Draft Plan for a Defense Waste Repository

December 2016

Foreword

In March 2015, the President found that "the development of a repository for the disposal of high-level radioactive waste (HLW) resulting from atomic energy defense activities only is required" in a *Presidential Memorandum for the Secretary of Energy* (Obama 2015). The presidential finding was accompanied by a March 2015 U.S. Department of Energy (DOE) *Report on Separate Disposal of Defense High-Level Radioactive Waste* (DOE 2015), which concluded that "the Secretary may develop a Defense HLW Repository under his Atomic Energy Act of 1954 authority. In developing a Defense HLW Repository, the Secretary would be subject to U.S. Nuclear Regulatory Commission (NRC) licensing authority, but would not be subject to the Nuclear Waste Policy Act's (NWPA) siting provisions, apart from the State and tribal participation provisions specified in Section 101 of the NWPA" (DOE 2015, p. 2).

Consistent with the Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* (DOE 2013), the DOE is considering options for establishing an integrated waste management system (IWMS). The IWMS will consist of facilities and other key infrastructure needed to safely manage both spent nuclear fuel (SNF) and high-level radioactive waste (HLW) from commercial electricity generation, research, and atomic energy defense activities. Over the past year and a half, the DOE has begun early planning to identify various activities that need to be performed to evaluate and design a separate repository for defense waste. In this draft plan "defense waste" refers to all or a portion of the high level radioactive waste and spent nuclear fuel derived from atomic energy defense activities and research and development (R&D) activities of the DOE. Going forward, DOE will continue to assess the feasibility of disposing non-defense DOE R&D nuclear waste in a defense repository, cost shared proportionately from defense and non-defense funding sources. Although the plan is preliminary, it begins to describe the different components—including technical, regulatory, risk management, cost and schedule considerations—that need to come together to build a viable program, all within the framework of a consent-based siting process. It is now appropriate to share the progress made on this preliminary plan and ask the public for their review and feedback. To accomplish this, the draft plan is being released for public comment. Ultimately, the defense waste repository plan would provide meaningful information to any community interested in learning more about what it would take to host such a facility.

This draft plan describes a path for development of a Defense Waste Repository (DWR) for the permanent disposal of all or a portion of defense waste. Specifically, this plan documents the activities needed to implement disposal of these wastes consistent with the DOE's existing authority under the Atomic Energy Act of 1954 (AEA), and consistent with the requirements of the Nuclear Waste Policy Act of 1982, as amended (NWPA). The plan is independent of facility location and disposal medium (e.g., crystalline rocks, bedded salt, clay/shale, or other sedimentary rocks). This draft plan emphasizes the use of a phased approach to development, within the context of a consent-based siting process. Although this plan intends to conform to a consent-based siting process, it does not include a full description of the process. The draft design document describing a consent based siting process is expected to be released for public comment in December 2016.

This draft plan builds upon existing plans and acknowledges commitments and requirements where applicable. The activities described focus primarily on technical issues regarding the development of a disposal capability rather than programmatic or regulatory constraints. This draft plan has been prepared to solicit public views on the topic and initiate discussion with interested parties, and may change based

on comments received in response to this draft plan and other elements of the IWMS. This draft plan may also change if legislation, regulations and policy change.

Executive Summary

Overview

Consistent with the Administration's *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* (*Strategy)*(DOE 2013), the U.S. Department of Energy (DOE) is considering options for establishing an integrated waste management system (IWMS). The IWMS will consist of facilities and other key infrastructure needed to safely manage both spent nuclear fuel (SNF) and high-level radioactive waste (HLW) from commercial electricity generation, research, and national defense activities. This plan describes a path for development of a Defense Waste Repository (DWR)[1] for the permanent disposal of all or a portion of the HLW and SNF derived from atomic energy defense activities, research and development (R&D) activities of the DOE, or both; these materials are referred to in this plan as "defense waste." Specifically, this plan documents the activities needed to develop a DWR for disposal of the defense waste consistent with the DOE's existing authority under the Atomic Energy Act of 1954 (AEA), and consistent with the requirements of the Nuclear Waste Policy Act of 1982, as amended (NWPA). This draft plan emphasizes the use of a phased approach to development, within the context of a consent-based siting process. The *Strategy* calls for "a phased, adaptive, and consent-based approach to siting and implementing a comprehensive management and disposal system" for nuclear waste. Although this plan conforms to the overall approach of a consent-based siting process, it is not intended to define the process. The draft *Consent-Based Siting (CBS) Process Design Document* provides a more complete description of the process; it is expected to be released in December 2016.

DOE views the development of a DWR as part of a larger strategy for the storage and ultimate permanent disposal of all of the nation's HLW and SNF, including HLW and SNF of commercial origin. The activities outlined in this draft plan would be conducted in the context of existing legislation, regulations and policies as described in Section 2. This plan acknowledges existing plans, commitments, and requirements where applicable, but the activities described herein are based on those necessary for development of a disposal capability based primarily on technical, rather than programmatic or regulatory constraints.

The principal elements relevant to development of a DWR and considered in this draft plan are:

- The proposed DWR siting process, preliminary summary schedule, and preliminary estimates of representative costs
- The types and quantities of HLW and SNF that have been identified as candidates for disposal in a DWR
- The transportation of the wastes from their current locations to the DWR
- The characteristics of the DWR for permanent disposal of the wastes

This draft plan is a snapshot of an evolving process. It projects the principal activities that need to occur, but cannot predict the timing or fashion in which they will occur. This is inherent in the nature of a

[1] Defense Waste Repository—a deep geologic repository developed by the DOE under the Atomic Energy Act for the disposal of all or a portion of the HLW and SNF resulting from atomic energy defense activities, R&D activities of the DOE, or both.

flexible, phased, and consent-based process. Note that in the context of DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, the project that is the subject of this plan has not met the CD-0 (Approve Mission Need) threshold. This draft plan is being published to solicit public views on the topic, and may change based on events or comments received in response to this draft plan and other elements of the IWMS. This draft plan may also change if legislation, regulations and policy change.

Neither the NWPA nor the AEA fully specify a process for locating, evaluating, and selecting sites for a DWR. The Blue Ribbon Commission on America's Nuclear Future (BRC) identified the importance of a workable siting process for radioactive waste facilities in general, and stated that the future siting process that will be most likely to succeed must be: "consent-based—in the sense that affected communities have an opportunity to decide whether to accept facility siting decisions and retain significant local control" (BRC 2012, pp. 47–48). The Administration's Strategy (DOE 2013, p. 9) endorses the proposition that prospective host jurisdictions be recognized as partners and identifies the establishment of a consent-based siting process as one of the critical elements for successful implementation of the strategy.

Preliminary Schedule

A preliminary schedule is discussed in Section 3.3, which shows key milestones assumed for this plan including: initiation of the development of a consent-based siting process, identification of sites for evaluation, selection of a site for characterization, submittal of a license application to the NRC seeking authorization to construct the DWR, and initiation of disposal operations. This indicates that a DWR could be available about a decade earlier than a common repository. Anticipated timeframes are included for an example scenario. Although the DOE believes that the schedule outlined in Section 3.3 is achievable, it recognizes that multiple factors could contribute to the risk that specific milestones might not be met, and that failure to meet intermediate milestones could lead to corresponding delays in subsequent milestones.

Significant risks are listed below, (risks are further described and enumerated in Section 3.5):

- Initial requests for expressions of interest fail to identify potential host communities
- Failure to negotiate mutually acceptable consent agreement with community at selected site
- No sites found suitable after screening is complete
- Site characterization finds the site unsuitable
- NRC denies license for construction
- NRC denies disposal license
- Legal challenges, which could occur at any stage of the process, many of which could result in failure of the effort if successful.

Preliminary Cost Estimate

Costs in the early stages of repository development (site identification and site screening/selection) are likely to be relatively independent of the host rock type eventually selected, but will be strongly influenced by schedule and programmatic uncertainties. Section 3.4 includes a ROM cost and schedule estimate for an example scenario that includes site identification, screening and characterization to

evaluate site suitability. To calculate a more reliable and complete cost we need to know the geology, location, and waste quantities and forms. These inputs will not become available until potential, volunteer host communities have been identified through the consent-based siting process.

In October 2014, the DOE published a report titled, *Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel* that shared rough order-of magnitude (ROM) cost estimates for a separate repository for DOE managed HLW and SNF for design, construction, startup, operations, closure and monitoring; the estimates did not include the up front site identification and screening process.

The broad range of uncertainty for the ROM cost estimates results from multiple sources, including uncertainty regarding the site selection process, the host rock type selected for the DWR (e.g., crystalline rocks, bedded salt, clay/shale, or other sedimentary rocks), the inventory of waste selected for disposal, and the final design of the DWR. The largest contributor to cost is the construction and operation of the DWR, and the largest source of uncertainty in the total life-cycle cost of the repository is associated with the selection of the geologic media and consequent decisions about repository design and waste packaging.

Preliminary Inventory

A DWR may be used only for the disposal of defense waste, i.e. HLW and SNF resulting from atomic energy defense activities and/or, potentially, DOE R&D activities. HLW and SNF of commercial origin are not candidates for disposal in this repository. Not all wastes are available today in their final form for disposal, and, as described in Section 3.6, disposal operations are assumed to proceed in phases. Identification of a waste type here as a candidate for disposal in the DWR does not preclude consideration of other disposal options, including emplacement in a repository sited and developed under the process set forth in the NWPA (i.e., an NWPA Repository), which may be used for disposal of commercial-origin HLW and SNF. Table 2 summarizes the volumes of the various wastes in the forms currently projected for disposal, estimated as of 2048.

Primary Technical Activities

The primary technical activities that must be completed to implement the plan are listed below and further described in Section 4:

- Site Identification
- Site Screening/Selection
- Site Characterization
- Waste Characterization
- Repository Design
- Licensing
- Evaluation of System Performance
- Repository Construction

- Waste Transportation
- Repository Operations
- Repository Closure
- License Termination

The National Environmental Policy Act (NEPA) will require the DOE to prepare an Environmental Impact Statement (EIS) (10 CFR 1021 Subpart D, Appendix D, D10), as is the case for an NWPA repository.[2] Preparation of an EIS would begin at the time that a site is selected for detailed characterization, and would include evaluation of reasonable alternatives. DOE is currently developing a preliminary NEPA strategy that will take into consideration comments received in response to this draft plan and through the consent-based siting process.

For the purposes of this draft plan, the DOE assumes that repository development can be initiated under the existing generic regulations that apply to geologic repositories at sites other than Yucca Mountain (YM) (EPA's 40 CFR 191 and NRC's 10 CFR 60), as discussed in Section 2.6. However, at the appropriate time in the IWMS process, DOE will request that regulators provide revised standards to support repository development.

The DOE will engage with a broad range of governmental entities and other parties interested in the DWR during development and implementation of the siting process and subsequent operation and eventual decommissioning of the repository (Section 6). These stakeholders include but are not limited to governmental bodies in jurisdictions in which the wastes are currently stored and jurisdictions potentially affected by transportation; organizations of tribal, state, and local governments; and stakeholder groups interested in radioactive waste management. These efforts will build on the existing relationships that the DOE maintains with a wide range of stakeholders.

