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NEVADA NATIONAL SECURITY SITE DEMONSTRATION REACTOR SITING AND CAPABILITIES STUDY

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DISCLAIMER

SUMMARY

The Nevada National Security Site (NNSS) Demonstration Reactor Siting and Capabilities Study identifies siting opportunities supporting the demonstration of advanced and emerging reactor designs and operations that optimizes these activities within the NNSS physical, operational, and regulatory footprint considering relevant evaluation factors to ensure the designated site locations provide the necessary defense-in-depth for safe and secure sustained operations. The study's key aspects include the derivation and associated weighting of evaluation factors, identification of candidate locations, evaluation of locations relative to the evaluation factors, and ultimately the determination of siting opportunities with their associated advantages and limitations.

Mission Support and Test Services LLC (MSTS), which serves as the NNSS Management and Operating (M&O) Contractor for NNSS Prime Contract DE-NA0003624, has been tasked and funded through the Department of Energy Office of Nuclear Energy (DOE-NE) to complete the NNSS Demonstration Reactor Siting and Capabilities Study. The study identifies locations within the NNSS that may be suitable for advanced reactor demonstrations, advanced reactor fuel fabrication, or other experimental support for advanced reactor demonstrations.
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ACKNOWLEDGEMENTS

In order to execute the study, an integrated project team (IPT) was formed with the requisite multi-disciplinary expertise to identify potential siting locations and conduct an analysis of alternatives of these postulated siting options against derived evaluation criteria to determine optimal locations. The following MSTS staff are acknowledged as key contributors to this report by their role in the IPT or other ad hoc support:

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ACRONYMS

AB	Authorization Basis
AD	Aerodynamic Diameter
AFB	Air Force Base
ALS	Advance Life Support
AOA	Analysis of Alternatives
ARD	Advanced Reactor Demonstration
ARF	Airborne Release Fraction
ARL/SORD	Air Resource Laboratory / Special Operations and Research Division
ATV	All-Terrain Vehicles
BEEF	Big Explosive Experimental Facility
CAS	Corrective Action Sites
CD	Company Directive
DAF	Device Assembly Facility
DOE	Department of Energy
DOE-NE	Department of Energy Office of Nuclear Energy
DR	Damage Ratio
DRI	Desert Research Institute
DSA	Documented Safety Analysis
DUFF	Demonstration using Flat-Top Fissions
EA	Environmental Assessment
EIS	Environmental Impact System
EPHA	Emergency Planning Hazards Assessment
EPZ	Emergency Planning Zone
F&R	Fire and Rescue
FFACO	Federal Facility Agreement and Consent Order
FPSs	Fission Power Systems
FRM	Form
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information Systems

HAZMAT	Hazardous Materials
HE	High Explosives
HSPD	Homeland Security Presidential Directive
INL	Idaho National Laboratory
IPT	Integrated Project Team
KRUSTY	Kilopower Reactor Using Stirling Technology
kV	Kilo-Volts
LLW	Low-level Radioactive Waste
LOCA	Loss of Coolant Accident
LPF	Leakpath Factor
LPZ	Low Population Zone
M&O	Management & Operating
MAR	Material at Risk
MEDA	Meteorological Data Acquisition
MLLW	Mixed Low-level Radioactive Waste
MSTS	Mission Support and Test Services LLC
MW	Megawatts
MWt	Megawatts thermal
MTHM	Metric Ton Heavy Metal
NAC	Nevada Administrative Control
NASA	National Aeronautics and Space Administration
NCERC	National Criticality Experiments Research Center
NE	Nuclear Energy
NEICA	Nuclear Energy Innovation Capabilities Act
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NFO	Nevada Field Office
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NRIC	National Reactor Innovation Center

NvE	Nevada Enterprise
PNNL	Pacific Northwest National Laboratory
PPE	Plant Parameter Envelope
PRT	Project Review Team
PSHA	Probabilistic Seismic Hazard Analysis
PWS	Public Water Supply
REOPs	Real Estate Operations Permits
RF	Respirable Fraction
ROD	Record of Decision
SRAs	Security Risk Assessments
SMP	Safety Management Program
SNM	Special Nuclear Material
SHPO	Nevada State Historic Preservation Office
SWEIS	Sitewide Environmental Impact Statement
TED	Total Effective Dose
TREDS	Technical Research, Engineering, and Development Services
TSR	Technical Safety Requirements
U.S.	United States
USGS	United States Geological Survey
USQD	Unreviewed Safety Question Determination
UXO	Unexploded Ordnance
V	Volts
VA	Vulnerability Assessments
VEA	Valley Electric Association
WECC	Western Electricity Coordination Council

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1. RESULTS SUMMARY

1.1 Mission Need

A capability gap exists for industrial partners who are designing and collaborating on advanced reactor technologies because they lack the ability to harness the Department of Energy's (DOE) world-class capabilities to bridge the gap between research, development, and the energy marketplace to help convert advanced nuclear concepts into commercial applications. This study attempts to address this capability gap by identifying potentially suitable advanced reactor testbed locations and capabilities within the Nevada National Security Site (NNSS) to provide a possible testbed for industry to build and demonstrate advanced reactor technologies. Supporting the development of advanced nuclear energy (NE) in this manner will allow the National Reactor Innovation Center (NRIC) on the Department of Energy Office of Nuclear Energy's (DOE-NE) behalf to attain the goal of demonstrating advanced reactors by the end of 2025 and converting the most promising nuclear concepts into commercial applications by 2030.

1.2 Approach

This study conducts and documents an evaluation of potential demonstration reactor siting locations within the NNSS in a structured feasibility study to determine the preferred siting locations and other unique NNSS capabilities supporting the development of these emerging technologies. A multi-disciplinary integrated project team (IPT) held structured workshops to perform an analysis of alternatives (AOA) of potential siting locations following the applicable AOA best practices. The use of the NNSS Geographic Information System (GIS) capability was heavily leveraged to determine viable siting locations. The NNSS GIS provides various site maps associated with siting related evaluation factors that can be layered on top of one another to determine optimal siting locations. This tool was used first to exclude locations that did not meet "must" evaluation factor criteria (e.g., lack of preexisting radiological contamination) and subsequently to evaluate preferences or "wants" type of evaluation factors (e.g., proximity to required power supply) to provide a relative "heat" map of the more optimal siting locations. The key milestones in the application of this process included the following steps.

- Identify siting evaluation factors
- Weight evaluation factors
- Identify candidate siting locations using GIS mapping
    - Couple "must" exclusion evaluation factors with available GIS maps to exclude non-viable locations
    - Define evaluation factor preferences or "wants" to be used with layered GIS maps
    - Layer GIS maps with established preferences to determine optimal locations
- Assemble and organize available information for identified siting locations from GIS mapping

- Conduct AOA using weighted evaluation factors to rank locations
- Document AOA Results to be addressed to host reactor operations
- Describe any other unique NNSS capabilities for advanced reactor demonstration operations.

1.3 Results

The NNSS is a unique outdoor, indoor, and underground experimentation and training user facility located in a remote, highly secure area of southern Nevada. The NNSS is primarily a user-site for high-hazard experimentation. The NNSS has demonstrated success in creating innovative testbeds with supporting diagnostics to capture data for technically complex demonstration tests or simulations associated with national security missions. The NNSS's vision is to be the preferred national security user-site for largescale, high-hazard experimentation, with premier facilities and capabilities below ground, on the ground, and in the air. Support of advanced reactor demonstration (ARD) activities fit with both the NNSS vision and capabilities.

The NNSS has demonstrated success in creating innovative testbeds with supporting diagnostics to capture data for technically complex demonstration tests or simulations associated with national security missions. This study has shown that the NNSS has suitable locations to host ARD activities. These viable locations coupled with the established facility user model paradigm for high-hazard experimentation and enabling operating infrastructure provides an opportunity to integrate new ARD activities with the existing national security mission portfolio conducted at the NNSS. In addition, existing, unique NNSS capabilities, such as tunnels and a secure operating nuclear facility footprint that includes state of the art nuclear criticality safety program research, provides additional opportunities for ARD development for work involving reactor design, assembly, testing, and disassembly.

The study results provide the foundational groundwork to make informed decisions on the compatibility of ARD activities with existing programs and available NNSS resources. The results also give insights on the NNSS's capability in fulfilling the needs of ARD activities as established by the plant parameter envelope for microreactors and advanced reactors, and the basis for siting ARD activities within specific locations within the NNSS based on documented evaluation factors and the application of comprehensive mapping to determine suitable locations. If the NNSS is selected to host ARD activities, the study results should be used as an input to the established program/project screening process to support developing a documented proposal to conduct specific ARD activities for NNSS Management and Operating (M&O) Contractor concurrence and approval by the National Nuclear Security Administration Nevada Field Office (NNSA/NFO). The study results should also be used to match the requirements of the specific ARD activity desired to be performed to the location that best satisfies them.

The following candidate site locations were identified for consideration based on the application of the GIS mapping methodology with the established factors (the characters in parentheses are code names or abbreviated identifiers):

- Location 1: Area 5 – Near Frenchman Flat Substation (1A5FF)
- Location 2: Area 6 – Near Tweezer Substation (2A6TW)
- Location 3: Area 2 – Near Valley Substation (3A2VA)
- Location 4: Area 25 – Near Jackass Flats Substation (4A25JF)
- Location 5: Area 18 – Near Stockade Wash Substation (5A18SW)

These locations are described in terms of the defined NNSS operational area that they are located within and proximity to the nearest electrical substation. These locations were selected using GIS mapping because they reside outside of defined exclusion areas and are generally favorable locations based on the established desired preferences for site suitability. Common attributes for these potential locations are in proximity (less than 5 miles) to electrical services and primary roads to preclude excessive costs for new infrastructure capabilities.

The results of the AOA ranked the candidate locations in the following order of preference: (1) Area 25 – Near Jackass Flats Substation (4A25JF), (2) Area 6 – Near Tweezer Substation (2A6TW), (3) Area 5 – Near Frenchman Flat Substation (1A5FF), (4) Area 2 – Near Valley Substation (3A2VA), and (5) Area 18 – Near Stockade Wash Substation (5A18SW). In addition to ranking these locations, the study gives the positive attributes and potential constraints of each location.

The study's results demonstrate the suitability of these locations for hosting ARD activities and describe other capabilities that may aid in the research and development ARD technologies. The five selected locations for hosting ARD activities were all outside the defined exclusion areas defined in this study, thereby satisfying the "must" evaluation factors related to surface geology, drainage, and whether it is outside the areas of past nuclear testing, radiological contamination, environmental restrictions, and other land-use restrictions. In addition, the locations were determined to be the more suitable locations for hosting ARD activities using GIS maps based on their ability to meet siting preferences. These siting preferences aided in identifying locations that are more favorable for siting based on availability and proximity to existing infrastructure (power, roads, and water), desired slope of terrain, distance from seismic faults while minimizing ecological impacts and remaining a sufficient distance from areas with known historic or controlled hazards (e.g., areas of potential unexploded ordnance, energetic materials storage, and corrective action sites).

The NNSS has other unique capabilities that can support the research and development of ARD activities. Among these are several tunnel complexes located throughout the NNSS. By the nature of their construction with limited-access portals and an overburden of rock, tunnels provide a secluded area to perform operations with inherent confinement features in an underground working environment. The Device Assembly Facility (DAF) provides an operating Hazard Category 2 nuclear facility with modern security features, a mission enabled operating footprint, and capabilities that can safely and securely perform assembly/disassembly of nuclear materials for ARD activities. The National Criticality Experiments Research Center within the DAF include four critical assemblies that can be used to assess the properties of reactor materials and designs similar to how they have been applied for proving fission power system designs for the National Aeronautics and Space Administration (NASA).

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2. INTRODUCTION

2.1 Purpose

The study's purpose is to identify suitable testbeds within the NNSS for the demonstration of advanced and emerging reactor technologies. These testbeds are envisioned to be existing structures, facilities, or sites that may be suitable for advanced reactor demonstrations, advanced reactor fuel fabrication, or other experimental support for advanced reactor demonstrations. This study examines siting alternatives at NNSS with the objective of identifying locations for near-term ARD projects. Included in the outcomes is an evaluation of the quantitative and qualitative factors that must be addressed for each site if selected to host an ARD sponsored demonstration.

2.2 Background

NRIC at Idaho National Laboratory (INL) provides resources for testing, demonstration, and performance assessment to accelerate deployment of new advanced nuclear technology concepts. In this capacity, NRIC is authorized by the Nuclear Energy Innovation Capabilities Act (NEICA) to provide private sector technology developers access to the strategic infrastructures and assets of the national laboratories. Companies can use these resources for commercial NE research, development, demonstration, and deployment activities. NRIC initiatives are sponsored and overseen by DOE-NE. A key NRIC initiative is the completion of a National Demonstration Reactor Siting Study. Argonne National Laboratory is currently undertaking this study (ANL/NRIC-20/1), which includes the NNSS as a proposed demonstration reactor site.

The NNSS M&O contractor has been tasked and funded through DOE-NE and NRIC to complete a NNSS Demonstration Reactor Siting and Capabilities Study. The study identifies locations within the NNSS that may be suitable for advanced reactor demonstrations, advanced reactor fuel fabrication, or other experimental support for advanced reactor demonstrations. This study complements the NRIC National Demonstration Reactor Siting Study by identifying potential siting locations within the NNSS geographic boundary should the NNSS be determined to be a location for future ARD activities. This study also applies information from NRIC-21-ENG-001 (PNNL-30992), *Advanced Nuclear Reactor Plant Parameter Envelope and Guidance*. This latter study provides a plant parameter envelope (PPE) for a surrogate microreactor plant (defined as a single unit with an output of less than 60 MWt, plus any associated support facilities) and a surrogate small- to medium-sized advanced reactor (defined as a single unit with an output of 1,000 MWt or less, plus any associated support facilities). PPE values are used to define the plant parameter needs of ARD activities (e.g., permanent disturbed acreage to support plant operations) that are optimal with the NNSS locations.

The NNSS prime contract imposes project screening and siting requirements by invoking NFO O 410.X1, *Nevada National Security Site and North Las Vegas Facilities General Use and Operations Requirements*. These requirements are fulfilled by compliance to Company Directive (CD) CD-1000.004, *Program/Project Screening and Siting Process for Nevada National Security Site and North Las Vegas Facility*. Collectively, these documents provide a consistent methodology to screen and site new programs and/or projects coming to the NNSS and satellite locations managed by the M&O contractor for NNSA/NFO. The methodology is designed to ensure compatibility of new programs and/or projects with existing strategic direction, site planning, appropriate use of site resources, and directorate missions/lines of business. The project screening and siting process invokes the following requirements:

- New projects at the NNSS must be approved by the NNSA/NFO Manager based on the recommendation of the Project Review Team (PRT)
- New projects require obtaining screening and location information and a recommendation from the M&O contractor
- The PRT recommendation must be forwarded to the NNSA/NFO Manager, and the Manager's approval obtained before the project or activity is initiated.

This study supports the established project screening and siting process by systematically identifying possible siting locations with NNSS for ARD activities. The outcome of the study is envisioned to be an input document to the PRT should NRIC make the determination to site ARD activities at the NNSS. Following this determination, the PRT will compile the necessary information to support review of the proposed project using Form FRM-2782, "Project Screening" (Appendix A). Therefore, the optimal locations for siting ARD activities at NNSS, identified by this study, are pre-decisional pending completion of the integrated project screening and siting process with associated recommendation by the M&O contractor and approval by NNSA/NFO.

2.3 Site Information

The NNSS occupies 1,355 square miles of desert and mountain terrain (Figure 2-1) in southern Nevada. About 6,500 square miles of the U.S. Air Force's Nevada Test and Training Range and the Desert National Wildlife Refuge surround the NNSS on the northern, western, and eastern sides. It is a multi-disciplinary, multi-purpose site primarily engaged in work that supports national security, homeland security initiatives, waste management, environmental restoration, and defense and nondefense research and development programs for the DOE NNSA and other government entities.

The NNSS has a long history of supporting national security objectives by conducting underground nuclear tests and other nuclear and nonnuclear activities. Since the October 1992 moratorium on nuclear testing, missions at the NNSS have evolved to become the following DOE/NNSA core missions: national security/defense, environmental management, and nondefense. The national security/defense mission includes the Stockpile Stewardship and Management, Nuclear Emergency Response, Nonproliferation and Counterterrorism, and Work-for-Others Programs. The Work-for-Others Program supports other DOE programs and federal agencies such as the U.S. Department of Defense (DoD), U.S. Department of Justice, and U.S. Department of Homeland Security. The Environmental Management Mission includes the Waste Management and Environmental Restoration Programs. The nondefense mission includes the general site support and infrastructure, conservation and renewable energy, and other research and development programs.

On December 18, 2014, DOE/NNSA issued a record of decision (ROD) for the continued management, operation, and activities of the NNSS and offsite locations in Nevada pursuant to DOE/EIS-0426, *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada* (Final NNSS SWEIS). The NNSS SWEIS analyzes the potential environmental impacts of continued management and operation of the NNSS and other

DOE/NNSA managed sites in Nevada. As part of the ROD, DOE/NNSA decided to implement the preferred alternative that is summarized in Appendix B.

CD-0410.002, *National Environmental Policy Act* establishes the process for ensuring that M&O contractor projects and activities are conducted in compliance with the National Environmental Policy Act (NEPA) during their initial planning stages. As part of this process, the Environmental Compliance NEPA subject matter expert (SME) is consulted to determine the need for and extent of new or revised NEPA documentation. This SME and other Environmental Programs SMEs are contributors to this study as IPT members allowing for the appropriate consideration of environmental related evaluation factors as part of the identification of potentially viable ARD site locations. However, determining the need for new or revised NEPA documentation is considered outside of this study and will occur if a decision is made to proceed with ARD siting at the NNSS.

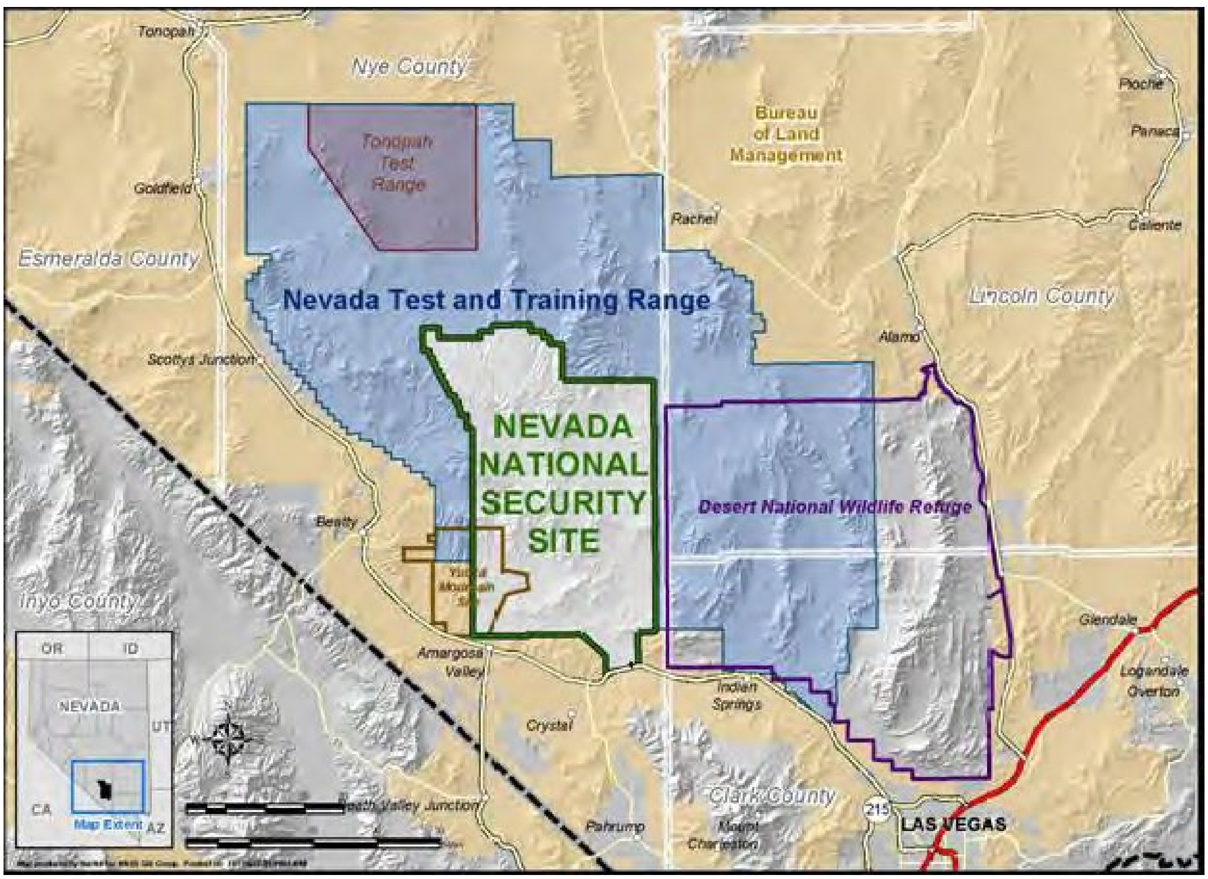
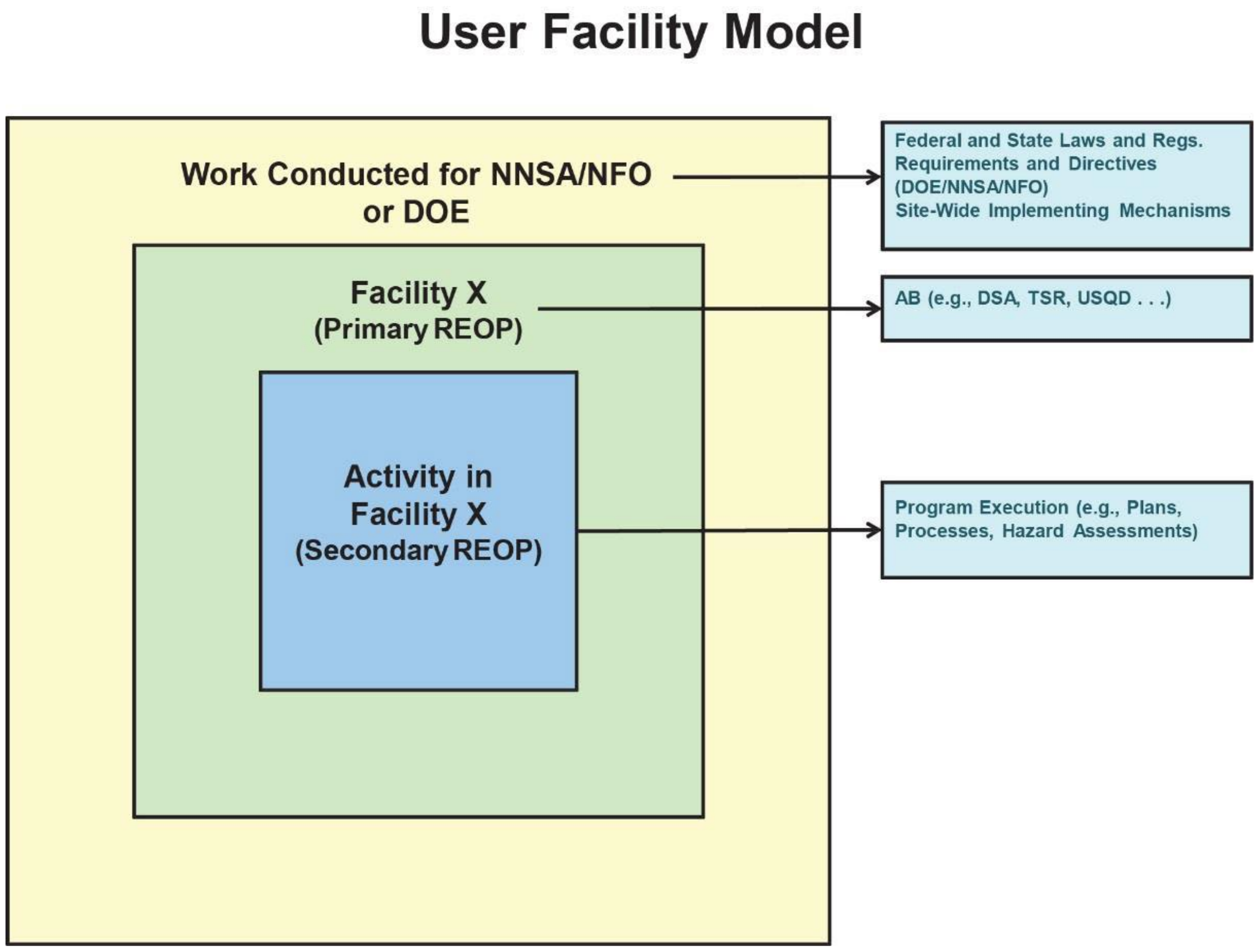


Figure 2-1. NNSS and Surrounding Areas.

2.4 Real Estate Operations Permit

NNSA/NFO utilizes real estate operations permits (REOP) to ensure work performed under its purview, including work for DOE organizational elements such as intelligence, NE, or environmental management, is clearly defined, properly authorized, and has distinct geographical boundaries. The REOP's requirements are described in NFO O 412.X1, *Real Estate Operations Permit*. REOP form the basis for the Nevada Facility User Model shown in Figure 2-2. In the user facility concept, secondary REOP holders are authorized to perform hands-on programmatic work in facilities managed by the primary REOP holder.



Note: DSA = Documented Safety Analysis; TSR = Technical Safety Requirement; USQD – Unreviewed Safety Question Determination

Figure 2-2. Nevada Facility User Model.

An approved primary REOP, or a combination of a primary REOP and one or more secondary REOPs, constitutes authorization to conduct work within the defined boundaries of real estate and authorization basis (AB) described. In this model, a primary REOP holder (designated by NNSA/NFO) is responsible for reviewing and ensuring that activities and operations conform to the AB for the permitted facility/activity or revising the AB to include the scope of work identified in a secondary REOP. Standardized, sitewide safety management programs (SMP) developed jointly by the M&O contractor and secondary REOP holder(s) are preferred in the

Nevada Facility User Model; however, primary REOP holders are required to accept secondary REOP holders' SMPs developed under a DOE-approved Integrated Safety Management System or equivalent. Secondary REOP holders authorize programmatic work, assign safety responsibility at the activity level, and, together with the primary REOP, document the roles, responsibilities, and relationships between the primary and secondary REOP holders. In this model, contractor/user organizations may assign their staffs to jointly complete work using shared plans and procedures.

An application of the existing Nevada Facility User Model paradigm for an ARD activity could entail the M&O contractor taking a primary REOP for the selected ARD location and establishing the necessary AB. The ARD vendor or DOE-NE sponsor could take a secondary REOP allowing for the performance of ARD activities in compliance with agreed upon SMPs.

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3. METHODS, ASSUMPTIONS, AND PROCEDURES

3.1 Overall Methodology

The overall methodology used to complete the NNSS ARD siting and capabilities study is shown in Figure 3-1.

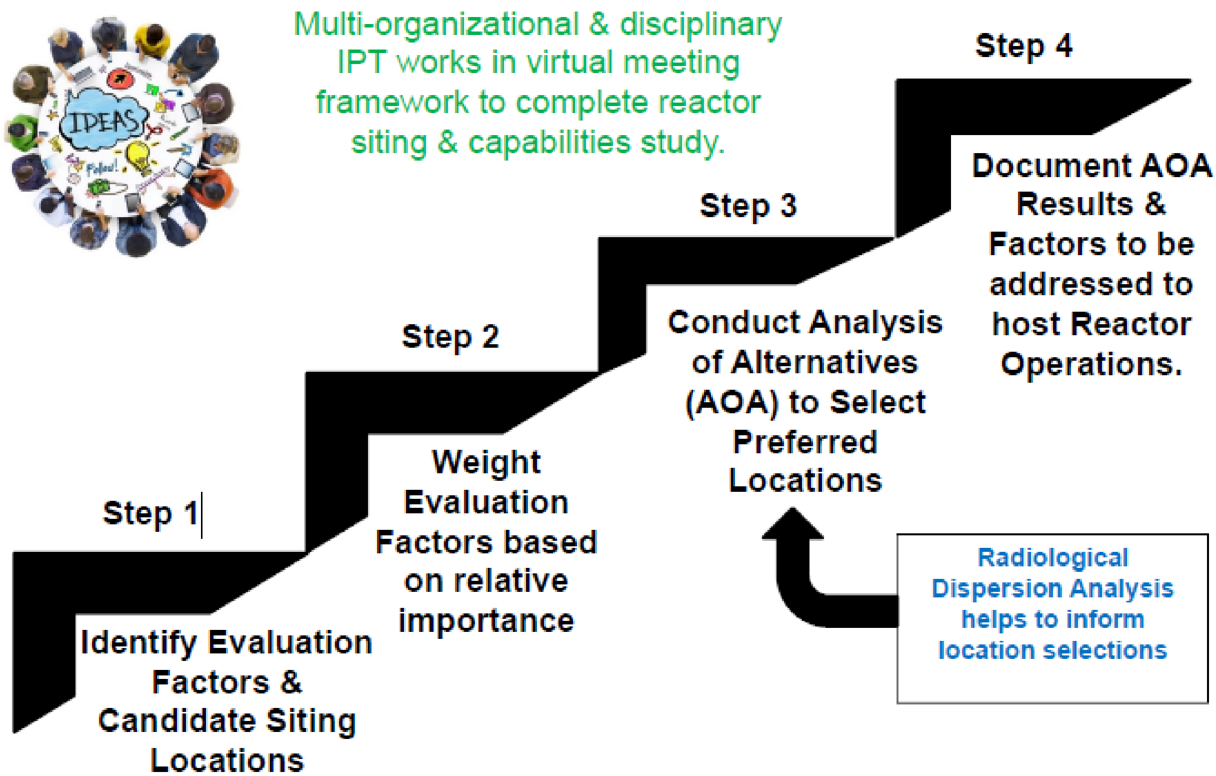

Figure 3-1. Overall Study Approach.

A technically diverse and multi-disciplinary IPT was formed and met in structured meeting workshops to complete the study. The IPT was formed with the required subject matter expertise to derive and make informed siting decisions on relevant siting related evaluation factors. The evaluation factors were developed from regulatory sources (e.g., 10CFR 100), DOE Orders & Guides (e.g., DOE O 420.1C and DOE G 420.1-1A), the NNSS SWEIS, Nuclear Regulatory Commission (NRC) documents (e.g., applicable siting related sections of NUREG-0800, *Standard Review Plan*), other siting studies, and IPT expertise. The evaluation factors were subsequently tailored for their application to the NNSS.

Candidate siting locations were identified by leveraging the capability of NNSS GIS that provide a repository of the site-specific geospatial data and information. This information provides various maps based on available geospatial data that can be layered to exclude unsuitable locations and then buffered based on established preferences to determine more optimal locations for ARD project siting. The application of the GIS tool, informed by the siting evaluation factors, provided an objective and systematic means to determine potential siting locations for further evaluation as part of the AOA. The application of the GIS tool was supplemented by the PPE for microreactors and small- to medium-sized advanced reactors documented in report NRIC-21-ENG-001 (PNNL-30992). Although these plant parameter envelopes were not considered constraining because they are associated with a postulated surrogate microreactor or advanced reactor, they were used to provide a better perspective on the plant parameter requirements for these types of operations (e.g., amount of disturbed land, raw water consumption).

The NNSS evaluation factors were weighted using a paired comparison similar to the approach used in INL/EXT-20-57821, *Evaluation of Sites for Advanced Reactor Demonstrations at Idaho National Laboratory*. In applying this approach, each IPT member provided their individual weighting of the evaluation factors and then these results were compiled to provide evaluation factor weighting for the integrated IPT.

The next step of the overall methodology was to conduct an AOA to rank the candidate siting locations based on how well these respective sites meet the weighted evaluation factors. A key element of this step is to collect pertinent site location information to make an informed objective evaluation using the established weighted evaluation factors. The candidate site locations are then evaluated and ranked against one another using available documentation and the weighted evaluation factors in a similar manner as performed in INL/EXT-20-57821 and INL/EXT-20-59627, *Evaluation of Proposed Oklo Aurora Microreactor Sites at Idaho National Laboratory*. A radiological dispersion analysis also helped to inform the relative site location ranking by providing postulated doses as a function of distance to estimate the low population zone (LPZ) distance.

