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Ecological Resources Assessment for the Stand-Off Experiment Range Environmental Assessment

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Table of Contents

List of Figures

List of Tables

RESOURCES ASSESSMENT FOR THE STAND-OFF EXPERIMENT RANGE ENVIRONMENTAL ASSESSMENT

1.0 Purpose and Need

The purpose of this report is to assess the potential impacts to ecological resources including threatened, endangered, and sensitive species due to construction and operation of the Stand-off Experiment Range facility. This analysis is associated with the alternatives as received October 21, 2010, and as described below. Text for Sections 1 -2 with the exception of the ***Assumptions*** listed throughout was provided by the SOX Range project personnel. Content was not changed or clarified and edits were not made to these sections.

Various organizations within the United States government have recognized the need to rapidly identify, characterize, and verify container contents without the time consuming manual inspection methods currently used. Since the 9-11 terrorist attacks, nuclear and explosive material detection have become a major focus area. To aid in the detection of nuclear and explosive materials, Idaho National Laboratory (INL) is developing *nonintrusive active-interrogation (AI) systems* (see glossary) capable of detecting illicit materials in a variety of field-deployable applications. [Jones 2002, Jones 2003, Norman 2005a, Norman 2005b, Jones 2005a, Jones 2005b, Jones 2005c, Jones 2005d]

INL has a long history of active interrogation research and development (R&D) activities, especially in the area of *high energy x-ray* (see glossary) (sometimes referred to as photonuclear) related technologies. Early photonuclear R&D conducted at INL in the 1970’s focused on waste monitoring (Vegors 1978) while more recent efforts have focused on developing material identification and nuclear arms treaty verification technologies. [Jones 1993, Jones 1994, Jones1996, Blackwood 1999, Jones 2000] For many of these years INL has been working collaboratively with Idaho State University (ISU) and other governmental agencies to enhance nuclear material detection capabilities.

This environmental assessment (EA) evaluates constructing and operating a high energy x-ray Stand-off Experiment (SOX) Range at the INL Site. The proposed range would be capable of operating several *linear particle accelerators* (*linacs*) (see glossary) from 30 to 60 MeV 100 micro-amp configurations (see inset). Currently, INL is studying the use of *linear particle accelerator (linac)* AI technologies at the ISU airport facility and INL’s Power Burst Facility (PBF) area. To continue this technology development effort a dedicated range with a longer beam path than is currently available at PBF or the ISU facility is required. This would allow INL to continue its leading role in the research, development, and assessment of AI photonuclear-based technologies at greater stand-off distances.

2.0 Alternatives

2.1 Background

DOE proposes to locate a SOX Range on the INL Site. The INL Site, an 890-square mile reservation in southeastern Idaho, is managed and operated by Battelle Energy Alliance (BEA). INL continues to build on several decades of research and development efforts in the area of photonuclear AI for material detection and identification. One of the goals of this effort is to detect actively induced signatures from nuclear materials from large stand-off distances. The

Pulsed Photonuclear Assessment (PPA) (see glossary) is an AI technique that uses an electron linac to produce high energy x-ray (MeV) (also called high energy *bremsstrahlung photons* [see glossary]) and various detector technologies to identify materials of interest, including both nuclear and non-nuclear materials. Based on INL's success with R&D of PPA technology, the need for a larger area to conduct further research and development has been identified. The Department of Energy (DOE) proposes locating the SOX Range on the INL Site to support continued research and development efforts in this important national homeland security area.

The objective of this EA is to evaluate the potential environmental impacts of creating and operating a Stand-Off Experiment Range on the INL Site. This document was prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969 (Public Law 91 190), as amended; the Council on Environmental Quality's (CEQ's) NEPA Regulations (40 Code of Federal Regulations [CFR] Parts 1500-1508); DOE Order 451.1; and DOE NEPA Implementing Regulations (10 CFR Part 1021).