This plan assumes that the DOE will have overall responsibility for developing the detailed plans necessary to implement the plan described and will be responsible for directing and managing all work activities. The DOE will be the licensee under applicable NRC regulations and will be responsible for meeting all legal and regulatory requirements. Successful implementation of this plan will require support activities in multiple areas.

[2] Note, however, that NWPA EIS provisions (e.g., NWPA Section 112) do not apply to a DWR.

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Acronyms and Abbreviations

AEA	Atomic Energy Act of 1954, as amended
ASME	American Society of Mechanical Engineers
BRC	Blue Ribbon Commission on America's Nuclear Future
CEQ	Council on Environmental Quality, Executive Office of the President
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE	U.S. Department of Energy
DWR	Defense Waste Repository
EIS	Environmental Impact Statement
EMT	Electrometallurgical Treatment
EPA	U.S. Environmental Protection Agency
FFCA	Federal Facility Compliance Act of 1992
FRG	Federal Republic of Germany
HIP	Hot Isostatic Pressing
HLW	High-Level Radioactive Waste
IWMS	Integrated Waste Management System
INL	Idaho National Laboratory
MTHM	metric tons of heavy metal
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
NWMO	Nuclear Waste Management Organization (Canada)
NWPA	Nuclear Waste Policy Act of 1982, as amended
QA	Quality Assurance
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
ROM	Rough Order of Magnitude
SNF	Spent Nuclear Fuel
SRG	State Regional Groups
SRS	Savannah River Site
TRU	Transuranic
WTP	Waste Treatment & Immobilization Plant at Hanford
YM	Yucca Mountain

1 Need for a Defense Waste Repository

In March 2015 the President found that "the development of a repository for the disposal of high-level radioactive waste resulting from atomic energy defense activities only is required" in a Presidential Memorandum for the Secretary of Energy (Obama 2015). The presidential finding was accompanied by a March 2015 DOE *Report on Separate Disposal of Defense High-Level Radioactive Waste* (DOE 2015), which concluded that "the Secretary may develop a Defense HLW Repository under his Atomic Energy Act of 1954 authority. In developing a Defense HLW Repository, the Secretary would be subject to U.S. Nuclear Regulatory Commission (NRC) licensing authority, but would not be subject to the NWPA's siting provisions, apart from the State and tribal participation provisions specified in Section 101 of the NWPA" (DOE 2015, p. 2).

Additional support for the DOE's 2015 report was provided in a 2014 DOE *Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Fuel* (DOE 2014) that evaluated technical options for the permanent disposal of HLW and SNF managed by the DOE.[3] Specifically, the 2014 report considered whether DOE-managed HLW and SNF should be disposed of with commercial SNF and HLW in one geologic repository or whether there were advantages to developing separate geologic disposal pathways for some DOE-managed HLW and SNF. The 2014 DOE report (DOE 2014, p. ES-1) recommended that "DOE pursue options for disposal of DOE-managed HLW from defense activities and some thermally cooler DOE-managed SNF, potentially including cooler naval SNF, separately from disposal of commercial SNF and HLW. Other DOE-managed HLW and SNF, including HLW and SNF of commercial origin and naval SNF with relatively higher heat output, would be disposed of with commercial SNF and HLW. This report also recommend[ed] that DOE retain the flexibility to consider options for disposal of smaller DOE-managed waste forms in deep boreholes rather than in a mined geologic repository."

The Administration's 2013 *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* (DOE 2013) and subsequent documents (DOE 2014 and DOE 2015) endorse a phased, adaptive, and consent-based approach to implement a flexible waste management system incrementally to ensure safe and secure operations, gain trust among stakeholders, and adapt operations based on lessons learned (DOE 2013). On December 23, 2015, the DOE issued an *Invitation for Public Comment to Inform the Design of a Consent-Based Siting Process for Nuclear Waste Storage and Disposal Facilities* (80 FR 79872) in the Federal Register, thereby initiating the development of its consent-based siting process. During 2016, the DOE conducted a series of public meetings with stakeholders and communities around the country to seek feedback and inform future efforts. This feedback has been documented in the draft Summary of Public Input Report that was released for public comment in September 2016; the final version is scheduled for publication in December 2016. A draft *Consent-Based Siting (CBS) Process Design Document* will also be published for public comment. The CBS process design document reflects input gathered and offers preliminary views on siting guidelines and criteria.

[3] DOE-managed HLW and SNF consists of two principal waste streams: (1) HLW, mostly resulting from atomic energy defense activities but also including a small amount of HLW of commercial origin; and (2) SNF, primarily from atomic energy defense activities (weapons plutonium production reactors and naval propulsion reactors), but also including a smaller amount of SNF from DOE R&D activities and some DOE-managed SNF from commercial sources (DOE 2014).

2 Legislative Authority and Regulatory Framework

This section of the draft plan describes the DOE's authority under existing laws and regulations to develop a DWR, using a consent-based siting process that is consistent with the requirements of the NWPA. The DOE's actions under this plan would be subject to a number of statutes, regulations, and DOE Orders and would be influenced by several existing agreements, some of which are briefly discussed below.

2.1 Atomic Energy Act

As noted in Section 1, the DOE concluded in March 2015 that "the Secretary may develop a Defense HLW Repository under his Atomic Energy Act of 1954 authority." In developing a Defense HLW Repository, the Secretary would be subject to U.S. Nuclear Regulatory Commission (NRC) licensing authority, but would not be subject to the NWPA's siting provisions, apart from the State and tribal participation provisions specified in Section 101 of the NWPA (DOE 2015, p. 2). These conclusions derive, in part, from Section 91(a)(3) of the AEA, which expressly provides the Secretary with the authority to "provide for safe storage, processing, transportation, and disposal of … radioactive waste… resulting from" defense activities. The Department's organic legislation reaffirms the Secretary's authority to dispose of nuclear waste. In particular, Section 203(a)(8)(C) of the Department of Energy Organization Act clarifies that the DOE has authority under the AEA to "establish … temporary and permanent facilities for storage, management, and ultimate disposal of nuclear wastes." A DWR would be subject to NRC licensing and the state and tribal participation provisions of Section 101 of the NWPA but not the other provisions of the NWPA.

2.2 National Environmental Policy Act

NEPA requires federal agencies to consider the environmental consequences of their proposed actions and reasonable alternatives before making decisions through a transparent and inclusive public impact evaluation process. Because a DWR would be sited outside the context of most portions of the NWPA, the provisions of the NWPA that establish NEPA requirements for a repository would not apply. NEPA will therefore be conducted pursuant to Council on Environmental Quality (CEQ) and DOE implementing regulations (40 CFR Parts 1500–1508 and 10 CFR 1021, respectively). DOE's regulations require the preparation of an EIS for siting, construction, operation and decommissioning of disposal facilities, including a geologic repository, for high-level waste and spent nuclear fuel (10 CFR 1021 Subpart D, Appendix D, D10). In planning for future NEPA activities, the DOE is developing a preliminary strategy that will take into consideration comments received in response to this draft plan and through the consent-based siting process.

2.3 Resource Conservation and Recovery Act

Some HLW that may be considered for disposal in a DWR is mixed waste in that, in addition to its radioactive constituents, it exhibits one or more hazardous waste characteristics or contains one or more listed hazardous wastes regulated under the Resource Conservation and Recovery Act (RCRA). The DOE has significant experience with state regulatory authority over the hazardous waste aspects of its cleanup mission through its compliance with RCRA. In addition, the Federal Facility Compliance Act of 1992 (FFCA) requires the DOE to develop waste treatment plans for its sites that contain mixed wastes. The DOE and state regulators work together in establishing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and RCRA on-site disposal cells at many of the sites across the DOE complex. Consistent with this experience, mixed waste could be disposed of in a DWR.

2.4 DOE Orders

For the purposes of this draft plan, the DOE assumes that a DWR will be planned, constructed, and operated consistent with the requirements of DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, and other applicable DOE Orders.

2.5 Consent Orders and Certain Agreements

As described below, enforceable consent orders and certain agreements between the DOE and states that host DOE facilities require the DOE's Office of Environmental Management to achieve cleanup objectives by specific dates, and expose the DOE to substantial fines and penalties if it fails to meet the terms of the orders or agreements.

The principal orders and agreements relevant to this draft plan are listed below. Only the Idaho and Colorado agreements establish schedules for removal of SNF; no state agreement sets a date for removing HLW.

- **Idaho Settlement Agreement**. The Idaho Settlement Agreement, executed in 1995 and amended in 2008, establishes 2035 as the deadline for the treatment of all HLW and the removal of all SNF from the State of Idaho, with the exception of a working volume of 9 metric tons of heavy metal (MTHM) of naval SNF. The Idaho agreement provides that unless all covered SNF is removed by January 1, 2035 the federal government shall pay the State $60,000 for each day such requirement has not been met, subject to the availability of the appropriations provided in advance for this purpose.

- **Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement).** The 1989 Tri-Party Agreement at Hanford, involving DOE, EPA, and the State of Washington, addresses vitrifying the HLW stored in tanks at the Hanford Site and closure of the tanks. The Tri-Party Agreement also requires DOE to develop a disposition plan for the cesium and strontium capsules stored at the Hanford Site. In 2010, the Department entered into a Consent Decree with the State of Washington requiring hot start of the Waste Treatment and Immobilization Plant (WTP) by December 31, 2019. Over the last 3-4 years, the Department has notified the State of Washington that a serious schedule risk had arisen and that it may be unable to meet milestones under the Consent Decree. On October 3, 2014, the Department and the State of Washington each filed separate motions to amend this Consent Decree (DOE 2015). On March 11, 2016, the court ordered that the Consent Decree between the Department of Energy and the State of Washington be modified so that "DOE shall achieve "Hot Start of Waste Treatment Plant" by December 31, 2033, and achieve "initial plant operations" of the WTP no later than December 31, 2036" (Moniz v. State of Washington 2016).

- **Savannah River Site (SRS)**. The 1993 Federal Facility Agreement for the SRS and the SRS Treatment Plan of 1995 between the DOE and the South Carolina Department of Health and Environmental Control focus on completing the DOE's closure of tanks that store liquid waste and solidifying its HLW for safer storage.

- **Fort St. Vrain Site**. In 1996, Colorado signed an agreement with the DOE, the "Agreement between the Department of Energy and the State of Colorado Regarding Shipping Spent Fuel

Out of Colorado." The agreement states that the DOE is committed to shipping its SNF stored at Fort St. Vrain out of Colorado by January 1, 2035.

2.6 Regulatory Framework for Geologic Repositories

There are two existing sets of federal regulations in the U.S. that govern permanent disposal of HLW. Consistent with the legal framework defined in the NWPA, each set includes overall safety standards set by the EPA and implementing criteria defined by the NRC. One set, EPA's 40 CFR 197 and NRC's 10 CFR 63, was written in the last twenty years specifically for the proposed YM repository, and does not apply to any other disposal concept. The other set, EPA's 40 CFR 191 and NRC's 10 CFR 60, date from the middle 1980s, prior to the decision to focus solely on YM, and, in the absence of new rule-making, would still apply to any disposal concept other than YM.