The final step of the study is to document the study results including unique site capabilities for ARD operational support and discuss any remaining factors or considerations that need to be addressed to host reactor operations. This latter consideration includes a description of additional documentation and associated timing to proceed with ARD project siting at NNSS. Examples of these considerations include supplemental environmental reviews, formal determination whether the ARD project is covered within the NNSS SWEIS or requires new EIS related documents to be developed (e.g., environmental assessment [EA]), completion of project siting and screening, and interface with outside agencies.

3.2 Integrated Project Team

A siting study requires a technically diverse and multi-disciplinary skill set to ensure applicable evaluation factors are identified and thoroughly evaluated. Table 3-1 provides the IPT resources that contributed to this siting study.

Table 3-1. IPT Expertise.

IPT Member	Role	Contribution
GIS Manager & Analyst	Geospatial Mapping	Apply layered maps using NNSS GIS to identify viable locations within NNSS for siting ARD project.
Power Operations Manager	Infrastructure Planning / Power Distribution	Identify and down-select potential reactor sites based on the availability and proximity of power supplies.

IPT Member	Role	Contribution
Security Specialist	Safeguards & Security	Evaluate security considerations to determine the optimal site location for a potential demonstration reactor. Specific expertise with factors influencing security risk assessments and vulnerability analyses.
Radiation Protection Supervisor	Radiological Protection	Evaluate and down select a potential demonstration reactor site based on radiological and environmental restoration considerations. Knowledgeable of legacy contamination areas at the NNSS.
Infrastructure Specialist	Land-Use & New Infrastructure Projects	Identify potential demonstration reactor sites based on NNSS land-use planning. In addition, provide insights on planned infrastructure projects to aid in determining an optimal site.
Environmental Compliance Subject Matter Expert	NEPA	Provide evaluative input on a broad range on NEPA considerations including hydrology, water use, historic, and cultural resource considerations.
Facility Manager	Facility & Space Availability	Provide expertise on availability of standby and excessed shutdown facilities suitable for the ARD project.
Biologist	Ecology and Environmental Considerations	Provide expertise on protected animal and plant species.
Nuclear Assurance Manager	Nuclear Safety	Evaluate and select a preferred reactor site based on accident analysis considerations. In addition, provide expertise for radiological dispersion analysis including meteorology.
Emergency Preparedness Specialist	Emergency Management	Provide input on a broad range of emergency planning evaluation factors as well as deconfliction with other hazardous facilities based on completed emergency planning hazards assessments (EPHAs).
Infrastructure Supervisor	Water, Roads, & Waste/ Landfills	Provide insights of available/planned water supply to support ARD project PPE. Also, provide expertise on the availability

IPT Member	Role	Contribution
		and proximity of roads. Provide input on landfills for industrial waste.
Geologist	Seismic and Geotechnical Considerations	Provide expertise on seismic considerations based onsite seismology and seismic studies. Also, provide expertise onsite geology and soil-geotechnical properties.
Conduct of Engineering Manager and Staff	Engineering	Provide expertise on civil engineering and fire protection considerations.
Environmental Emissions Specialist	Radionuclide Emissions	Provide expertise on radiological emission requirements (40 CFR 61 subpart H). Provide expertise on historic radiological contaminated areas.

3.3 Key Assumptions

Key assumptions applied during the siting study include the following:

- Only sites within the NNSS site boundary are evaluated
- PPE values for surrogate reactor designs (microreactor and small- to medium-sized advanced reactor) are based on information provided by NRIC
- PPE values are considered as desired parameters rather than absolute constraints because of variations in ARD technologies and designs
- Existing regulatory documentation, standards, other siting studies, and IPT expert-based judgment provide the information sources to derive siting evaluation factors
- The evaluation of how well potential NNSS locations meet the identified evaluation factors is done using existing documentation and IPT expertise (no new analyses such as geotechnical or seismic studies are needed for study completion)
- Radioactive source terms for bounding scoping dispersion analyses are attainable from NRIC
- The identification of suitable locations within NNSS boundaries to site reactor technologies is pre-decisional and requires follow-on activities to attain formal authorization to site ARD projects (i.e., project siting and screening).

3.4 Evaluation Factor Identification

3.4.1 Evaluation Factor Information Sources

Appropriate site selection is an essential element of defense-in-depth nuclear facility design. Evaluation factors are used to analyze the characteristics of proposed site locations to determine their relative advantages and disadvantages. The intent is to derive evaluation factors that provide site locations that fulfill the reactor design and infrastructure needs given in the PPE and have inherent advantages from both a nuclear safety and environmental protection perspective. The following information sources were reviewed to attain the evaluation factors used for this study.

3.4.1.1 *Regulatory Sources*

- 10 CFR Part 100, *Reactor Siting Criteria*
- 10 CFR Part 50, *Domestic Licensing of Production and Utilization Facilities*
- 10 CFR Part 51, *Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions*
- 10 CFR Part 52, *Licenses, Certifications, and Approvals for Nuclear Power Plants*
- 40 CFR Parts 1500-1508, *Regulations for Implementing NEPA*
- 40 CFR Part 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities*

3.4.1.2 *NRC Documents*

The following sections of NUREG-0800 were reviewed to obtain evaluation factors:

- Section 2.1.1, *Site Location and Description*
- Section 2.1.3, *Population Distribution*
- Sections 2.2.1–2.2.2, *Identification of Potential Hazards in Site Vicinity*
- Section 2.2.4, *Evaluation of Potential Accidents*
- Section 2.3.1, *Regional Climatology*
- Section 2.3.2, *Local Meteorology*
- Section 2.3.3, *Onsite Meteorological Measurements Program*
- Section 2.3.4, *Short-Term Atmospheric Dispersion Estimates for Accident Releases*
- Section 2.5.1, *Geologic Characterization*

- Section 2.5.2, *Vibratory Ground Motion*
- Section 2.5.3, *Surface Deformation*
- Section 2.5.4, *Stability of Subsurface Materials and Foundations.*

3.4.1.3 *DOE Requirements*

- DOE O 420.1C, *Facility Safety*
- DOE G 420.1-1A, *Nonreactor Nuclear Safety Design Guide for use with DOE O 420.1C, Facility Safety*

3.4.1.4 *Consensus Standards*

- ANSI/ANS-2.27, *Criteria for Investigations of Nuclear Facility Sites for Seismic Hazard Assessments*

3.4.1.5 *NNSS SWEIS*

The NNSS SWEIS evaluated the cumulative impacts associated with operations alternatives using distinct resources areas. Considerations with the following resource areas were reviewed for applicable evaluation factors:

- Land Use
- Infrastructure and Energy
- Transportation and Traffic
- Geology and Soils
- Hydrology
- Biological Resources
- Air Quality and Climate
- Visual Resources
- Cultural Resources
- Waste Management
- Human Health
- Environmental Justice

3.4.2 Evaluation Factor Categorization

The evaluation factors were categorized as shown in Figure 3-2 to group evaluation factors by common themes/resource areas consistent with the NNSS SWEIS.

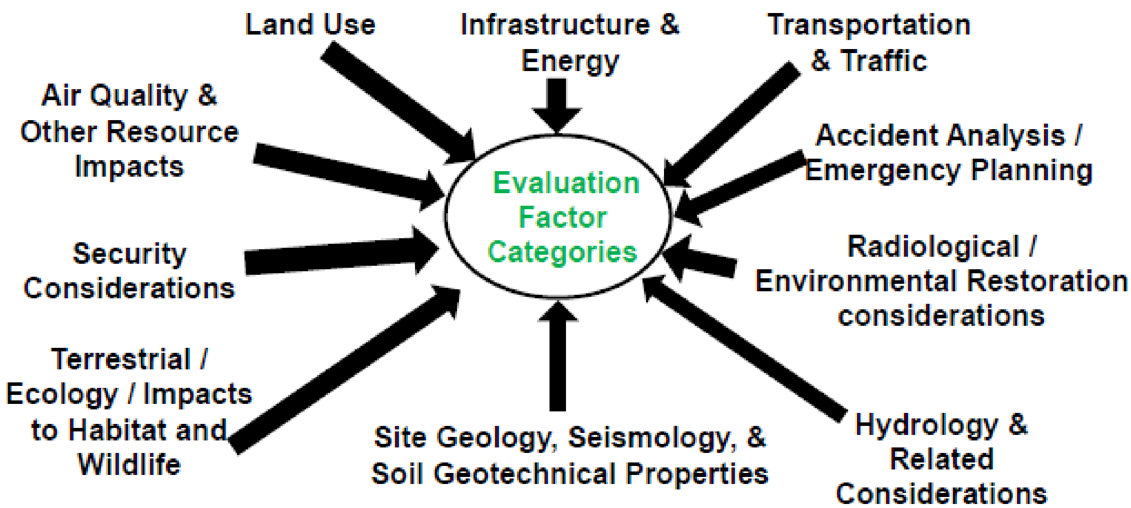

Figure 3-2. Evaluation Factor Categories.

3.4.3 Land Use

3.4.3.1 *Discussion*

At the NNSS, the missions, programs, capabilities, and projects are undertaken in one or more of seven land-use zones. Although land-use zones are used to manage activities at the NNSS and prevent interference among the various projects and activities, they are not considered absolute descriptors of the range of activities that may occur in a particular zone. In addition, the NNSS is divided into numbered operational areas to facilitate management communications, and distribution, use, and control of resources. Figure 3-3 provides the locations and sizes of these zones and operational areas, as well as the locations of major facilities within these zones and areas.

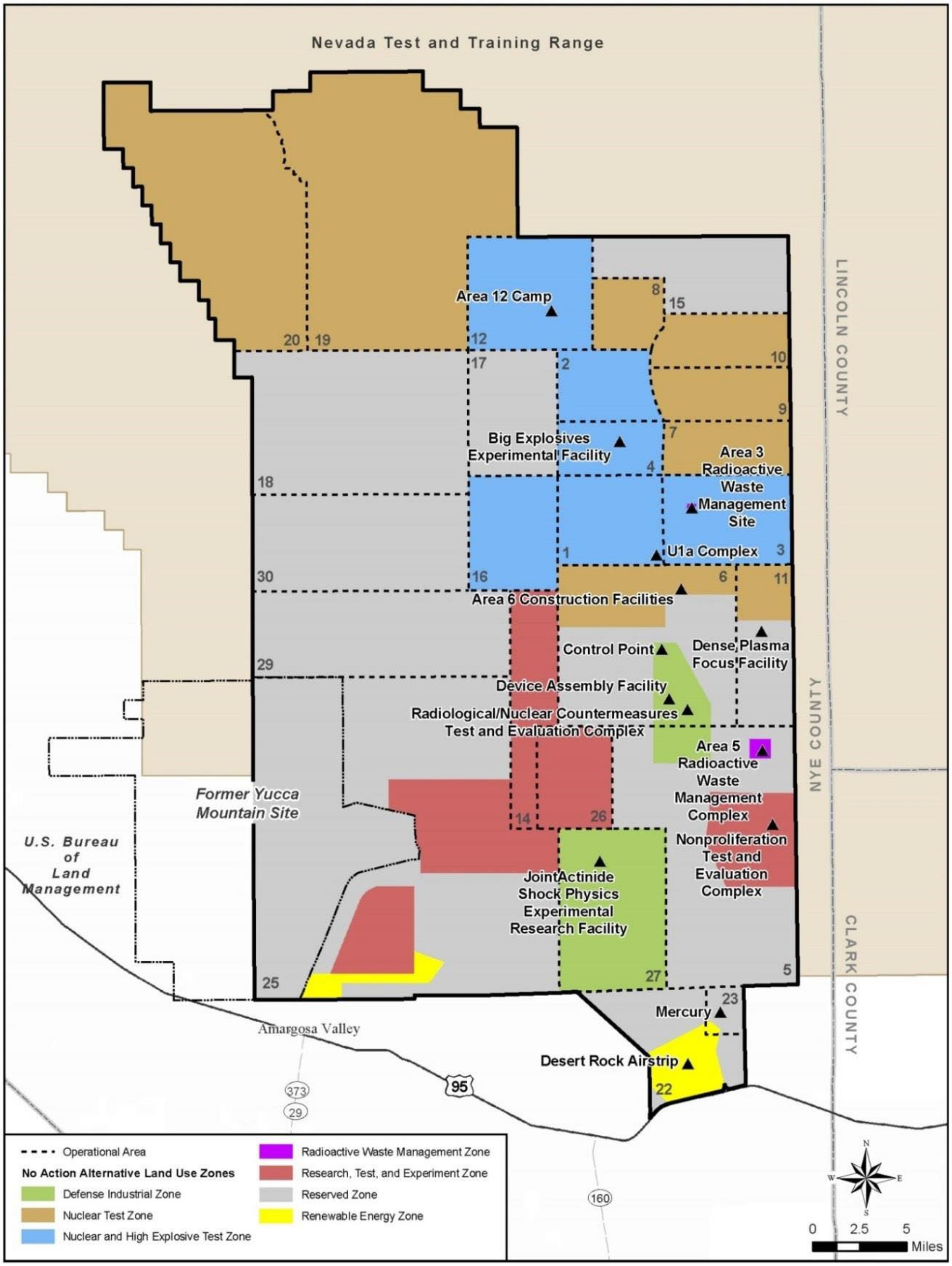

Figure 3-3. NNSS SWEIS No Action Alternative Land-Use Zones.

3.4.3.2 *Evaluation Factors*

The following land-use evaluation factors were derived for this siting study:

- Proposed site must be outside vertical openings (abandoned mine shafts/adits and hazardous big holes), and explosive contamination area
- Proposed site must be outside of past underground and surface nuclear testing locations with a one-kilometer buffer area
- Proposed site must be away from inventory emplacement holes (unused holes for underground tests) buffered at twice the total depth
- Site must be outside of land boundary subject to a Federal Facility Agreement and Consent Order (FFACO) land-use restriction
- The proposed site resides in a land-use zone (e.g., research/test/experiment zone) that is consistent with its designated use for demonstration reactors
- Selected site would optimize the land-use planning zones
- Selected site precludes or acceptably minimizes any untenable land-use conflicts with other stakeholders
- Siting a demonstration reactor would complement nearby activities and missions (e.g., shared power or water distribution systems)
- Use of site is not subject to agreements from outside parties/entities
- Proposed site offers preexisting features that support safe and efficient demonstration reactor activities
- There is reasonable assurance that no geographic or demographic features render the site unsuitable for operation of the proposed reactor
- Sufficient land availability exists to support safe plant operations
- Proposed site including support services (e.g., power and water) would minimize the amount of disturbed soils or related land disturbance
- Land use for transmission corridors and transportation routes does not result in undesirable impacts
- Factors affecting plant constructability are considered relatively desirable
- Site can support demonstration reactor research and development from multiple vendors using shared utilities
- Proposed site provides desired proximity to the target customer, energy-transmission capabilities, and accessibility and serviceability with respect to module transport, installation, and operations
- The proposed site boundary is at a sufficient distance to not interface with existing missions, land uses, or projects (e.g., on or within a 1-mile radius of the proposed project siting)
- The proposed site is not susceptible to frequency or electromagnetic interferences
- The site's remoteness provides assurance its activities will not be disrupted by nearby facilities and activities
- The proposed location avoids locations with surface laid cable
- Proposed site should minimize the risk of encountering unexploded ordinance.

3.4.4 Infrastructure and Energy

3.4.4.1 *Discussion*

The infrastructure and energy evaluation factor encompass water, power, road, waste management, emergency services, communications, and energy considerations.

Water

The NNSS Water System is dependent upon acquiring water from underground aquifers accessed through drilled wells and delivered to system users via pumping stations, water storage tanks, and distribution lines over long distances in an extreme arid environment. The NNSS water systems have evolved over 65 years. Today, many components exceed their original design lives placing a burden on the M&O contractor Water Department to maintain the operational status of NNSS water systems. Modernization projects are planned and being executed on a priority basis to ensure water availability. The NNSS Water System includes three permitted public water systems (PWSs). Only portions of the NNSS Water System have the capability to fully meet the 450 gpm consumption of PPE's water requirement for water-cooled microreactors (25 gpm for air-cooled), and the 415 gpm consumption of PPE's water requirement for an air-cooled small- to medium-sized advanced reactor (5,850 gpm for water-cooled. Alterations to the three permitted PWSs require compliance with Nevada Administrative Code (NAC) Chapter 445A, *Water Controls*. Water permits must be approved by the Nevada Division of Environmental Protection. Care must be taken with non-permitted water systems not to exceed minimum requirements and thereby invoke NAC Chapter 445A code requirements and Nevada's oversight of these systems.

The NNSS SWEIS conservatively assumes a continued annual water usage of 691 acre-feet based on annual water usage at the NNSS from 2005 through 2011 that ranged from 530 to 691 acre-feet. The SWEIS examined the extent continued operation alternatives would have on the capacity of aquifers within a hydrographic basin. This analysis provides insights on the groundwater quantity that can be withdrawn from a basin on an annual basis without depleting the basin while considering water rights already committed (i.e. sustainable yield). The sustainable yield of groundwater basins given in the SWEIS varies significantly with a sustainable yield of 100 acre-feet per year provided in Frenchman Flat Region to a 4,000 acre-feet per year in the Jackass Flats Region.

Water withdrawal data from NNSS water wells are provided to the United States Geological Survey (USGS), and this data, as well as data collected by the USGS on NNSS well water levels, are compiled and monitored For more information, visit the USGS website at https://nevada.usgs.gov/doe_nv. This data is useful in assuring the amount of water removed from a hydrographic basin at the NNSS on annual basis does not deplete the basin.

A potential constraint for the NNSS Water System is the excessive pump rates that could create on-forced gradient on groundwater. This has the potential to impact the model-based estimation of groundwater contamination from historic underground nuclear testing for established corrective action units complying with a FFACO. Another consideration related to excessive water withdrawal is the potential impact to aquatic life supported by the shared aquifer such as the critically endangered pupfish that resides at Devils Hole, a spring located within the Ash Meadows National Wildlife Refuge outside of the NNSS.

Power

Figure 3-4 provides a current depiction of the NNSS Power System in a hub-and-spoke model. Ideally a hub-and-spoke model allows for multiple paths to connect all substations such that loss of any one line does not result in a power loss to any substation. This chart demonstrates the vulnerability of some radial feeds where power loss can occur with a single break. Projects are planned and are being executed to provide layers of redundancy and centralized generation to allow for safe and low-cost maintenance to service transmission and distribution equipment, reduce energy costs, and eliminate electrical service interruptions to mission.

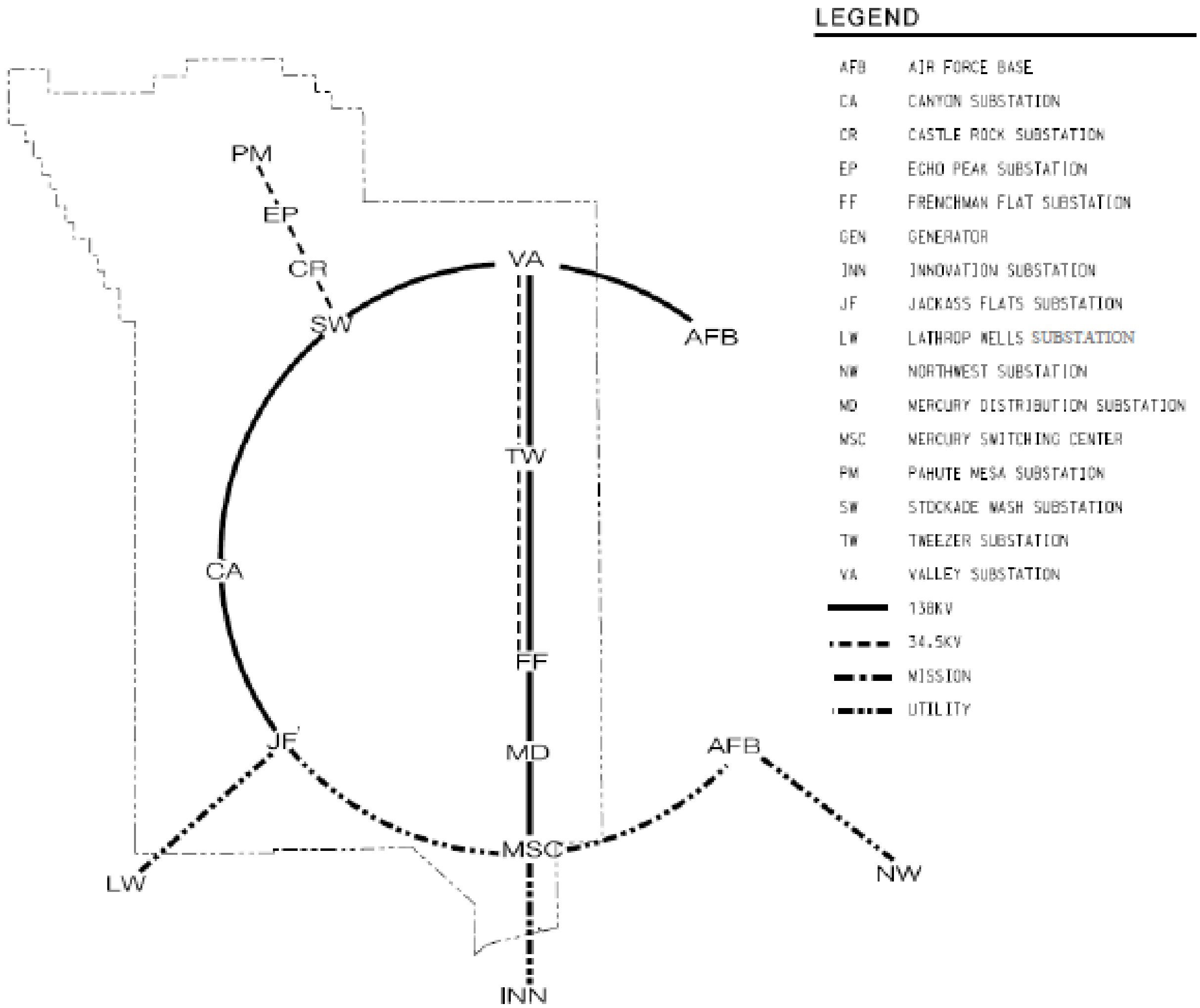

Figure 3-4. Existing Hub-and-Spoke Model of the NNSS Power System.

The total power system infrastructure includes:

- ~100 miles (605 structures) of 138 kV transmission (excludes other utilities)
- ~180 miles (2,702 structures) of 34.5 kV distribution (excludes underground and inactive)
- ~56 miles (2,126 structures) of 12.47 kV distribution (excludes underground and inactive)
- ~25 miles (311 structures) of 4,160V distribution (excludes underground and inactive)
- ~75 miles (990 inactive structures) of all other voltages and communication-only lines
- 8 primary substations (excludes inactive, lower voltages, or bypassed)
- ~301 metered customer facilities
- ~$6M/year in purchased power

Total external 138 kV power sources:

- Valley Electric Association (Innovation Substation)

- Valley Electric Association (Lathrop Wells Substation)
- Nevada Energy (Northwest Substation)

In electric power transmission, “wheeling” is the transportation of electric energy (megawatt-hours) from within an electrical grid to an electrical load outside the grid boundaries. The North American Electric Reliability Corporation (NERC) defines two types of wheeling:

- Wheel-through is where the electrical power generation and the load are both outside the boundaries of the transmission system
- Wheel-out is where the generation resource is inside the boundaries of the transmission system, but the load is outside.

Based on the above definitions, power from external sources is wheel-through the NNSS. The 138-KV lines from Nevada Energy and Valley Electric Association (VEA) also feed loads not associated with NNSS. NV Energy serves loads such as the state correctional facilities, the Indian Springs Community, and Creech Air Force Base (AFB). VEA serves loads including the communities of Pahrump, Lathrop Wells, Beatty, and others. These loads have a significant impact on the maximum capacity available to the NNSS, and the outside loads have been increasing rapidly over the past two decades. As a result, the spare power capacity of the 138-KV transmission system available for NNSS loads has decreased. Currently, the entire transmission system is limited to ~40 megawatts (MW) based on the thermal capacity of the smallest conductor.

Although externally supplied power is wheeled through the NNSS Power System to other customers or loads, the NNSS M&O contractor has not been required to register as a transmission operator by NERC or the Western Electricity Coordinating Council (WECC). WECC receives delegated authority from NERC, is the designated regional entity in the western interconnection responsible for compliance monitoring and enforcement and oversees reliability planning and assessments. Becoming a transmission operator would require time and funding to fully comply with all applicable standards with the commensurate benefit of standardizing regulation processes and giving the regulator greater visibility. Also, incorporating a generating capability within the NNSS in the form a microreactor or advanced reactor could require the M&O contractor to become designated as a generator operator. This designation would also impose incremental expectations and requirements.

Roads

The following three basic types of road construction have developed over the years at the NNSS:

- Primary Road – A road that provides safe access to heavily used areas at highway speeds (current speed limit is 55 miles per hour). These routes also provide basic emergency response, critical personnel, and material movement routes. Primary roads handle the entire spectrum of vehicular traffic encountered at the NNSS. Mercury Highway and Mercury Bypass are examples of primary roads.
- Secondary Road – A road that provides access to more remote areas and/or completes loop access to the most used areas. These roads facilitate periodic operations, construction, maintenance and provide bypass routes during selected operations. The major streets of Mercury, Nevada have also been included in this category.
- Unimproved Roads and Trails (Tertiary) – An unpaved road usually with less-access, restricted-access, or less-usage requirements than a secondary road that provides more direct access to selected sites or established isolated activities.

Primary, major transport routes, such as Mercury Highway, are generally constructed of asphalt concrete suitable for sustained highway loads and speeds (Cane Spring Road is an oil and chip road). Secondary, spur roads are shorter and provide access to specific activity locations. Spurs generally consist of either road-mix asphalt or multiple layers of oil and chip suitable for use at reduced speeds and loads. Tertiary roads are unpaved roads usually with less-access, restricted-access, or less-usage requirements than a secondary road that provide more direct access to selected sites or established isolated activities suitable for reduced speeds and loads. Some tertiary roads are occasionally graded and passable at low speeds and are generally suitable for occasional use by construction or maintenance four-wheel drive vehicles. In all cases, the approximately 400 miles of basic infrastructure and 1025 miles of unimproved roads were not designed for use at the loads and speeds of today's traffic. Upgrades and safety improvements to various segments have allowed continuous operations at the NNSS. The accessibility and proximity to primary roads are considered in this study.

Waste Management

NNSA operations, environmental restoration, and decontamination and decommissioning activities at the NNSS generate low-level radioactive waste (LLW); mixed low-level radioactive waste (MLLW); transuranic waste; hazardous waste; explosive waste; and nonhazardous wastes, including sanitary solid waste, hydrocarbon-contaminated soil and debris, and construction and demolition debris. NNSA also accepts waste for disposal at the NNSS, including LLW and MLLW and selected nonradioactive classified wastes from other in-state locations such as the Tonopah Test Range, as well as from authorized out-of-state DOE and DoD generators. This waste must meet the requirements, terms, and conditions specified by the NNSS Waste Acceptance Criteria. The Area 3 and 5 Radioactive Waste Facilities provide the capabilities and infrastructure to support NNSS waste management functions. These functions include LLW and MLLW disposal and low-level radioactive material storage; transuranic waste characterization, storage, repackaging, and shipping; classified material storage; and several secondary support functions such as LLW/MLLW sampling. Three existing state-permitted NNSS landfills have remaining waste capacities for disposal of construction, sanitary, and hydrocarbon solid waste. In this study, the primary considerations for waste management services are the proximity and availability to support ARD activities.

Emergency Services

Emergency services at the NNSS are provided by two fully equipped and manned fire stations: one in Area 23, Fire Station 1 and one in Area 6, Fire Station 2.

Fire Station 1 in Area 23 has the following equipment available:

- Two pumper trucks (Engine 1 and Engine 3) each equipped with a 1,250-gpm pump and a 1,000-gallon water tank
- Three ambulances (Medic 1, 4, 5) each equipped with Advanced Life Support (ALS) response capabilities
- One rescue truck (Heavy Rescue 1) used for specialized rescue operations, including as a first-response hazardous materials (HAZMAT) unit
- Four brush trucks (BRUSH 1, 4, 5, 6) each equipped with either a 200- or 300-gallon water tank and 5 to 10 gallons of Class A foam concentrate
- Seven wildland fast-attack all-terrain vehicles (ATV 1 through 7) each equipped with an air-driven water/foam pump, 14 gallons of water-foam solution, appropriate hoses, and nozzles
- Additional specialized response vehicles and trailers for response to wildland fires, HAZMAT, and mass casualty events
- Other support vehicles are deployed as appropriate for the nature of the incident, which may include mobile command centers and special operations vehicles.

Fire Station 2 in Area 6 has the following equipment available:

- One pumper truck (Engine 2) equipped with a 1,250-gpm pump and a 1,000-gallon water tank
- Two ambulances (Medic 2, 6) equipped with ALS response capabilities
- One water tender (Tender 1) equipped with a 2,000-gallon water tank, a 120-gallon foam concentrate tank, and a 750-gpm pump
- One rescue truck (Rescue 2) used for specialized rescue operations, including as a first-response HAZMAT unit
- Two brush trucks (BRUSH 2, 3) each equipped with either a 200- or 300-gallon water tank and 5 to 10 gallons of Class A foam concentrate
- One air supply trailer (AIR 1) that may be connected to response vehicles, towed to an incident, and used to fill self-contained breathing apparatus cylinders
- Three wildland fast-attack all-terrain vehicles (ATV 8 through 10) each equipped with an air-driven water/foam pump, 14 gallons of water-foam solution, appropriate hoses, and nozzles.

The Fire and Rescue (F&R) Department also responds with certified paramedics on ALS-equipped ambulances. Additionally, F&R Department firefighters are registered emergency medical technicians and may provide emergency medical services as required. The primary siting consideration in this study is the response time of emergency service capabilities to potential ARD siting locations.

<u>Communications</u>

Telephone and information technology services are provided throughout the NNSS. Classified computing services and capabilities are provided in selected locations. The primary siting considerations for communications are the availability of these services to potential ARD locations.

<u>Energy</u>

The NNSS infrastructure provides capability for various energy services such as unleaded gasoline, ethanol-gasoline blended fuel, and biodiesel fuel. The primary siting considerations for energy are the availability and proximity of energy sources to support potential ARD locations.

3.4.4.2 *Evaluation Factors*

The following infrastructure and energy evaluation factors were derived for this siting study:

<u>Water</u>

- Availability and proximity of current and planned public water distribution lines for potable water
- Availability and proximity of non-potable water to support construction and operations
- Maximize proximity to suitable sources of cooling water
- Availability of water for fire protection systems.

<u>Power/Electricity</u>

- Availability and proximity of current and planned power distribution systems (e.g., new 138-KV transmission system) with sufficient capacity to meet demonstration reactor needs
- Electric power from the transmission network to the onsite electric distribution system can be supplied by two physically independent circuits (not necessarily on separate rights of way)

designed and located so as to minimize the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions

- There are no transmission line right-of-way considerations that makes the proposed site unattractive for ARD siting.

Roads

- Availability and proximity of suitable roads to support demonstration reactor activities within 5 miles of an NNSS primary road.

Waste Management

- ARD sites must not be within boundaries on NNSS Solid Waste Landfills
- Availability and proximity of current and planned waste-water treatment systems
- Availability and proximity of sanitary services
- Availability and proximity of waste landfills (Area 6 Hydrocarbon Solid Waste Disposal Unit, Area 9 U10c Solid Waste disposal Site, and Area 23 Solid Waste Disposal Site) with sufficient capacity for projected waste
- The proposed site minimizes the distances for the onsite disposal/staging of LLW, MLLW, and transuranic waste
- Suitability of site for onsite storage of spent nuclear fuel
- The proposed site minimizes the distances for the onsite disposal/staging of hazardous waste
- The proposed site minimizes the distances for the onsite disposal/staging of solid waste.

Emergency Services

- The proposed site is within a reasonable proximity to established firefighting capabilities
- The proposed site provides sufficient access to and availability of onsite medical facilities and services.

Communications

- Availability and proximity of current and planned communication systems including information technology systems.

Energy

- Availability and proximity of energy infrastructure (e.g., liquid fuels and natural gas) needed to support operations.

3.4.5 Transportation and Traffic

3.4.5.1 *Discussion*

In the context of this siting study, transportation and traffic considerations are associated with minimizing the onsite distance traveled to dispose of any waste generated by ARD activities and to minimize traffic impacts caused by ARD construction and operational activities to other NNSS mission activities.

3.4.5.2 *Evaluation Factors*

The following transportation and traffic evaluation factors were derived for this siting study:

- Proposed site would minimize the distance of any radioactive-waste shipments going offsite
- Proposed site would minimize traffic impacts within and outside the site considering both construction and sustained operations of the new facility
- Proposed site would minimize the distance from transportation routes.

