Lake, and as a result much of the water in the Nisqually River Watershed has already been spoken for. Increased demands from population growth, low summer and early fall streamflow levels, and impacts from climate change add to the challenge of finding new water supplies in WRIA 11, especially during the summer months. Chapter 173-511 WAC (http://apps.leg.wa.gov/WAC/default.aspx? cite=173-511) is the instream flow rule for the Nisqually River Watershed, including the Mashel River and several smaller streams such as Ohop, Tanwax, McAllister, and Yelm creeks. This rule closes and partially closes numerous streams to any new unmitigated consumptive appropriations, as well as adopts instream flows on other streams and creeks. The instream flow rule was adopted in 1981 Tacoma Power operates Alder and La Grande Dams and under their FERC license must release water in amounts similar to the adopted instream flows for the Nisqually River. This results in stream flows in the Nisqually River below Alder Dam generally meeting instream flow levels year-round. However, Tacoma Power has the authority to withhold flows below the dam in certain circumstances in order to maintain operational levels in the Alder Lake Reservoir. It is not known if these rights would be sufficient to support a new SMR. There is no water set aside in reserves for future uses in these subbasins. Water for single domestic in-house use is exempt from the instream flow rule. Applicants seeking new water appropriations will likely need mitigation for the impacts their water use would have on surface water bodies. The Nisqually Indian Tribe is very concerned about maintaining flows and fish habitat in the watershed. Ecology submits all water right applications and associated mitigation plans to the Tribe for their review. Some areas located near Puget Sound, primarily east of Johnson Point, may have the potential for seawater intrusion.

Table B-1. Water Availability Considerations in Selected Large Rivers in Washington (continued)

River	Considerations for Water Right Availability
Cowlitz River	This watershed is one of the most intensely farmed basins in western Washington, and much of the water in this watershed is already spoken for. Additionally, Tacoma Power has senior water rights to maintain reservoir levels in Riffe and Mayfield lakes. There is limited water available for new uses, especially given that river levels need to be maintained to ensure adequate water quality and fish migration. The Cowlitz Watershed Plan recommends closures or restrictions of new water uses based on determinations of the Department of Fish and Wildlife known as Surface Water Source Limitations (SWSL), which limits most water sources in the watershed. Areas of potential water supply in the Cowlitz River watershed include municipal supplies and private water supply companies. In addition, the lower mainstem of the Cowlitz River and the tidally influenced areas of the Cowlitz, Coweeman, and Columbia rivers are proposed to be left open for new water rights. The Cowlitz has listed salmonids that would need to be considered in any future withdrawal proposals, unless municipal water supplies already covered under ESA are available.
Lewis River	There is limited water available for new uses in WRIA 27, especially given that river levels need to be maintained to ensure adequate water quality and fish migration. Additionally, Pacificorp has senior water rights to maintain reservoir levels in Lake Merwin and Yale Lake, and as a result, much of the water in the Lewis River Watershed has already been spoken for. Increased demands from population growth, low summer and early fall streamflow levels, and impacts from climate change add to the challenge of finding new water supplies in WRIA 27, especially during the summer months. Chapter 173-527 WAC (www.ecy.wa.gov/pubs/wac173527.pdf) is the instream flow rule for the Lewis River Watershed, including the Kalama, the North Fork of the Lewis River, and the East Fork of the Lewis River, and associated creeks. This rule establishes: ▪ Instream flows on streams (See Chapter 173-527-060 WAC). ▪ Closes all streams (See Chapter 173-527-070 WAC). Sources are likely to be interruptible, similar to many others, and not suitable for conventional cooling withdrawals. Reserves are established in subbasins for future domestic uses. To access these reserves for new appropriations, applicants must meet the mitigation requirements of the WRIA 27 established guidelines. Accessing municipal supplies or larger private water supply companies is the fastest and simplest option for obtaining a water supply, if the considerable volumes required can be made available.