For the purposes of this draft plan, the DOE assumes that the DWR effort can be initiated under the existing generic disposal regulations (40 CFR 191 and 10 CFR 60), and that disposal regulations will be updated at some future date to reflect the evolution of regulatory thinking during development of the YM specific regulations (40 CFR 197 and 10 CFR 63). In issuing 10 CFR 63, NRC stated that the more risk-informed, performance-based approach adopted therein provides a better regulatory framework for geologic disposal of HLW and SNF than the approach in 10 CFR 60. At that time, NRC stated that the "generic Part 60 [10 CFR 60] requirements will need updating if applied to sites other than Yucca Mountain" (66 FR 55732, p. 55736; see also DOE 2015, p. 15). As of 2012, NRC had "not yet begun rulemaking to effect this update" (Rubenstone 2012). NRC continues to recognize that the rule needs updating if applied to sites other than Yucca Mountain (Rubenstone 2016). Although the DOE recognizes that early interaction with the regulators on this subject would be helpful, it notes, that the early stages of a siting process are independent of the final regulatory standards, and this plan therefore assumes that the process can go forward in parallel with regulatory actions undertaken by the EPA and NRC. As the DWR plan and associated timeline mature, DOE will determine when revised standards are needed and will communicate those needs to EPA and NRC.

3 Plan and Strategy

The need for a separate DWR, as described in Section 1, contributes to the DOE's current strategy for an IWMS. This plan addresses development of a DWR as part of the DOE's overall strategy to transport, store, and dispose of the nation's SNF and high-level radioactive waste. Specifically, this plan describes activities needed to implement a plan for permanent disposal of the subject wastes within the DOE's existing authority under the AEA, using a phased and adaptive approach for implementation and a consent-based siting process, consistent with the applicable requirements of the NWPA.

The principal elements of the draft plan considered here are:

- The DWR siting process
- Phased implementation for DWR development
- Summary schedule
- Estimated costs
- General risks
- The types and quantities of waste that have been identified as candidates for disposal
- Activities to implement this plan.

Each of these elements is discussed in the following sections of the plan.

3.1 Siting Process

For the purposes of this draft plan, siting a DWR pursuant to the DOE's AEA authority is assumed to be done using a consent-based approach, consistent with the Administration's 2013 Strategy (DOE 2013). As specified in Section 101 of the NWPA, siting must follow the participation provisions of the NWPA Sections 115–118. These provisions (discussed further below) are compatible with a consent-based approach.

One of the initial steps assumed for the implementation of this plan will be to develop a consent-based siting process for a DWR. A draft *Consent-Based Siting Process Design Document* is scheduled to be published for public comment in December 2016. This draft document reflects input gathered and offers preliminary views on siting guidelines and criteria.

Phases in the technical evaluation of sites are assumed to be:

- Identification of sites for evaluation
- A screening phase in which sites are evaluated using available information to the maximum extent possible, to determine whether they are sufficiently promising for further consideration
- A longer and more extensive site characterization phase involving both surface based and underground tests to determine whether the site is suitable for a repository and provide the data needed to support repository design, licensing, and construction.

For the purposes of this draft plan, the DOE assumes that the process will include the following features:

- Multiple opportunities for dialogue with and feedback from stakeholders during the design and implementation of the siting process.

- A request for expressions of interest from communities with potentially suitable sites early in the siting process (BRC 2012, p. 53), "while also allowing for the waste management organization to approach communities that it believes can meet the siting requirements" (DOE 2013, p. 3).

- Opportunities for potentially interested host communities to obtain grants to support their acquisition of sufficient knowledge of the implications of hosting a DWR and allow them to evaluate their interest in going further. Provisions of the NWPA applicable to a DWR already authorize funding to states, Tribes, and affected local governments during the site characterization phase and possibly as soon as a site has been identified as potentially acceptable. A program for providing grants to potentially interested host jurisdictions at the initial phase of site exploration, similar to the one previously established under the NWPA to support the efforts of the U.S. Nuclear Waste Negotiator to find a host for a storage facility, may also be used.

- Negotiated Consultation and Cooperation agreements between the DOE and participating states and Tribes during the site characterization phase, and possibly as soon as a site has been identified as potentially acceptable, are contemplated by the NWPA Section 117. As discussed in more detail in Section 6.1, one of the provisions of the NWPA that will apply to a DWR requires the DOE, during site characterization and subsequent repository development and operation, to consult and cooperate with the Governor and legislature of the host state and the governing body of any affected Indian tribe "in an effort to resolve the concerns of such State and any affected Indian tribe regarding the public health and safety, environmental, and economic impacts of any such repository" (NWPA Section 117(b)).

3.2 Phased Implementation for DWR Development

The phased (staged) development strategy assumed for this draft plan focuses on achieving initial operation of a DWR using that portion of the inventory that is ready for disposal at the time the DWR can receive waste and that presents the fewest technical and regulatory challenges, which is expected to be the existing defense HLW glass and cooler DOE-managed SNF.

As shown previously (DOE 2014), all of the defense HLW and much of the DOE-managed SNF could be emplaced in a wide range of repository concepts without further aging or thermal load management considerations. The planned and existing canisters for defense HLW and much of the DOE-managed SNF described in Section 3.6 are compatible in size with any mined repository concept under consideration, including those that rely on hoists in vertical shafts for access to the underground. No significant technological advances are necessary to support a repository design and license application for a repository for this HLW and SNF. Furthermore, the development of a safety case for a DWR could be simplified by the lower thermal output and overall lower radioactivity of the HLW and SNF (as compared to commercial SNF, for example), and by the very low potential for criticality in the defense HLW because of the recovery and removal of fissile material during reprocessing (DOE 2014).

The key initial steps in detailed planning for phased DWR development include:

- Development of design concepts that facilitate phased development of the DWR, with the capability to receive the simplest waste forms as soon as possible. Additional waste forms—higher thermal loads, different dimensions—would be accepted as annual disposal capacity, technical developments, or disposal needs evolve (with consent of the host Tribe/state/community and regulatory approval from the NRC).

- Development of operational scenarios that link the stages and schedules for deployment of the DWR in phases to the anticipated timing of availability of current and potential new waste forms and packages for disposal.

- Development of a licensing strategy for phased DWR development under existing NRC generic repository regulations and identification of regulatory modifications that could facilitate such development including possible regulatory interactions about updates of the regulations.

- Early development of preliminary waste acceptance criteria, consistent with the above bullets, to support packaging needs, treatment options, and other considerations important to the waste generators.

As discussed further in Section 3.6, a significant amount of defense HLW already exists in its final form. N-Reactor (plutonium production) SNF at Hanford has been packaged in multicanister overpacks and is in dry storage until a repository is available. Much of the remaining DOE-managed SNF will be packaged in canisters for disposal. Packaging of such DOE-managed SNF into standard canisters could begin before a DWR is available, based on preliminary acceptance criteria. Existing and projected HLW canisters and the standard canisters for relevant DOE-managed SNF are of a size that are transportable by truck if needed to allow disposal to begin as soon as possible. Existing and projected naval SNF canisters are transportable using available railcars.

Much of the potential inventory for the DWR, however, has not yet been placed into a final form for disposal (DOE 2014), and might be suitable for different waste forms and disposal approaches than assumed to date. Current plans for some waste forms date from the early 1980s, when much less was known about the capabilities of repositories to isolate radioactive material. Depending on the characteristics of the selected DWR site and future developments with respect to waste treatment options, additional HLW waste forms other than those currently anticipated could be considered in a later phase of DWR development.

This draft plan also recognizes that, as discussed below, there could be significant benefits in terms of reducing the total number of waste packages and simplifying operations if larger, higher-thermal-load packages can be shown to be disposable at the DWR after initial operation has begun. Such packages could be used in a subsequent phase of operations, with consent of the host Tribe/state/community and appropriate regulatory approval.

3.3 Preliminary Schedule

Based on the assumptions made for this draft plan, first disposal of defense waste could occur about 22 years after the consent-based siting process has been initiated. A preliminary schedule in Figure 1 shows key milestones in the draft plan including identification of site(s) for a period of three years, selection of a

site for characterization after three additional years, and submittal of a license application to the NRC seeking authorization to construct the DWR.

Four main phases of the development of the DWR prior to beginning disposal operations are reflected in Figure 1 and described as follows:

- **Site Identification**. This is the early phase in which potential candidates identified through the consent-based process are evaluated based on preliminary information. Site Identification ends with the selection of a subset of sites for full screening evaluations. In this example, it is assumed that two sites are selected for screening.

- **Site Screening and Selection**. Thorough screening evaluations would be conducted for a limited number of sites, allowing the selection of one or more sites for detailed subsurface site characterization. In this example schedule, site screening ends with the selection of a single site for characterization and subsequent licensing.

- **Site Characterization**. Subsurface investigations from boreholes, exploratory shafts, and tunnels, laboratory research, and modeling provide the necessary information to support detailed repository design and the preparation of an EIS. Assuming the site is found suitable, site characterization ends when a license application seeking authorization to construct the facility is submitted to the NRC.

- **Licensing and Construction**. License review and hearings are assumed to take three to four years. DWR construction cannot begin until after NRC has issued a construction authorization. Receipt and disposal of radioactive waste will require a license to receive and possess waste to begin disposal operations.