3.4.6 Radiological/Environmental Restoration Considerations

3.4.6.1 *Discussion*

The radiological and environmental restoration considerations related to this study are primarily focused on finding land locations not subjected to radiological contamination requiring environmental restoration as a result of past nuclear testing. Site maps are available within the NNSS GIS that define radiological contaminated areas based on historical nuclear testing and other NNSS activities. M&O contractor assets at the Remote Sensing Laboratory have done aerial radiological monitoring surveys documented in DOE/NV/11718--324, *An Aerial Radiological Survey of the Nevada Test Site* to define the boundaries of radiological contaminated areas. GIS maps exist for the outcome of these surveys.

3.4.6.2 *Evaluation Factors*

The following radiological / environmental restoration evaluation factors were derived for this siting study:

- Site must be outside of radiologically impacted area boundaries and areas identified by aerial radiation surveys with elevated manmade exposure rate and americium count rate
- Must be located outside of Comprehensive Environmental Response, Compensation, and Liability Act sites
- Site is desired to be located outside of a FFACO subsurface use restriction; note that the FFACO-use restriction is used to communicate all subsurface activities, including drilling, pumping, and testing of wells, that may impact the flow of contaminated groundwater
- Site should not be in a legacy beryllium contamination area
- The proposed site should be outside the geographic boundary of environmental restoration activities and/or corrective action sites
- Radiological control areas for ARD operations can be readily instituted

- The proposed site can readily support decontamination and decommissioning, as well as remediation activities after project completion
- Offsite radiological impacts of spent nuclear fuel and high-level waste disposal.

3.4.7 Accident Analysis/Emergency Planning Considerations

3.4.7.1 *Discussion*

Accident analysis considerations related to this siting study are associated with ensuring ARD activities are not adversely impacted by external hazards, or the hazards presented by other NNSS high-hazard or nuclear operations. Similarly, the study considers the impacts that ARD activities may have on ongoing NNSS mission activities. The GIS mapping capability includes a detailed map of known and potential hazards at the NNSS (e.g., collapse sinks, potential unexploded ordinance areas, and radiological impact areas). This map was used to select potential ARD locations that are outside of these defined hazards.

The availability of relevant meteorological and climatology data is also a consideration for this study. The National Oceanic and Atmospheric Administration Air Resources Laboratory/Special Operations and Research Division (ARL/SORD) maintains meteorological capability that provides real-time and historical meteorological data throughout the NNSS (https://www.sord.nv.doe.gov). The relative proximity of potential ARD locations to meteorological stations that provide representative data is an important consideration for the conduct of realistic atmospheric dispersion calculations.

Because of the diverse nature of operations, as well as the complex mix of tenants and users on and away from the NNSS, an all-hazards comprehensive emergency management system has been incorporated to ensure an effective and efficient response to an operational emergency occurring at facilities and sites or during other activities under the cognizance of the NNSA/NFO. The comprehensive emergency management system is intended to:

- Provide adequate protection for onsite and offsite personnel who could be affected by an emergency at NNSA/NFO facilities and sites
- Provide baseline guidance and requirements for emergency planning, preparedness, response, recovery, and readiness assurance activities to provide appropriate levels of protection for the safety and health of employees, responders, and the public
- Ensure protection of national security, the environment, critical infrastructure, facilities, and equipment during operational emergencies not requiring classification, operational emergencies requiring classification, and incidents less than an operational emergency
- Minimize the impact of an emergency on facility and site operations and security
- Provide clear, timely, and technically accurate emergency information to public officials; federal, state, county, and tribal agencies and organizations; DOE/Headquarters; and the media for site-related emergencies
- Provide emergency assistance to Nevada and Nevada counties and communities in planning and responding to an emergency occurring outside the boundaries of the NNSS when requested and in accordance with Memoranda of Agreement and Memoranda of Understanding
- Facilitate emergency planning with offsite authorities by providing a technically based assessment of hazards, including transportation hazards
- Ensure continuous and adequate protection of strategic quantities of special nuclear material, nuclear test devices, components, and/or nuclear weapons during an emergency

- Provide full compliance with the National Incident Management System in accordance with U.S. Department of Homeland Security Presidential Directive HSPD-5, "Management of Domestic Incidents."

The emergency management siting considerations in this study focus on how well emergency planning can be accommodated for the proposed ARD locations.

3.4.7.2 *Evaluation Factors*

The following accident analysis/emergency planning evaluation factors were derived for this siting study:

Accident Analysis Considerations

- The site must be a sufficient distance from nearby explosive facilities to preclude adverse effects resulting from a nearby explosion
- The proposed site is sufficiently distance from other facilities and projects so not to pose potential health and safety risks to individuals not associated with demonstration reactor activities
- The proposed site is located far enough away from airstrips to reduce the possibility of an aircraft crash
- The proposed site is located to avoid being in airspace that is used other projects or activities
- The relative risk posed to proposed site by wildland fires
- The proposed site provides sufficient separate distances from nearby facilities, military installations/activities, and transportation facilities and routes (including airports, airways, roadways, railways, and pipelines) to prevent an external event from impacting safe reactor operations
- The wind related hazard characteristics of this site makes this site relatively more attractive for reactor siting
- The proposed location provides sufficient standoff distances from offsite hazards
- Nearby hazardous activities do not affect plant safety
- The proposed site provides intrinsic confinement features (e.g., underground) and other protection features.

Meteorological / Atmospheric Dispersion Considerations

- Proximity to existing meteorological towers for collecting data for use in characterizing atmospheric dispersion conditions within the general site area
- Meteorology and climatology data provides confidence of the proposed site being suitable for demonstration reactor operations
- The proposed site is advantageous for minimizing localized and offsite emissions
- The lack of extreme weather considerations makes this site suitable
- Dispersion of radiological releases are minimized during plant-accident conditions based onsite meteorological considerations
- Potential dose to the public from radiological releases during normal operations is minimized; note that an assessment of a potential offsite dose must be completed per 40 CFR 61 Subpart

H. Approval from the Environmental Protection Agency and is required prior to construction if potential dose exceeds 0.1 mrem/year

- The proposed site has an acceptable incidence of lightning strikes and is near lightning monitoring instrumentation
- Other natural phenomena hazard considerations associated with meteorological considerations such as drought, fog, frost, and extreme temperatures impact the suitability of the site.

Emergency Planning Considerations

- The proposed site is at an optimal distance from the Emergency Planning Zone (EPZ) of other NNSS facilities/activities with an established EPHA
- The proposed site boundary and land-use characteristics of the site surroundings are attractive for demonstration reactor siting with consideration to risk from accidental exposures, public exclusion zones (access control), population center distances, and population density
- Proposed site is advantageous for emergency response considerations, including population sheltering or shielding parameters and evacuation delay times and rates for the public and collocated workers
- Emergency planning for the plant and surrounding area can be accommodated
- Impacts on area populations are minimized by site location.

3.4.8 Site Geology, Seismology, and Soil-Geotechnical Properties

3.4.8.1 *Discussion*

The NNSS is in the southern Great Basin (Figure 3-5). The NNSS topography is typical of the Great Basin which is generally characterized by more or less regularly spaced, generally north-south trending mountain ranges and intervening alluvial basins that were formed by faulting. Elevation changes and variations in topographic relief are considerable within the NNSS. On the NNSS, elevation varies from less than 3,280 ft above sea level in Frenchman Flat and Jackass Flats, about 7,680 ft on Rainier Mesa, and about 7,220 ft on Pahute Mesa.

Figure 3-5. Great Basin Range.

An important consideration for this study was to select site locations for ARD activities where the terrain is relatively flat. The GIS includes the capability to map site locations based on degree of slope. Using this capability and input from an IPT member with civil engineering expertise, it was preferred to identify potential ARD locations with a slope of less than 5%. The basis for this preference was to facilitate more cost-effective construction in terms of grading and structural foundations. Another siting consideration pursued with available GIS maps was to select potential ARD locations that are in alluvial valley areas rather than being in areas with bedrock close to the surface. The PPE provides a foundation embedment (depth from finished grade to the bottom of the base-mat or the most deeply embedded power-block structure) of 20 ft and 155 ft for microreactors, and small- to medium-sized advanced reactors, respectively. This siting factor was again used to select site areas that would be easier for structural foundation construction.

Another desire is to choose terrain for ARD locations that are relatively stable from a seismic perspective. Figure 3-6 provides the prominent active faults at the NNSS. The GIS includes a detailed map of Quaternary faults from the USGS Quaternary Fault and Fold Database. This map was used to provide preferences for determining potential ARD site locations. It was decided that being within 1 mile of a fault line would not be cost effective based on civil engineering input that this proximity to a fault line would impose greater International Building Code construction requirements. The distance to known fault lines was further buffered out to 5 miles based on the siting exclusion criteria used in INL-EXT-20-57821.

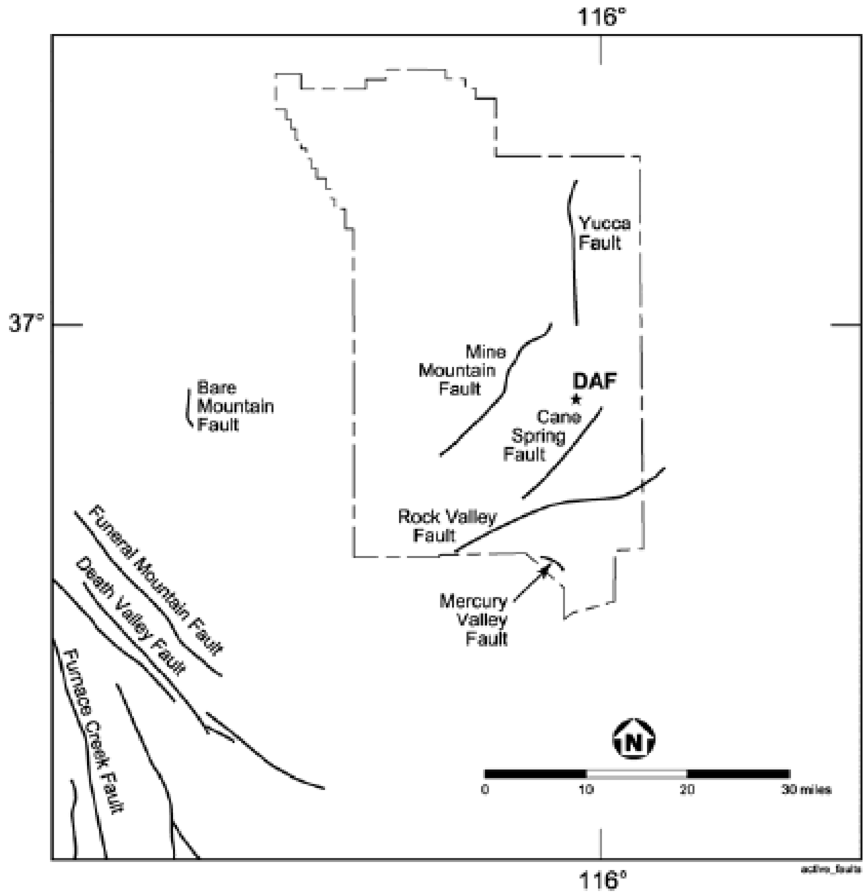

Figure 3-6. NNSS Prominent Active Faults.

A final report on the Probabilistic Seismic Hazard Analysis (PSHA) and Design Ground Motions for the DAF at the NNSS was issued in October 2007 (Geomatrix 2007). This study was conducted using the Senior Seismic Hazard Advisory Committee Level 2 framework and updates the Level 4 Yucca Mountain PSHA completed in 1997 (Civilian Radioactive Waste Management System Management and Operating Contractor [CRWMS M&O] 1998). There is precedence for updating the early site permits for licensed nuclear plants that began with a Level 4 study and then use a Level 2 to include updates that incorporate local information. The use of PSHA information in this study is limited to being a data source to support the preferential ranking of ARD locations; however, information on the extent of past PSHA work is presented to provide some perspective on historic seismic studies that can be leveraged for future seismic studies supporting the pursuit of an early site permit.

3.4.8.2 *Evaluation Factors*

The following site geology, seismology, and soil-geotechnical properties evaluation factors were derived for this siting study:

- The site must be in an area of Quaternary/Tertiary alluvial sediments
- The location terrain is flat and stable to enable construction; the site is not susceptible to nearby landslides

- The proposed site provides for stability of subsurface materials and foundations, based on comparison to similar NNSS geologic settings where geological characterization data have been collected
- The terrain is relatively stable from a seismic perspective, based on available seismic monitoring data. Maximize use of updated seismic hazard analysis and other characterization data, such as might be available from Yucca Mountain sites.

3.4.9 Hydrology and Related Considerations

3.4.9.1 *Discussion*

For this study's purposes, hydrology and related considerations primarily relate to localized flooding concerns, hydrology related impacts to ephemeral surface waters, availability of sustainable water supplies to support projected water usage, and aquatic ecology. The NNSS has an arid climate. The average annual precipitation on the valleys ranges from 3 to 6 inches and on most of the ridges and mesas averages less than 10 inches. There are no perennial or intermittent streams on the site. Water for site use is acquired from underground aquifers and needs to be within the sustainable yield of an aquifer.

The NNSS is located within three groundwater basins Pahute Mesa-Oasis Valley, Alkali Flat-Furnace Creek Ranch, and Ash Meadows. Figure 3-7 gives these groundwater basins with their relative transmissivity. Transmissivity describes how fast and far a pumping signal propagates through an aquifer and is measured as the rate at which groundwater can flow through an aquifer section of unit width under a unit of hydraulic gradient. The darker brown areas of Figure 3-7 indicate regions of higher relative transmissivity.

Hydrology studies (e.g., Halford and Jackson 2020; Winograd and Pearson, 1976) show that a high-transmissivity corridor exists within the Ash Meadows basin. This basin also connects to Devils Hole where the endangered pupfish reside. A potential concern is that a prolonged pumping drawdown may impact the water level at Devils Hole over time.

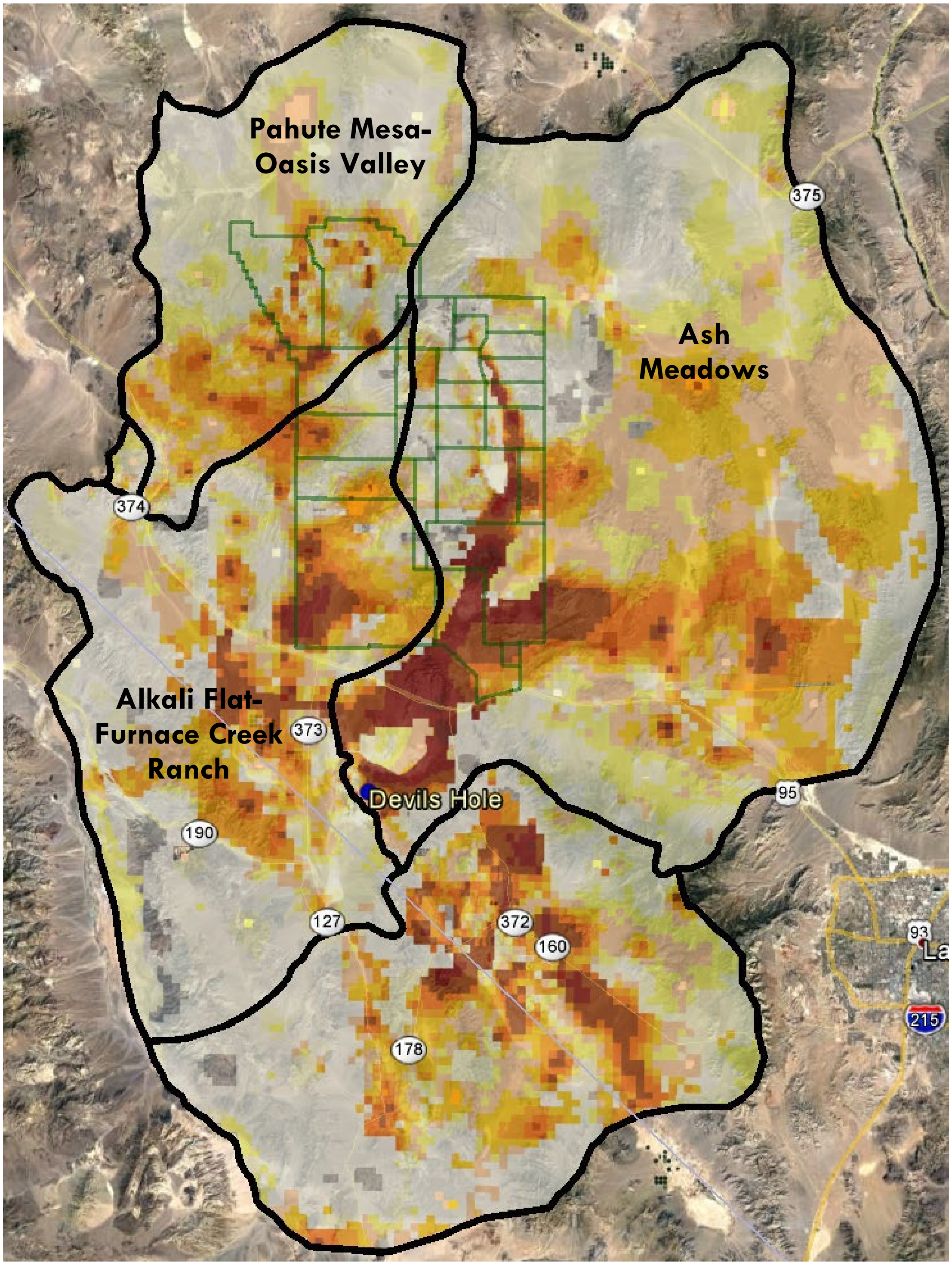

Figure 3-7. NNSS Groundwater Basins.

3.4.9.2 *Evaluation Factors*

The following hydrology and related considerations evaluation factors were derived for this siting study:

- Proposed site must not be in a playa
- Proposed site must not be in a location of known intermediate and major drainages (buffered at 100 and 200 meters respectively)
- Proposed site must be located outside of 100-year floodplain
- Proposed site must be located above the design basis flood level determined from a probabilistic flood hazard analysis
- Proposed site must be located outside wetland areas
- The terrain should not be susceptible to flooding or have other unique flooding concerns
- Projected water usage for the demonstration reactor is within the available sustainable yield of the NNSS hydrographic basin at that location
- Proposed site limits hydrology related impacts to ephemeral surface waters by minimizing alterations to natural drainage pathways, increased erosion, contamination via chemical agents, and sedimentation
- The potential for flood related hazards at this site makes it desirable based on precipitation data and its hydrologic characteristics and surroundings
- The availability of precipitation, hydrologic characteristics, meteorological characteristics, and topographical feature information to perform a probabilistic precipitation hazard assessment
- Proposed site must avoid areas of surface-water flooding/ponding
- Proposed site would not result in substantial surface-water conflicts with other users.

3.4.10 Terrestrial/Ecology/Impacts to Habitat and Wildlife

3.4.10.1 *Discussion*

This study's focus for the terrestrial/ecology impacts to the habitat and wildlife evaluation factor category is to minimize potential adverse impacts to sensitive and protected species. An attribute for minimizing these impacts is to limit the amount of land disturbance. Currently, the only species on the NNSS listed under the Endangered Species Act is the Mojave Desert tortoise (Gopherus agassizii), hereafter the tortoise, and is listed as "threatened" by U.S. Fish and Wildlife Service (FWS). GIS maps that provide the locations of sensitive and protected species were used in this study to provide a siting preference to locations that minimize impacts to these locations.

There are established biological compliance requirements at the NNSS for sensitive and protected species. These requirements are summarized in the following paragraphs:

<u>Tortoise Habitat (Endangered Species Act, Covered Under Programmatic Biological Opinion File Number 08ENVS00-2019-F-0073, Effective 2019 through 2029)</u>

1. Permanent disturbances of pristine tortoise habitat greater than 20 acres or 1-linear mile require consultation with the DOE regulator, FWS.

    i. This can take up to 4 months.

ii. Biologists may be required to conduct preliminary field surveys of the project area.
iii. Biologists will complete a report on the potential impacts to the tortoise and its habitat to submit to FWS.
iv. Once approved, FWS will set an acreage limit for disturbance and a "take" limit for tortoises. "Take" is harassing, moving, or killing a tortoise.
v. FWS will set terms and conditions for the project to minimize impacts to the tortoise and its habitat as follows:
   - Tortoise clearance surveys
   - "Tortoise monitors," (i.e., construction personnel will be trained by biologists on the requirements of working in the tortoise habitat)
   - Cover or fence all trenches left open and unattended
   - Possible tortoise fencing requirement for perimeter of facility.

2. Permanent disturbances of pristine tortoise habitat (or disturbed habitat that has revegetated) of less than 20 acres or 1-linear mile can proceed with the current terms and conditions set forth by FWS in the DOE's Programmatic Biological Opinion (i.e., Biological Opinion) as follows:

   - Tortoise clearance surveys
   - "Tortoise monitors," (i.e., construction personnel will be trained by biologists on the requirements of working in the tortoise habitat)
   - Cover or fence all trenches left open and unattended
   - Possible tortoise fencing requirement for perimeter of facility.

3. Projects disturbing tortoise habitat under the Work-for-Others Program are required to pay remuneration fees per acre of disturbance (currently $932/acre) to FWS. Habitat reclamation (revegetation) may serve as an alternative to payment (this would be for the temporary habitat disturbance).

Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act

1. Avian Power Line Interaction Committee requires power structures to be avian friendly with at least a 60-inch space between live lines to avoid electrocutions and power outages.

2. Active nests found during the project cannot be disturbed until all birds have left the nest. If a nest is found on a powerline and causes a threat to the birds or an outage, appropriate laws will be followed to relocate the nest.

Outside Tortoise Habitat and Other Sensitive and/or Protected Species

1. Project area will be reviewed by biologists to determine if other sensitive and/or protected species (e.g., burrowing owls and sensitive plants) utilize the habitat and will determine appropriate mitigation requirements as follows:

   i. A pre-activity survey will be conducted
   ii. If possible to avoid certain biological resources, these resources will be flagged for avoidance
   iii. Post-activity survey will be conducted.

3.4.10.2 *Evaluation Factors*

The following evaluation factors were derived for this siting study related to the terrestrial/ecology impacts to the habitat and wildlife evaluation factor:

- Must be located outside natural or manmade water sources utilized by wildlife (e.g., Cane Spring, Gold Meadows, existing ponds, or sumps) with a one-kilometer buffer area
- Minimize disturbance of sensitive or protected species habitat (e.g., tortoise, sensitive plants, burrowing owls).

3.4.11 Air Quality and Other Resource Impacts (e.g., Historic and Cultural Resource Considerations)

3.4.11.1 *Discussion*

For this siting study, several diverse and distinct siting related considerations were grouped together for air quality and other resources impacts evaluation category. Air quality in this study's context is primarily focused on air quality during ARD construction and operational activities. Other resource impacts are generally associated with potential cultural resource impacts to known areas of archaeology significance or eligible sites for the National Register of Historic Places.

As part of compliance with Section 106 of the National Historic Preservation Act, NNSA supported by the Desert Research Institute (DRI) conducts cultural resource surveys and identifies cultural resources within the area of potential effect for all proposed projects and activities (undertakings) that may affect cultural resources. If possible, NNSA avoids significant cultural resources impacts by adjusting the location of a proposed undertaking. When avoidance is not practicable, NNSA consults with the Nevada State Historic Preservation Officer, and possibly the Advisory Council on Historic Preservation, to identify measures to mitigate adverse impacts on those resources. Maps and survey data for cultural resource impacts are maintained by DRI and are not available within the M&O GIS. Consequently, the evaluation of cultural resource impacts for this study utilized the judgment of environmental protection SMEs assigned as part of the IPT. If the NNSS is selected and approved for ARD activities in the future, it is expected that detailed cultural resource surveys will be needed to evaluate the impact of these resources at the proposed locations.

3.4.11.2 *Evaluation Factors*

The following evaluation factors were derived for this siting study related to the air quality and other resource impacts evaluation factor:

- The impacts to air quality attributed to construction activities is not significant and would be short lived and would cease after construction is completed
- Required transmission lines do not provide a detriment to air quality based on production of ozone and oxides of nitrogen
- The proposed site would minimize impacts to cultural resource sites or historic preservation areas that may be eligible for the National Register of Historic Places or covered by other National Historic Preservation act considerations
- The proposed siting avoids areas of high-predictive archaeology zones
- The proposed site does not cause or minimizes any irreversible or irretrievable commitments of resources

- The site does not provide adverse societal effects.

3.4.12 Security Considerations

3.4.12.1 *Discussion*

NNSS operations are technically diverse and include operations with Category I nuclear material. Accordingly, the Nevada Enterprise (NvE) infrastructure contains the requisite safeguards and security program to manage these materials safely and securely. Physical security is provided by a designated security contractor that provides the necessary armed security police officers to respond to security related incidents based on well-established plans and procedures. The NvE security contractor also provides technical security functions for maintaining security systems such as the Perimeter Intrusion and Detection System at the DAF.

The M&O contractor also supports the safeguards and security program. A key function of the M&O contractor is conducting security risk assessments (SRAs) or vulnerability assessments (VAs) to characterize and neutralize security related design basis threats. A SRA or VA was not undertaken for ARD activities based on the lack of a specific target definition. It is anticipated that ARD activities likely would involve activities with Category 4 nuclear material based on the graded safeguards table in DOE O 474.2, *Nuclear Material Control and Accountability*, but could involve higher security category materials for selected ARD research and development activities. An aspect of this study for preferential site ranking is how well-identified ARD locations can be protected against postulated security related threats based qualitative SRA and VA considerations and assuring these locations do not adversely impact Design Basis Threat mitigation at nearby sites.

3.4.12.2 *Evaluation Factors*

The following evaluation factors were derived for this siting study related to the security considerations evaluation factor:

- The proposed site is advantageous for physical security protection and the protection on nuclear materials
- Siting supports ensuring appropriate security controls are available
- Sufficient area exists at the site to permit adequate security standoff distances
- Features that could affect security measures and security plans are favorable
- Site selection facilitates mitigation of Design Basis Threats to reactor site and does not exacerbate Design Basis Threat mitigation at nearby sites.

3.5 Identify Candidate Siting Locations

3.5.1 Siting Location Approach

The mapping capability of the NNSS GIS was leveraged to determine candidate site locations for a more in-depth AOA using the weighted evaluation factors. The first step in using this capability was creating exclusion area maps based on the “must” evaluation factors where ARD siting would undesirable. These exclusion areas are depicted by blacked-out areas within the NNSS boundary. These individual exclusion area maps were then subsequently layered upon one another to provide a singular exclusion area map.

The next step in applying the GIS capability was to generate data maps considering preferences for site suitability. This includes an integrated layered map showing all data taken into consideration, along with maps showing the different types of data considered for suitability (e.g., slope, seismic, and proximity to infrastructure). Transparency was applied to the data, so that lighter areas are more suitable and darker areas are less suitable for ARD siting.

Finally, an integrated map with all data used to determine suitability was generated showing potentially optimal locations for ARD activities. For this integrated suitability map, the exclusions are overlaid on the data used for consideration of site suitability based on preferences. Varying degrees of transparency were used to depict the more suitable locations by a lighter degree of shading.

3.5.2 Siting Exclusion Areas

Figure 3-8 shows the combined siting exclusion area map. The data in this map includes all areas excluded from siting consideration (i.e., blacked-out areas) due to contamination, use restrictions, nuclear testing, geology, or environmental factors.

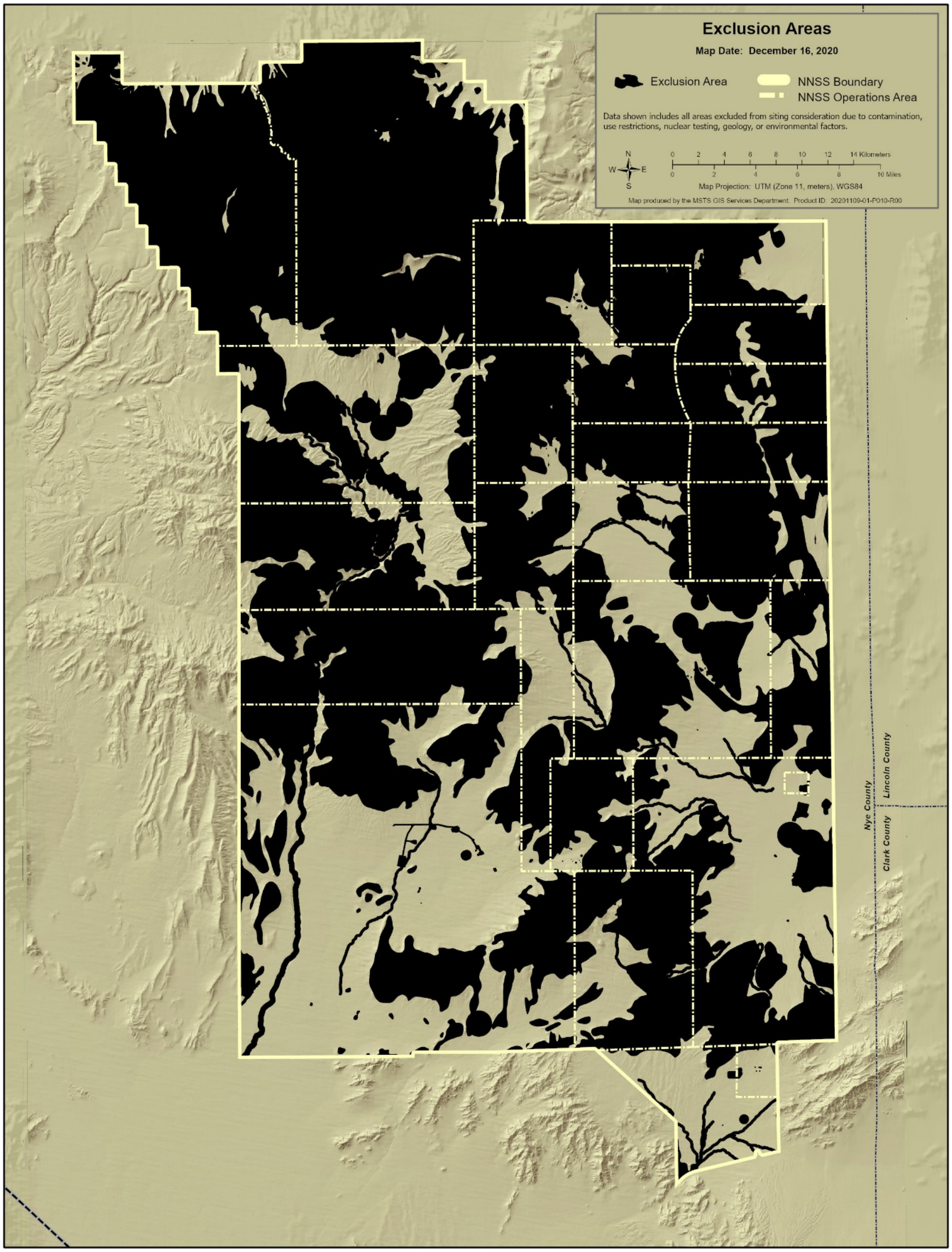

Figure 3-8. Exclusion Areas for ARD Siting.

The following siting exclusion maps from the GIS were individually generated and combined to provide an integrated layered exclusion area map.

- Geology (Figure 3-9): This map excludes areas that have a surface geology other than Quaternary/Tertiary alluvial sediments.

- Nuclear Testing Areas (Figure 3-10): This map excludes areas of past underground and surface nuclear tests with a one-kilometer buffer area, and the inventory emplacement holes are buffered at twice the total depth.

- Radiological Areas (Figure 3-11): This map excludes defined radiological areas. These areas are past on aerial radiation surveys, and other identified radiologically impacted area boundaries.

- Drainage (Figure 3-12): The data in this map excludes playas and intermediate and major drainages (buffered at 100 and 200 meters, respectively).

- Environmental Restrictions (Figure 3-13): The data in this map excludes natural and manmade water sources displayed with a one-kilometer buffer area.

- Land-Use Restrictions (Figure 3-14): The data in this map includes FFACO land-use restrictions and explosive operating areas.

- Vertical Openings and Explosive Contaminated Areas (Figure 3-15): The data in this map includes explosive contamination areas, abandoned mine shafts/adits, and hazardous big holes. Explosive contamination areas depict zones around active firing tables that are subject to explosives' contamination from incomplete or failed detonation. Known mine shafts, adits, vaults, and other potentially hazardous open holes and steep-sided or vertical openings in the ground are displayed with a 100-foot buffer area.