2.2 Range of Reasonable Alternatives

DOE considered several sites within the INL Site boundaries to construct and operate the SOX Range. These included the Critical Infrastructure Test Range Complex (CITRC), The Central Facilities Area (CFA) Gun Range, The Material and Fuels Complex (MFC) Gun Range, a remote area east of MFC, a location near the Unmanned Aerial Vehicle (UAV) runway, and the Initial Engine Test (IET) site near Test Area North/Technical Support Facility (TAN/TSF). DOE developed the following set of site selection criteria to help identify alternatives to meet the purpose and need and satisfy program requirements (see inset box). The Initial Engine Test (IET) site has several clear advantages compared to the other locations considered; it met all the site selection criteria. These other locations did not meet the criteria for site-selection and were dropped from further analyses in this environmental assessment. The CITRC site, CFA Gun Range, UAV runway area, and the MFC Gun Range were removed from consideration due to obstructed terrain and/or proximity to other work activities. The area east of MFC has acceptable terrain, but is located in an undeveloped area with a lack of nearby power and well-maintained roads. Road upgrades and power installation to this location are cost-prohibitive.

DOE did not consider offsite locations because the purpose and need is directly related to supporting R&D activities already begun at smaller scales at INL. The propose work expands on current technology and knowledge developed at INL. Based on the criteria, DOE chose to evaluate two alternatives: Alternative 1: The Proposed Action – Constructing and Operating the SOX Range on the INL just north of TAN (see Section 2.3) and Alternative 2: No Action (see Section 2.4).

2.3 Alternative 1: Proposed Action

> Appendix A includes maps showing the SOX footprint and operational activities for the proposed action.

DOE's proposed action is to establish a SOX Range with the capability to perform outdoor accelerator testing with several linacs to the northeast of the TAN/ TSF boundary fence and TSF parking lot. This location includes a fenced area that surrounds the IET Facility. The area was developed in the 1950s to support engine development of the aircraft nuclear propulsion program. A small fenced area (850 ft x 780 ft), known as IET, was created to support operation of the portable reactors. About six miles of perimeter fence creates an outer fenced boundary, octagonal in shape that is about two miles across, was also constructed to provide distance/exclusion from the area. A paved road runs from the TAN/TSF parking area to IET, and more than 30 two track roads can be found within the fenced area.

2.3.1 Construction Activities

Construction activities include constructing a main building to house the linacs, erecting power poles to extend power to the building and connecting to water lines (or place a tank near the building) to bring water to the building, laydown gravel and concrete pads to stage equipment, build a gravel road, and fix fences surrounding the SOX Range (Table 1).

Table 1. General Construction Activities

Construction Activities
• Construct 40 ft x 60 ft insulated metal building with additional 20 ft-wide concrete pad around the building and 50-ft cleared gravel perimeter around the concrete pad; the building would have heating, ventilation, and air conditioning, electrical power, and water systems; the overall footprint is about 180 ft x 200 ft). ***Assumption***: *This building area will have a perimeter fence that is immediately around the graveled area. It will be 10' tall and constructed of chain link or a similar material that is permanent and exclusionary*.
• Construct up to six concrete or gravel pads (40 ft x 40 ft) for control stations, storage areas, detector laydown areas, etc. ***Assumption***: *These pads are located outside of the initial building and pad location and will result in a larger cumulative footprint than that of the structure above.*
• Construct up to a 10-foot high fence around building perimeter and up to 328 ft wide on either side and in back of the building and extending up to 1,640 ft down range in the northward direction to create a boundary for a 'Very High Radiation Area (VHRA). ***Assumption***: *This fence is constructed of chain link or a similar material that is permanent and exclusionary.*
• Repair about 100 ft of the SOX Range fence.
• Construct about 1.6 miles of road down range from the building (to the north).
• Improve access and perimeter roads.
• Re-install about 0.5 miles of overhead power lines. ***Assumption***: *This would be about 20 poles.*
• Extend potable water lines by following the path of the old lines, when possible.
• Construct a septic system and drain field <u>or</u> a stand-alone 2,000 gallon buried tank system for sanitary facilities that would require routine pumping and disposal.
• Establish controlled area that encompasses the VHRA, including the installing an intrusion detection system (IDS) that would automatically shut off the linac if it detects inadvertent access to the high radiation area by humans and large animals.
• Place cargo containers on concrete or graveled surface. ***Assumption***: *These containers will be place on the gravel or concrete pads discussed in bullet 2.*

2.3.2 Operational Activities

Nearly all activities would be conducted within the SOX Range perimeter fence. In addition, the vast majority of these actives would be confined within a few hundred feet of the proposed building location except for those that are conducted along the down range access road. Table 2 shows the typical type of activities that would occur at the SOX Range.

INL has three linacs that could be used at the range. These linacs are very similar to those used in radiotherapy. However, the linacs at the INL are bigger, transportable, and have significantly reduced radiation output as compared to medical counterparts. The INL linacs are configured for industrial application and are usually designed to fit within cargo like containers.