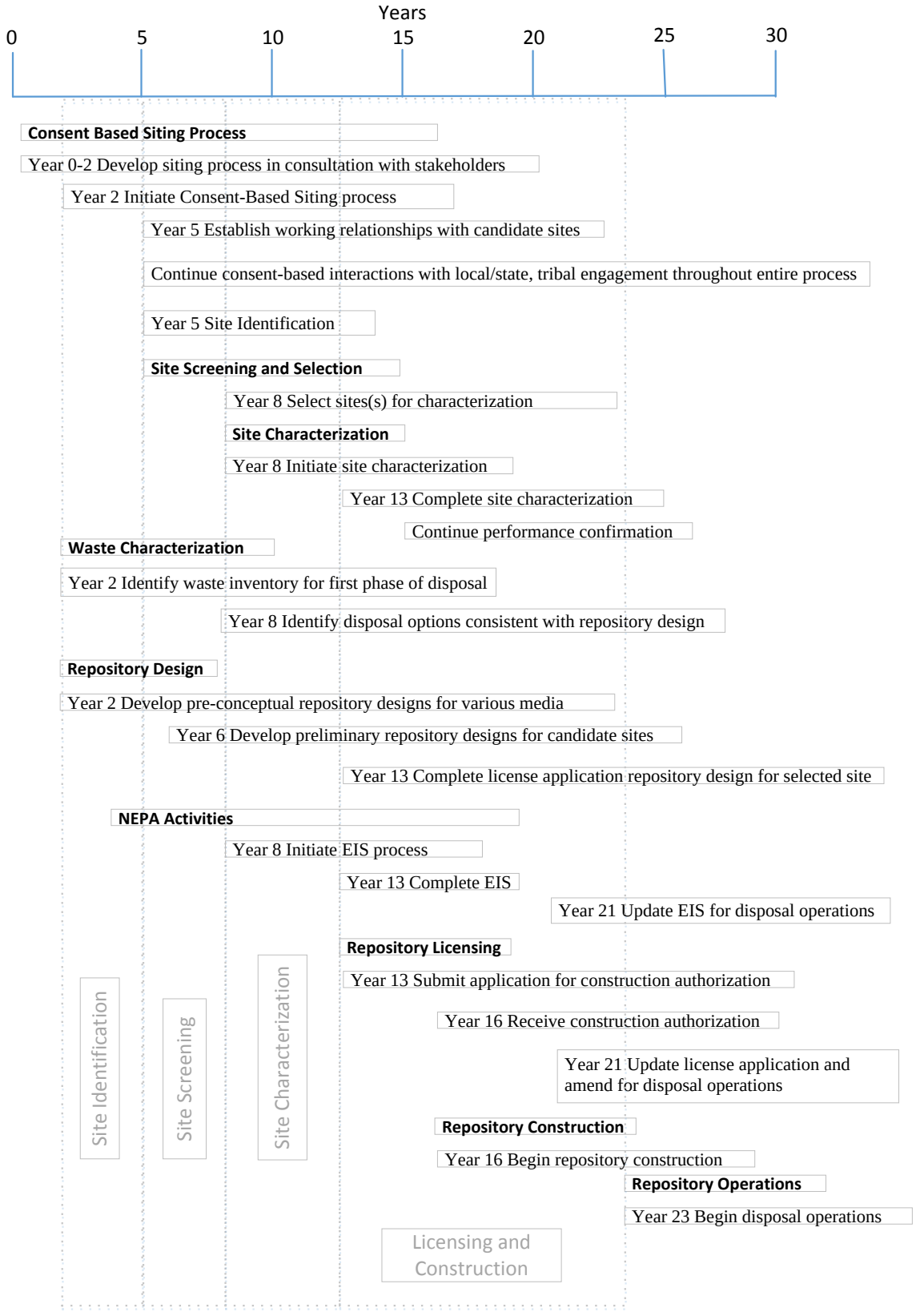

Figure 1 Preliminary Schedule for the Development of a DWR

3.4 Preliminary Project Cost Estimate

Recent ROM estimates of repository costs in the U.S. (e.g., as reported in the *Assessment of Disposal Options for DOE-Managed High-Level Radioactive Waste and Spent Nuclear Fuel* (DOE 2014)) indicate a range of costs for a DWR depending on the host geologic media and the types of waste that are included in the disposal inventory.

To calculate a more reliable and complete cost, the geology, location, and waste quantities and forms need to be better defined. These inputs will not become available until a potential host community volunteers through the consent-based siting process. Table 1 shows a ROM estimate for an example scenario to better understand what resources would be needed to identify and screen potential sites and perform the needed characterization to evaluate site suitability. This cost estimate is independent of geology.

Table 1. Preliminary ROM estimate of program costs from inception to site characterization for a representative case in which two candidate sites are identified for screening and only one site is chosen for full characterization (Millions of Dollars)

DURATION	3 YEARS	3 YEARS	5 YEARS	11 YEARS
PROGRAM PHASE	Site Identification	Site Screening	Site Characterization	TOTAL
Consent-Based Siting Process	$45 M	$45 M	$300 M	$390 M
Site Screening and Selection	$45 M	$400 M	$10 M	$455 M
Site Characterization	$0 M	$50 M	$600 M	$650 M
Waste Characterization	$6 M	$10 M	$35 M	$51 M
Repository Design	$4 M	$30 M	$275 M	$309 M
National Environmental Policy Act (NEPA) Activities	$10 M	$15 M	$100 M	$125 M
Repository Licensing	$5 M	$15 M	$100 M	$120 M
Repository Construction	$0 M	$0 M	$730 M	$730 M
Management Support	$15 M	$70 M	$150 M	$235 M
TOTAL	$130 M	$635 M	$2300 M	$3065 M

Uncertainty associated with cost estimates for the early years of DWR development is also large, and is primarily associated with the implementation of the siting process. Costs in the early years will increase with the number of initial sites and the number of sites carried forward at each step in the process. As discussed in Appendix A, Section A-1, Table 1 shows a preliminary ROM estimate of program costs from inception through site characterization. This estimate is made for a single representative case in which it is assumed that there are two candidate sites identified and that only a single site is selected for full characterization. Because the actual number of sites that may be identified and screened is unknown, costs associated with the siting process are shown as single values rather than as a range; these costs can be assumed to increase with the number of sites under consideration. Because costs associated with the consent-based siting process and site screening, selection, and characterization dominate the total costs during the first decade, costs of other aspects of the program are also shown as single values; in actuality, these costs are also uncertain and estimates shown here will need to be refined and updated as more information becomes available. Note that to a first approximation, cost estimates shown in Table 1 can be interpreted as being independent of the final choice of geologic media and repository design because the largest source of uncertainty during this period will be associated with the siting process itself rather the construction and operation of the repository.

3.5 Risk Management

Although the DOE believes that the schedule outlined in Section 3.3 is achievable, it recognizes that multiple factors could contribute to the risk that specific milestones might not be met, and that failure to meet intermediate milestones could lead to corresponding delays in subsequent milestones. As shown in Figure 2 and discussed in the following sections, the primary risks can be grouped into broad categories that are mapped to the primary components of the schedule. Some risks will be relevant early in the process, while others will not become factors until later in the development of the DWR. All risks identified in Figure 2 have the potential to impact both cost and schedule of the proposed activities. Risks shown in red have the potential, should they be realized, to lead to abandoning or restarting the effort. Risks associated with litigation are shown in blue; many of these also have the potential to result in major redirection depending on the nature of court decisions. Note that Figure 2 is only intended to show the timing during which the risk is likely realizable, it is not intended to show the schedule impact of any given risk.

3.5.1 General Risks External to the Effort

External risks fall into two main groups: legal challenges and Congressional actions that might change the DOE's ability to develop the DWR. Past experience suggests that the effort should be assumed to be confronted with legal challenges throughout the process. Others should also be anticipated (e.g., adjudicatory or rulemaking challenges). Mitigation of the risks associated with legal challenges will rely in part on the implementation of a consent-based siting process, and in part on the strength of the technical investigations that will support decisions to proceed.

Risks associated with Congressional actions are relevant throughout the life of the development effort. In the absence of a sustained long-term national commitment, milestones identified in this draft plan will be delayed or unmet. There is little that can be done to mitigate these external risks, but project management should be aware that they exist.

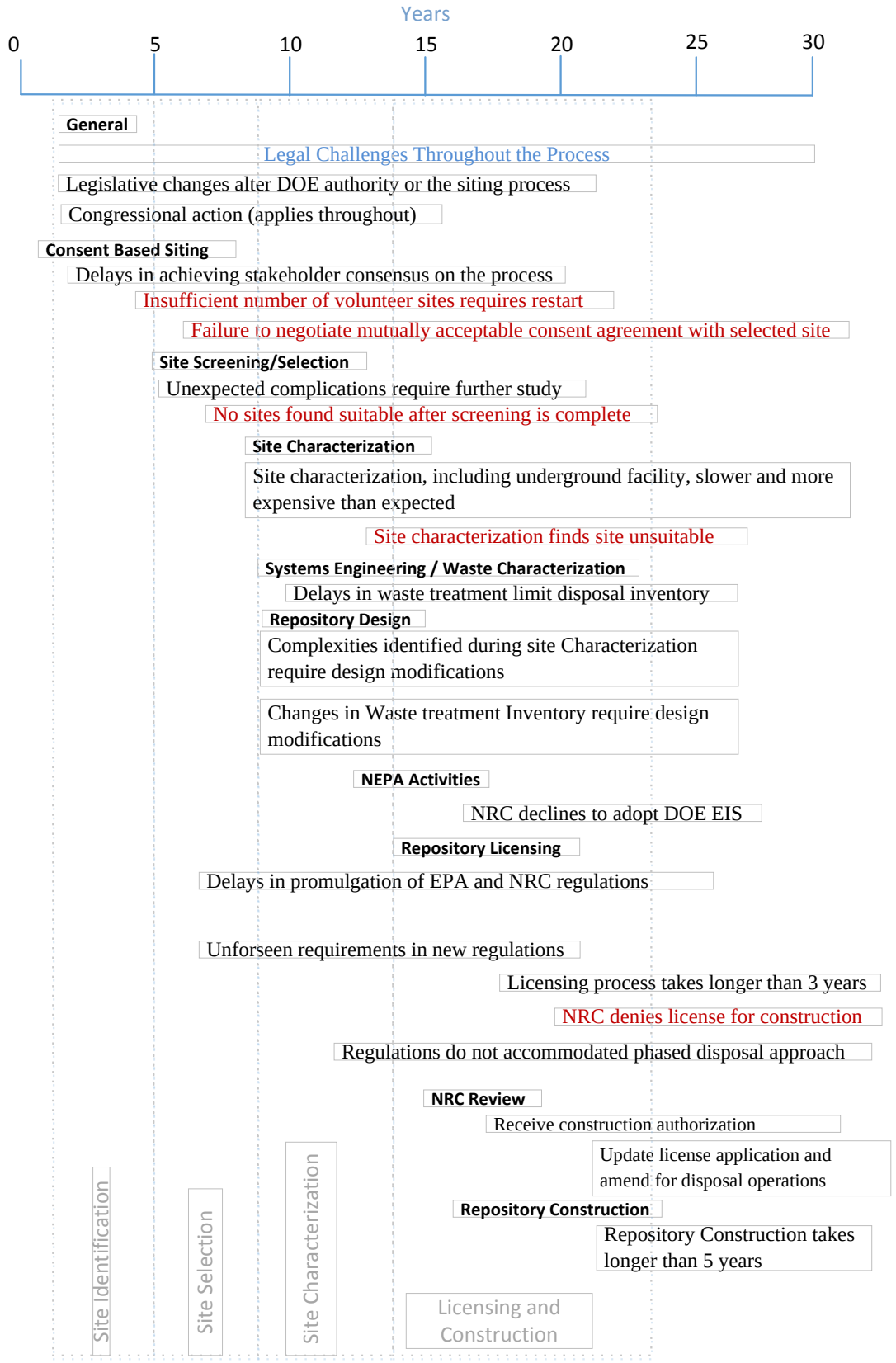

Figure 2 Selected DWR Development Risks

3.5.2 Risks Associated with Site Identification, Screening/Selection, Characterization, and Licensing

Although the DOE believes that experience gained in the U.S. and other nations over the past decades greatly increases the likelihood of successfully identifying a DWR site through a consent-based process, the possibility remains that the process will not result in the identification of a suitable site or construction of a DWR. The process could be delayed or fail at multiple points. For example, initial requests for expressions of interest could fail to identify potential host communities. If one or more potential host communities are identified, comparisons with initial screening guidelines could subsequently indicate that none warrant detailed site characterization. If one or more sites are selected for site characterization, detailed investigation could indicate that none are suitable for proposing to the NRC for licensing. The DOE's selection of a site notwithstanding, the NRC could ultimately determine that a proposed site was unsuitable for licensing as a DWR. Mitigation of risks associated with site identification and selection will be based on the adoption and implementation of a consent-based siting process. Risks that a selected site will ultimately be found unsuitable, either by the DOE or by the NRC, cannot be eliminated completely, but can be reduced through sound scientific investigation and appropriate repository design during the site characterization phase. Early notification that the regulator may find a site unacceptable is most readily fostered by maintaining close coordination with the regulator.

3.5.3 Risks Associated with the Complexity and Cost of Site Characterization, Repository Design, and Repository Construction

The durations of the Site Characterization, Repository Design, Licensing, and Construction activities described in Sections 3.3 and 3.4 are based on past experience and reasonable assumptions about how these activities may progress. They should not, however, be interpreted as bounding estimates and there will be multiple opportunities for unforeseen complications to cause delays at each step of the process. Mitigation of these risks will require continuous attention to project management.