- Solid Waste Landfills (Figure 3-16): This map shows the geographic locations of solid waste landfills within the NNSS site boundary.

The exclusion maps that follow are ordered by their relative amount of excluded areas within the map.

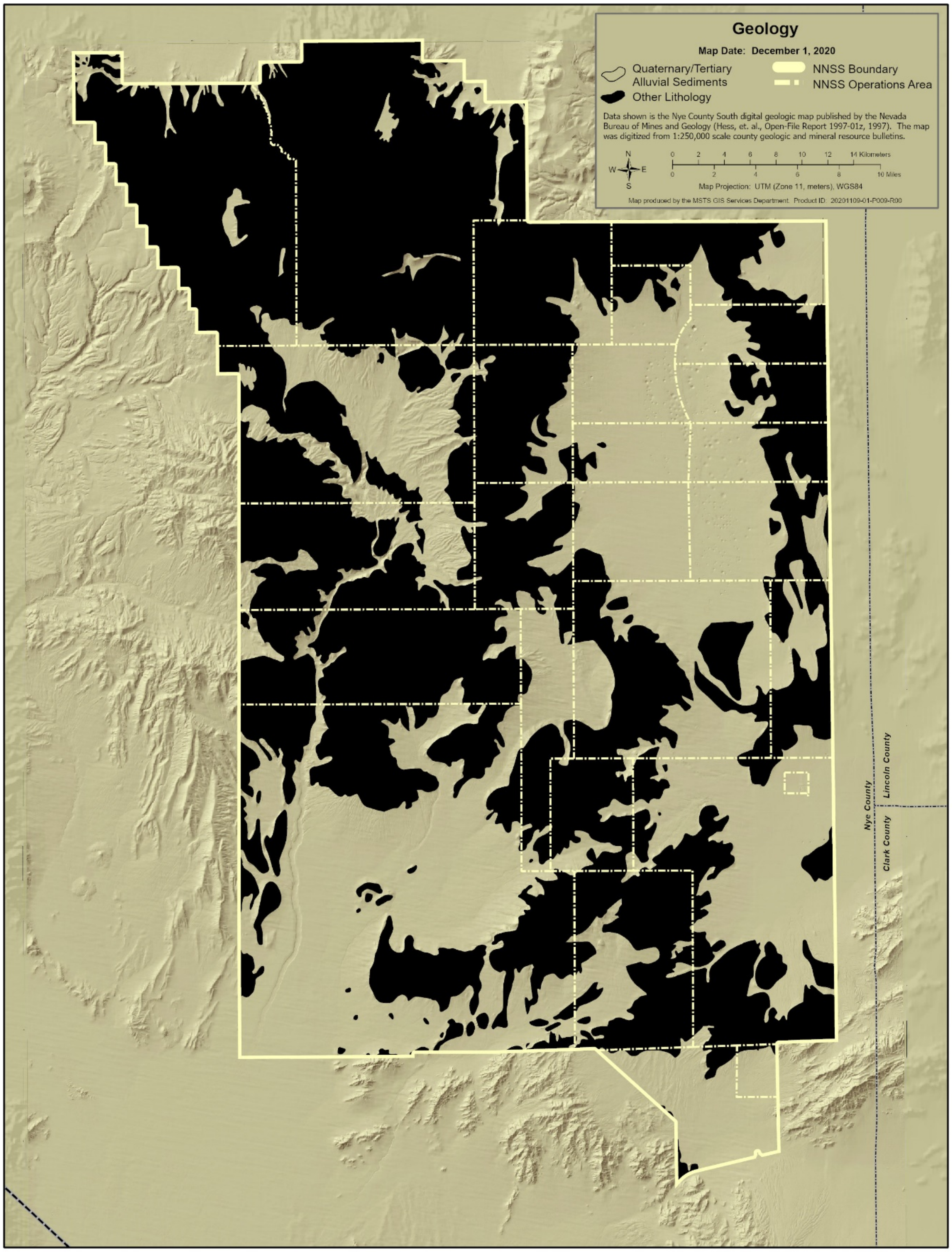

Figure 3-9. Geology Exclusion Areas.

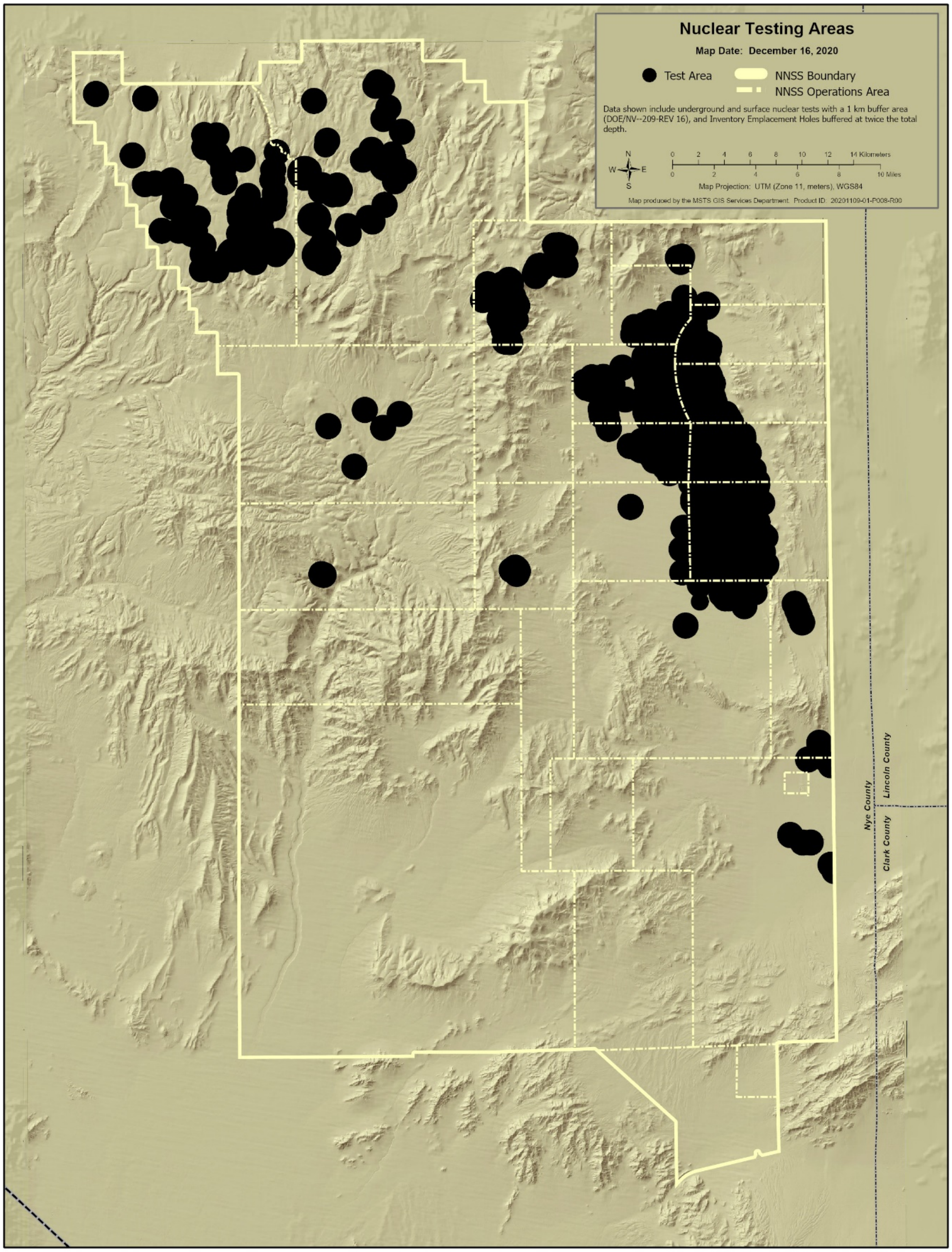

Figure 3-10. Exclusions for Nuclear Testing Areas.

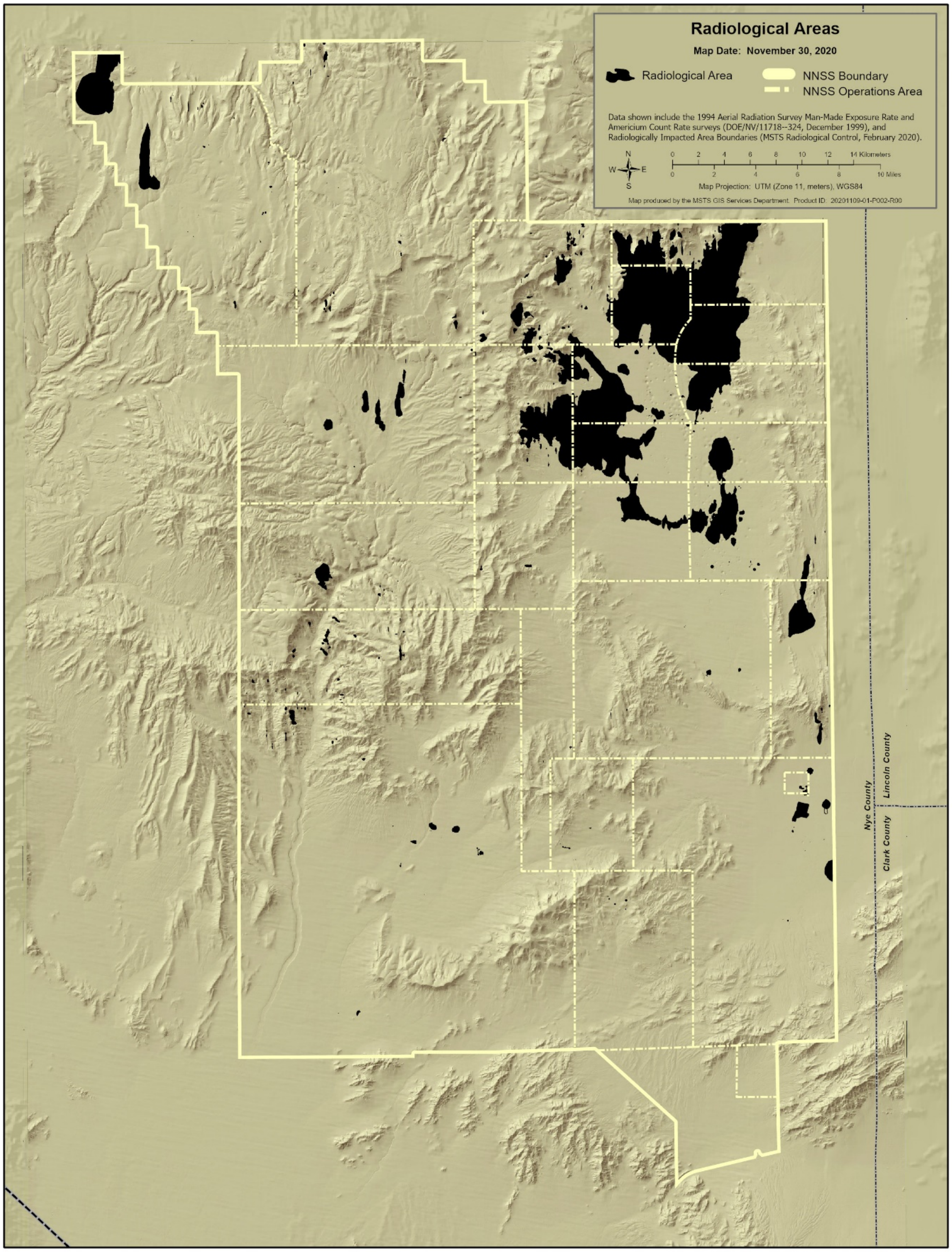

Figure 3-11. Exclusions for Radiological Areas.

Figure 3-12. Drainage Related Exclusion Areas.

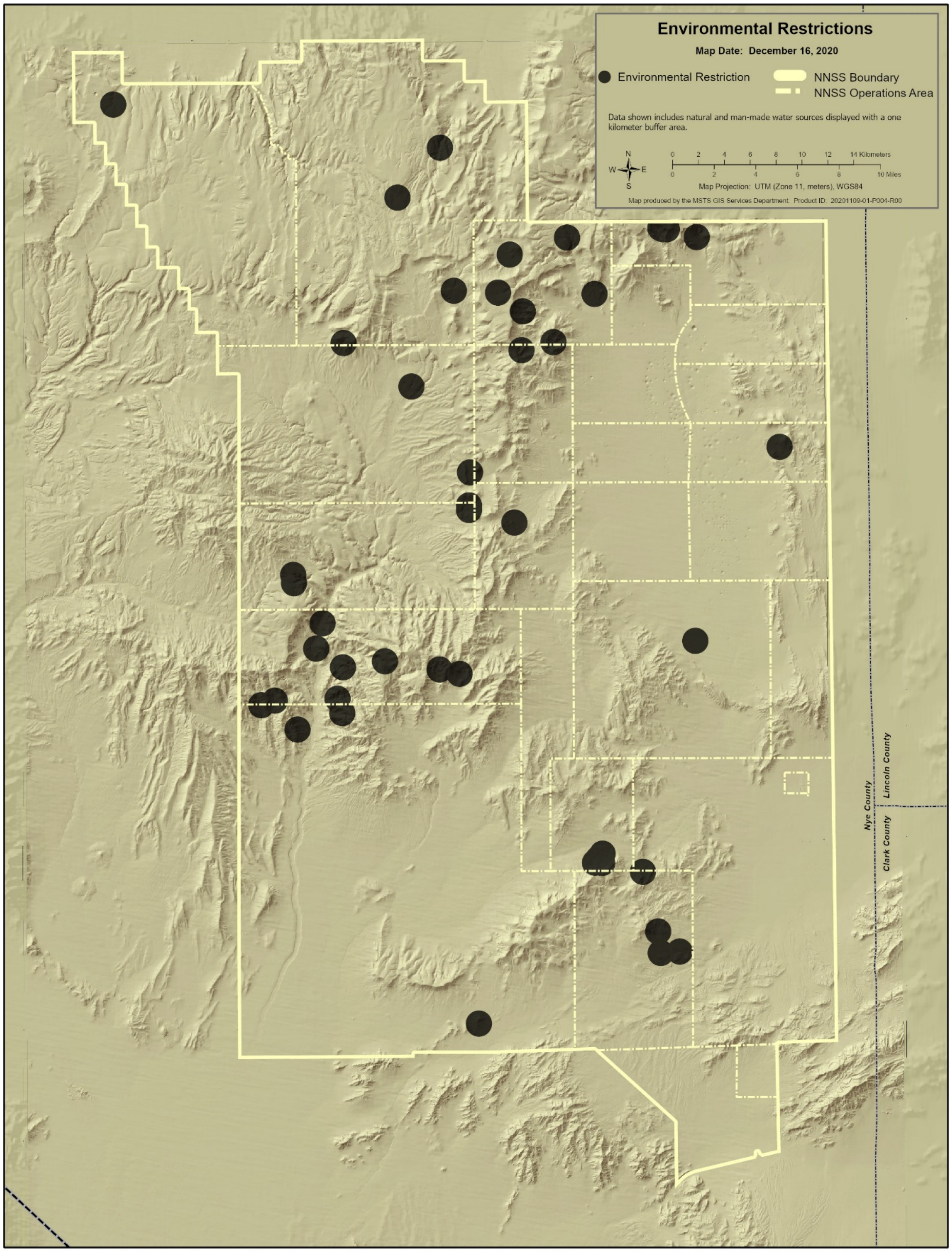

Figure 3-13. Exclusions for Environmental Restrictions.

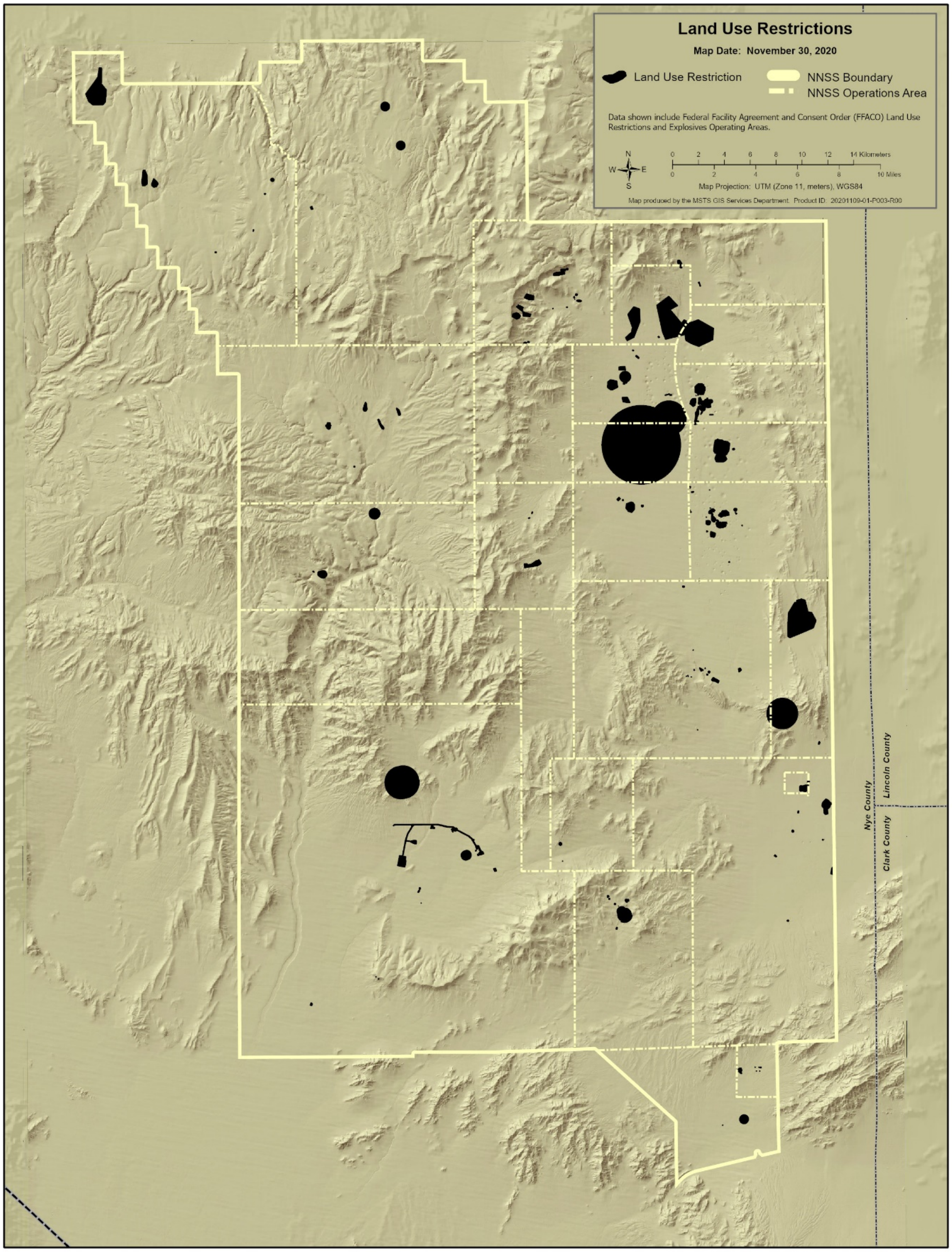

Figure 3-14. Exclusions for Land-Use Restrictions.

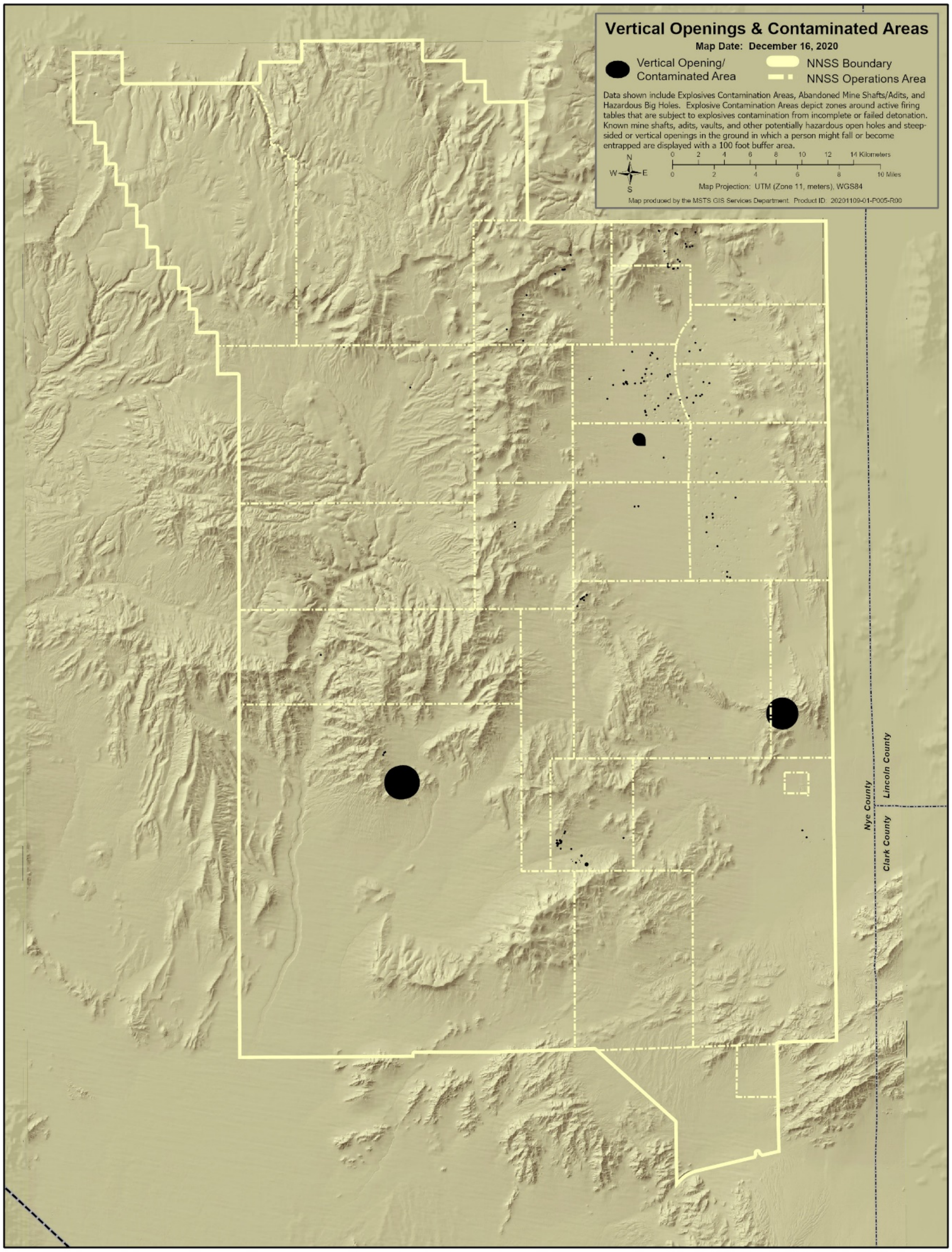

Figure 3-15. Exclusions for Vertical Openings and Explosive Contaminated Areas.

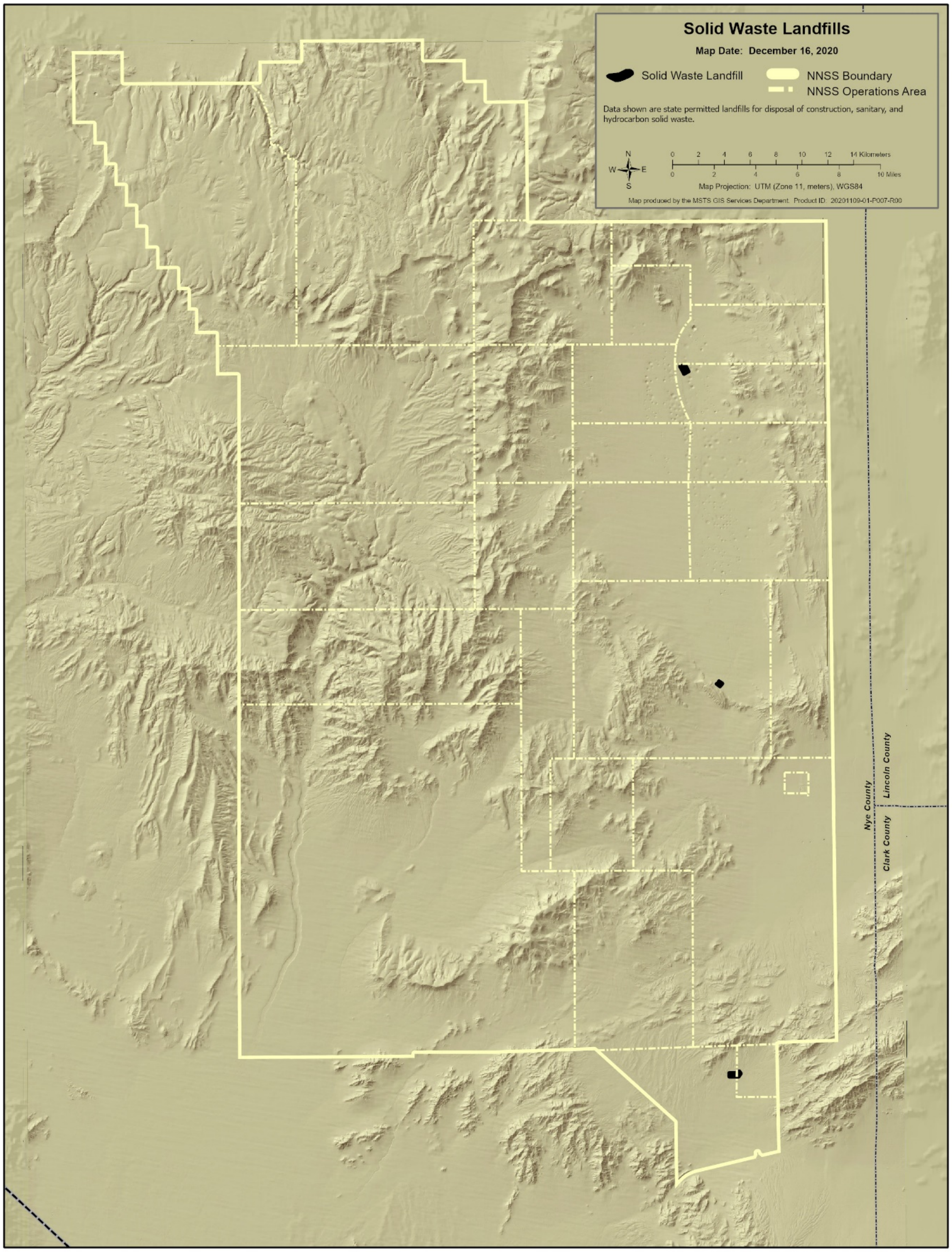

Figure 3-16. Exclusions for Solid Waste Landfills.

3.5.3 Siting Preferences

Figure 3-17 shows the combined siting preference map. Data shown include locations considered for siting due to proximity to existing infrastructure, contamination, topography, seismic, ecological, or other factors. All layers have a 50% transparency, with lighter colors indicating areas that are more suitable for siting, and darker colors indicating areas that are less suitable. The approximate northern boundary of the tortoise range (green line) is shown to reference tortoise habitat south of this line.

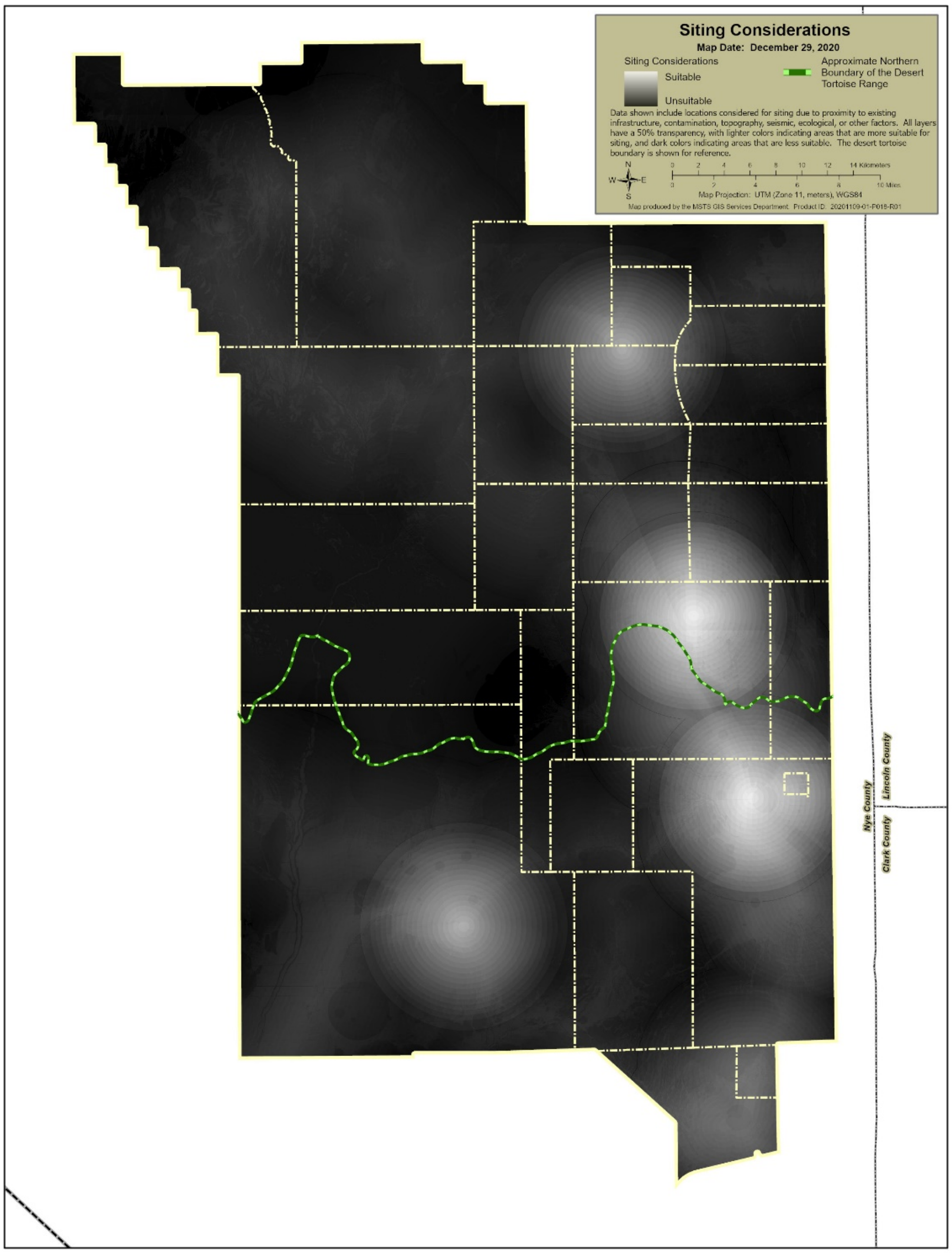

Figure 3-17. Integrated Siting Preferences Map.

The following siting preference maps from the GIS were individually generated and combined to provide an integrated, layered exclusion area map:

- Power Infrastructure (Figure 3-18): The power infrastructure was buffered by the distance from an electrical substation (to beyond 5 miles) associated with the 34.5 kV (yellow lines) or 138 kV power lines (black lines). The preference is to be near an existing electrical substation.

- Road Infrastructure (Figure 3-19): The road infrastructure was buffered by the distance from a primary road (to beyond 5 miles). The preference is to be near a primary onsite road.

- Bounding PPE Water Capacity (Figure 3-20): This map shows the areas in the current water system that meets the PPE raw water consumption requirement for flowrate of 450 gallons per minute. The preference is to be near an area (less than 5 miles) that can meet the bounding PPE water demand.

- Slope (Figure 3-21): This GIS map provides data on the slope's degree for the following slope intervals: less than or equal to 1%, 1 to 2%, 2 to 3%, 3 to 4%, 4 to 5%, and greater than or equal to 5%. The preference is for flat a terrain as possible for construction.

- Seismic Considerations (Figure 3-22): This map was buffered by distance from Quaternary faults out to beyond 5 miles. The preference is to be at sufficient distance from faults to have no incremental construction requirements or undesired seismic risks.

- Other Considerations (Figure 3-23): The data on this map includes potential unexploded ordnance (UXO) and energetics materials storage (with 1250-foot buffer area). Although the potential exists to encounter UXO anywhere on the NNSS (former gunnery range), the UXO polygons depicted on this map represent areas of the NNSS believed to have greater potential UXO density based on historical accounts of activities conducted in those areas. The preference is to avoid siting in these areas.