Linacs have targeting capabilities that enable them to be aimed at an inspection object. The linac beam would be oriented between azimuths of about 347 to 90 degrees so that the beam would be directed toward the north as approved by the INL safety program.

The down range access road would be constructed to allow continuous distances to be selected between the linac and the inspection object or measurement device. This road is planned to be along the 5 degree azimuth beam line and would extend from the linac to the IET outer perimeter fences, which is about 2,600 meters down range from the linac located at Site A.

Linac operations would also be conducted at other locations within the SOX Range other than at the building at Site A. Some of these operations are expected to be powered by a portable electrical generator that can be pulled behind a pickup truck. The maximum sized generator expected to be used at the range is about 130 KVA. As with all activities within the SOX Range, project personnel would use the arc roads created during past IET project.

Table 2. General Operational Activities

Operating Activities
• Installing, assembly, and operating electron linacs within the INL Accelerator Safety Envelope (ASE-101) currently allowing beam energies up to 60 million electron volts (MeV) and beam currents up to 100 micro-amps. • Placing shield blocks, targets, and detector systems • Inspecting objects and moving and handling fissile material • Using radioactive check sources • Using the extended range.

Installing and Operating Linacs

Installing and placing linac is usually an infrequent process. For large linacs like the INL Varitron-III, locating the linac involves semi-trucks cranes and forklifts. For small linacs like the INL Varitron-I and Varitron-II usually pickup trucks and trailers pulled behind the pickup trucks are used to move the linacs.

The radiation footprint needed to support the experimental exercise is determined and the facility shielding is determined. In some cases no shielding would be desirable, but in most cases back, side, and/or beam stop shielding is used. While this range would provide the unique ability to allow the high energy x-rays to naturally attenuate in air that is usually not the focus of the experiment. When the naturally attenuated x-rays in air is not the focus of the experiment shield blocks may be used to shorten the radiation footprint. Therefore it is common to temporary shield walls.

Radiation Areas Boundary and Intrusion Detection Systems

Based on the linac configuration, operational conditions, and shielding the Radiation Area boundary is estimated and a boundary that encompasses the area is established. One of the options planned for posting the radiation area is that the SOX Range outer perimeter fence would be used as the Radiation Area boundary and posted as such even though in most operational cases the dose rate at the fence would be undetectable above background. If a temporary area needs to be posted a method of using traffic candles with rope and signs.

An Intrusion Detection System (IDS) would also be installed to prevent access to the high radiation area the detailed requirements are listed in the Accelerator Safety Envelope (ASE-101) and described in the Safety Analysis Document (SAD-101). This IDS system has towers that can be located about 700 feet apart. These towers are small and self contained; receiving power via photocell mounted on top of the tower and transmits its status wirelessly. These towers are about 6 feet tall, and have a very small footprint. Two installation configurations are being considered to minimize foot print; installing guy wires into the ground to hold the plastic tower directly to the ground; and/or using a 2’ square 4” thick pre-poured concrete base and running guy wires to the corners of the base.

After the linac and shielding is placed, an incremental start up is conducted to ensure the radiation levels would not exceed the predetermined limits and boundaries that have been set. As an example of this process a dose rate of 1/10 the expected operation level of 5 mrem/hr is selected for linac operations. Then during operations radiological control technician would measure the dose rates at the boundary. Thus the 5 mrem/hr boundaries should be less than 0.5 mrem/hr. To ensure this the entire perimeter is measured usually done of foot for the current ranges. The instruments that are used are small handheld instruments. After it is confirmed that the boundaries as setup appropriately, the linac is operated at the full power planned for the experiments and the entire perimeter is measured again to confirm the dose rates.

Detector Placement

After the linac operations have been established, detection equipment is setup. A wide range of detector types and sizes are used in this R&D effort ranging from less than an inch to systems that are mounted in trailers. These detectors can be located near the linac, near the inspected object down range, or any at locations between or to the side (off-axis). Detector materials can consist of solid state electronics such as a High-Purity Germanium (HPGe) or Silicon Carbide, scintillators such as sodium iodide (NaI) crystals, plastics, liquids, and gasses such as He-3, BF3. These detectors are connected to electronics systems to record and analyze the data. These detector systems range in size from handheld to trailer size configurations. One primary use of the trailers was to protect the equipment for the weather so that the detector can be left at the testing location overnight and during inclement weather. At times detectors need to be shielded. A detector system is in the small trailer and three shield blocks were stacked to provide shielding between the linac at the detectors (see blocks between to detection system trailers).