3.6 Types and Quantities of Waste for Disposal

The DWR may be used to dispose of HLW and SNF derived from atomic energy defense activities and/or, potentially, the DOE's R&D activities. HLW and SNF of commercial origin are not candidates for disposal in the DWR. Specific waste types that are potentially eligible for disposal in the DWR are listed in the following sections. Not all wastes are available today in their final form for disposal, and as described in Section 3.2, disposal operations will proceed in phases. Preliminary identification of a waste type here as a candidate for disposal for the DWR does not preclude consideration of other disposal options for that waste, including emplacement in an NWPA repository, or other approved disposal alternatives. Table 2 summarizes the volume of the various wastes in the forms currently projected for disposal, estimated as of 2048, by which time most waste will have been treated.

Table 2. Summary of Volume of HLW and SNF derived from atomic energy defense activities or DOE R&D activities estimated as of 2048 (DOE 2014, Figure 1 and Table 1: SNL 2014 Table ES-1; and Appendix C, Table C-1)

Waste	Total Volume (m^3)
Savannah River Site — vitrified HLW	6,957
Hanford — vitrified HLW	14,089
INL — Calcine HLW	3,661
INL — Sodium-bearing waste after treatment by fluidized bed steam reforming	721
Hanford — Post-vitrification volume of cesium (Cs) and strontium (Sr) currently in capsules	453
INL — Electrometallurgically Treated HLW[4]	132
Hanford — Federal Republic of Germany HLW glass	3
INL — Naval SNF[5]	4,600
DOE-managed SNF[6]	1,800

3.6.1 Defense High-Level Waste (HLW)

The following subsections describe the characteristics of various types of defense waste.

3.6.1.1 Existing and Projected HLW Glass at the Savannah River Site

As of the end of 2015, the Defense Waste Processing Facility at SRS had generated approximately 4,000 canisters of borosilicate glass resulting from the vitrification of liquid HLW created by SNF reprocessing that began at the SRS in 1954. Individual stainless steel canisters are 3 m (9.8 ft) long and 61 cm (2 ft) in diameter. Current projections call for generation of an additional 4,210 canisters of HLW glass at SRS (Chew and Hamm 2016), with vitrification activities complete in 2036. Additional information regarding the HLW glass at SRS, including radionuclide content and thermal output, is summarized by Chew and Hamm (2013, 2016) and SNL (2014).

3.6.1.2 Projected HLW Glass at the Hanford Site

The Hanford Site, located in southeastern Washington State, has approximately 207 million liters (54.6 million gallons) of radioactive and listed hazardous wastes stored in 177 underground tanks (Certa et al. 2011). The Waste Treatment and Immobilization Plant is being constructed on the Hanford Site to treat the tank wastes and convert them to glass waste forms for disposal.

The 2016 Amended Consent Decree sets a milestone for the WTP to achieve initial operations by 2036 (Moniz v. State of Washington 2016). It is now expected that the WTP will produce between 9,000 and 15,000 (GAO 2009) stainless steel canisters of HLW glass with a nominal value of 10,600 canisters (Wells 2014); canisters are planned to be 4.5 m (14.7 ft) long and 61 cm (2 ft) in diameter. Additional information regarding the projected HLW glass at the Hanford Site, including radionuclide content and thermal output, is summarized by DOE (2014) and SNL (2014, Section A-2.2.1).

[4] The total volume of treated sodium bonded fuel treated includes Fermi-1 sodium bonded blanket fuel for which alternative treatments are under consideration (65 FR 56565), and which may not be included in wastes considered for disposal under this plan.

[5] The total volume of projected naval spent nuclear fuel given here corresponds to 400 packages (SNL 2014), of which only the cooler packages may be included as wastes considered for disposal under this plan.

[6] The total volume reported here is approximate, and will be affected by future decisions regarding the eligibility of some DOE-managed SNF for disposal in a DWR. The volume reported here is estimated to be approximately 70% of the total volume of DOE-managed SNF reported by DOE (DOE 2014, Figure 1 and Table 1).

3.6.1.3 Calcine HLW at the Idaho National Laboratory

Liquid HLW generated by the reprocessing of defense SNF at the Idaho Chemical Processing Plant (now the Idaho Nuclear Technology and Engineering Center) between 1953 and 1994 was stabilized as a solid granular calcine waste form between 1963 and 2000 (SNL 2014, Section A-2). Approximately 4,400 m^3 (150,000 ft^3) of calcine is currently stored in six sets of stainless steel bins within concrete vaults at the Calcine Solids Storage Facility at the INL, and final packaging has not been determined.

3.6.1.4 Sodium-Bearing Waste at the Idaho National Laboratory

Approximately 3.2 million liters (850,000 gallons) of liquid sodium bearing radioactive wastes resulting from the reprocessing of defense SNF (SNL 2014, Section A-2.3.2) are stored at the INL. These wastes contain transuranic elements, but have significantly less radioactivity from fission products than the calcine HLW derived directly from the reprocessing liquids. Fluidized-bed steam reforming has been selected as the preferred method of treatment for the waste, and will result in a dry, granular/powder carbonate mineral product (ID-DEQ 2013). A final decision regarding the disposition path for this waste has not been made (75 FR 137).

3.6.1.5 Cesium and Strontium Capsules at Hanford

There are 1,936 capsules stored at the Hanford Site that contain radioactive cesium and strontium extracted from wastes generated from the chemical processing of defense SNF. Cesium and strontium isotopes were removed from liquid HLW between 1974 and 1985 to reduce the heat load of wastes stored in underground tanks, and were packaged as cesium chloride and strontium fluoride salts placed in stainless steel and Hastelloy capsules. The primary radioactive isotopes remaining in these capsules are ^{137}cesium, ^{135}cesium, and ^{90}strontium and their decay products; 1,335 capsules contain cesium chloride and 601 capsules contain strontium fluoride. Individual cylinders are relatively small (less than 9 cm (3.5 in.) in diameter and less than 56 cm (22 in.) in length), but in aggregate, contain approximately one third of the total radioactivity (in curies) at the Hanford Site (SNL 2014). They are currently stored under water at the Waste Encapsulation and Storage Facility in the 200 East Area of the Hanford Site (SNL 2014, Section A-2).

3.6.1.6 Electrometallurgically Treated HLW

The DOE inventory of sodium-bonded SNF includes about 3.4 MTHM driver fuel and 57 MTHM blanket fuel. These fuels, which were generated during the operation of experimental fast-neutron breeder reactors, consist of both highly enriched and depleted uranium alloy fuel surrounded by a layer of sodium metal (for heat transfer) within an alloy cladding. The separation and refining of uranium using the electrometallurgical treatment (EMT) process will generate about 32,350 kg (72,320 lbs) of low-enriched uranium and two separate waste streams—high-level radioactive salt waste and metallic waste—that would be immobilized into waste forms for disposal. The recovered uranium will be stored until the DOE decides on its future use, and the two waste types will be immobilized in suitable waste forms and disposed of in a DWR (SNL 2014).

Salt wastes from EMT of sodium-bonded fuels result in a waste form that is a glass-bonded sodalite material referred to as the ceramic waste form. The ceramic waste form is being formed as a right cylinder up to 1 m (3.3 ft) tall with an outer diameter of about 0.5 m (1.6 ft). Each 1-m cylinder (~128 cylinders total) will weigh about 400 kg (900 lbs) and occupy a volume of about 0.2 m^3 (7 ft^3). The ceramic waste form product dimensions provide the option of packaging two ceramic waste form products in a HLW canister that is 3 m (9.8 ft) length, with a 61 cm (2 ft) outer diameter (the internal length and volume of this canister are about 2.5 m (8.2 ft) and 0.67 m^3 (24 ft^3), respectively). It is estimated that 128 ceramic waste form cylinders will be produced from treating 26 MTHM of sodium-bonded spent fuel from the Experimental Breeder Reactor-II and the Fast Flux Test Reactor. Assuming the amount of ceramic waste produced is proportional to the amount of fuel being treated, it is estimated

that 167 ceramic waste form cylinders will be produced from treating 34 MTHM of sodium-bonded spent fuel from Fermi-1. The approximately 295 ceramic waste form cylinders to be produced from all sources of sodium-bonded spent fuel will require 148 HLW canisters, each containing two ceramic waste forms.

The EMT metallic waste stream will be immobilized by melting it in an induction furnace at about 1,600°C with added zirconium and depleted uranium to produce an alloyed metallic waste form. The metallic waste form products are being cast as ingots sized to fit in the 3 m (9.8 ft) long HLW canisters that are also to be used to store/dispose the ceramic waste form products. The disk-shaped ingots will be about 0.4 m (1.3 ft) in diameter and up to 13 cm (5.1 in) thick, and will weigh about 12 kg (26 lbs). The first metallic waste form ingot was produced in 2012 (Westphal et al. 2013). It is currently estimated that 5,850 kg (12,900 lbs) of metallic waste form will result from EMT treatment of sodium-bonded spent fuel from the Experimental Breeder Reactor-II and the Fast Flux Test Reactor, yielding approximately 488 12-kg disks. It is estimated that 7,650 kg (16,900 lbs) of metallic waste form will result from EMT treatment of sodium-bonded spent fuel from the Fermi 1 reactor, yielding approximately 638 12-kg (26 lb) disks. It is assumed that the metal disks will be disposed of in the HLW canisters that contain the ceramic waste forms.

3.6.1.7 Existing Radioactive Waste Glass at the Hanford Site

Although the large majority of HLW at the Hanford Site exists in liquid form and will require further treatment before disposal, there are 34 canisters of radioactive borosilicate glass stored at the site that are ready for disposal (DOE 1997; SNL 2014, Section A-2.2.1.3). These canisters are 1.2 m (3.9 ft) long by 0.3 m (11.8 in.) in diameter, and were prepared by Pacific Northwest Laboratory in 1986 and 1987 to be used as heat and radiation sources for proposed experiments to be conducted by the Federal Republic of Germany (FRG) in the Asse Salt Mine (Kuhn and Rothfuchs 1989). The stainless steel canisters were fabricated in Germany and filled at the Hanford Site using a radioactive liquid-fed ceramic melter with borosilicate glass spiked with ^{137}cesium and ^{90}strontium to achieve the desired heat and dose targets. The FRG testing program was stopped before the canisters could be shipped, and they have remained at the Hanford site. They are currently stored at the Central Waste Complex at the 200-West area on the central plateau of the Hanford site.

3.6.2 DOE Managed Spent Nuclear Fuel

The DOE manages SNF from over 500 different sources (DOE 2007; DOE 2014). DOE-managed SNF includes a broad range of physical and chemical forms, most of which exist in relatively small quantities. Based on characteristics relevant to disposal options, they were aggregated into five of the ten waste groups addressed in DOE's *Assessment of Disposal Options* (DOE 2014, Table 2; SNL 2014). Four of these five groups contain SNF that is potentially eligible for disposal in a DWR. A fifth group, coated particle SNF, contains material of commercial origin and is not discussed in this plan since it is not eligible for disposal in a defense repository.