- Contamination Considerations (Figure 3-24): This map's data include beryllium legacy sites, corrective action sites (CAS), and FFACO subsurface use restrictions. Beryllium and CAS locations are displayed with a 100-foot buffer area. The FFACO-use restriction boundaries were established to communicate all subsurface activities, including drilling, pumping, and testing of wells that may impact the flow of contaminated water. The preference is to avoid siting in these locations.

- Ecological Considerations (Figure 3-25): This map's data map include areas with sensitive plant species having additional compliance requirements. The preference is to avoid these areas. Tortoise biological compliance is required within tortoise habitat (south of the green line in Figure 3-17), as well as potential tortoise habitat (at or just north of the green line in Figure 3-17), and tapers off as the project moves further north.

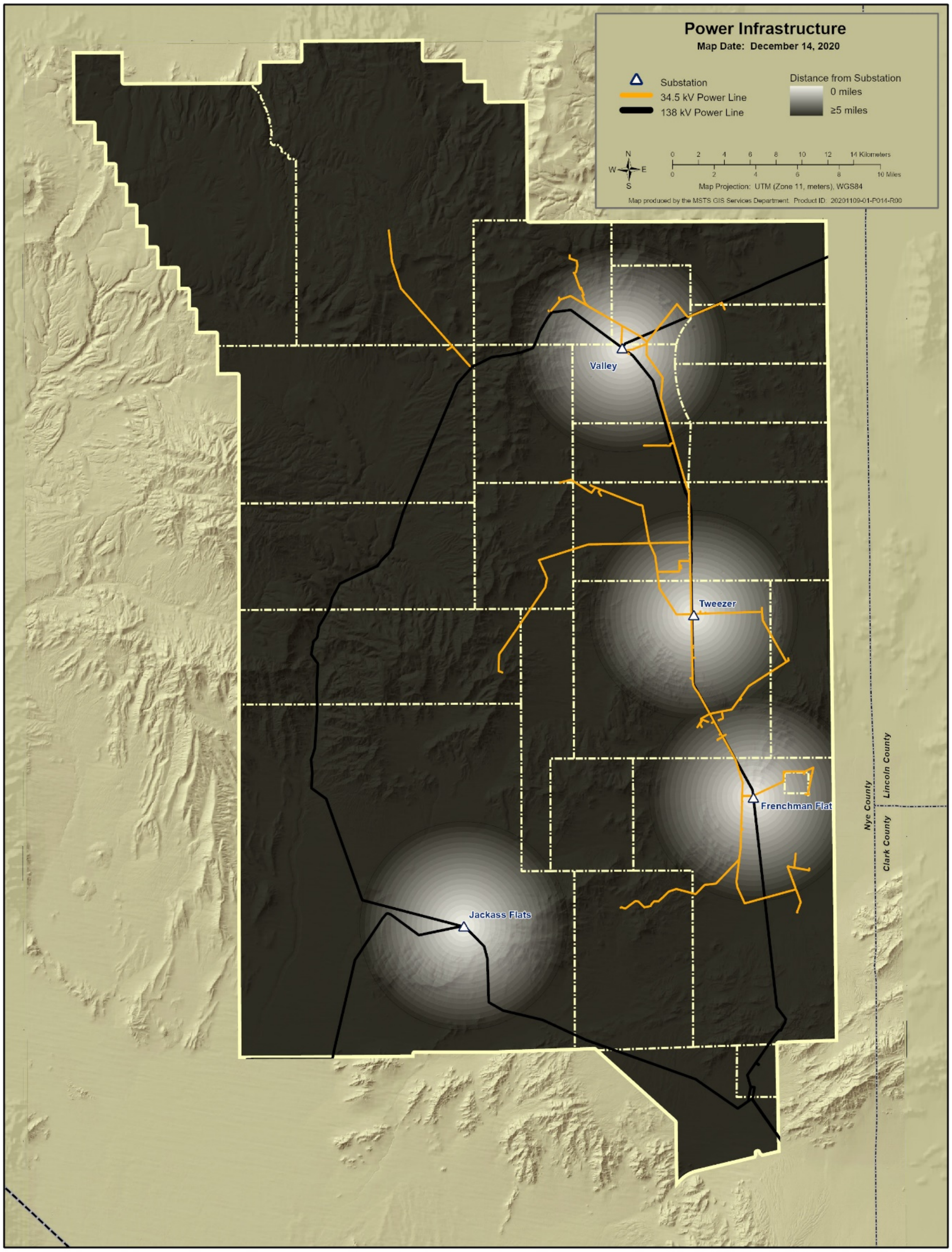

Figure 3-18. Power Infrastructure Preferences.

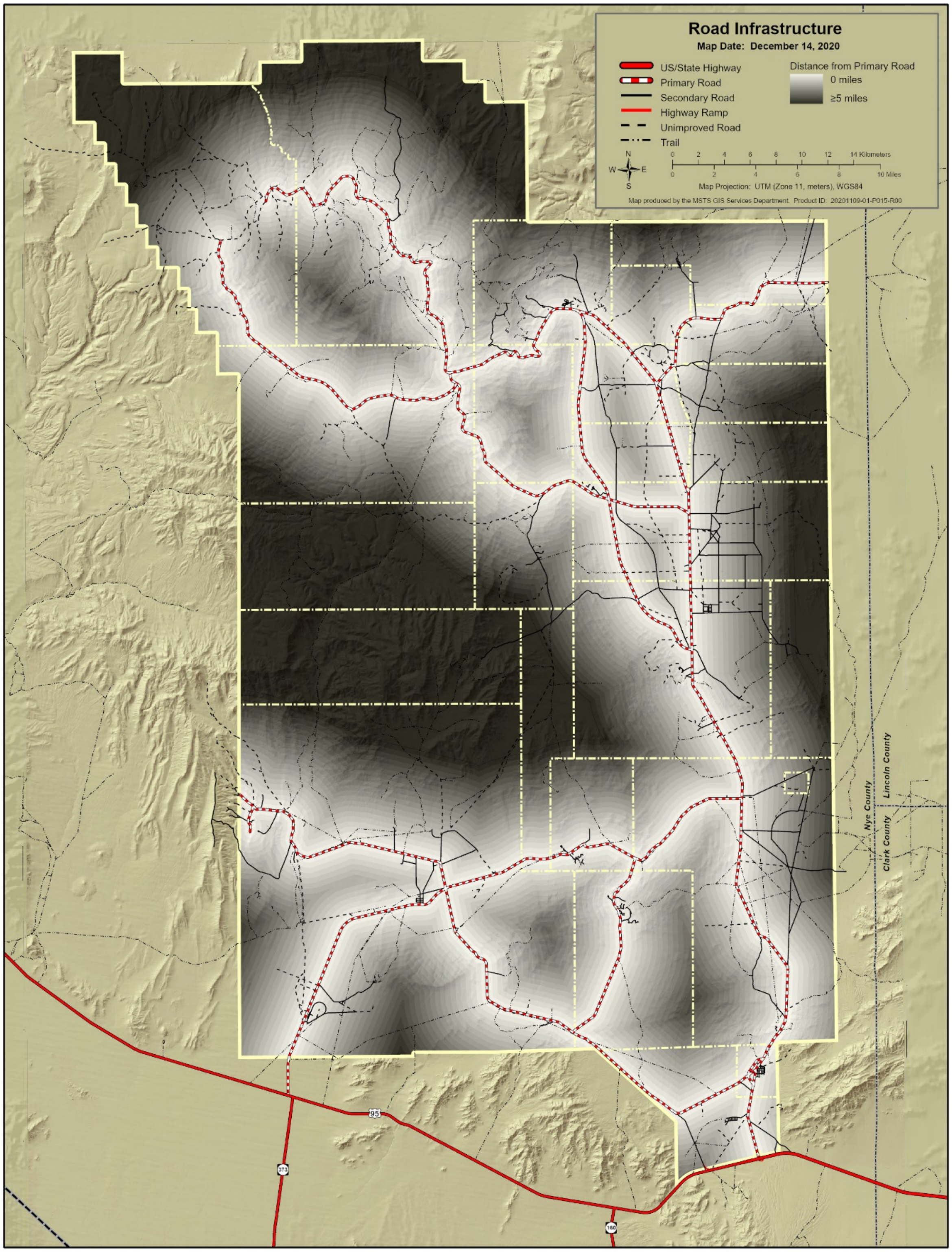

Figure 3-19. Road Infrastructure Preferences.

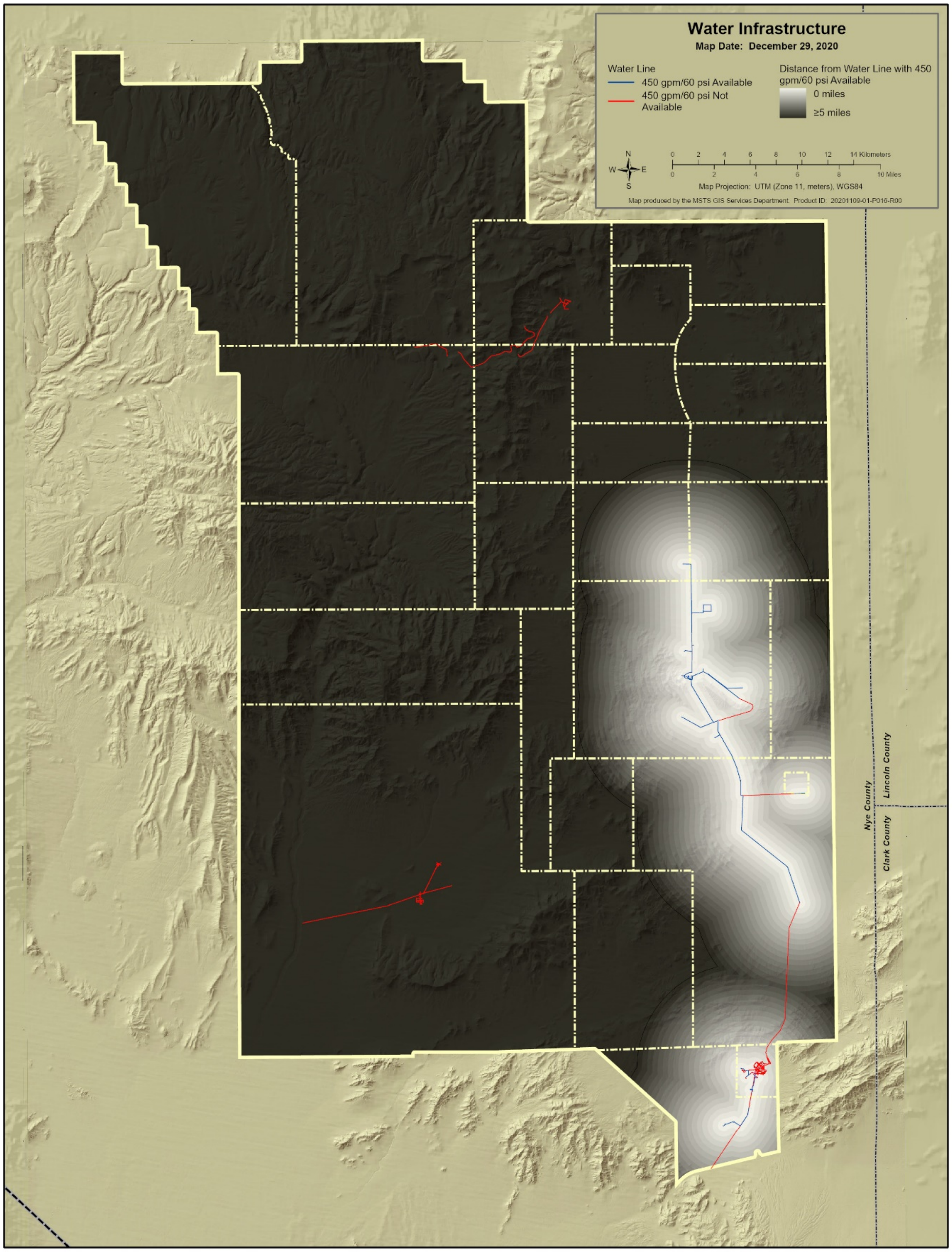

Figure 3-20. Water Distribution System Preferences.

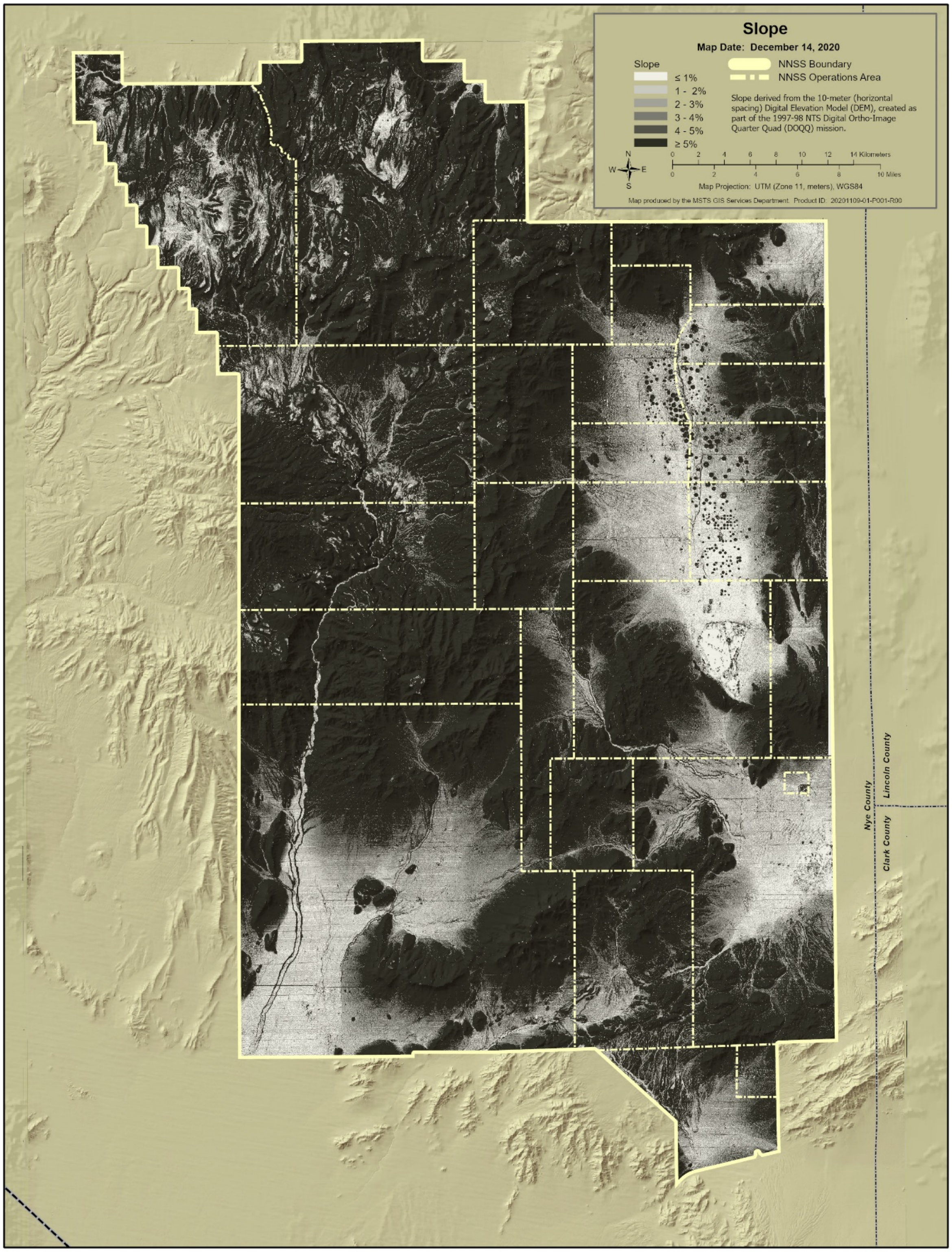

Figure 3-21. Slope Preferences.

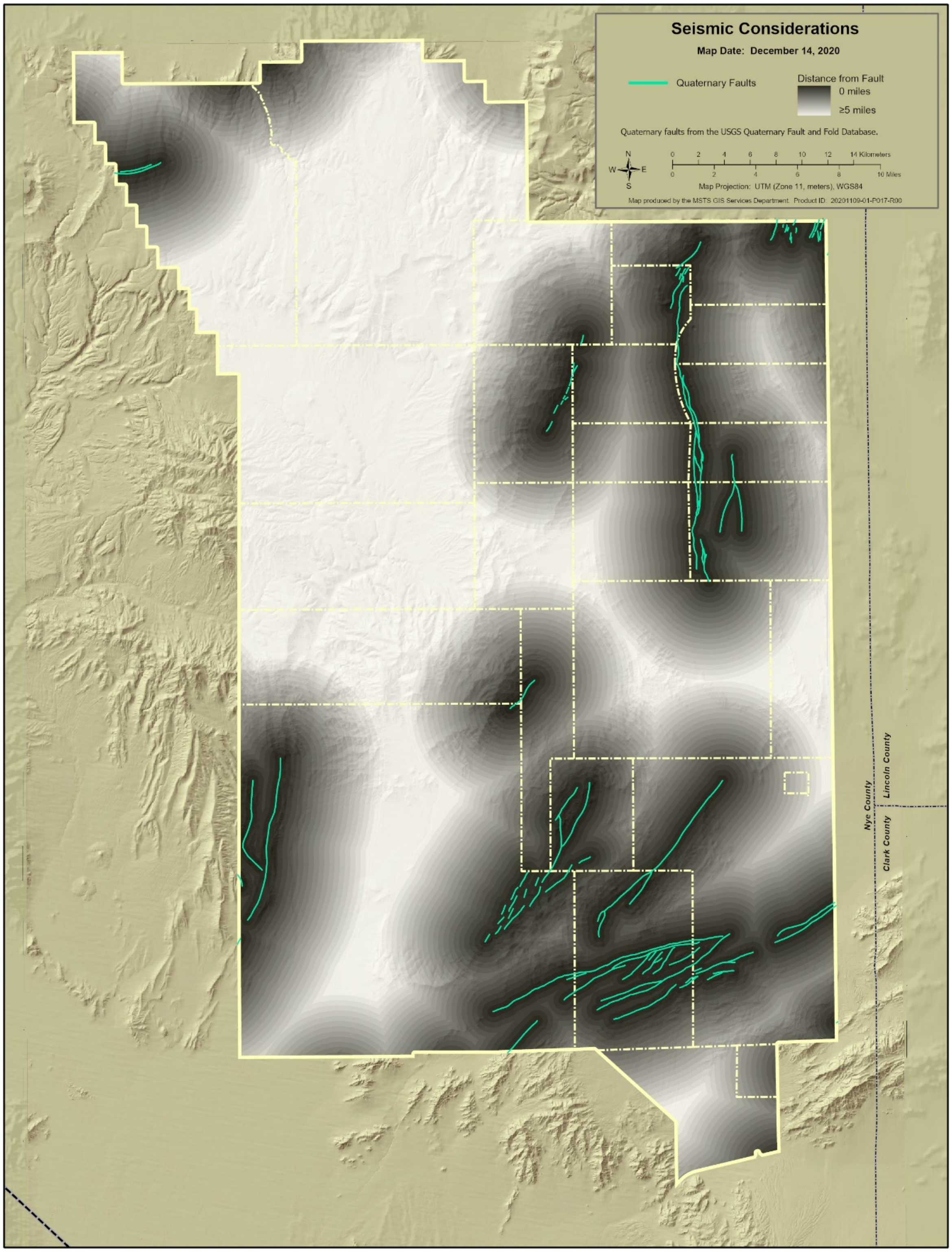

Figure 3-22. Seismic Preferences.

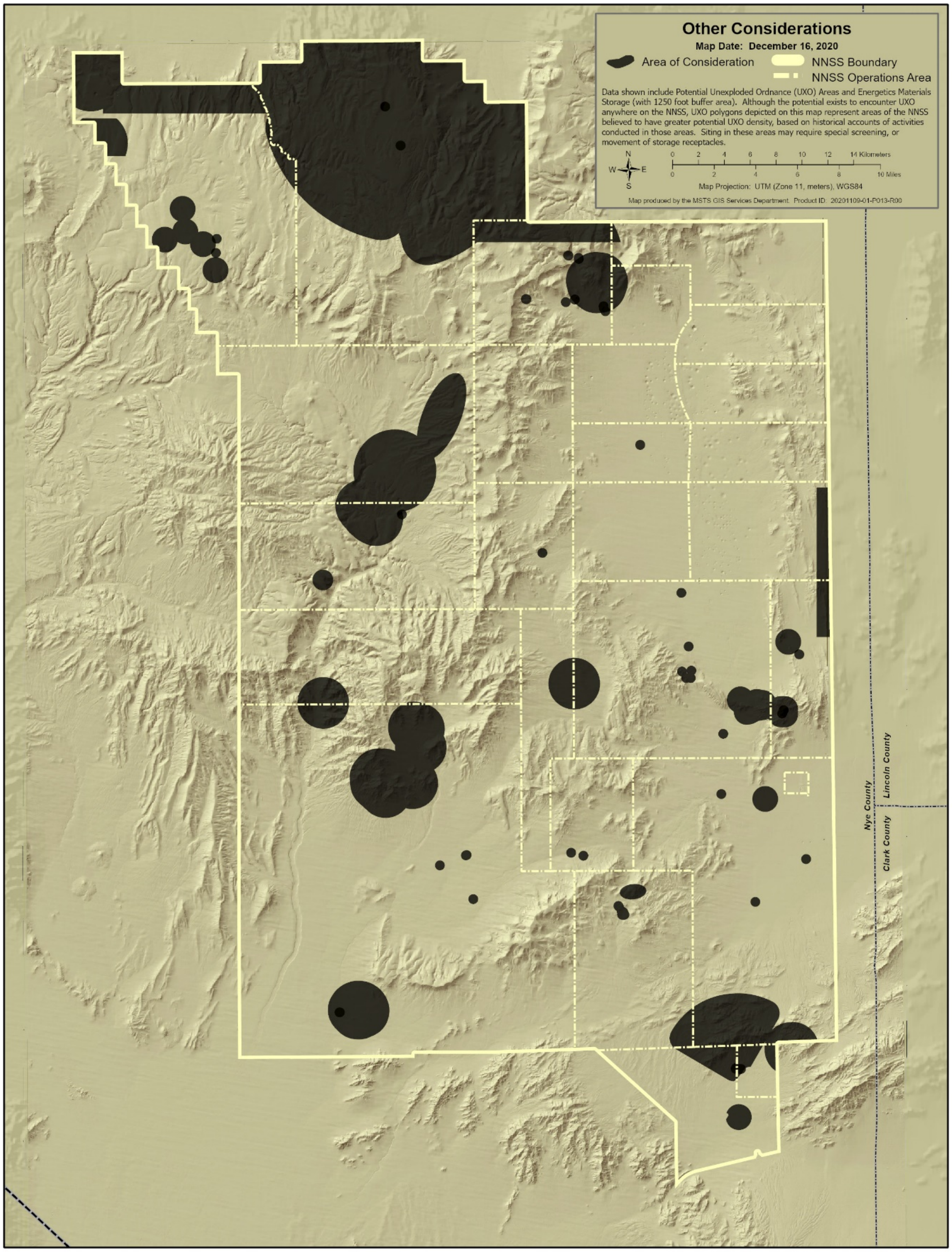

Figure 3-23. Preferences for Other Considerations (UXO and Energetic Materials Storage).

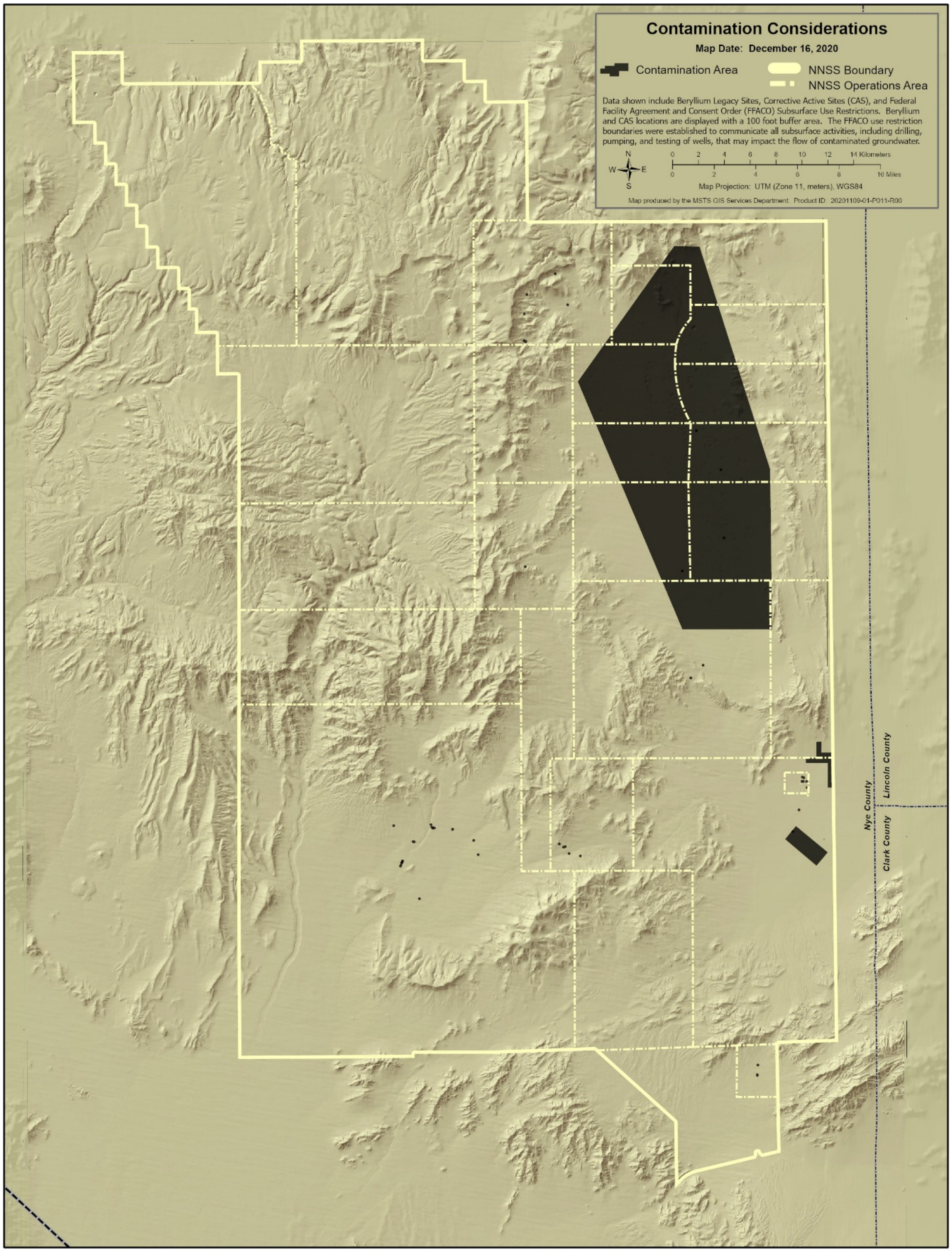

Figure 3-24. Preferences for Contamination Considerations (Beryllium Legacy Sites, CAS, and FFACO Subsurface Use Restrictions).

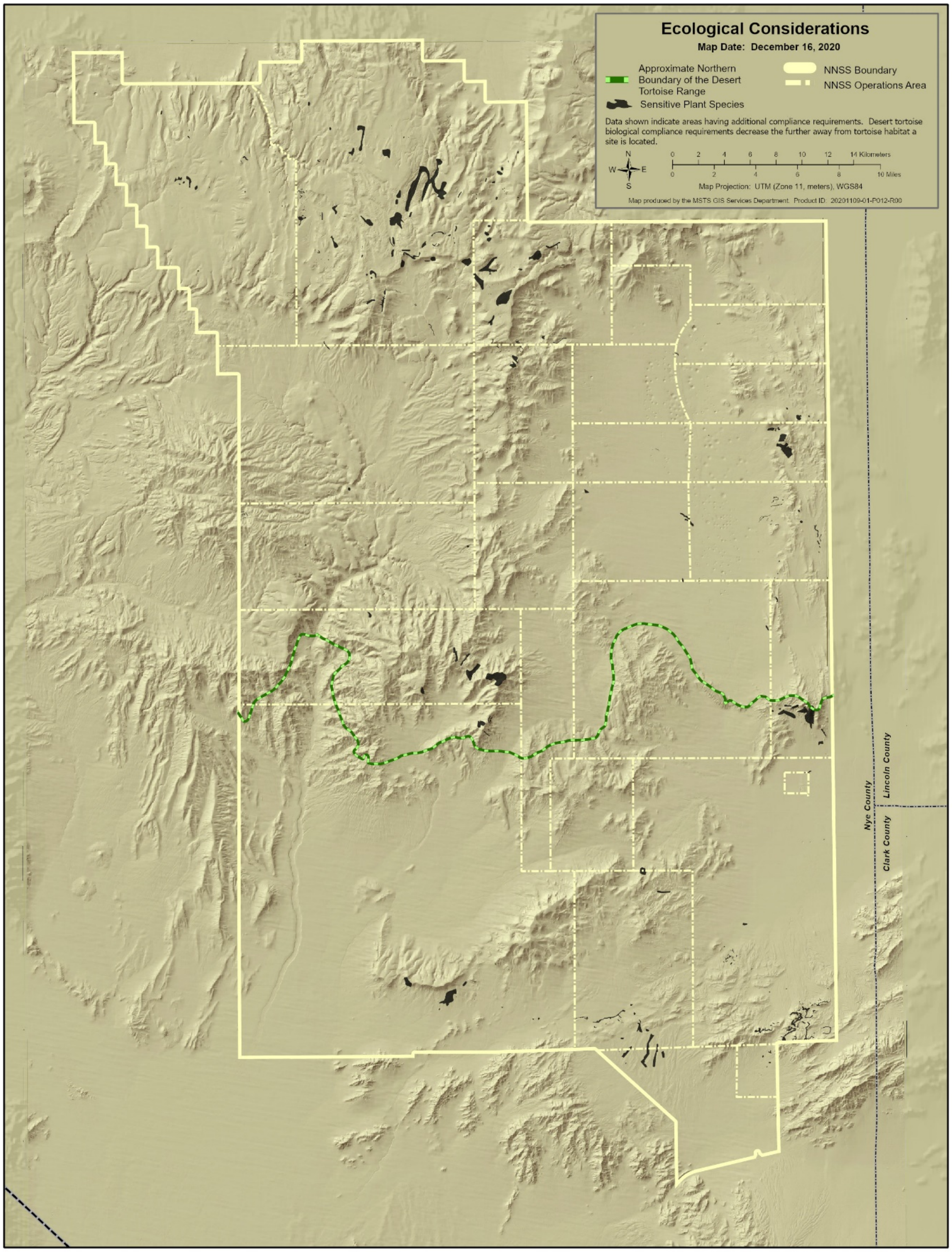

Figure 3-25. Ecological Preferences.

3.5.4 Siting Suitability

Figure 3-26 provides a map with all exclusion and preference data to determine suitability for potential ARD activities. The lighter areas on this map are the most suitable locations for these activities.