Table B-1. Water Availability Considerations in Selected Large Rivers in Washington (continued)

River	Considerations for Water Right Availability
Klickitat River	Tribal lands cover most of the upper and middle Klickitat subbasins. Federally Reserved Rights for the reservation are not quantified at this time and thus the legal availability of water in these areas is uncertain. Those lands in the middle to upper basin, outside the Yakama Tribe's reservation, are in small drainages that have undergone adjudications (Bird Creek, Frasier Creek, and Bacon Creek). Prior adjudication in an area is a sign that most—if not all—of the available water has already been allocated to existing uses. Availability of water in the Lower Klickitat and Swale Creek subbasins is limited due to concerns about maintaining flows and fish habitat. Applications for surface water withdrawals from the mainstem Columbia River are subject to the Instream Resource Protection Program for the Columbia River, as are any proposed groundwater withdrawals determined to have a significant and direct impact on the Columbia River. Surface water and groundwater availability is currently very limited throughout the basin, although there are significant agricultural irrigation water rights with high consumptive uses that may be good candidates for acquisition.
Naches River	Surface waters in the Yakima Basin are currently under adjudication and are not available for new uses. Adjudications are typically an indication that most if not all of the available water in an area has already been allocated to existing uses. Adjudication is intended to review all claimed water rights and to rule on their validity, quantification, and priority. The Yakima adjudication has affirmed very early priority date water rights held by the Yakama Nation, for both on-reservation irrigation uses and on- and off-reservation instream flows. Several thousand state-issued water rights have also been confirmed. This means that large amounts of water have final confirmation by the courts as "already in use," making it tougher to secure water for new projects unless the use is mitigated.
Columbia River	The Columbia River has instream flow requirements but opportunities for mitigation via transfer or relinquishment of upstream rights are available. There is a significant amount of mitigation water available from Lake Roosevelt, although half of the water allocated for this purpose has been applied for or allocated and a 600MW SMR would likely require more than half of the remainder – water that is generally intended for municipal and industrial development needs. Existing rights from current power users may be an option; or mitigation or cooling technology options, depending on the desires of a future applicant and/or conditions at the timer of application. Options include acquisition of summer irrigation rights that are sufficient to meet plant needs if spread over all months; or acquisition of summer rights and applying for new winter rights. This report did not evaluate the availability of existing water rights at any specific location, such as Hanford.

Table B-1. Water Availability Considerations in Selected Large Rivers in Washington (continued)

River	Considerations for Water Right Availability
Touchet River	This basin has an instream flow regulation in order to protect senior water rights, maintain the current basin ecosystem, and to meet further water resource management objectives established by WAC 173-532. Seasonal closures in the basis prohibit withdrawals and low flows are insufficient to support such a demand. Based on the hydrogeology of the basin, Ecology concluded that gravel aquifers in the basin are hydraulically connected to surface waters in the basin. Therefore, the gravel aquifers are closed. Future permits to withdraw surface water during non-closure periods shall be limited to environmental enhancement projects as described in WAC 173-532-055. In general, availability and yield of groundwater from bedrock in this WRIA is very limited by climate and geology. In addition, many areas are in decline, meaning little if any water is available for new consumptive appropriations.
Snake and Palouse Rivers	Much of the water in the Middle Snake Watershed has already been spoken for. Increased demands from population growth, declining groundwater levels, and impacts from climate change are adding to the challenge of finding new water supplies in WRIA 35, especially during the summer months. Municipal withdrawals from groundwater has lowered groundwater levels in the basalt aquifers, making water resources a high profile issue in the basin. Alpowa Creek, Deadman Creek, Meadow Gulch Creek and Wawawai Creek are adjudications that have been completed within WRIA 35. In general, most of the water in these adjudicated basins has been allocated and new appropriations are not available. The Middle Snake watershed is not closed to new water uses (appropriations). However, the majority of water has been appropriated and new uses are subject to listed restrictions that are challenging for a baseload plant.
Spokane River	The Little Spokane Watershed located in eastern Washington includes the Little Spokane River and its numerous tributary creeks and streams. Its proximity to Idaho has made interstate management of water resources a high profile in this basin. Much of the water in the Little Spokane Watershed has already been appropriated. Increased demands from population growth, declining groundwater levels, and impacts from climate change are adding to the challenge of finding new water supplies in WRIA 55, especially during the summer months. In 2004, the US Bureau of Reclamation (BOR) filed notice with the Department of Ecology (Ecology) that the U.S. intends study the possible use of unappropriated waters of the Columbia River and its tributaries above Priest Rapids Dam (see RCW 90.40.030). The withdrawal of these waters from future appropriations is currently in effect until December 23, 2017, to allow for continued investigation of the Yakima River Basin Integrated Water Resources Management Plan. Availability beyond that date is uncertain.

Source: Washington State Department of Ecology. 2015. Water Availability in You Watershed/WRIA. Available at http://www.ecy.wa.gov/programs/wr/rights/wrpenapp_avail.html

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