- **Metallic and non-oxide SNF** is, by mass, the largest category of DOE-managed SNF, and is dominated by about 2,100 MTHM of plutonium-production fuels at the Hanford Site, most of which has been packaged in multicanister overpacks for disposal. The group also includes smaller quantities of a wide range of metallic and carbide fuels of both high and low uranium enrichment used in production and research reactors.

- **Sodium-bonded SNF** consists of a relatively small quantity (about 56 MTHM) of sodium-bonded fuels from research activities at the Fermi 1 reactor, the Hanford Site, and INL. These fuels are grouped separately from others because of the chemically reactive nature of the waste form, and they represent the only group of DOE-managed HLW and SNF for which information is insufficient to identify a disposal option for the waste form as it exists today,

without further treatment (SNL 2014). Because sodium-bonded fuels are expected to be treated prior to disposal these wastes are also discussed in Section 3.6.1.6.

- **DOE-managed oxide SNF** consists of about 180 MTHM of a variety of fuel types all of which share the common attribute of containing oxides of uranium or plutonium, in both highly enriched and low-enrichment forms. Some fuel in this group is originally of commercial origin and is not eligible for disposal in a DWR. Other fuel in this group is derived from defense and DOE research activities and therefore could be eligible. A small amount of SNF in this group will continue to be generated from future research activities.

- **Naval SNF** consists of SNF derived from research and operational activities of the Navy. Naval SNF is projected to contain 65 MTHM of highly enriched SNF in 2035; however, the inventory of naval SNF will continue to increase throughout the operational lifetime of the nuclear Navy.

Additional information about the DOE-managed SNF can be found in Wagner et al. (2012) and SNL (2014, Section A-1.3).

The DOE plans to package most (about 98% by mass) of its SNF other than sodium bonded fuels into canisters suitable for storage, transport, and disposal without the need to be re-opened (SNL 2014). A total of 3,542 of these canisters are projected at all DOE sites combined, of which approximately 2,450 canisters may be eligible for disposal in a DWR (DOE 2014, Table 1).

4 Plan Activities

This section summarizes the primary activities that must be completed to implement the plan using a consent-based process. Figure 3 illustrates how the initial planning for a separate repository for defense waste was performed in parallel with the consent based siting effort. The DWR draft plan has been modified to reflect current thinking in the draft consent-based process and will continue to be updated to reflect feedback on the consent-based siting process.

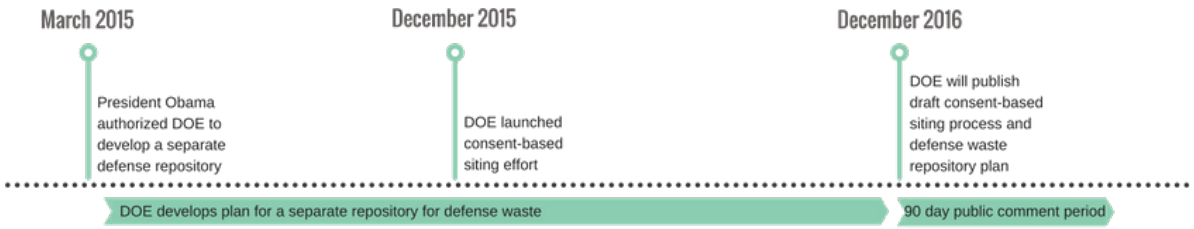

Figure 3 Initial plan for a DWR developed in parallel with the consent-based siting process

As noted in Section 3.3 and Table 1, an example scenario (two sites selected for screening and one site for characterization) is assumed to prepare a preliminary schedule for site identification, screening/selection, and characterization. Different scenarios would follow similar sequence of activities. The support activities that will need to precede or be performed in parallel with these activities are briefly described in Section 8.

4.1 Siting

In addition to the institutional aspects of the consent-based siting process that are described in Section 3.1, siting of the DWR will require extensive technical activities to identify potential candidates sites, screen them, and characterize one or more promising sites in detail to establish a technical basis for proceeding with DWR development.

The NWPA Section 8(b)(3) requires that a DWR will comply with NRC licensing requirements, and if, as discussed in Section 2.6, the DOE proceeds with implementing this plan under the requirements of existing regulations at 40 CFR 191 and 10 CFR 60, the DOE will use siting criteria specified by the NRC at 10 CFR 60.122 in evaluating sites during this process.

The DOE will collaborate with stakeholders consistent with the consent-based siting approach throughout the site evaluation process.

4.1.1 Site Identification

As shown in Table 1 and Figure 1, site identification activities are assumed in this example to begin following development of the consent-based siting process. In this phase, preliminary information will be

used to evaluate potential candidate sites identified through the consent-based siting process. It is expected that a subset of sites can be selected for full screening evaluations in Year 5.

4.1.2 Site Screening / Selection

As discussed in Section 3.3, site screening activities are assumed to begin in Year 5, following the identification of potential candidates in the first phase. Site screening could be complete by Year 8.

4.1.3 Site Characterization

If site screening / selection activities indicate potentially suitable sites among the candidates identified through a consent-based process, the DOE will select one or more of those sites for detailed site characterization consistent with the consent-based siting approach, beginning in Year 8. Site characterization plans will be developed for any site selected for site characterization, and will be consistent with the NRC's expectations for site characterization activities in 10 CFR 60. Specifically, the NRC defines site characterization at 10 CFR 60.2 as follows:

> "Site characterization means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under this part. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing at depth needed to determine the suitability of the site for a geologic repository, but does not include preliminary borings and geophysical testing needed to decide whether site characterization should be undertaken."

If, as discussed in Section 2.6, the DOE proceeds with implementing this plan under the requirements of existing regulations at 40 CFR 191 and 10 CFR 60, site characterization plans will follow the requirements specified in 10 CFR 60.15 through 60.18.

Once site characterization is complete, and if the site is confirmed to be suitable for disposal, these activities will support completion of the EIS and license application for construction authorization.

4.2 Waste Characterization

Waste characterization activities are assumed to begin in Year 2 with the evaluation of HLW and SNF that is potentially eligible for disposal in a DWR.

Characterization would focus on gathering new information based on existing or expected disposal-ready waste forms (e.g., HLW glass at SRS and SNF already packaged at the Hanford Site), with the expectation that those wastes will be the focus of the first phase of DWR design, licensing, and operation. As site selection and repository design activities progress, additional information will become available that will help inform decisions about treatment options and disposition pathways for other eligible waste forms. Comprehensive waste acceptance criteria for the DWR are assumed to be developed before the repository conceptual design is complete. If, and when, a new waste form is proposed for disposal, characterization can be conducted to support its inclusion in the initial licensing action or in a license amendment, as timing allows.

4.3 DWR Design

Preliminary DWR design concepts are assumed to be developed for various geologic media beginning in Year 2. In the absence of site-specific information, these design concepts will be based on generic geologic information, and will examine options for disposing of both existing and projected HLW and SNF, as described in Section 3.6. More detailed repository designs will be developed beginning in Year

6, after a site(s) is identified, and a detailed preliminary design suitable for supporting the EIS and License Application would then be developed. This design will include both surface handling and temporary storage facilities and subsurface emplacement operations.

4.4 Evaluation of System Performance

Iterative evaluations of the anticipated performance of the disposal system will be performed in parallel with site characterization, waste characterization, and repository design activities. These evaluations of system performance will be used to inform site characterization activities, waste treatment and waste acceptance decisions, and repository design, and will contribute to the overall safety case for the disposal system. These evaluations will be used to support EIS and License Application documentation.

4.4.1 Operational and Preclosure Safety Assessment

The operational and preclosure safety assessment will be based on information from the repository design, site characterization, and waste characterization activities, and will include both a preclosure safety analysis and documentation of procedural controls that will ensure DWR safety during operations. When complete, the operational and preclosure safety assessment will support both the EIS and the license application for construction authorization.

As the licensee for the DWR the DOE will need to provide as part of the Safety Analysis Report (10 CFR 60.21(c)) an analysis of the performance of the major design structures, systems, and components, both surface and subsurface, to identify those that are "important to safety" (10 CFR 60.21(c)(1)(ii)(E)). With respect to repository structures, systems and components, important to safety means engineered features of the repository, the functions of which are to prevent the exceedance of radiation exposure limits in the event of the occurrence of two categories of design basis events (10 CFR 60.21(c)). The two categories of design basis events are distinguished by whether they are reasonably likely to occur regularly, moderately frequently, or one or more times before permanent closure of the repository (Category 1); or, considered unlikely, but sufficiently credible to warrant consideration (Category 2). The description and analysis of design and performance requirements for repository structures systems and components must include a demonstration that the exposure limits at 10 CFR 60.111(a) and 10 CFR 60.136 will be met for Category 1 and Category 2 design basis events, respectively (DOE 2008a, Section 1.6.1).

4.4.2 Postclosure Safety Assessment

As prescribed in EPA and NRC regulations, the DOE is required to perform a postclosure safety assessment that evaluates the capability of the disposal system to provide effective long-term isolation of the wastes. The assessment will be based on information from the repository design, site characterization, and waste characterization activities, and will examine how the engineered and natural (i.e., geologic) components of the disposal system work together to ensure long-term safety. When complete, the postclosure safety assessment will support both the EIS and the license application for construction authorization to be submitted to the NRC.

The form of the postclosure safety assessment is specified in EPA and NRC regulations 40 CFR 191 and 40 CFR 197 and 10 CFR 60 and 10 CFR 63, respectively. Specifically, as defined by the EPA for repositories at locations other than YM at 40 CFR 191.12, "*Performance assessment* means an analysis that: (1) identifies the processes and events that might affect the disposal system; (2) examines the effects of these processes and events on the performance of the disposal system; and (3) estimates the cumulative releases of radionuclides, considering the associated uncertainties, caused by all significant processes and events. These estimates shall be incorporated into an overall probability distribution of cumulative release to the extent practicable."

4.5 DWR Construction

DWR construction can begin after authorization by NRC (10 CFR 60.31). Repository construction is typically divided into surface and subsurface realms and further subdivided into non-radiological and radiological facilities and systems. Depending on the scope and design for initial repository operations, the number of surface facilities and the extent of subsurface excavation will vary. Listed below is a representative selection of items requiring construction for repository operations based on information for the previously considered YM repository (DOE 2008b). The construction period is anticipated to last 5 to 7 years and includes activities that would begin on receipt of the construction authorization from the NRC and that the DOE would complete by the time it received SNF or HLW.

Surface non-radiological facilities / systems:

- Domestic water systems
- Two water sources for fire suppression
- Electrical power and distribution system
- Septic tank and leach field/wastewater treatment systems
- Sewer and storm water collection systems
- Site roads and rail
- Hazardous Materials Collection Depot
- Borrow pits
- Explosives Storage Area
- Central Security Station
- Central Control Center Facility
- Offsite Training Facility
- Housing for construction workers
- Sample Management Facility
- Facilities for Performance Confirmation activities
- Marshalling yard and warehouse
- Heavy Equipment Maintenance Facility
- Warehouse and Non-radiological Receipt Facility
- Utilities Facility, cooling tower, and evaporation pond
- Emergency and Standby Diesel Generator Facilities

- Railcar buffer area
- Truck buffer area
- Helicopter pad

Surface Radiological facilities / systems:

- Cask Receipt Security Station
- Site Transportation Network
- Receipt Facility
- Initial Handling Facility
- Canister Receipt and Closure Facility
- Wet Handling Facility (potentially not needed if all SNF is placed in sealed canisters before shipment)
- Transporter Security Station
- Low-Level Waste Facility

The design of DWR subsurface facilities and the openings providing access to them are more dependent on the repository location and geologic media than are the surface facilities. Listed below is a representative selection of subsurface openings requiring construction to enable repository operations based on information for the previously considered YM repository (DOE 2008b). It is likely that subsurface construction will be staged so that after an initial subsurface layout is constructed to accommodate beginning waste package disposal, subsurface construction will proceed in conjunction with waste emplacement.