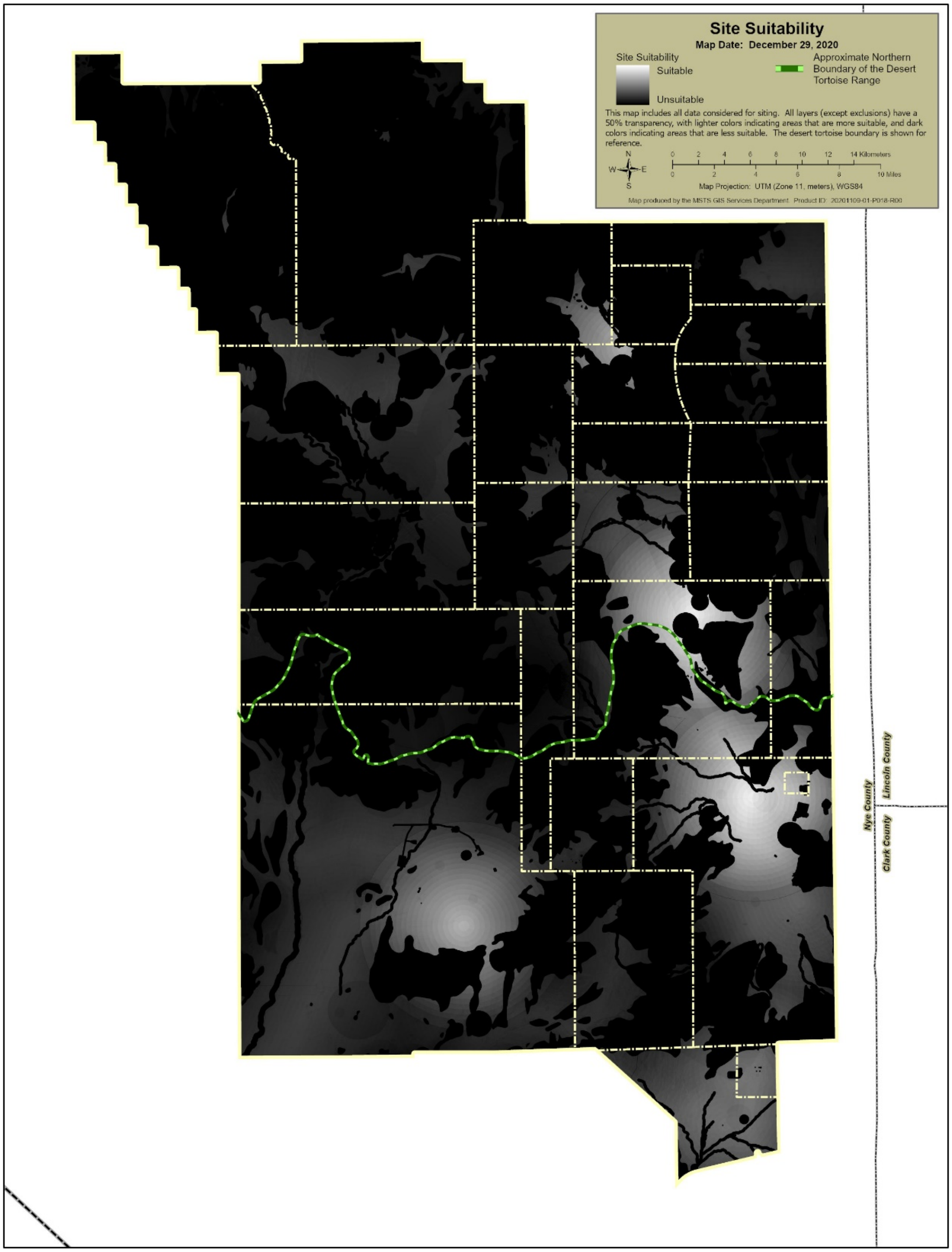

Figure 3-26. Site Suitability Locations for ARD Activities.

3.6 Evaluation Factor Weighting

3.6.1 Methodology

The evaluation factors were ranked against each other by each IPT member using a paired comparison method to weight the criteria based on relative importance. This method systematically compared each evaluation factor against the others to derive the relative importance. Each IPT member decided which evaluation factor was more important based on their knowledge and field of expertise and assigned a weighting factor on a graded scale of five (much more important) to zero (equal in importance) to signify how much more important one evaluation factor was over another. The individual IPT member scores were then combined to provide consolidated evaluation factor weighting for use in the AOA.

3.6.2 Weighted Evaluation Factor Results

Table 3-2 provides an example of a completed evaluation factor paired comparison for an IPT member. Table 3-3 provides the combined evaluation factor paired comparison from all IPT members to determine the evaluation factor weighting.

Table 3-2. Evaluation Factor Paired Comparison Example.

Evaluation Factor Considerations	B		C		D		E		F		G		H		I		J		Total (total + 1)	Weight %
A. Land Use	B	3	A	3	A	1	E	3	F	3	A	1	H	3	A	5	A	3	14	10.1
B. Infrastructure and Energy			B	5	B	3	B	1	B	1	B	3	B	1	B	5	B	5	28	20.1
C. Transportation and Traffic					D	3	E	5	F	5	G	3	H	3	C	3	C	1	5	3.6
D. Radiological / Environmental Restoration Considerations							E	3	F	3	D	1	H	3	D	3	D	1	9	6.5
E. Accident Analysis / Emergency Planning Considerations									F	3	E	3	H	1	E	3	E	3	21	15.1
F. Site Geology, Seismology, and Soil-Geotechncial Properties											F	3	F	1	F	3	F	5	27	19.4
G. Hydrology and Related Considerations													H	3	G	3	G	3	10	7.2
H. Terrestrial / Ecology / Impacts to Habitat and Wildlife															H	3	H	3	20	14.4
I. Air Quality and Other Resource Impacts (e.g., Historic and Cultural Resource Considerations)																	J	3	1	0.7
J. Security Considerations																			4	2.9
Weighting Factors: 5 - Much More Important 3 - More Important 1 - Minor Difference 0 - Equal in Importance	Enter more important factor or either factor if equally important. Enter numiceral weighting factor based on scale.																		139	100.0

Table 3-3. Consolidated Weighted Evaluation Factors.

Evaluation Factor / IPT Member	1	2	3	4	5	6	7	8	9	10	11	Total	Weight %
A. Land Use	14	1	33	4	26	25	1	10	18	23	1	156	11.0
B. Infrastructure and Energy	28	6	26	24	22	23	10	26	26	7	9	207	14.5
C. Transportation and Traffic	5	1	9	16	2	9	7	2	17	1	5	74	5.2
D. Radiological / Environmental Restoration Considerations	9	4	33	28	5	19	16	12	16	4	13	159	11.2
E. Accident Analysis / Emergency Planning Considerations	21	1	24	10	17	15	13	19	1	24	11	156	11.0
F. Site Geology, Seismology, and Soil-Geotechncial Properties	27	2	21	10	1	30	46	25	28	46	18	254	17.8
G. Hydrology and Related Considerations	10	1	8	4	13	18	4	10	20	5	10	103	7.2
H. Terrestrial / Ecology / Impacts to Habitat and Wildlife	20	11	1	5	8	9	31	10	7	5	8	115	8.1
I. Air Quality and Other Resource Impacts (e.g., Historic and Cultural Resource Considerations)	1	1	6	13	9	7	31	4	2	1	4	79	5.6
J. Security Considerations	4	6	14	16	4	1	19	12	2	14	28	120	8.4
Consolidated Results												1423	100.0

3.7 AOA Process

3.7.1 Candidate ARD Locations

Candidate ARD locations were identified by selecting regions within the lighter shaded areas of the Site Suitability map given in Figure 3-26. These locations are described in terms of the defined NNSS Area that they are located within and proximity to the nearest electrical substation. These locations are shown in Figure 3-27 and summarized as follows (the list's order does not imply ranking of the sites):

- Location 1: Area 5 – Frenchman Flat Substation (1A5FF)
- Location 2: Area 6 – Tweezer Substation (2A6TW)
- Location 3: Area 2 – Valley Substation (3A2VA)
- Location 4: Area 25 – Jackass Flats Substation (4A25JF)
- Location 5: Area 18 – Stockade Wash Substation (5A18SW)

The candidate ARD locations to be subjected to ranking by the AOA are outside of defined exclusion areas and are generally favorable locations based on the established, desired preferences for site suitability. Common attributes for these potential locations are proximity (less than 5 miles) to electrical services and primary roads to preclude excessive costs for new infrastructure capabilities.

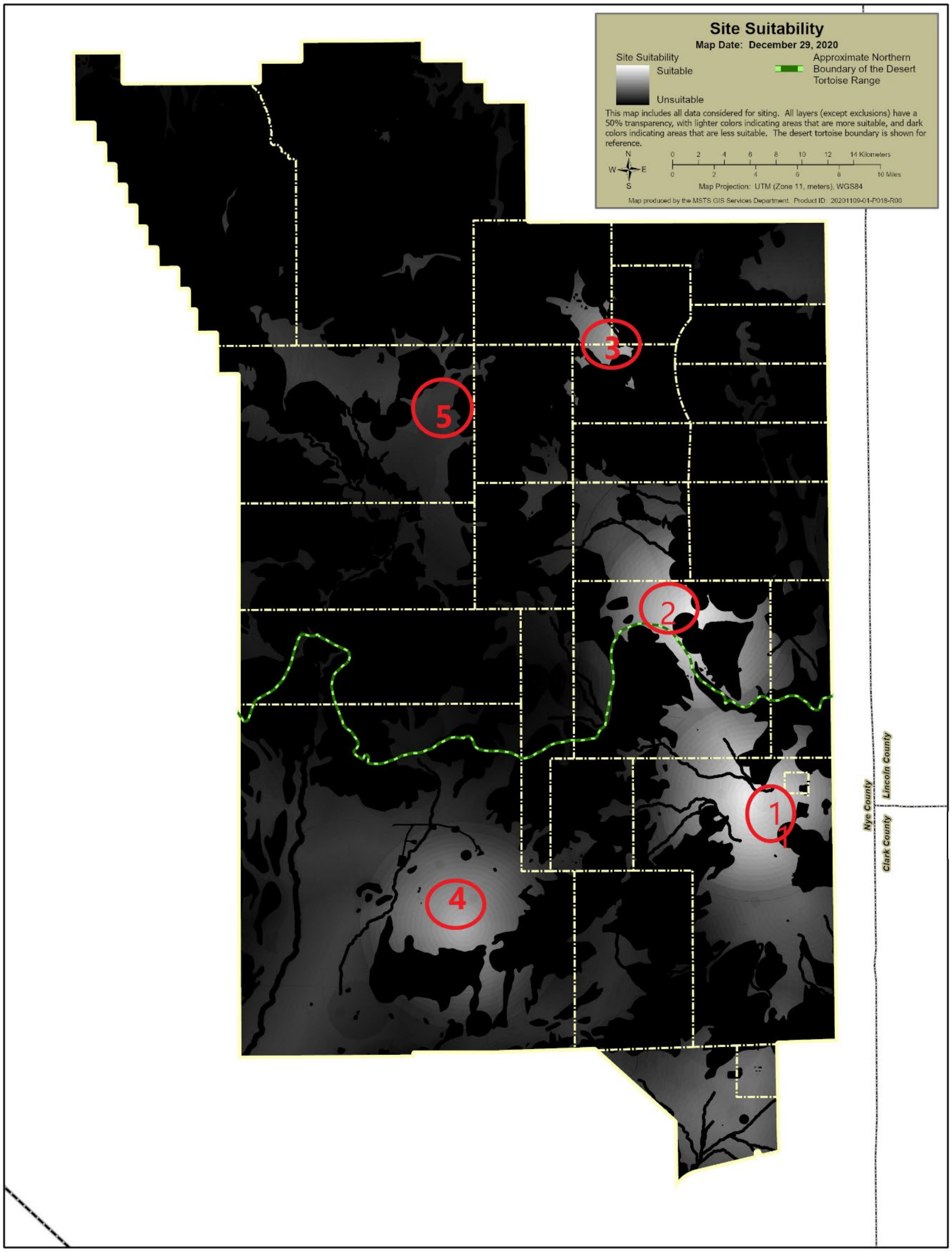

Figure 3-27. Site Suitability Locations for ARD Activities.

3.7.2 Candidate Location AOA Methodology

Candidate ARD locations were subjected to an AOA using the derived weighted evaluation factors. IPT members assigned a value of 10–0 to a candidate location based on how well the location scored against each of the established evaluation factor categories. Individual IPT members only scored the evaluation factors where they could provide informed input based on their knowledge and experience. The 10–0 scale is defined as follows:

- 10 = Candidate location is advantageous for most evaluation factors
- 5 = Candidate location is advantageous for many evaluation factors
- 1 = Candidate location is advantageous for some evaluation factors but has some limitations for some evaluation factors
- 0 = Candidate locations have disadvantages for some evaluation factors that render the location more undesirable than desirable.

The values assigned by each IPT member were then multiplied by the evaluation factor weighting factors, and these products are summed to provide an overall score for each candidate site. The AOA matrixes prepared by each IPT member were subsequently consolidated to provide an average score based on the number of IPT member responses. The candidate locations with the resulting highest scores are the most advantageous and ranked accordingly. A lower score does not necessarily eliminate a candidate location from future consideration but simply indicates it is less preferable based on the methodology used for this ARD siting study. Table 3-4 provides the structure of the AOA comparison of candidate locations.

Table 3-4. AOA Matrix for Candidate Location Ranking.

AOA MATRIX	CANDIDATE ARD LOCATIONS										
Evaluation Factor Categories:	WEIGHT %	1A5FF		2A6TW		3A2VA		4A25JF		5A18SW	
		Score	Value	Score	Value	Score	Value	Score	Value	Score	Value
A. Land Use	11.0										
B. Infrastructure and Energy	14.5										
C. Transportation and Traffic	5.2										
D. Radiological / Environmental Restoration Considerations	11.2										
E. Accident Analysis / Emergency Planning Considerations	11										
F. Site Geology, Seismology, and Soil-Geotechnical Properties	17.8										
G. Hydrology and Related Considerations	7.2										
H. Terrestrial / Ecology / Impacts to Habitat and Wildlife	8.1										
I. Air Quality and Other Resource Impacts (e.g., Historic and Cultural Resource Considerations)	5.6										
J. Security Considerations	8.4										
TOTALS	**100**										
RANK											

Scoring Definitions for A to J:
10 = Candidate location is advantageous for most evaluation factors.
5 = Candidate location is advantageous for many evaluation factors.
1 = Candidate location is advantageous for some evaluation factors but has some limitations for some evaluation factors.
0 = Candidate location has disadvantages for some evaluation factors that render the location more undesirable than desirable.

3.7.3 AOA Results

Table 3-5 provides the consolidated AOA Matrix results. These results established the relative ranking of candidate locations for ARD activities, with one being the highest or most preferred, based on the established evaluation factors. The AOA Matrix results also provide insights on the relative strengths or weaknesses of the candidate locations to specific evaluation factor categories allowing for the tailored consideration of the locations based on the specific needs and requirements of ARD activities desired to be performed.

Table 3-5. Consolidated AOA Matrix for Candidate Location Ranking.

AOA MATRIX	CANDIDATE ARD LOCATIONS						
Evaluation Factor Categories:	WEIGHT %	# of Responses	1A5FF Average Score	2A6TW Average Score	3A2VA Average Score	4A25JF Average Score	5A18SW Average Score
A. Land Use	11.0	6	91.7	58.7	91.7	100.8	75.2
B. Infrastructure and Energy	14.5	5	145.0	145.0	66.7	66.7	40.6
C. Transportation and Traffic	5.2	6	43.3	27.7	16.5	35.5	8.7
D. Radiological / Environmental Restoration Considerations	11.2	6	93.3	93.3	102.7	112.0	112.0
E. Accident Analysis / Emergency Planning Considerations	11	5	30.8	39.6	68.2	79.2	99.0
F. Site Geology, Seismology, and Soil-Geotechnical Properties	17.8	3	118.7	178.0	89.0	178.0	17.8
G. Hydrology and Related Considerations	7.2	5	46.1	46.1	23.0	44.6	38.9
H. Terrestrial / Ecology / Impacts to Habitat and Wildlife	8.1	5	13.0	48.6	81.0	21.1	64.8
I. Air Quality and Other Resource Impacts (e.g., Historic and Cultural Resource Considerations)	5.6	3	46.7	46.7	56.0	56.0	56.0
J. Security Considerations	8.4	4	73.5	54.6	52.5	63.0	52.5
TOTALS	**100**		702.0	738.3	647.2	757.0	565.4
RANK			3	2	4	1	5

3.7.4 Radiological Dispersion Analysis

3.7.4.1 *Overview*

A radiological dispersion analysis was performed with the intent of demonstrating the distance to the LPZ would remain within the boundaries of the NNSS for the candidate ARD locations. In terms of reactor siting, 10 CFR 100, Reactor Siting Criteria considers "a low population zone of such size that an individual located at any point on its outer boundary who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a total radiation dose to the whole body in excess of 25 rem or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure." The analysis was done using version 3.0.2 of the HotSpot Health Physics code. HotSpot calculates the radiological exposure to a target individual who remains at the same downwind location throughout the passage of the plume and has the capability to determine the committed dose equivalent to organs.

3.7.4.2 *Methodology*

The respirable source term is calculated using the following formula:

Respirable Source Term = MAR x DR x LPF x ARF x RF; where:

- Material at risk (MAR) is the total quantity of the radionuclide involved in the release scenario
- Damage ratio (DR) is the fraction of the MAR that is actually impacted in the release scenario
- Leakpath factor (LPF) is the fraction of the MAR that passes through some confinement or filtration mechanism
- Airborne release fraction (ARF) is the fraction of the MAR that is aerosolized and released to the atmosphere
- Respirable fraction (RF) is the fraction of aerosolized material that is respirable (aerodynamic diameter (AD) ≤ 10 microns).

Table C.3 of NRIC-21-ENG-001 (PNNL-30992) provides the maximum and average radionuclide activity for radionuclides with potential mobility at the end of operation for microreactors. This radiological release inventory was used in conjunction with the parameters in Table 3-6 as inputs into HotSpot to calculate receptor doses.

Table 3-6. Radiological Dispersion Analysis Parameters.

Parameter	Assumption / Value	Rational
Core Size	Five metric tons	Initial fuel loading for Microreactor given in PPE
Accident Type	Large loss of coolant accident (LOCA)	Regulatory Guide 1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors* indicates an accident source term is intended to represent a major accident involving significant core damage and is typically postulated to occur in conjunction with a large LOCA.
Release Type	Non-buoyant, ground level, point source release	Required by DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Document Safety Analysis* for ensuring conservative calculation of offsite doses using a DOA approved toolbox code (e.g., HotSpot).
Consequence Calculation	Plume centerline concentrations for calculation of dose consequences	
Dispersion Coefficients	Rural dispersion coefficients. HotSpot using Briggs open-country dispersion coefficients	
Deposition Velocity	0.1 cm/sec for unfiltered release of particles (1–10 µm Aerodynamic Equivalent Diameter); 0 cm/sec for tritium/noble gases	
Surface Roughness	3 cm	
Weather Conditions	F-stability class (moderately stable), wind speed of 1 m/s	
Breathing Rate	3.3E-04 m^3/s	Recommended value in DOE-STD-3009-2014.

Parameter	Assumption / Value	Rational
Dose Conversion Factor (DCF)	HotSpot DCF library from Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*	Newer dose coefficients provided by HotSpot.
DR	1.0	The conservative assumption is all MARs are affected by postulated accident.
LPF	.01	10 CFR 50.34(a)(1)(ii)(D) indicates an applicant shall perform an evaluation and analysis of the postulated fission product release, using the expected demonstrable containment leak rate and any fission product cleanup systems intended to mitigate the consequences of the accidents. An LPF of .01 is deemed to be reasonably conservative for containment leak rate.
ARF X RF	Noble gases: 1.0 Halogens: 0.4 Alkali metals: 0.3 Tellurium group: 5.0E-02 Barium, strontium: 2.0E-02 Noble metals: 2.5E-03 Tritium: 1.0	The values for ARF x RF except for tritium are from RG 1.183 for a pressurized water reactor LOCA release for the types of radionuclides involved in the release. The value for tritium is from ANSI/ANS-5.10, *Airborne Release Fractions at Non-Reactor Nuclear Facilities* for tritium as water at temperatures > 200°C to 600°C.

3.7.4.3 ***Results***

The results of the radiological dispersion analysis indicate the LPZ distance to be less than 6 kilometers (km). Figure 3-28 provides the calculated total effective dose (TED) for a 5 metric tons of heavy metal (MTHM) microreactor as a function of distance using the maximum and average radionuclide activity from Table C.3 of NRIC-21-ENG-001 (PNNL-30992). At 6 km, the calculated TED using the maximum radionuclide activity is calculated to be less than the 25-rem criterion for the LPZ. Figure 3-29 shows the calculated committed dose equivalent to the thyroid associated for a 5-MTHM microreactor with the maximum radionuclide activity for iodine releases. This calculation shows that the LPZ criteria from iodine exposure is not exceeded at 4 km. Therefore, based on the assumptions for this analysis (Table 3-6), it is expected that the LPZ remain within the boundaries of the NNSS for candidate site locations that are 6 km to the nearest NNSS site boundary.

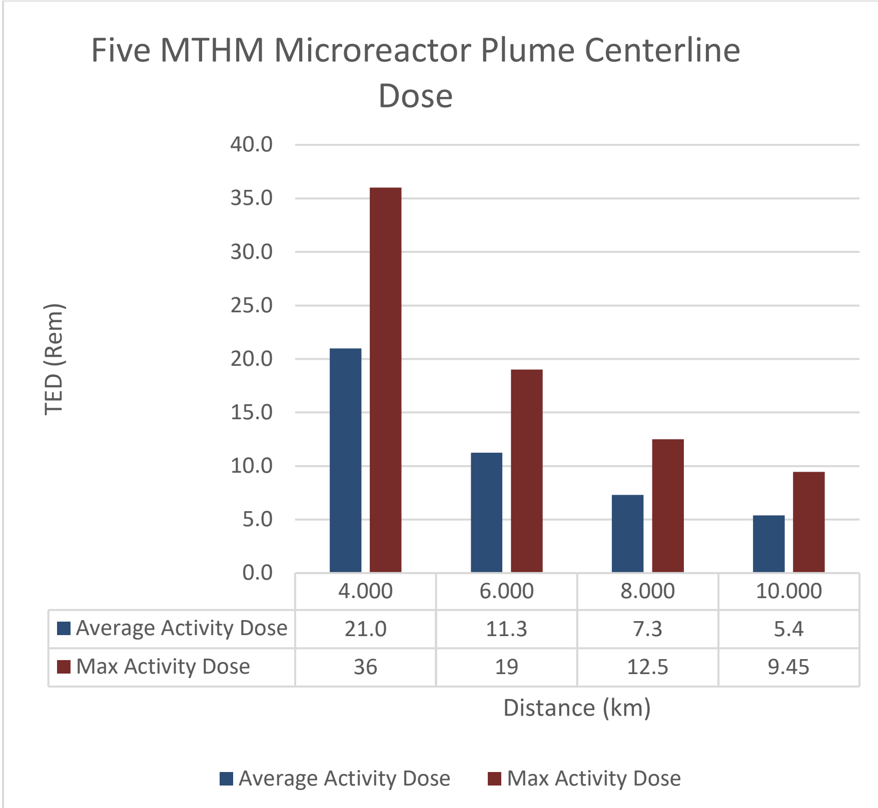

Figure 3-28. Microreactor Plume Centerline Dose for LPZ Determination.

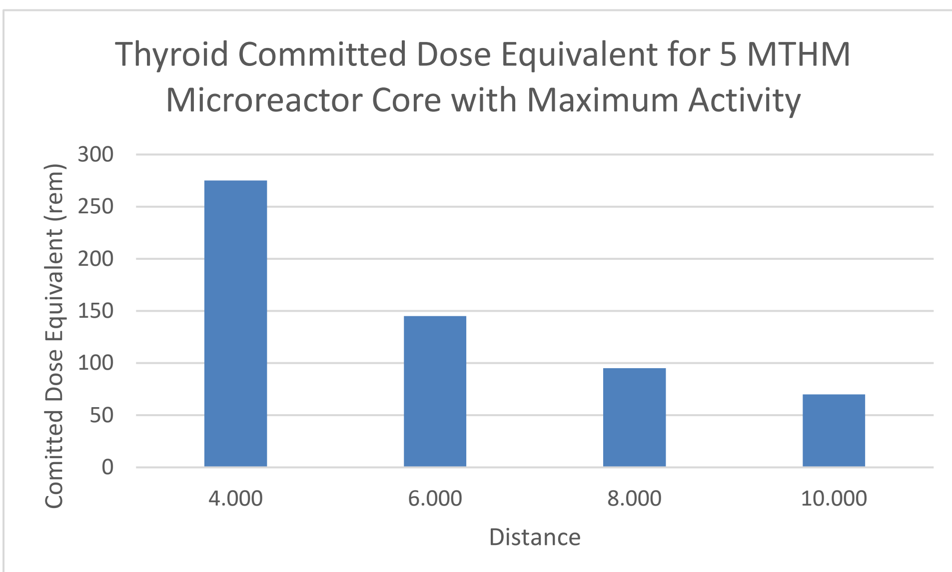

Figure 3-29. Microreactor Thyroid Committed Equivalent Dose for LPZ Determination.

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4. RESULTS AND DISCUSSIONS

4.1 Preferred ARD Locations

The preferred ARD locations are outside of the defined exclusion areas established by this study and have features that demonstrate their suitability for siting ARD activities based on the geospatial preference criteria evaluated with the use of NNSS GIS mapping capability. The AOA analysis supplements the site suitability map by allowing for a qualitative evaluation of the siting related evaluation factors using the expertise of the IPT.

4.1.1 Area 25 – Jackass Flats Substation

The proposed candidate location is in Area 25 of the NNSS near the Jackass Flats Substation in an area designated as a reserved land-use zone.

4.1.1.1 *Positive Attributes*

The proposed location near the Jackass Flats Substation ranked relatively high for following evaluation factor categories: (1) land use; (2) transportation and traffic, (3) radiological/environmental restoration considerations; (4) accident analysis/emergency planning C\considerations; (5) site geology, seismology, and soil-geotechnical properties; (6) air quality and other resource impacts; and (7) security considerations.

The proposed location is in a reserved land-use zone that is consistent for its potential use for ARD activities. Sufficiently available land exists to support the permanent and temporary (construction) desired by the PPE for ARD activities. Using this location would optimize this land-use zone by providing new research and development in a currently underutilized area of the NNSS, and could complement future envisioned missions (e.g., solar demonstration projects) through shared utility systems. The location is sufficiently isolated from other mission facilities to preclude adverse safety and security impacts and is the second closest location to the entry gate to NNSS providing for more ease of access and transportation of materials. The location is also within reasonable proximity (less than 25 minutes) of the Mercury Fire Station and Medical Facility. The proximity to the Mercury Campus also enhances other logistic considerations such as food and housing. The proximity to the Jackass Flats Substation provides access to a 138-kV power supply and the electrical transmission network. The location is in an area of alluvial sediments and has flat terrain enabling construction. The relative proximity to Yucca Mountain, as opposed to other candidate sites, may enhance applying the results of the Level 4 Yucca Mountain PSHA to this location although there are differences in the geologic medium between the sites (i.e., Tuff versus Alluvium). The site is near a Meteorological Data Acquisition (MEDA) tower to obtain relevant data for use in characterizing atmospheric dispersion conditions and approximately a distance of 8 km from the site boundary. There are no nearby airstrips to this location. The location is within the Alkali Flat-Furnace Creek groundwater basin, which is decoupled from the groundwater basin for Devils Hole reducing the likelihood of impacts on the endangered pupfish. NNSS SWEIS data suggests a higher sustainable yield for this groundwater basin indicating a higher quantity of groundwater that can be withdrawn from the basis on an annual basin without depleting the basin and considering water rights already committed to others. Also, this area is distant from established corrective action units for groundwater contamination from past underground nuclear testing precluding impacts on known contaminant boundaries.

4.1.1.2 *Potential Location Specific Constraints*

The proposed location near the Jackass Flats Substation ranked relatively low for following evaluation factor categories: (1) infrastructure and energy, and (2) terrestrial/ecology/impacts to habitat and energy.

A new water well would be needed to support ARD activities at this location because at present water is unavailable. This site historically had four water wells, but recent failures and past well retirements have made water service unavailable at present. The Nevada State Engineer issued an order in 2008 stating that, with some exceptions, they will deny permits to withdraw water within a 25-mile radius of Devils Hole. Therefore, the new water well will need to be outside of this established radius. There are future prioritized projects to restore water services in this area. This location is also within the tortoise habitat that would require evaluation and response in accordance with the established biological opinion. The location is within the EPZ of the Port Gaston high-hazard facility that conducts hazardous material experiments.

4.1.2 Area 6 – Tweezer Substation

The proposed candidate location is in Area 6 of the NNSS near the Tweezer Substation in an area designated as a reserved land-use zone that borders the nuclear test land-use zone.

4.1.2.1 *Positive Attributes*

The proposed location near the Tweezer Substation ranked relatively high for following evaluation factor categories: (1) infrastructure and energy; (2) transportation and traffic; (3) site geology, seismology, and soil-geotechnical properties; (4) hydrology and related considerations; and (5) terrestrial/ecology/impacts to habitat and wildlife.

A key strength of this location is its proximity to the required infrastructure (e.g., roads, power, and water) to support ARD activities. The site is within a water service area that can meet a PPE flowrate demand of 450 gpm. The Tweezer Substation is centrally located within the NNSS hub-and-spoke electrical grid providing for the redundancy, and this substation provides both a 138 kV and 34.5 kV electrical supply. The location is in proximity to the F&R Station 2 (less than 5 minutes), and adjacent to the Area 6 Construction facility infrastructure providing access to maintenance shops and a cafeteria. The location is readily accessible to the Mercury Highway and the third shortest distance to the NNSS entry gate. The location is along the defined mission corridor of the site providing greater accessibility to energy and communications services. The location is also within reasonable proximity (less than 40 minutes) of the Mercury Fire Station and Medical Facility. The location is not within an EPZ of a nearby facility and approximately 10 km from the site boundary. The location is an area of alluvial sediments and has flat terrain enabling construction. The site is in proximity to a MEDA tower to obtain relevant data for use in characterizing atmospheric dispersion conditions and may be able to leverage the MEDA data previously collected for radiological dispersion modeling at nearby nuclear facilities (i.e., DAF and U1 Complex). The location is just outside the range of the tortoise and known to be poor tortoise habitat in general.

4.1.2.2 *Potential Location Specific Constraints*

The proposed location near the Tweezer Substation ranked relatively low for following evaluation factor categories: (1) land use; (2) radiological/environmental restoration considerations; (3) accident analysis/emergency planning considerations; (4) air quality and other resource impacts; and (5) security considerations.

Although this location is in an appropriate land-use zone (i.e., reserve) and has the desired space for ARD activities, there are concerns that conflicts could arise with nearby facilities. The proposed location is between the Nuclear Hazard Category 2 DAF (approximately 5.2 miles away) and the U1a Complex (approximately 2.3 miles away). The relative proximity of ARD activities to these nuclear facilities may create new external event considerations that need to be addressed documented safety analyses for these existing nuclear facilities. The U1a Complex is currently performing several high-priority significant modifications through line item capital acquisition projects including a U1a Complex Enhancement Project to provide enhanced capabilities for subcritical experiments. These projects include required power system upgrades that may create conflicts with the power needs for ARD activities. This location is also in a high-traffic area for personnel, and near transportation routes for movement of materials for national security missions that could create traffic congestion and incremental security considerations. This latter concern could be exacerbated by short-term increases in personnel for ARD construction activities who are uncleared (no security clearance). This location is within the Ash Meadows groundwater basin that also provides a source of water to Devils Hole where the endangered pupfish reside. This groundwater basin has an identified high-transmissivity corridor that facilitates how fast and far a pumping signal propagates through an aquifer. The underlying concern is that prolonged high-flowrate pumping drawdown in support of ARD activities may propagate through the high-transmissivity corridor, impacting water levels at Devils Hole and the pupfish. The SWEIS indicates this groundwater basin also has a lower sustainable yield raising concerns for its timely replenishment to sustain water levels.

4.1.3 Area 5 – Frenchman Flat Substation

The proposed candidate location is in Area 5 of the NNSS near the Frenchman Flats Substation in an area designated as a reserved land-use zone.

4.1.3.1 *Positive Attributes*

The proposed location near the Frenchman Flats Substation ranked relatively high for following evaluation factor categories: (1) land use; (2) infrastructure and energy; (3) transportation and traffic; (4) site geology, seismology, and soil-geotechnical properties; (5) hydrology and related considerations; and (6) security considerations.

The proposed location is in a reserved land-use zone that is consistent for its potential use for ARD activities. Sufficiently available land exists to support the permanent and temporary (i.e., construction) desired by the PPE for ARD activities. This location provides both availability and proximity to desired water, power, and road infrastructure. The site is near a water service area that can meet the PPE flowrate demand of 450 gpm. The Frenchman Flats Substation is centrally located within the NNSS hub-and-spoke electrical grid providing for the redundancy, and this substation provides both a 138 kV and 34.5 kV electrical supply. This substation has a spare transformer that can be used for ARD activities. The location is near the Area 5 Radioactive Waste Management Complex minimizing the travel distance for any low-level waste generated by ARD activities. The location is also the shortest distance to the entrance of the NNSS. The location is near the Mercury Highway and is approximately 15 minutes from both fire stations and the Mercury Medical Facility. The location is near the defined mission corridor of the site providing greater accessibility to energy and communications services. The proximity to Mercury Campus also enhances other logistic considerations such as food and housing. The location is an area of alluvial sediments and has flat terrain enabling construction. The site is near two MEDA towers to obtain relevant data for use in characterizing atmospheric dispersion conditions.