In most cases detector system and any required shielding is setup by hand on stands, in trailer, or in trucks. In the detection work for smaller configurations, the detection system can be carried by hand to the test location.

Inspecting Objects and Radioactive Material

The materials that are inspected can consist of nuclear, non-nuclear, and radioactive materials. Not only does the INL Radiological Controls Program have requirements pertaining to linac operations it also address radiological concerns for the radioactive and nuclear materials. Even though this facility would not be a nuclear facility, the INL nuclear facility criticality control groups ensure the non-nuclear facility requirements are met (DOE Standard 1027 less the Hazard Category III) (see ECAR 910 and IAG-545). One of the nuclear materials of interest is uranium. Uranium has a relatively low radiation emission and has several industrial and military applications such as, ballast in ships and airplanes, counter weights, armor piercing ammunition, etc. Radiation dose measurements are also taken during operations.

Extended Range Activities

An Extended Range is located to the north of the SOX Range outer fence for about 920 meters north of the fence. This Extended Range is just over 3,500 meters and is expected to be used only on a very infrequent (3 weeks per year on average) basis. During these operations it is likely that traffic candles would be used with radiation rope to demark the 5 mrem/hr boundary. An intrusion detection system may or may not be used depending on approved method used and radiation dose rates.

Activities occurring within the Extended Range area would not be permanent in nature and, aside from foot traffic, would occur on existing two-track roads. Any off-road activities not performed on foot would be surveyed for environmental, ecological, and archaeological related concerns to ensure that no significant impacts would occur prior to conducting any activities in the buffer area. Therefore, when the Extended Range is being used, the range perimeter would include both the SOX Range and the Extended Range.

The main purpose for the Extended Range is to allow the high energy x-rays to naturally attenuate in air to where they are undistinguishable above background. Therefore the primary activity planned to be conducted in the Extended Range is radiation dose monitoring. These activities are usually conducted with a handheld type of instrument. The used of shield wall are not expected and the on the Extended Range.

Typical Linac Operations

The linac activities are controlled by INL safety programs as described in Safety Analysis Document (SAD)-101 and generally can be divided into two classes; those that are greater than 10 MeV, and those that are 10 MeV and lower. For linacs that are operated at electron beam energies greater than 10 MeV the requirements of the Accelerator Safety Envelope (ASE)-101 and the INL Accelerator Program requirements are also implemented. It is expected that both classes of linacs would be operated on the SOX Range.

The average use of the linac is expected to be about 2 to 3 days per week, and common day to day operations are expected to use beam energies of 2 MeV to 30 MeV at beam currents between 1 to 30 micro-amps. With these commonly used energy parameters the radiological issues are more than 10 times less than for the maximum approved 60 MeV 100 micro-amp type systems. The linac is usually operated 2 to 4 hours during the day. The remainder of the day is used to prepare the detection and acquisition systems, clear the area, position materials and detectors, prepare the linac for operations, review data, change material and detector configurations, put materials and detectors away, and shut down the linac.

During day to day operations, if the entire beam is not necessary for the experiment, collimation and beam stops would be used to stop the beam.

It is expected that use of beam energies up to 60 MeV at beam currents up to 100 micro-amps would be much less frequent and would only occur periodically at the INL. A transportable linac capable of achieving these beam energies would operate a few hours a day, similar to those for lower energy systems, and would require the use of the extended range.

There are several types of detection systems that could be used in conjunction with the linac activities including signature, radiation, and proximity. The main goal of the effort is detection of actively induced signatures from materials that are being interrogated with the radiation beam from the linac. The detector can be placed at or near the linac, next to the inspected object, or at about any other location within the SOX Range. Detectors are generally much smaller and more transportable than the linacs and are designed to detect a variety of signatures (e.g., neutrons, gamma-ray, light, heat, sound, etc.).

Radiation type detectors that verify and record radiation levels would also be used to verify and ensure 1) acceptable LINAC operations and beam targeting, 2) worker safety, and 3) that machine operational parameters are within the limits established by the INL safety program. Passive radiation dosimetry would also be placed to provide a continuous measure of radiation.

Additionally, an Intrusion Detection System (IDS), designed to prevent entry into a high radiation area, would also be used. Activation of the IDS automatically shuts off the LINAC.