Subsurface non-radiological facilities / systems:

- Initial subsurface entry development area
- Subsurface access by ramp(s) or shaft(s)
- Ventilation shaft(s)
- Access main(s)
- Emplacement drift(s)

4.6 Transportation

Detailed planning for transportation of HLW and SNF from DOE sites is highly dependent on the location of the DWR site; regardless of the destination, shipments will meet or exceed the level of safety established by the NRC's and the Department of Transportation's (DOT) requirements and standards. The DOE has authority under the AEA to regulate transportation of radioactive materials undertaken by the DOE or on its behalf. The DOE exercises this authority to regulate certain DOE shipments, such as shipments undertaken by government employees or shipments involving national security or other critical interests. For most of its shipments, the DOE typically utilizes commercial carriers and does not exercise its AEA authority. Accordingly, most DOE shipments are undertaken by commercial carriers under the same terms and conditions as comparable commercial shipments and are subject to regulation by the DOT and the NRC. The DOT and the NRC regulate commercial transportation of radioactive material. Transportation and packaging requirements and standards are provided in the NRC's regulations at 10 CFR Part 71 Packaging and Transportation of Radioactive Material, and the DOE regulations at 49 CFR Subchapter C—Hazardous Materials Regulations. Even in those instances where DOE does exercise its AEA authority over its shipments, it is DOE policy that all DOE shipments are to be conducted in a manner that meets or exceeds the level of protection associated with comparable commercial shipments under the NRC's and DOT's regulations. DOE's transportation policy is set forth in several directives including Order 460.1C, Packaging and Transportation Safety, Order 460.2A, Departmental Materials Transportation and Packaging Management, and Order 461.1C, Packaging and Transportation for Offsite Shipment of Materials of National Security Interest. Transportation risks have been analyzed and discussed by the NRC (NRC 2014) and the National Research Council of the National Academy of Sciences (National Research Council 2006). The DOE would transport spent nuclear fuel and high-level radioactive waste from DOE sites to the DWR in NRC-certified transportation casks. The transportation mode is uncertain; however, the mix may include both rail and truck transport.

4.7 DWR Operations

DWR operations can only begin after NRC has issued a license to receive and possess source, special nuclear, or byproduct material at a geologic repository operations area (10 CFR 60.41). DWR operations will last for decades and are divided into several contiguous activities: waste receipt, waste packaging (if necessary), waste package transport to the subsurface facility, and waste emplacement. Depending on the scope and design for initial DWR operations, the extent of subsurface excavation will vary. As mentioned in Section 4.5, it is likely that construction will proceed in conjunction with waste emplacement. Described below is a representative selection of steps required for repository operations based on information for the previously considered YM repository (DOE 2008b).

Transportation casks containing SNF or HLW would be received at the cask receipt security station. Shipments of SNF and HLW would arrive at the station on commercial railcars that carried rail transportation casks or on truck trailers that carried truck transportation casks. On arrival, the shipments would be inspected and custody of, or responsibility for, the transportation casks and the waste would be transferred to the repository. Casks would be moved to a buffer area in the protected area of the repository operations area to await processing in other facilities.

After processing in either the initial handling facility, the canister receipt and closure facility, or conceivably a wet handling facility, wastes would be packaged as appropriate for disposal and prepared for the transport and emplacement vehicle(s) to receive it, move it to the subsurface, and emplace it in the repository. A site transportation network consisting of rail lines and roads would be used to transport the waste from the waste handling facilities to the emplacement portal (either a shaft or a ramp). Canister movement would be accomplished in shielded transfer casks.

The mode of access to the underground (ramp or shaft) has substantial impacts on the mechanisms used to convey the waste to its emplacement area. Ramp access allows use of a single transport vehicle to convey the waste from surface facilities to the underground and into the emplacement panel. Shaft access obviates the use of a single transport vehicle, and requires three logistical steps for delivery to the emplacement panel: transport from surface facilities to the top of the shaft; lowering the waste package down the shaft; and transport from the base of the shaft to the emplacement panel.

The completed waste packages would be moved to the subsurface and emplaced in the repository. Transport and emplacement vehicle(s) would transport the waste package to the subsurface portal or shaft, convey it to the subsurface access main(s), and then to the appropriate emplacement drift. The transport and emplacement vehicle(s) used would be a specialized, shielded vehicle(s) designed to move waste packages safely from the surface facilities into the subsurface facility for emplacement. To accommodate the high radiation environment of the emplacement drifts, the transport and emplacement vehicle(s) would be remotely controlled.

4.8 DWR Closure

The final phase of the DWR preclosure period is the closure of the subsurface facility which requires NRC approval of an application submitted by the DOE to amend the license (10 CFR 60.51) prior to executing closure activities.

The following activities are a representative selection of activities required for repository closure based on information for the previously considered YM repository (DOE 2008a):

- Installation of any engineered barriers external to emplaced waste packages, if necessary
- Removal of noncommitted materials from the subsurface facility
- Placement of backfill in ramps and shafts
- Re-grading of affected areas and installation of surface monuments
- Final site restoration

4.9 License Termination

Following permanent closure and the decontamination or dismantlement of surface facilities, the DOE may apply to NRC for an amendment to terminate the license (10 CFR 60.52).

4.10 Research, Development, and Demonstration

In parallel to its work on a DWR, the DOE continues to conduct R&D on multiple concepts for geologic disposal of DOE-managed HLW and SNF (e.g., evaluation of design concepts for mined repositories in multiple rock types and deep boreholes in crystalline rock). To complement the proposed development of a separate DWR, additional R&D efforts will focus on information needs specific to disposal of high thermal-output naval SNF in mined repositories that would occur in a later phase and the field-scale testing of deep borehole disposal concepts for some smaller waste forms (DOE 2014, Section 5).

5 Environmental and Regulatory Compliance Activities

5.1 National Environmental Policy Act Related Activities

The general applicability of NEPA is described in Section 2.2. The DOE is currently developing a preliminary NEPA strategy that will take into consideration comments received in response to this draft plan and through the consent-based siting process. Activities related to NEPA requirements will continue throughout the DWR effort, will require substantial resources, and will be integrated into other technical and regulatory activities.

Appendix D to Subpart D of 10 CFR 1021, which discusses classes of actions that normally require preparation of an EIS, specifically identifies "Siting, construction, operation, and decommissioning of major treatment, storage, and disposal facilities for high-level waste and SNF, including geologic repositories…" among such actions. Consequently, DOE acknowledges that the final decision on the location for a DWR will require preparation of an EIS.

5.2 Nuclear Regulatory Commission Related Activities

The general applicability of NRC regulations is described in Section 2.6. Activities related to NRC requirements will not be as resource-intensive as other efforts in the first five years. However, they will escalate throughout the site characterization phase and will eventually consume much of the effort leading up to the submittal and review of the license application. One important early step in implementation of this plan, identified in Section 3.2, will be development of a licensing strategy for phased DWR development under the existing applicable regulations (10 CFR 60 and 40 CFR 191) including possible regulatory interactions about updates of the regulations. If as expected, the EPA and NRC develop new regulations governing geologic disposal of SNF and HLW, the licensing strategy will be revised accordingly.

As discussed in Section 8, DOE activities potentially relevant to future licensing activities for a DWR will be conducted in a manner that meets the NRC's expectations for a licensee. NRC expectations for the DOE will include, among other things, demonstration of a Nuclear Safety Culture with a Safety Conscious Work Environment (NRC 2004; NRC 2005; 76 FR 34773), and attention to Quality Assurance (QA). The DOE is familiar with operating in compliance with EPA and NRC requirements, based on its activities on previously proposed repository sites.

It will be important for the DOE to interact with NRC early and frequently to maintain a constant working relationship with the regulator for this project. As early as site characterization the DOE may consider inviting an NRC On-Site Representative to participate. The representative is an NRC employee, often a geoscientist or nuclear engineer, who is present at the project site and has access to and observes day-to-day project activities.

One of the most significant activities prior to construction of the DWR will be development of the license application tendered to the NRC. The DOE should assume this effort will consume many resources for at least 2 to 3 years. The license application for the previously considered YM repository constituted more than 8,000 pages, and was accompanied by more than 100 supporting technical documents.

5.3 Other Requirements

Multiple statutes and regulations in addition to those that implement the NEPA, AEA, and NWPA will also apply to the development, operation, and closure of a geologic repository. Specifically, the DOE is subject to environmental protection and transportation requirements including, but not limited to, those set by the Clean Air Act; Clean Water Act; Hazardous Materials Transportation Act; Emergency Planning and Community Right-to-Know Act of 1986; Comprehensive Environmental Response, Compensation,

and Liability Act; Resource Conservation and Recovery Act; National Historic Preservation Act; Archaeological Resources Protection Act; Endangered Species Act; NRC regulations; and applicable state statutes and regulations.

In meeting these requirements, the DOE will interact with local, state, tribal, and federal agencies authorized to issue necessary permits, licenses, and other regulatory approvals, and will also work with agencies responsible for protecting such significant resources as endangered species, wetlands, or historic properties. Depending on the location of selected sites, the DOE may also need to coordinate with other branches of the Federal government including the U.S. Department of Agriculture, U.S. Department of the Interior including its Bureaus (U.S. Fish and Wildlife Service, National Park Service, and Bureau of Land Management), and the Mine Safety and Health Administration.

Complete listings of applicable statutes and regulations will be site-specific, and will be prepared as part of the NEPA EIS documentation.

6 Institutional Activities

The NWPA (Section 101(b)) provides that states or Tribes involved with the development of a geologic repository for permanent disposal of HLW and SNF derived from national defense and R&D activities of the Department "shall be entitled … to rights of participation and consultation identical to those provided in sections 115 through 118 [of the NWPA], except that any financial assistance … shall be made from amounts appropriated to the Secretary for purposes of carrying out this section." Section 115 of the NWPA defines the process for review and approval of the site selection process. Section 116 of the NWPA defines the terms of state participation in siting decisions, and Section 118 defines terms for tribal participation. Section 117 specifies the terms under which the Federal government must consult with states and Tribes.

Additional institutional activities will be defined as the consent-based siting process is developed. For the purposes of this draft plan, the primary institutional activities that will be required are those that are described in the following sections.