4.1.3.2 *Potential Location Specific Constraints*

The proposed location near the Tweezer Substation ranked relatively low for following evaluation factor categories: (1) radiological/environmental restoration considerations; (2) accident analysis/emergency planning considerations; (3) terrestrial/ecology/impacts to habitat and wildlife; and (4) air quality and other resource impacts.

Although this location is in appropriate land-use zone (i.e., reserve) and has the desired space for ARD activities, there are concerns that conflicts could arise with nearby facilities. The location is within the EPZ of the Nonproliferation Test and Evaluation Complex High-Hazard Facility that conducts hazardous material experiments in the open atmosphere. The location is also near the EPZ of the Area 5 Radioactive Waste Facilities. The relative proximity of ARD activities to the Area 5 Radioactive Waste Management Complex (approximately 3 kilometers) may create new external event considerations that would need to be addressed in the Documented Safety Analysis for these existing nuclear operations. This location is also the closest of the ARD locations to the site boundary (approximately 5 kilometers) resulting in the highest relative radiological consequences for any postulated accidents. This location is within tortoise habitat that would require evaluation and response in accordance with the established biological opinion. In addition, this location is within the Ash Meadows groundwater basin with the concern that prolonged high-flowrate pumping drawdown in support of ARD activities may propagate through the high-transmissivity corridor, impacting water levels at Devils Hole and the pupfish. The SWEIS indicates this groundwater basin also has a lower sustainable yield raising concerns for its timely replenishment to sustain water levels. The location is also near an area with past identified UXO.

4.1.4 Area 2 – Valley Substation

The proposed candidate location is in Area 2 of the NNSS near the Valley Substation in an area designated as a nuclear and HE land-use zone.

4.1.4.1 *Positive Attributes*

The proposed location near the Valley Substation ranked relatively high for following evaluation factor categories: (1) land use; (2) accident analysis/emergency planning considerations; (3) terrestrial/ecology/impacts to habitat and wildlife; and (4) air quality and other resource impacts.

The proposed location is in a nuclear and HE land-use zone that is consistent for its potential use for ARD activities. Sufficiently available land exists to support the permanent and temporary (construction) desired by the PPE for ARD activities. The location is an area of alluvial sediments and has flat terrain enabling construction. The nearby Valley Substation is centrally located within the NNSS hub-and-spoke electrical grid providing for the redundancy, and this substation provides both a 138 kV and 34.5 kV electrical supply. This portion of the electrical grid has an extension to wheel power to the AFB. The location is near Rainer Mesa's primary road for accessibility. The site is approximately 10 kilometers from the nearest site boundary to minimize postulated radiological consequences. The location is not within tortoise habitat.

4.1.4.2 *Potential Location Specific Constraints*

The proposed location near the Valley Substation ranked relatively low for following evaluation factor categories: (1) infrastructure and energy; (2) transportation and traffic; (3) site geology, seismology, and soil-geotechnical properties; (4) hydrology and related considerations; and (5) security considerations.

Water services at this location are currently insufficient to support ARD activities. There is a nearby transient water system with an operating well in Area 18 that supplies water to Area 12 that includes some piping near the proposed location in Area 2. This location is relatively remote (approximately 38 miles from the NNSS access gate) with an approximate travel time of an hour to reach Mercury. As a result of this remoteness, emergency fire response is less timely (approximately 25 minutes from F&R Station 2), and the proximity to supporting energy services (e.g., liquid fuels, natural gas) would be more distant with longer travel times. The remoteness and longer distance from this location to Mercury is also envisioned to degrade the timeliness of logistical support for ARD construction activities. The location would require personnel supporting ARD construction and operations activities to travel past NNSS mission corridor facilities causing more traffic congestions and potentially some incremental security considerations. The remoteness of this site is anticipated to limit the applicability of the data from past seismic studies at Yucca Mountain and DAF. This location may have potential conflicts with known beryllium legacy sites, CAS and/or FFACO subsurface use restrictions based on contamination considerations preference map. There are no MEDA towers in this NNSS area. This location is in the Ash Meadows groundwater basin with the concern that prolonged water drawdown may propagate to the high-transmissivity corridor impacting water levels at Devils Hole and the pupfish. The location is within an EPZ of a nearby facility and near (two to three miles) an area where high explosives (HE) experiments are conducted.

4.1.5 Area 18 – Stockade Wash Substation

The proposed candidate location is in Area 18 of the NNSS near the Stockade Wash Substation in an area designated as a reserved land-use zone.

4.1.5.1 *Positive Attributes*

The proposed location near the Stockade Wash Substation ranked relatively high for following evaluation factor categories: (1) radiological/environmental restoration considerations; (2) accident analysis/emergency planning considerations; (3) terrestrial/ecology/impacts to habitat and wildlife; and (4) air quality and other resource impacts.

The proposed location is in a reserved land-use zone that is consistent for its potential use for ARD activities. Sufficient available land exists to support the permanent and temporary (i.e., construction) desired by the PPE for ARD activities. The location is an area of alluvial sediments supporting construction. The nearby Stockade Wash Substation provides both a 138 kV and 34.5 kV electrical supply. The site is approximately 11 kilometers from the nearest site boundary to minimize postulated radiological consequences and is not in an EPZ of a nearby facility. The location is near Stockade Wash's primary road for accessibility. The location is not within tortoise habitat. There are two MEDA towers within reasonable distance to provide characteristic atmospheric dispersion data. The location is in the Alkali Flat-Furnace Creek Ranch groundwater basin that has a higher relative sustainable yield for water and is decoupled from Devils Hole, reducing the likelihood of potential adverse impacts to pupfish resulting from water drawdown.

4.1.5.2 *Potential Location Specific Constraints*

The proposed location near the Stockade Wash Substation ranked relatively low for following evaluation factor categories: (1) land use; (2) infrastructure and energy; (3) transportation and traffic; (4) site geology, seismology, and soil-geotechnical properties; (5) hydrology and related considerations; and (6) security considerations.

Although this location is in appropriate land-use zone (i.e., reserve) and has the desired space for ARD activities, there are conflicts with ongoing activities that need to be deconflicted. The location is within the geographic boundaries of existing active REOPs for work for other exercises that would require permission from NNSA/NFO and the M&O contractor for the use of this location. Water services at this location are currently insufficient to support ARD activities at the desired flowrate of 450 gpm provided by the PPE. However, there is a transient water system with an operating well in this area. This location is relatively remote (approximately 40 miles from the NNSS access gate) with an approximate travel time of an hour to reach Mercury. As a result of this remoteness, emergency fire response is less timely (approximately 25 minutes from F&R Station 2), and the proximity to supporting energy services (e.g., liquid fuels, natural gas) would be more distant with longer travel times. The remoteness and longer distance from this location to Mercury is also envisioned to degrade the timeliness of logistical support for ARD construction activities. The location would require personnel supporting ARD construction and operations activities to travel past NNSS mission corridor facilities causing more traffic congestions and potentially some incremental security considerations. Additional security considerations may be necessary during work for other exercises currently performed near this location. The location has greater relative slope challenges that may make construction more difficult and the remoteness of this site is anticipated to limit the applicability of the data from past seismic studies. The steeper nearby terrain is anticipated to complicate security protection. The location is also near an area with past identified UXO.

4.2 Other NNSS Capabilities for ARD Activities

This study is focused on candidate locations that can best meet the PPE of microreactors and small- to medium-sized advanced reactors based on available NNSS GIS maps and an analysis of applicable evaluation factors. The NNSS has other capabilities that may support the research and develop for ARD activities. These capabilities were not considered possible locations for full-scale ARD activities because they do not meet PPE structure and layout expectations (e.g., permanent disturbed acreage). However, these unique capabilities may be of value in developing ARD technologies.

4.2.1 Underground Tunnels

The NNSS has several underground mined tunnels. Common attributes of these tunnels are portal(s) for access, mined underground drifts and alcoves (e.g., rooms, open spaces) for experimental operations, and an overburden of rock to the surface level. Historically, selected tunnels were used to provide containment for underground testing that reduces their underground length and have legacy radiological contamination. A NNSS underground facility safety and health program description provides the safety and health requirements for operating and construction activities within the tunnels. The availability of infrastructure (e.g., power, water, and ventilation) within the tunnels varies, and some tunnels are currently inactive and would require some degree of refurbishment or back-fit prior to use to meet current requirements.

Underground tunnels may be of use for ARD activities based on their intrinsic confinement and containment features. Experiments have leveraged these features to preclude radiological releases to the environment. The tunnels are also remotely located and support national security initiatives that are more clandestine in nature. The tunnels are designated as high-hazard facilities whose operational activities are covered within a common NNSS AB document. An established change control process exists for the high-hazard tunnels to evaluate the introduction of new operational activities against the applicable safety documentation, and enable changes, as needed, for new operational activities. Appendix C provides a summary description of selected NNSS tunnels.

4.2.2 DAF

The DAF located with Area 6 of the NNSS is a 100,000 square-foot operating Hazard Category 2 nuclear facility. The DAF is authorized to conduct operations with security Category I nuclear materials and as such is secured by 24-hour guard force and security alarm systems. Key facility features include:

- Facility designed to effectively mitigate primary hazards of HEs and nuclear material.
    - Heavily reinforced concrete structure for blast safety.

  - Buildings designed to confine nuclear material releases.
  - Engineered safety features ensure filtered release.

- Independent buildings (including safety systems) connected by common corridor.
- Facility robustness enables staging/use of large quantities of material.
- Facility remoteness coupled with modern security features ensure secure staging of assets.

The DAF includes the following primary operating areas:

- Assembly Cells (5) with Gravel Gerties: The round assembly cells have gravel roof structures (i.e., Gravel Gerties) designed to expand upward after a HE detonation, then collapse into the building, providing filtration of radioactive material. Other confinement equipment includes blast doors and blast-activated valves that limit propagation of the blast to other areas.
- Assembly Bays (3) and High Bays (4): Used for operations associated with HE and/or special nuclear material (SNM).
- Staging Bunkers (5): Used to stage HE, SNM, and subcritical test assemblies. No actives are performed in these bunkers.
- Radiography Buildings (2): Contain equipment for the radiography of components and assemblies but may also be used for limited operations associated with HE and/or SNM.

A portion of the DAF has been rededicated as the National Criticality Experiments Research Center (NCERC). Other buildings have been modified to perform operations within engineered containment systems such as gloveboxes and a downdraft table providing added flexibility with the types on nuclear material forms that can be safety handled or assembled.

A key advantage of the DAF for ARD activities is an authorized, enabled footprint to perform safely and securely the assemble and disassembly operations with nuclear materials.

Figure 4-1. DAF in Area 6 of NNSS.

4.2.3 NCERC

NCERC within the DAF consists of four critical assemblies with two control rooms within several operational buildings, and other operational buildings used for subcritical experiments and the staging of research materials. A primary sponsor of NCERC is the DOE Nuclear Criticality Safety Program whose mission is to provide sustainable expert leadership, direction, and the technical infrastructure necessary to develop, maintain, and disseminate essential technical tools, training, and data required to support safe, efficient fissionable material operations within the DOE. NCERC provides the following unique capabilities:

- Measurement of fundamental physics constants
    - Nuclear cross sections
- Nuclear weapons science support
    - Actinide properties
    - Weapons safety
- Nuclear nonproliferation and nuclear counterterrorism support
    - Detector development
    - Dosimetry benchmarking
- Criticality safety research and training
    - Benchmarks

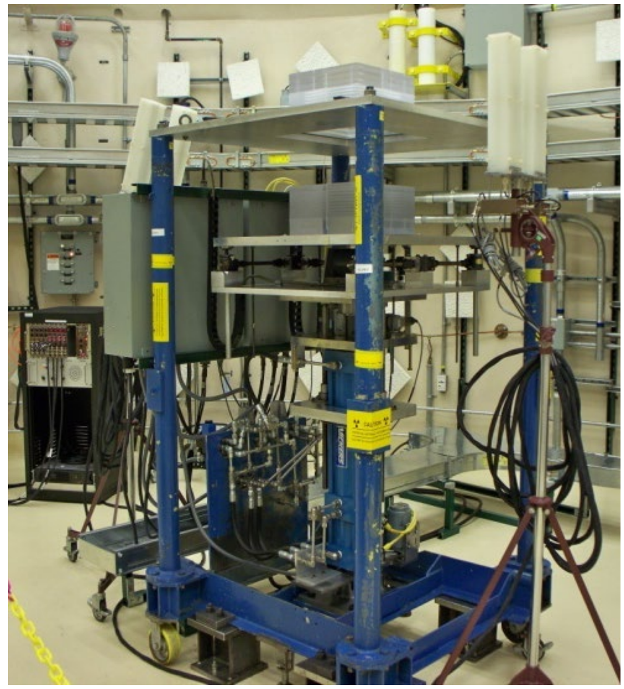
- Temperature coefficients
- Basic and advanced training

NCERC operational capability includes four critical assemblies named Comet, Flat-Top, Godiva, and Planet (Figure 4-2). Comet is a general purpose vertical critical assembly designed to accommodate experiments in which neutron multiplication is measured as a function of separation distance between two experimental components. The Flat-Top critical assembly provides benchmark neutronic measurements in spherical geometry with several different fissile driver materials. The Flat-Top critical assembly is used for fundamental reactor-physics studies and for performing irradiations in the known neutron spectra to provide samples for radiochemical research. The Godiva critical assembly is designed to operate in both the critical and prompt-critical regimes and to produce bursts of fast neutrons. The Godiva critical assembly has fixed fuel components and a permanent structural base. The fuel components are plated and held together by three external C-shaped clamps made from high-performance, ultra-high-strength steel. A hollow steel cylinder is positioned inside the plates to provide a sample cavity. Planet is a general purpose, vertical critical assembly that uses a movable table powered by a hydraulic lift. Planet is used to investigate the criticality characteristics of different geometries and compositions. Both heterogeneous and homogeneous arrangements of fissile materials with different types and quantities of moderator materials can be used.

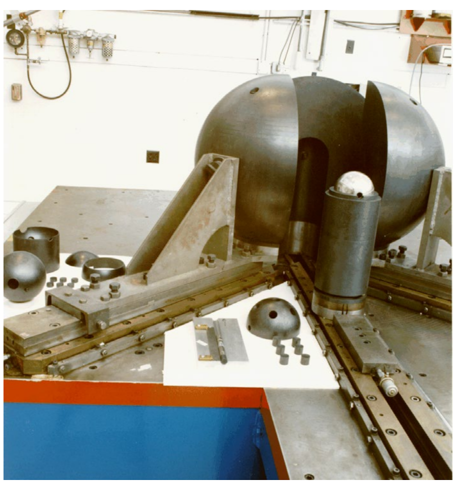
Work done by NCERC in collaboration with NASA demonstrates the capability and agility of the critical assemblies being used for the research and development of fission power systems (FPSs) for space system applications. A successful NCERC experiment named Demonstration Using Flat-Top Fissions (DUFF) provided a proof of concept test for nuclear heated power generation with the objective of producing positive electric power from nuclear heat. The significance of this test was the first ever Stirling engine operation with fission heat, and first ever heat pipe cooled fission experiment. The complete experimental set-up for DUFF is shown in Figure 4-3.

The success of the DUFF experiment was leveraged to pursue a full-scale nuclear ground test, nicknamed “KRUSTY” (i.e., Kilopower Reactor Using Stirling Technology) using nuclear heat power generation with a specially design reactor core, heat pipe thermal transport systems, and Stirling power conversion. The goal of this subsequent experiment was to demonstrate the capability of FPSs to generate power that is scalable in the range of 1 to 10-kilowatt electric enabling both science and human exploration space missions. The KRUSTY experiment was successfully executed using the Comet critical assembly. Figure 4-4 shows a schematic drawing of experiment configurations on the Comet critical assembly.

Comet General Purpose Critical Assembly



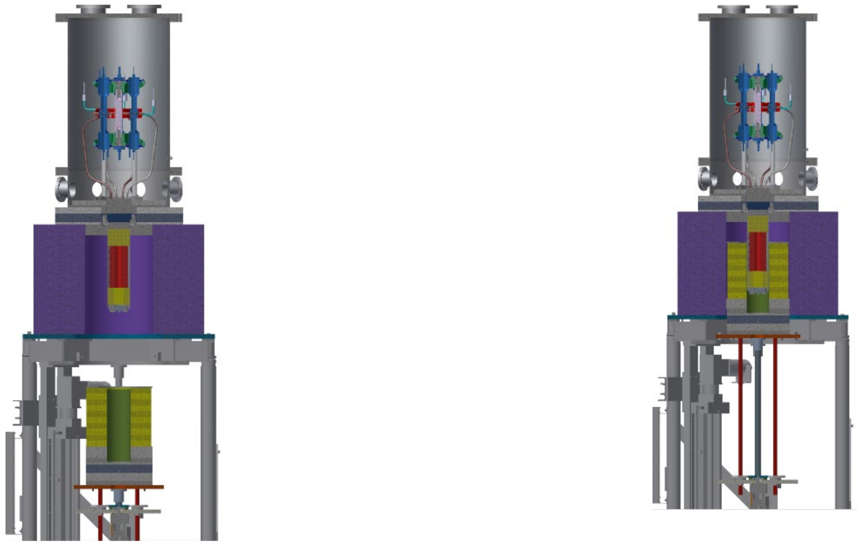
Planet General Purpose Critical Assembly



Flat-Top Critical Assembly

Godiva IV Fast Burst Assembly

Figure 4-2. NCERC Critical Assemblies.



Platen fully withdrawn. Reactor is highly subcritical with the fuel (red) unreflected.

Platen lifts reflector (green) and lower shielding to approach then achieve criticality.

Figure 4-3. KRUSTY Experiment Configurations using Comet Critical Assembly.

4.2.4 External Threat Testing

The NNSS has other high-hazard facilities and constructed past testbeds that may be of value for evaluating external threats to ARD activities. An example of these unique facility capabilities is the Big Explosive Experimental Facility (BEEF) located in Area 4 of the NNSS. The BEEF's primary responsibility is in hydrodynamic research and development testing providing for the study and investigation of explosives characteristics, impacted materials, vehicle born improvised explosives devices, and HEs pulsed power. BEEF offers the availability of high-quality diagnostics apparatus for explosives, and explosives device research and development. BEEF operations include firing site, staging, storing, handling energetic materials (explosives), inspection, experiment device assembly/disassembly and modification for National Weapons Laboratory and other NNSS federal programs. These unique facility capabilities may be of value in evaluating ARD facility structural response to external blast conditions. A unique test recently completed at BEEF was a largescale fuel fire test. This test evaluated the ability of a full-scale mock nuclear configuration to survive a fire under controlled test conditions. This type of testbed may be of value in evaluating simulated fire threats to ARD activities.

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5. CONCLUSIONS

5.1 Suitability of NNSS to Host ARD Activities

The large geographic footprint of the NNSS, encompassing 1,355 miles, and its remote location being approximately 65 miles from Las Vegas, gives the NNSS inherent advances for ARD siting. This vastness and remoteness ensure minimize impacts to the public from postulated releases and facilitates emergency response and planning. The NNSS also has a proven institutionalized facility user model paradigm that enables new projects or users to safely conduct activity level work that is appropriately coordinated with the M&O contractor or other organizational entities holding a primary REOP. It is envisioned this existing paradigm could enable vendors to design, construct, and operate ARD activities on the site in collaborative partnerships.

The NNSS possesses vital infrastructure to support ARD activities including redundant power supplies and paved primary roads to afford access to potential ARD activities. The power infrastructure is unique by having the capability to wheel-through power generated by ARD activities to outside customers including the nearby AFB. The site also has other critical support infrastructure including a continuously manned operations control center, two F&R units, medical facility, and other logistic services (e.g., dormitory housing, cafeterias).

The NNSS is a highly secure site based on the nature of high-hazard and nuclear operations and the types materials that support these operations. Accordingly, a designated security contractor provides the necessary security police officers for round the clock protection of assets. A vulnerability assessment laboratory is in place to evaluate the impact of new activities and ensured the desired level of security protection is preserved for critical mission activities. The radioactive waste facilities within the NNSS provide for the disposal of LLW and MLLW. The use of this internal capability would preclude the need to ship these types of wastes offsite. The NNSS in collaboration with ARL/SORD has an extensive network of MEDA towers throughout the site. This collects real-time and historical meteorological data that can support realistic atmospheric dispersion calculations for ARD siting.

The NNSS has an approved SWEIS for its continued preferred operations. The SWEIS includes supporting the evaluation of operations to ensure potential environment impacts are understood and acceptable. This preexisting SWEIS can be used to evaluate any proposed ARD activities to determine the need for any new environmental analyses and provides a framework and starting point for performing incremental environmental analyses. The use of a preexisting SWEIS to evaluate new activities is perceived to be advantageous over sites without an SWEIS who would not be able to leverage preexisting EA information to evaluate new proposed activities.

The outcome of this study determined that the NNSS has several candidate locations that can host ARD activities and other capabilities that may aid in the research and development ARD technologies. Leveraging the capability and available data within the NNSS GIS, five potential locations were identified for ARD activities and ranked based on how well they met the established weighted evaluation factors developed for this study. The five locations were all outside the defined exclusion areas defined in this study, thereby satisfying "must" evaluation factor considerations related to surface geology, drainage, and being outside of areas of past nuclear testing, radiological contamination, environmental restrictions, and other land-use restrictions. Moreover, these locations were determined to be the more suitable locations for hosting ARD activities using GIS maps based on their ability to meet siting preferences. These siting preferences aided in identifying locations that are more favorable for ARD siting based on availability and proximity to existing infrastructure (i.e., power, roads, and water), desired slope of terrain, distance from seismic faults, minimizing ecological impacts, and remaining a sufficient distance from areas with known historic or controlled hazards (e.g., areas of potential UXO ordinance, energetic materials storage, and CAS).

The NNSS has other unique capabilities that can support the research and development of ARD activities. Several underground tunnels exist throughout the NNSS. By the nature of their construction with limited-access portals, and an overburden of rock and tunnels provide a secluded area to perform operations with inherent confinement features presented by an underground working environment. The DAF provides an operating Hazard Category 2 nuclear facility with modern security features with a mission enabled operating footprint and capabilities that can safely and securely perform assembly/disassembly of nuclear materials for ARD activities. The NCERC within the DAF possess four critical assemblies that can be used to assess the properties of reactor materials and designs in a manner similar to how they have been applied for proving NASA FPSs designs. The NNSS has other unique capabilities such as BEEF for HE testing that may provide an opportunity for external threat testing.

5.2 AOA Outcomes, Limitations, and Uncertainties

The NNSS GIS provided an effective and objective means to identify suitable candidate ARD locations within the spacious NNSS using layered maps that provided explicit criteria for siting exclusions and preferences. The AOA supplemented this extensive use of maps by providing a systematic approach to rank the candidate ARD locations using siting related evaluation factors derived from various regulatory sources that were weighted using the expertise of a multi-disciplinary IPT to derive their perceived relative importance. The resulting consolidated AOA Matrix provides the outcome of an assessment of how well the candidate sites meet each of the weighted evaluation factor categories.

The AOA outcome ranks the candidate sites and gives their positive attributes and potential constraints. These results are best applied by the tailored consideration of the specific needs and requirements of the ARD activities that are desired to be performed. For example, the Jackass Flats Substation site ranked as the most preferred site based on being in an area of the NNSS that would remove conflicts with mission facilities along the Mercury Highway and could complement envisioned future missions. However, this location was not optimal in terms of meeting the water demand in the PPE. If the water demand became a predominant consideration for the specific needs of an ARD activity, then another location might be more suitable (Tweezer and Frenchman Flats Substation locations) given that the desired water use can be sustained with no adverse environmental impacts.

A limitation of the AOA is that it involves a subjective assessment of how well the candidate sites meet the established, weighted evaluation factors and is dependent on available information and the application of IPT expertise to make informed decisions. This limitation was mitigated by assembling an IPT with the requisite subject matter expertise and engaging the IPT in all aspects of the study including the derivation of evaluation factors, use of maps, and location comparison using the AOA Matrix. This engagement using a structured methodology produces a study outcome that is non-biased and credible.

For the comparative assessment of selected evaluation factors, the expertise provided by the M&O contractor IPT is limited because the required expertise is provided by outside organizations. For example, evaluations of cultural resource sites or historic preservation sites and the identification of high-predictive archaeology zones are performed by a separate technical research, engineering, and development services (TREDS) contractor, presently DRI. Similarly, the USGS conducts groundwater transport modeling that could aid in the better understanding of impacts on the groundwater basin from desired water usage. The lack of specialized expertise for selected evaluation factors does introduce some uncertainties for the study results. These uncertainties can be addressed by engaging additional expertise during the siting and screening process if the NNSS is selected to host ARD activities.

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6. RECOMMENDATIONS

6.1 Use of AOA Results for ARD Siting and Screening

The results provided by this study provide the foundational groundwork to make informed decisions on the compatibility of ARD activities with existing programs and available NNSS resources. The results also provide insights on the capability of the NNSS to fulfill the needs of ARD activities as established by the PPE, and the basis for siting ARD activities within specific locations within the NNSS based on documented evaluation factors and the application of comprehensive mapping to determine suitable locations. If the NNSS is selected to host ARD activities, the study results should be used as an input to the established program/project screening process to support the development of a documented proposal to conduct specific ARD activities for M&O contractor concurrence and NNSA/NFO approval. The study results should also be used to match the requirements of the specific ARD activity desired to be performed to the location that best satisfies these requirements.

6.2 Additional NNSS Factors and Timing for Hosting ARD Activities

A key factor associated with hosting ARD activities is the timing and completion of required NEPA documentation. The NEPA review process at the NNSS, as described in CD-1000.004, entails the completion of a NEPA Environmental Checklist form. The form includes a declaration with supporting details if the proposed project involves preliminary environmental considerations in areas such as waste, HAZMAT , air emissions and site location/other (e.g., cultural/historic resource area). These documented consideration impacts are reviewed by the NNSA/NFO NEPA Compliance Officer who makes the determination if the proposed project is included in the NNSS SWEIS and associated ROD, or other NEPA document. If the project is not addressed in these environmental documents, the NNSA/NFO NEPA compliance officer determines the appropriate NEPA implementing document course of action in accordance with Subpart D of 10 CFR 1021, *National Environmental Policy Act Implementing Procedures* that could include but is not limited to an EA or an EIS. This determination is documented on the NEPA checklist and serves to provide the level of additional environmental review and analysis.

The NEPA checklist is completed as early as possible during the planning stage of each project or activity with a minimum of four months typically being allowed for the NEPA checklist to be processed and approved. However, this processing time does not account for the time to evaluate and document the environment considerations imposed by the proposed project. An example of an environmental consideration that requires advanced planning is the cultural/historic resource area that requires coordination with DRI who serves as the TREDS contractor. This process described in CD-0700.001, *Planning, Prioritizing, and Scheduling Activities Requiring Cultural Resource Evaluation*, entails advanced planning where annually, generally in the April timeframe a prioritized integrated planning list is prepared that documents all known organizational undertakings/activities planned for execution in the coming fiscal year that may require cultural resource evaluation. This list is coordinated at an annual integration meeting with NNSA/NFO and DRI to communicate the next fiscal year's projects requiring cultural resource evaluation. DRI will evaluate the project to determine if the scope of the project is already covered within the scope of existing documents or is exempted from cultural resource evaluation in accordance with executed agreement documents such as Memoranda of Agreements and Programmatic Agreements. If the project(s) are not already covered, DRI will develop fiscal year task plans and budget to address the needed cultural resources work scope that are reviewed and approved by NFO to enable the execution of the work scope of the upcoming fiscal year. The completed cultural resource evaluation for the area of potential impact requires additional coordination and time depending on the results. This could include a nominal timeframe of 30 days to ensure no objection from the Nevada State Historic Preservation Office (SHPO) if no historic properties are present or affected, or a more prolonged time period for additional assessment and mitigation with the SPHO and other stakeholders if adverse effects are determined for the project. These cumulative timeframes dictate preplanning for cultural resource reviews nine to 12 months in advance.

Advanced planning may also be needed for the biological/tortoise resource area. There is an established biological opinion with FWS for permanent disturbances to tortoise habitat. M&O contractor actions associated with this biological opinion and biological considerations are described in CD-0732.001, *Conservation and Protection of Biological Resources*. These actions require the completion of a Biological Resource Compliance worksheet. If it is determined the project will impact biological resources, up to 135 days is allowed for coordination with FWS for approval.

The transmission of power to external customers by being wheeled through the NNSS Power System may require the M&O contractor to register as a transmission operator with NERC or the WECC. Also, the incorporation of power generating capability from ARD activities may require the M&O contractor to become designated as a generator operator. Both these designations, if required in the future, would require time and funding to comply with incremental expectations and requirements.

A challenge identified in this study is the ability to meet the PPE water demand of 450 gpm. Although this study identified locations that can meet this demand (locations near Tweezer and Frenchman Flats Substations), these locations are located within a groundwater basin with a high-transmissivity corridor that promotes how fast and far a pumping signal can propagate through an aquifer with potential impacts to an offsite endangered aquatic species. This groundwater basin also has a lower sustainable yield to sustain water levels against higher drawdown rates. It is anticipated that groundwater modeling would need to be done to determine the impact of water removal fulfilling ARD requirements on the basin. The capability to perform this evaluation exists with ongoing collaboration with the USGS. Another consideration for high-water usage rates is the potential to create a forced gradient on groundwater that could impact the model-based estimation of groundwater contamination from historic underground nuclear testing. Similarly, the capability exists to update groundwater flow and transport models to ensure no unacceptable change in known contaminant boundaries.

6.3 Application of NNSS Capabilities for ARD Activities

The NNSS is a unique outdoor, indoor, and underground experimentation and training user facility located in a remote, highly secure area of southern Nevada. As an integral component of the United States (U.S.) National Security Enterprise, the NNSS provides applied engineering innovation, high-hazard test and evaluation, and operating services for the U.S. Government and its allies. The vision of the NNSS is to be the preferred national security user-site for largescale, high-hazard experimentation with premier facilities and capabilities below ground, on the ground, and in the air. Support of ARD activities fits with both the NNSS vision and capabilities.

The NNSS is primarily a user-site for high-hazard experimentation. A core capability associated with this role is to provide engineering test, evaluation, verification, and validation services. Accordingly, the NNSS maintains and provides user facilities, testbeds, equipment, diagnostics, technical services, and support services to the using community (typically scientists from the national laboratories or other government customers). The NNSS has demonstrated success in creating innovative testbeds with supporting diagnostics to capture data for technically complex demonstration tests or simulations associated with national security missions.

This study has shown that the NNSS has suitable locations to host ARD activities. These viable locations coupled with the established facility user model paradigm for high-hazard experimentation and enabling operating infrastructure provides an opportunity to integrate new ARD activities with the existing national security mission portfolio conducted at the NNSS. Moreover, existing unique NNSS capabilities such as tunnels and a secure operating nuclear facility footprint that includes state of the art nuclear criticality safety program research provides additional opportunities for ARD development for work involving reactor design, assembly, testing, and disassembly.

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7. REFERENCES

10 CFR Part 1021, *National Environmental Policy Act Implementing Procedures*

10 CFR Part 50, *Domestic Licensing of Production and Utilization Facilities*

10 CFR Part 51, *Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions*

10 CFR Part 52, *Licenses, Certifications, and Approvals for Nuclear Power Plants*

10 CFR Part 100, *Reactor Site Criteria*

40 CFR Parts 1500-1508, *Regulations for Implementing NEPA*

40 CFR Part 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities*

ANL/NRIC-20/1, *National Demonstration Reactor Siting Study – Phase I, prepared by Argonne National Laboratory*

ANSI/ANS-2.27, *Criteria for Investigations of Nuclear Facility Sites for Seismic Hazard Assessments*

ANSI/ANS-5.10, *Airborne Release Fractions at Non-Reactor Nuclear Facilities*

CD-1000.004, *Program/Project Screening and Siting Process for Nevada National Security Site and North Las Vegas Facility*

CD-0410.002, *National Environmental Policy Act*

CD-0700.001, *Planning, Prioritizing, and Scheduling Activities Requiring Cultural Resource Evaluation*

CD-0732.001, *Conservation and Protection of Biological Resources*

CRWMS M&O 1998, *Probabilistic Seismic Hazard Analyses for Fault Displacement and Vibratory Ground Motion at Yucca Mountain, Nevada: Prepared for the U.S. Geological Survey in cooperation with the U.S. Department of Energy*

DOE/EIS-0426, *Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada*

DOE G 420.1-1A, *Nonreactor Nuclear Safety Design Guide for use with DOE O 420.1C, Facility Safety*

DOE-STD-3009-2014, *Preparation of Nonreactor Nuclear Facility Document Safety Analysis*

DOE/NV/11718--324, *An Aerial Radiological Survey of the Nevada Test Site, dated December 1999*

DOE/NV-325-16-00, *Nevada National Security Site Waste Acceptance Criteria*

DOE O 420.1C, *Facility Safety*

DOE O 474.2, *Nuclear Material Control and Accountability*

Federal Register, Vol. 79, No. 249, *Record of Decision for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada, dated December 30, 2014*

FRM-2782, *Project Screening*

Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*

Geomatrix 2007, *Probabilistic Seismic Hazard Analysis and Design Ground Motions for Device Assembly Facility Site*, dated October 2007

Halford, K. J., and T. R. Jackson, 2020. *Groundwater Characterization and Effects of Pumping in the Death Valley Regional Groundwater Flow System, Nevada and California, with Special Reference to Devils Hole*. U.S. Geological Survey Professional Paper 1863.

HSPD-5, *U.S. Department of Homeland Security Presidential Directive, Management of Domestic Incidents*

INL/EXT-20-57821, *Evaluation of Sites for Advanced Reactor Demonstrations at Idaho National Laboratory*

INL/EXT-20-59627, *Evaluation of Proposed Oklo Aurora Microreactor Sites at Idaho National Laboratory*

NAC Chapter 445A, *Water Controls*

NFO O 410.X1, *Nevada National Security Site and North Las Vegas Facilities General Use and Operations Requirements*

NFO O 412.X1, *Real Estate Operations Permit*

NRIC-21-ENG-0001; PNNL-30992, *Advanced Nuclear Reactor Plant Parameter Envelope and Guidance*

NUREG-0800, U.S. Nuclear Review Commission Standard Review Plan

- Section 2.1.1, *Site Location and Description*
- Section 2.1.3, *Population Distribution*
- Sections 2.2.1 – 2.2.2, *Identification of Potential Hazards in Site Vicinity*
- Section 2.2.4, *Evaluation of Potential Accidents*
- Section 2.3.1, *Regional Climatology*
- Section 2.3.2, *Local Meteorology*
- Section 2.3.3, *Onsite Meteorological Measurements Program*
- Section 2.3.4, *Short-Term Atmospheric Dispersion Estimates for Accident Releases*
- Section 2.5.1, *Geologic Characterization*
- Section 2.5.2, *Vibratory Ground Motion*
- Section 2.5.3, *Surface Deformation*
- Section 2.5.4, *Stability of Subsurface Materials and Foundations*

Regulatory Guide 1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors*

Winograd and Pearson (1997), *Major Carbon 14 Anomaly in a Regional Carbonate Aquifer: Possible Evidence for Megascale Channeling, South Central Great Basis*, December 1976

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Appendix A – NNSS Project Screening Form

Company Form FRM-2782	PROJECT SCREENING AND SITING	12/10/20 Rev. 04 Page of 5

Project Initiator and Contact Information:
Funding Level: **Total** ______________ **Annual** ______________
Funding Source: ______________________________
Planned Start Date: ______________
Project Executed Under: **Primary REOP No(s).** ______________ **Secondary REOP No(s).** ______________ **SEP No(s).** ______________
Project Scope (briefly describe proposed project):
Project General Requirements:
Project Top Risks:
Proposed Primary Siting Location (if known):
Proposed Secondary Siting Location (if known):

Project Impacts: Check "Y" (Yes), "N" (No), or "U" (Unknown) for each of the following questions.
For each "Yes" or "Unknown" answer, provide a brief explanation in the space below the question.

A. Mission	Y	N	U
A1. Does the proposed project support a DOE or NNSA program?	☐	☐	☐
A2. Does the proposed project support a national interest?	☐	☐	☐
A3. Is the proposed project to be sited in an area outside of the NNSS EIS corresponding land use zone plan?	☐	☐	☐

A. Mission	Y	N	U
A4. Are there existing missions, land uses or projects on or within a 1-mile radius of the proposed project siting?	☐	☐	☐
A5. Are there any existing memorandums of agreement or memorandums of understanding applicable to the proposed project?	☐	☐	☐
A6. Will the proposed project site require remediation after the project is completed?	☐	☐	☐
A7. Is this a multi-year effort?	☐	☐	☐

B. Site Infrastructure and Support	Y	N	U
B1. Will the proposed project require the construction of a new building(s) or will it use an existing building(s)?	☐	☐	☐
B2. Are new or upgraded roads (paved or dirt) required for the proposed project?	☐	☐	☐
B3. Does the proposed project require utilities that are not currently available at the proposed location or a specific utility (i.e., power) that does not have sufficient capacity for the project?	☐	☐	☐
B4. Does the proposed project require permanent or temporary power?	☐	☐	☐
B5. Does the proposed project require water for drinking or fire protection?	☐	☐	☐
B6. Will the proposed project require a sewer connection or porta potties?	☐	☐	☐
B7. Will the proposed project require communications capabilities (i.e., telephone, fax, computer lines, and/or radio)?	☐	☐	☐
B8. Will this project involve lasers of highradio frequencies?	☐	☐	☐
B9. Does the proposed project require the use of petroleum or other liquid fuels?	☐	☐	☐

B. Site Infrastructure and Support	Y	N	U
B10. Will this project need access to classified information systems?	☐	☐	☐

C. Health and Safety	Y	N	U
C1. Does the proposed project require the use or potential use of medical facilities or services?	☐	☐	☐
C2. Does the proposed project require the use or potential use of fire protection services?	☐	☐	☐
C3. Are there any potential health and safety risks different than standard industrial hazards to project workers?	☐	☐	☐
C4. Are there any potential health and safety risks to individuals not associated with the proposed project that are adjacent and may be affected by the proposed project?	☐	☐	☐
C5. Are there any noise or vibration effects from the proposed project?	☐	☐	☐
C6. Does the proposed project use, transport, generate, or store radioactive materials or wastes? Does this project intend to use nuclear material requiring Nuclear Category 3 or above classification, per DOE-STD-1027?	☐	☐	☐
C7. Does the proposed project use, transport, generate, or store hazardous materials or wastes?	☐	☐	☐
C8. Does the proposed project use, transport, generate, or store explosives?	☐	☐	☐
C9. Does the proposed project require asbestos removal?	☐	☐	☐
C10. Does the proposed project plan to use aviation assets?	☐	☐	☐
C11. Can the proposed project affect any nuclear facilities, nuclear facility operations, or nuclear facility safety basis, as determined by an Unreviewed Safety Question review process? **USQ Number #:** **(must be included or determined not applicable by a USQAnalyst)**	☐	☐	☐

D. Environmental	Y	N	U
D1. Does the proposed project require a land area, including buffer area?	☐	☐	☐
D2. Is the proposed project to be sited in an institutionally controlled area, and if so, is the proposed project compatible with those institutional controls?	☐	☐	☐
D3. Will the proposed project have a permanent effect on the land used?	☐	☐	☐
D4. Does the proposed project require water that may result in formation of a wetland or have other impacts on the environment?	☐	☐	☐
D5. Will the proposed project have an impact on the quality of groundwater on the NNSS?	☐	☐	☐
D6. Will the proposed project produce air emissions during construction and/or operations?	☐	☐	☐
D7. Does the proposed project require access to the airspace above the NNSS and/or the Nevada Test and Training Range (NTTR) and if so at what altitudes?	☐	☐	☐
D8. Does the proposed project require frequency scheduling/deconfliction?	☐	☐	☐
D9. Will the proposed project cause GPS jamming, or will the customer be impacted by GPS activities on the NNSS/NTTR?	☐	☐	☐
D10. Are sensor and/or optics being utilized in support of the mission? If so, provide detail.	☐	☐	☐
D11. Does the proposed project require airspace closure above the project site?	☐	☐	☐

E. Security and Media	Y	N	U
E1. Does the proposed project have any security requirements?	☐	☐	☐
E2. Will foreign nationals be involved in the proposed project?	☐	☐	☐

E. Security and Media	Y	N	U
E3. Will this project require non-standard operational times?	☐	☐	☐
E4. Will this project have significant involvement with the local or national media?	☐	☐	☐

Additional Information:

Preparer:	Date:

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Appendix B – NNSS SWEIS PREFERRED ALTERNATIVE

Preferred Alternative (blue shading)

NO ACTION ALTERNATIVE	*EXPANDED OPERATIONS ALTERNATIVE*	*REDUCED OPERATIONS ALTERNATIVE*
National Security/Defense Mission		
Stockpile Stewardship and Management Program		
Maintain readiness to conduct underground nuclear tests.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Conduct up to 10 dynamic experiments per year within NNSS Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 16, 19, or 20.	Conduct up to 20 dynamic experiments per year within NNSS Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 16, 19, or 20.	Conduct up to 6 dynamic experiments per year at the NNSS; no dynamic experiments would be conducted in Areas 19 or 20.
Conduct up to 20 conventional explosives experiments per year at the Big Explosives Experimental Facility and up to 10 per year within NNSS Areas 1, 2, 3, 4, 12, or 16 using up to 70,000 pounds TNT-equivalent of explosives charges; would also support Work for Others Program.	• Conduct up to 100 conventional explosives experiments per year within NNSS Areas 1, 2, 3, 4, 12, or 16 using up to 120,000 pounds TNT-equivalent of explosives charges (50 of these would be at the Big Explosives Experimental Facility with a TNT-equivalent limitation of 70,000 pounds); would also support Work for Others Program. • Add second firing table and high-energy x-ray capability at Big Explosives Experimental Facility. • Establish up to three areas at the NNSS for conducting explosives experiments with depleted uranium and conduct up to 20 experiments per year.	Conduct up to 10 conventional explosives experiments per year at the Big Explosives Experimental Facility using up to 70,000 pounds TNT-equivalent of explosives charges per year to directly support the Stockpile Stewardship and Management Program; no other explosives experiments would be conducted.
Conduct up to 12 shock physics experiments per year at the NNSS using actinide targets at the Joint Actinide Shock Physics Experimental Research Facility in Area 27 and up to 10 experiments per year using the Large-Bore Powder Gun in Area 1.	Conduct up to 36 shock physics experiments per year at the NNSS using actinide targets at the Joint Actinide Shock Physics Experimental Research Facility in Area 27 and up to 24 experiments per year using the Large-Bore Powder Gun in Area 1.	Conduct up to 6 shock physics experiments per year at the NNSS using actinide targets at the Joint Actinide Shock Physics Experimental Research Facility in Area 27 and up to 8 experiments per year using the Large-Bore Powder Gun in Area 1.
Conduct up to 500 criticality operations, training, and other operations per year at the National Criticality Experiments Research Center at the Device Assembly Facility in Area 6.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Maintain the Atlas Facility in standby with the capability to conduct up to 12 pulsed-power experiments per year.	Activate the Atlas Facility and conduct up to 24 pulsed-power experiments per year.	Decommission and disposition the Atlas Facility.
Conduct up to 600 plasma physics and fusion experiments each year at NLVF and 50 per year in NNSS Area 11.	Conduct up to 1,000 plasma physics and fusion experiments each year at NLVF and 650 per year in NNSS Area 11, increasing the size and complexity of such experiments.	Conduct up to 350 plasma physics and fusion experiments each year at NLVF and 25 per year in NNSS Area 11.
Conduct five drillback operations at the NNSS over an approximate 10-year period.	Same as under the No Action Alternative.	Same as under the No Action Alternative.

NO ACTION ALTERNATIVE	EXPANDED OPERATIONS ALTERNATIVE	REDUCED OPERATIONS ALTERNATIVE
Conduct Stockpile Stewardship and Management Program activities in NNSS Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 16, 19, or 20, including the following:	Same as under the No Action Alternative:	Same as under the No Action Alternative, except Stockpile Stewardship and Management Program activities would not be conducted in Areas 19 and 20.
• Disposition damaged U.S. nuclear weapons on an as-needed basis.	• Stage nuclear devices pending dismantlement, modification/maintenance, and/or transportation to another location. • Dismantle up to 100 nuclear weapons per year • Replace limited-life components of up to 360 nuclear devices per year and conduct associated maintenance activities. • Test weapons components for quality assurance under the Limited Life Component Exchange Program.	
• Stage special nuclear material, including nuclear weapon pits.	• Transfer special nuclear material, including nuclear weapon pits, to and from other locations in the DOE complex for staging and use in experiments at the NNSS.	
Conduct training for the Office of Secure Transportation up to six times per year at various locations on NNSS roads.	Same as under the No Action Alternative, plus: • Develop facilities in Area 17 and upgrade or construct new facilities in Area 6, 12, or 23 to support training for the Office of Secure Transportation.	Conduct training for the Office of Secure Transportation up to four times per year at various locations on NNSS roads.
Conduct the following stockpile stewardship operations at the TTR: • Conduct tests and experiments, including flight test operations for gravity weapons (i.e., bombs). • Conduct ground/air-launched rocket and missile operations. • Conduct impact testing. • Conduct passive testing of joint test assemblies and conventional weapons. • Conduct fuel-air explosives testing.	Same as under the No Action Alternative, except: • Certain safeguards and security functions and other administrative functions would be turned over to the U.S. Air Force.	Same as under the No Action Alternative, except: • Discontinue ground/air-launched rocket and missile operations. • Discontinue fuel-air explosives testing.
Nuclear Emergency Response, Nonproliferation, and Counterterrorism Programs		
Provide support for the Nuclear Emergency Support Team, the Federal Radiological Monitoring and Assessment Center, the Accident Response Group, and the Radiological Assistance Program (most of this support is provided by RSL at Nellis Air Force Base).	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Conduct Aerial Measuring System activities from RSL at Nellis Air Force Base.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Conduct weapon of mass destruction emergency responder training at various DOE/NNSA NSO locations.	Same as under the No Action Alternative.	Same as under the No Action Alternative.

NO ACTION ALTERNATIVE	EXPANDED OPERATIONS ALTERNATIVE	REDUCED OPERATIONS ALTERNATIVE
Support DOE Emergency Communications Network.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Disposition improvised nuclear dispersion devices and deploy the DOE/NNSA Disposition Program and Federal Bureau of Investigation Disposition and Disposition Forensics Program to the NNSS for training and exercises or for an actual event, as needed.	Same as under the No Action Alternative, plus: • Disposition radiological dispersion devices, as needed	Same as under the No Action Alternative.
Integrate existing activities and primarily NNSS facilities to support United States efforts to control the spread of weapons of mass destruction, particularly nuclear weapons of mass destruction, including arms control, nonproliferation activities, nuclear forensics, and counterterrorism capabilities.	Same as under the No Action Alternative, plus: At the NNSS: • Construct laboratory space and other facilities for design and certification of treaty verification technology, training of inspectors, and development of arms control confidence-building measures as part of the Arms Control Treaty Verification Test Bed. [a] • Develop and construct new facilities to support a Nonproliferation Test Bed to simulate chemical and radiological processes that an adversary would clandestinely conduct. [a] • Construct an Urban Warfare Complex to support counterterrorism training. [a]	Same as under the No Action Alternative.
Work for Others Program		
Work for Others Program activities would continue to be conducted in all appropriate zones on the NNSS, and at RSL and NLVF.	Same as under the No Action Alternative, except the NNSS land use zone designation for Area 15 would be changed from "Reserved Zone" to "Research, Test, and Experiment Zone."	Same as under the No Action Alternative, except Work for Others Program activities, with the exception of military training and exercises, would not be conducted in Areas 18, 19, 20, 29, and 30 of the NNSS.
Host treaty verification activities.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Conduct nonproliferation projects and counterproliferation research and development at the NNSS, including:	Same as under the No Action Alternative.	Same as under the No Action Alternative, except:
• Conduct conventional weapons effects and other explosives experiments within parameters established for conducting conventional high-explosives experiments.		• Discontinue Work for Others Program conventional weapons effects and other high-explosives experiments.
• Support development of capabilities to hold at-risk and defeat military assets in deeply buried hardened targets. • Conduct up to 20 controlled chemical and biological simulant release experiments per year (each experiment would include multiple releases by a variety of means, including explosives).		• Discontinue development of capabilities to hold at-risk and defeat military assets in deeply buried hardened targets. • Discontinue projects requiring explosive releases of chemical or biological simulants.

NO ACTION ALTERNATIVE	EXPANDED OPERATIONS ALTERNATIVE	REDUCED OPERATIONS ALTERNATIVE
• Support training, research, and development of equipment, specialized munitions, and tactics related to counterterrorism.		
Support the U.S. Department of Defense and other Federal agencies in developing counterterrorism capabilities.	Develop and construct new facilities to support counterterrorism training, research, and development activities.	Same as under the No Action Alternative.
Conduct criticality experiments to support National Aeronautics and Space Administration deep space power source development within the parameters for criticality experiments established under the Stockpile Stewardship and Management Program.	Same as under the No Action Alternative, plus: • Conduct experiments using existing boreholes at the NNSS to sequester emissions such as radionuclides.	Same as under the No Action Alternative.
Host the use of various aerial platforms, such as airplanes, unmanned aerial systems, and helicopters, at various locations at the NNSS for research and development, training, and exercises.	• Increase use of various aerial platforms, such as airplanes, unmanned aerial systems, and helicopters, for research and development, training, and exercises, including constructing additional hangars, shops, and buildings at existing airports at the NNSS. • Conduct up to 3 underground and 12 open-air radioactive tracer experiments per year. • Host treaty verification activities, including development of a facility for simulating nuclear fuel cycle-related radionuclide release detection and characterization. [a] • Develop a facility for specialized explosive experiments and simulated manufacture to support high-explosives experiments. [a] • Support increased research and development of active interrogation equipment, methods, and training. • Develop new facilities to support research and development in radio frequency generation and infrasonic observations. [a] • Develop new facilities, including simulated clandestine laboratories, to support chemical and biological simulant experiments. [a]	Same as under the No Action Alternative.
Conduct Work for Others Program activities at the TTR, including robotics testing, smart transportation-related testing, smoke obscuration operations, infrared tests, and rocket development.	Same as under the No Action Alternative, except: • Certain safeguards and security functions and other administrative functions would be turned over to the U.S. Air Force.	Same as under the No Action Alternative.

NO ACTION ALTERNATIVE	EXPANDED OPERATIONS ALTERNATIVE	REDUCED OPERATIONS ALTERNATIVE
Environmental Management Mission		
Waste Management Program		
Dispose up to 15 million cubic feet of low-level radioactive waste and 900,000 cubic feet of mixed low-level radioactive waste in the Area 5 Radioactive Waste Management Complex.	Dispose up to 48 million cubic feet of low-level radioactive waste and 4 million cubic feet of mixed low-level radioactive waste at the Area 5 Radioactive Waste Management Complex and Area 3 Radioactive Waste Management Site.[b]	Same as under the No Action Alternative.
Maintain the Area 3 Radioactive Waste Management Site on standby.	Open the Area 3 Radioactive Waste Management Site for disposal of authorized and/or permitted waste.	Same as under the No Action Alternative.
Treat onsite-generated mixed low-level radioactive waste.	Same as under the No Action Alternative, plus: • At the Area 5 Radioactive Waste Management Complex, store mixed low-level radioactive waste received from on- and offsite generators pending treatment via macroencapsulation and microencapsulation (i.e., repackaging), sorting/segregating, and bench-scale mercury amalgamation, as appropriate, and/or disposal.	Same as under the No Action Alternative.
Store onsite-generated transuranic waste (up to 9,600 cubic feet over the next 10 years) pending offsite disposal.	Same as under the No Action Alternative, except a larger volume of transuranic waste (up to 19,000 cubic feet over the next 10 years) would be generated by increased activities at NNSS facilities, such as the Joint Actinide Shock Physics Experimental Research Facility.	Same as under the No Action Alternative, except a smaller volume of transuranic waste (up to 7,100 cubic feet over the next 10 years) would be generated by increased activities at NNSS facilities, such as the Joint Actinide Shock Physics Experimental Research Facility.
Store onsite-generated hazardous waste as needed at the Area 5 Hazardous Waste Storage Unit pending offsite treatment or disposal. Up to 170,000 cubic feet would be generated over the next 10 years.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Operate the Area 11 Explosives Ordnance Disposal Unit. No more than 41,000 pounds of explosives would be treated over the next 10 years.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Operate the Area 6 Hydrocarbon Landfill.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Operate the Area 23 Solid Waste Disposal Site and the U10c Solid Waste Disposal Site. Up to 3,400,000 cubic feet would be disposed over the next 10 years.	Same as under the No Action Alternative, except larger volumes of solid sanitary waste (up to 8,500,000 cubic feet) would be generated by increased activity levels at the NNSS over the next 10 years. Construct new sanitary solid waste disposal facilities as needed in Area 23 and develop a new solid waste disposal site in Area 25 to support environmental restoration activities.	Same as under the No Action Alternative, except smaller volumes of solid sanitary waste (up to 3,300,000 cubic feet) would be generated by reduced activity levels at the NNSS over the next 10 years).

NO ACTION ALTERNATIVE	*EXPANDED OPERATIONS ALTERNATIVE*	*REDUCED OPERATIONS ALTERNATIVE*
Environmental Restoration Program		
Underground Test Area Project – Comply with the Federal Facility Agreement and Consent Order; monitor groundwater from existing wells; drill new characterization and monitoring wells; develop groundwater flow and transport models; and continue to evaluate closure strategies.	Same as under the No Action Alternative, except: • Characterization and monitoring wells would be developed more quickly.	Same as under the No Action Alternative.
Soils Project – Identify and characterize areas with contaminated soils and perform corrective actions in compliance with the Federal Facility Agreement and Consent Order.	Same as under the No Action Alternative, except: • If stricter cleanup standards were implemented, larger volumes of radioactive waste would be generated and disposed.	Same as under the No Action Alternative.
Industrial Sites Project – Identify, characterize, and remediate industrial sites under the Federal Facility Agreement and Consent Order and continue decontaminating and decommissioning facilities.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Defense Threat Reduction Agency Sites – In accordance with the Federal Facility Agreement and Consent Order, perform remediation activities at sites that are the responsibility of the Defense Threat Reduction Agency.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Execute the Borehole Management Program.	Same as under the No Action Alternative.	Same as under the No Action Alternative.
Nondefense Mission		
General Site Support and Infrastructure Program		
Conduct small projects to maintain the present capabilities of DOE/NNSA NSO facilities in all areas of the NNSS and at NLVF, RSL, and the TTR. Maintain existing infrastructure, manage various permits and agreements, and provide security for the former Yucca Mountain Repository site.	Same as under the No Action Alternative, plus: • Construct a new 85,000-square-foot multistory security building in Area 23. • Replace the NNSS 138-kilovolt electrical transmission system. • Expand cellular telecommunication system on the NNSS. • Reconfigure Mercury.[a]	Same as under the No Action Alternative, except: Only critical infrastructure would be maintained within Areas 18, 19, 20, 29, and 30 of the NNSS, including certain communications facilities, electrical transmission lines and substations, and Well 8. Roads within these areas would only be maintained to provide access to the infrastructure and environmental restoration sites.

NO ACTION ALTERNATIVE	*EXPANDED OPERATIONS ALTERNATIVE*	*REDUCED OPERATIONS ALTERNATIVE*
Conservation and Renewable Energy Program		
Continue to identify and implement energy conservation measures and renewable energy projects in compliance with applicable Executive Orders and DOE Orders. • Reduce energy intensity by 3 percent annually and a total of 30 percent by the end of fiscal year 2015. • Reduce greenhouse gas emissions by 28 percent by fiscal year 2020. • Install advanced electric metering systems. • Obtain at least 7.5 percent of the NNSS annual electricity and thermal consumption from renewable energy sources. • Support development of a 240-megawatt commercial solar power generation facility in NNSS Area 25.[a] • Reduce water use by 16 percent by 2015. • Maximize use of alternative fuels (e.g., E85 and biodiesel). • Ensure all new construction and renovation projects implement high-performance building goals.	Same as under the No Action Alternative, plus: • Support development of 1,000 megawatts of commercial solar power generation facilities in NNSS Area 25.[a] • Modify NNSS land use zones to establish a 39,600-acre Renewable Energy Zone in Area 25. • Construct a 5-megawatt photovoltaic solar power generation facility near the Area 6 Construction Facilities. • Support a Geothermal Energy Demonstration Project and Geothermal Research Center at the NNSS.[a]	Same as under the No Action Alternative, except: • Support development of a 100-megawatt commercial solar power generation facility in NNSS Area 25.[a]
Other Research and Development Programs		
Support the DOE National Environmental Research Park Program and other non-DOE/NNSA research and development activities in all areas of the NNSS.	Same as under the No Action Alternative.	Same as under the No Action Alternative, except: Activities would be conducted in all areas of the NNSS, except Areas 18, 19, 20, 29, and 30.

NLVF = North Las Vegas Facility; NSO = Nevada Site Office; RSL = Remote Sensing Laboratory; TNT = 2,4,6-trinitrotoluene; TTR = Tonopah Test Range.

[a] These potential projects have not reached a point of development that allows full analysis in this *NNSS SWEIS*, and would be subject to additional NEPA review before DOE/NNSA would make any decision regarding implementation. At this point, DOE/NNSA has not received or solicited proposals for any commercial solar power generation projects.

[b] Reopening of the Area 3 Radioactive Waste Management Site would only occur based upon mission need and as stated in Chapter 4, Section 4.1.11.1.1.1, of the *NNSS SWEIS*, including detailed consultation with the state of Nevada.

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Appendix C – SUMMARY DESCRIPTION OF SELECTED NNSS TUNNELS

<table>
<tr><th>TUNNEL</th><th>STATUS/DESCRIPTION</th><th>COMMENTS</th></tr>
<tr><td>U16b
No Active Programs</td><td>Active

Dimensions
Length Mined (ft) = 1,150
Length Open (ft) = 1,150

Overburden
Has less than 500 ft overburden through its entire length; Approximately 170 ft at the deepest point.

Geology Characteristics
Fractured Pennsylvanian to early Permian-age interbedded limestone and micrite of the Tippipah Limestone formation. Dry

<table><tr><th>Infrastructure</th><th>Yes</th><th>No</th></tr><tr><td>Grid Power</td><td></td><td>X</td></tr><tr><td>Water</td><td></td><td>X</td></tr><tr><td>Telephone</td><td>X</td><td></td></tr><tr><td>Fiber/Microwave</td><td></td><td>X</td></tr></table></td><td>• U16b Tunnel is an active Hard Target Defeat facility mined in the late 1990s
• Used extensively for bomb (ordnance) tests and other program activities
• 3 portals
  o 16b.01
  o 16b.03
  o 16b.02 as a "dummy" portal 60 ft long—inaccessible
• Nominal portal access is 16 ft by 16 ft
• Rock invert
• Drift size varies and is constricted by bulkheads in the 01 and 03 drifts—approx 12 ft by 12 ft
• Ground conditions are stable, clean, and dry with most interior wall surfaces covered with shotcrete
• No permanent ventilation system
• No vents to surface

</td></tr>
</table>

TUNNEL	STATUS/DESCRIPTION	COMMENTS

U12p
ACTIVE NNSA PROGRAMS
Deconfliction of activities required
	Active
	
	Dimensions
	Length Mined (ft) = 23,597
	Length Open (ft) = 16,783
	
	Overburden
	Along the Main Access drift (and also the Vent drift), an overburden depth of 500 ft is reached at approximately 850 ft from the portal.
	
	Geology Characteristics
	Mined within a thick section of Tertiary-age partially zeolitized to zeolitized, bedded ash-fall and reworked ash-fall tuff
		• The site of four nuclear weapons effects tests conducted between 1987 and 1992
		• Inspection required before program use
		• 2 portals
		  o 12p.main drift
		  o 12p vent drift
		• Some deficiencies to be corrected before program use
		• Permanent ventilation system
		• Vent drift configured for chem/bio or explosive testbed operations
		• Nominal portal access is 18 ft by 18 ft
		• Concrete invert in main drift and some of the side drifts. Dirt in the rest of the tunnel complex
		• Nominal drift size is 16 ft by 16 ft, with mining car rail access to nearly all areas
		• Ground conditions are stable, clean, and dry with most interior wall surfaces covered with shotcrete
		• Presently used by NNSA for Technical Forensics
		• Testbed being developed in the .06 Bypass Drift

Infrastructure	Yes	No
Grid Power	X	
Water (N/P)	X	
Telephone	X	
Fiber/Microwave	X	

<table>
<tr><th>TUNNEL</th><th>STATUS/DESCRIPTION</th><th>COMMENTS</th></tr>
<tr>
<td>U12v
No Active Programs</td>
<td>Standby

Dimensions
Length Mined (ft) = 1,270
Length Open (ft) = 1,270

Overburden
Has less than 500 ft overburden through its entire length: Approximately 190 ft above the alcove.

Geology Characteristics
Devonian-age highly jointed, gray, aphanitic, hard to very hard dolomite.

<table>
<tr><th>Infrastructure</th><th>Yes</th><th>No</th></tr>
<tr><td>Grid Power</td><td></td><td>X</td></tr>
<tr><td>Water</td><td></td><td>X</td></tr>
<tr><td>Telephone</td><td>X</td><td></td></tr>
<tr><td>Fiber/Microwave</td><td></td><td>X</td></tr>
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<td>
• U12v Tunnel is a simulated hardened command and control facility
• Equipped with a security system, mission control offices, planning offices, system control and data acquisition (SCADA) systems, blast bulkhead, heating, ventilation, and air conditioning (HVAC) system with chiller, and underground 350-KW diesel generator
• The ventilation system consists of an underground fan coupled to a 60-inch vertical vent raise to surface
• 2 portals
  o 12v.01
  o 12v.02
• Portal access is 13 ft by 13 ft, and 6 ft by 8 ft
• Rock invert with concrete invert in mission alcove and mission support alcove
• Nominal drift size varies
• No permanent ventilation system
• Ground conditions are stable, clean, and mostly dry with occasional infiltration by meteoric water
• Fully equipped Mission Alcove completed
• No current program activities

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<table>
<tr><th>TUNNEL</th><th>STATUS/DESCRIPTION</th><th>COMMENTS</th></tr>
<tr>
<td>U25x
No Active Programs</td>
<td>STANDBY

Dimensions
Length Mined (ft) = 972
Length Open (ft) = 972

Overburden
Has less than 500 ft overburden through its entire length: Approximately 425 ft at the deepest point.

Geology Characteristics
Mined in Tertiary-age thick-bedded, reworked ash-fall and non-welded ash-flow tuff of the Wahmonie Formation. Dry

<table>
<tr><th>Infrastructure</th><th>Yes</th><th>No</th></tr>
<tr><td>Grid Power</td><td>X</td><td></td></tr>
<tr><td>Water</td><td></td><td>X</td></tr>
<tr><td>Telephone</td><td>X</td><td></td></tr>
<tr><td>Fiber/Microwave</td><td>X</td><td></td></tr>
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U25x Tunnel has been used for environmental testing and dispersion modeling of effluents from destruction of artillery rounds, missiles, and other explosives
Portal Access is 18 ft by 18 ft
A chamber 50 ft wide by 75 ft long by 35 ft high was constructed at far end of tunnel
Concrete invert
Permanent ventilation system
Ground conditions are stable, clean, and dry with most interior wall surfaces covered with partial shotcrete
Contains a lined, vertical 15-ft-diameter borehole from surface to tunnel level (side drift)—Boring machine still in place


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<table>
<tr><th>TUNNEL</th><th>STATUS/DESCRIPTION</th><th>COMMENTS</th></tr>
<tr>
<td>U25y
No Active Programs</td>
<td>Closed/Standby

Dimensions
Length Mined (ft) = 410
Length Open (ft) = 410

Overburden
Has less than 500 ft overburden through its entire length: Approximately 375 ft at the deepest point.

Geology Characteristics:
Mined in Tertiary-age thick-bedded, reworked ash-fall and non-welded ash-flow tuff of the Wahmonie Formation. Dry

<table>
<tr><th>Infrastructure</th><th>Yes</th><th>No</th></tr>
<tr><td>Grid Power</td><td></td><td>X</td></tr>
<tr><td>Water</td><td></td><td>X</td></tr>
<tr><td>Telephone</td><td></td><td>X</td></tr>
<tr><td>Fiber/Microwave</td><td></td><td>X</td></tr>
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<td>

U25y Tunnel was constructed at Little Skull Mountain, approximately 730 ft southeast of U25x Tunnel
Portal access is 20 ft wide by 20 ft high
Nominal drift size varies
A chamber 40 ft wide by 65 ft long by 50 ft high was constructed near the end of the tunnel
A boring machine used to drill a 15-ft diameter vertical hole to the surface is still in place
No permanent ventilation system
Most of the drift surfaces have a flash coat of shotcrete
No current program activities


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