6.1 Interactions with Potential Host States, Tribes, and Communities

As discussed in Section 3.1, a consent-based siting process will provide a framework for the key technical steps in evaluating sites for a DWR. For the purposes of this draft plan, these steps are assumed to be:

- An initial phase in which potential candidates identified through the consent-based process are evaluated based on preliminary information
- A site screening phase in which potential candidates are more thoroughly evaluated using available information to the maximum extent possible to determine whether the site is sufficiently promising for further consideration
- A longer and more extensive detailed site characterization effort involving both surface-based and underground tests to determine whether the site is suitable for a DWR and provide the data needed to support repository design, licensing, and construction

One of the provisions of the NWPA that will apply to a DWR requires the DOE, during site characterization and subsequent repository development and operation, to consult and cooperate with the Governor and legislature of the host state and the governing body of any affected Indian tribe "in an effort to resolve the concerns of such State and any affected Indian tribe regarding the public health and safety, environmental, and economic impacts of any such repository" (NWPA Section 117(b)). The DOE is directed to seek to enter into a binding written agreement with the state and, where appropriate, to enter into a separate binding agreement with the governing body of any affected Indian tribe, specifying procedures for state and tribal participation, when a site is selected for characterization or even as soon as the site is identified as potentially acceptable (if the state or Tribe requests an agreement) (NWPA Section 117(c)). The NWPA also provides any state, Indian tribe or unit of local government within whose jurisdiction a site for a DWR is located an opportunity to designate a representative to conduct on-site oversight activities at the site.

6.2 Interactions with National Stakeholder Groups and Interested Parties

The DOE is already engaged in interactions with a wide range of stakeholders through a variety of mechanisms that can be utilized as needed for this purpose:

As mentioned above, DOE (through the Office of Nuclear Energy) issued an Invitation for Public Comment in December 2015 to solicit input from the public, communities, stakeholders, and

governments at the tribal, state, and local levels on how to design a consent-based siting process for nuclear waste storage and disposal facilities. During the first half of 2016, the Department hosted eight public meetings around the country plus two meetings (kick-off and close-out) in Washington, DC. At these meetings, which were held in geographically diverse locations, the Department heard first-hand from members of the public, communities, states, Tribes, and other interested stakeholders on what matters to them as DOE moves forward in developing a consent-based siting process. Meetings were held in major cities across four regions: the Northeast (one meeting), the Midwest (two meetings), the West (four meetings), and the South (one meeting). These meetings were designed to encourage participation and to provide multiple opportunities for public input and two-way dialogue. In addition to the Invitation for Public Comment and regional public meetings, the Department used other opportunities—including conferences and professional meetings—to engage in dialogue with stakeholders and members of the public on the design of a consent-based siting process. DOE also welcomed and accommodated requests, where possible, for additional meetings to discuss its consent-based siting effort. In September 2016 the DOE issued for comment a draft report summarizing the public input received. The final version is scheduled for publication in December 2016. A draft *Consent-Based Siting Process Design Document* will be published for public comment in December 2016. The CBS process design document reflects the public input and offers preliminary views on siting guidelines and criteria.

- The DOE Office of Environmental Management supports, by means of grants and cooperative agreements, various national intergovernmental organizations. These organizations include the Energy Communities Alliance, the Environmental Council of States, the National Association of Attorneys General, the National Governors Association, and the National Conference of State Legislatures, and the State and Tribal Governments Working Group.

- The Secretary of Energy Advisory Board provides the Secretary of Energy with advice and recommendations on activities and operations of the DOE as the Secretary may direct.

- The Environmental Management Advisory Board provides advice and recommendations to the Assistant Secretary for Environmental Management concerning issues affecting the Environmental Management program. Members may include representatives of entities including, but not limited to, research facilities, academic institutions, regulatory entities, and stakeholder organizations, as needed.

- The DOE Office of Nuclear Energy is creating a subcommittee of the Nuclear Energy Advisory Committee (NEAC) to provide advice on consent-based siting and integrated waste management.

- The DOE Office of Nuclear Energy is working with states and Tribes through a variety of means to develop institutional procedures for transportation of SNF to a federal facility or facilities. For example, DOE's National Transportation Stakeholders Forum is the mechanism through which DOE engages at a national level with states, Tribes, federal agencies, and other interested stakeholders about DOE's shipments of radioactive materials. In addition, the Nuclear Fuels Storage and Transportation Planning Project is working with states through cooperative agreements with State Regional Groups (SRGs). The SRGs which represent the interests of their member States include the Council of State Governments'

Northeast High-Level Waste Transportation Task Force, the Council of State Governments' Midwestern Radioactive Materials Transportation Committee, the Southern States Energy Board's Radioactive Materials Transportation Committee, and the Western Interstate Energy Board's High-Level Waste Committee. Tribal governments are sovereign nations, and the DOE interacts with Federally recognized Tribes on a government-to-government basis as described in DOE Order 144.1, *Department of Energy American Indian Tribal Government Interactions and Policy*.

Making use of these ongoing interactions concerning waste transportation could be an effective way to initiate a dialogue about DWR siting. This would be consistent with the BRC's conclusion that in the area of transportation, the DOE has done a good job of stakeholder interactions that should be emulated in the future (BRC 2012, p. 86). The experience and relationships developed by the DOE in dealing with transportation are particularly relevant to consultations concerning a national DWR siting process because the same entities—tribal, state, and local governments—are key actors in both areas. Tribal, state, and local governments and other stakeholders that have an interest in waste transportation are also likely to be equally interested in any process for siting waste facilities to and from which waste would be transported. Furthermore, transportation will clearly be a consideration in siting waste facilities.

7 Roles and Responsibilities

For the purposes of this draft plan, the DOE is assumed to have overall responsibility for developing the detailed plans necessary to implement the plan described and will be responsible for directing and managing all work activities, consistent with requirements established by DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*. The DOE will be the licensee under applicable NRC regulations, and will be responsible for ensuring that all legal and regulatory requirements are met.

Roles and responsibilities of the DOE contractors will be defined by contracts, and will include compliance with all applicable legal and regulatory requirements, and conduct of scientific and engineering investigations in support of this program. Federal agencies other than the DOE will have roles and responsibilities relevant to this effort as defined by statute.

8 Support Activities

Successful implementation of this plan will require effective support activities in multiple areas. Activities and roles will be identified as the DWR development planning progresses.

The list below summarily identifies some, but not all functions needed for a DWR development organization.

- *DWR Management* provides the vision, the management approach, and program policies and identifies procedures for the assembly and operation of the organization. The entire organization's activities need to be conducted in accordance with nuclear safety culture principles reflected in a Safety Conscious Work Environment and implementing a Quality Assurance (QA) program consistent with DOE expectations and those of the regulator.

- *Public Engagement and Consent-Based Siting* defines, designs, and implements processes for public engagement in organization activities.

- *Quality Assurance* defines the program level requirements necessary to formulate a high quality and streamlined QA program to satisfy ASME NQA-1 2015 standards that meet NRC licensing rules.

- *Regulatory/Licensing* addresses activities to manage the regulatory support activities conducted by the organization, regardless of the regulator's identity (e.g., NRC, EPA, or state entities).

- *Science and Engineering* is responsible for the direction, coordination, performance, and oversight of science and engineering activities discussed in more detail in Section 4.

- *Operations Management* is responsible for the direction, coordination, and oversight of the Business Management, Organizational Assurance, Information Management, and IT Systems elements. Reporting directly to the DWR Manager, Operations Management is responsible for the day-to-day functionality of the principal support organizations.

9 References

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Appendix A. Repository Program Cost Estimates

A-1. Estimated Costs for Initial Phase ofthe Defense Waste Repository

As stated in Section 3.4, the cost of a repository is highly uncertain; this uncertainty results from multiple sources, including the site selection process, the host rock type selected, the inventory of waste selected for disposal, and the final design of the repository.

To calculate a more reliable and complete cost, the geology, location, and waste quantities and forms need to be better defined. These inputs will not become available until a potential host community volunteers through the consent-based siting process. Table A-1 shows a ROM estimate for an example scenario to better understand what resources would be needed to identify and screen potential sites and perform the needed characterization to evaluate site suitability. This cost estimate is independent of geology.

Table A-1. Preliminary ROM estimate of program costs from inception through site characterization for a single representative case in which two candidate sites are identified for screening and only one site is chosen for full characterization (Millions of Dollars)

DURATION	3 YEARS	3 YEARS	5 YEARS	11 YEARS
PROGRAM PHASE	Site Identification	Site Screening	Site Characterization	TOTAL
Consent-Based Siting Process	$45 M	$45 M	$300 M	$390 M
Site Screening and Selection	$45 M	$400 M	$10 M	$455 M
Site Characterization	$0 M	$50 M	$600 M	$650 M
Waste Characterization	$6 M	$10 M	$35 M	$51 M
Repository Design	$4 M	$30 M	$275 M	$309 M
National Environmental Policy Act (NEPA) Activities	$10 M	$15 M	$100 M	$125 M
Repository Licensing	$5 M	$15 M	$100 M	$120 M
Repository Construction	$0 M	$0 M	$730 M	$730 M
Management Support	$15 M	$70 M	$150 M	$235 M
TOTAL	$130 M	$635 M	$2300 M	$3065 M

Additional information regarding cost estimates shown in Table A-1 is as follows:

Consent-Based Siting Process and Community Relations: Cost estimates are based on an assumed annual budget of $15 million during the initial phases with an increase to $50 million per year after a single site has been selected for full characterization. These costs include grants and other payments to potential host communities.

Site Screening and Selection: Cost estimates assume $15 million per year during initial phases, increasing to $100 million per year for technical investigations and evaluations during the screening and selection process. Costs end in this activity after a single site is selected for characterization.

Site Characterization: Costs are estimated to be on the order of $120 million per year during the period between site selection and the beginning of licensing.

Waste Characterization: A modest level of effort will be required throughout to identify the waste proposed for disposal in the DWR and to ensure that waste characterization information is sufficient to support licensing.

Repository Design: A modest level of effort will be needed early in the process to develop sufficient preliminary design information to support screening evaluations. Full scale repository design activities do not begin until after a site has been selected.

National Environmental Policy Act (NEPA) Activities: Cost estimates assume that NEPA-related activities begin with program inception and continue throughout, including preparation of an EIS during the site characterization phase.

Repository Licensing: Cost estimates assume that interactions with the NRC begin with program inception and continue throughout, culminating in preparation of a license application to the NRC.

Repository Construction: Construction-related costs are assumed to begin during the site characterization phase with the excavation of the first exploratory underground workings. Costs increase when construction of the disposal region begins following the issuance of a construction authorization license.

Management Support: Costs associated with management support include management and integration costs, business support, quality assurance, and organizational support functions. These costs are estimated at $30 million per year after a single site has been selected.

The estimates provided here and in Section 3.4 should be used for preliminary scoping purposes only. In the context of DOE Order 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, the plan to develop the DWR has not met the CD-0 (Approve Mission Need) threshold. New cost analyses were not performed to support these estimates, and the available source material summarized in the following sections was developed at different times for a range of disposal concepts, including significant differences in the type and quantity of waste for disposal, the chosen host rock, assumptions about the siting and licensing process. Cost estimates from other programs are presented in some cases in actual dollars at the time of expenditure, and in other cases in constant dollars reported for different years. Cost estimates from other programs, including in particular the previously considered YM repository, may have limited relevancy for development of a DWR because of major differences in both programmatic constraints and the disposal inventory.

More detailed cost estimates can be prepared at various stages in the effort, and will be impacted by choices regarding the inventory of waste for disposal, the approach taken to consent-based siting, the geologic media chosen for the repository, and the final design of the repository.

A-2. Other Cost References

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