2.4 Alternative 2: No Action

DOE must consider a no action alternative in all of its EAs; the selection of the No Action alternative means that the proposed activity, as described in Section 2.3, would not take place. For this EA, that means The SOX Range would not be constructed and the national need for developing AI technologies with large stand-off distances would not be met. The No Action alternative does not meet the purpose and need. The project area would be available for other uses or reclamation activities.

2.5 Construction and Operational Controls

Table 3. Mitigation to control environmental impacts

Activity	Mitigation
Ground disturbance from construction activities	• Nesting bird surveys required for any activities between May 1st and September 1st in any vegetated areas before disturbance may occur • Raptor perches mitigated how?? *Assumption: Mitigation for raptor/raven perches would be by installing perch deterrent devices.* • Limit size of disturbance • Use native species for revegetation • Noxious weeds and invasive plant species would be managed according to 7 USC § 2814, “Management of Undesirable Plants on Federal Lands”) and Executive Order 13112, “Invasive Species.” The INL would follow the applicable requirements to manage undesirable plants.

Activity	Mitigation
	• Use existing roadways where possible • Archaeological and wildlife surveys *Assumption: Necessary to protect resources if additional construction is needed.* • Implement stop work procedure to guide assessment and protection of any unanticipated discoveries of cultural resources • Complete cultural resource sensitivity training for project personnel to discourage unauthorized artifact collection, off-road vehicle use, and other activities that may impact cultural resources, and encourage a sense of stewardship for cultural resources, including tribally sensitive plants and animals • Minimize disturbance to wildlife species important to the Shoshone-Bannock Tribes by utilizing appropriate methods, which could include seasonal or time-of-day restrictions, good housekeeping, and awareness training • Use existing water line from TAN-610 • Permit would be secured for project activities disturbing greater than 1 acre and occurring within the stormwater corridor. • Road construction for a down range access road along the 5 degree beam line *Assumption: This is a construction activity, not a mitigation.*
Linac operation	• Follow approved Safety Analysis Document (SAD-101) and the Accelerator Safety Envelope (ASE-101) • Clear people and animals from radiation areas before operations are allowed to start *Assumption: Animals refers to ungulates.* • Beam collimation, run time, and beam energy controls would be used to ensure that the dose to the Maximally Exposed Individual (MEI) would be less than 0.1 mrem/year • Would develop EPA approved model for proposed activity to determine effect to MEI and the nearest worker • Any required permits would be in place before operations are conducted • Conduct biota dose assessment • Clear potential radiation areas of personnel and wildlife prior to operations by visually verify that all personnel and wildlife are cleared from areas that would become radiation areas during linac operations *Assumption: Same as bullet 2.*

3.0 Affected Environment

3.1 Vegetation

3.1.1 Plant Communities

The SOX Experiment Range covers several different vegetation community types including green rabbitbrush/winterfat shrubland, sickle saltbush dwarf shrubland, shadscale dwarf shrubland, horsebrush/greasewood shrubland, and short statured Wyoming big sagebrush/green rabbitbrush shrubland, as well as crested wheatgrass and halogeton monocultures. The area designated for the building, power structures, and water lines are primarily crested wheatgrass monocultures with some non-native annual species and very few native species. There is no shrub cover in the proposed linac location.

3.1.2 Sensitive Plant Species

A list of the sensitive plant species, compiled using data from the Idaho CDC (2009) that have the potential to occur within the INL would typically be considered in an EA. Field surveys specifically for these species could not be conducted because the appropriate season (mid- to late-June) had passed. However, the SOX Range location is not appropriate habitat for any of the species on the list due to the very high alkalinity and fine textured soils in the area. These species are unlikely to occur on the proposed project area.

3.1.3 Ethnobotany

A list of species thought to be of historical importance to local tribes was compiled from *Plant Communities, Ethnoecology, and Flora of the Idaho National Engineering Laboratory* by Anderson et al. (1996). The list included those species documented to have been used by "indigenous groups of the eastern Snake River Plain," (Anderson et al. 1996). Table 4 lists those species of ethnobotanical concern observed during the ecological surveys for the SOX Range in September 2010.

Table 4. List of species of ethnobotanical concern occurring in the surveyed area for the proposed SOX range.

Current Scientific Name	Common Name	Uses
Achnatherum hymenoides	Indian ricegrass	food
Artemisia tridentata	big sagebrush	food, medicine, cordage, clothing, shelter, fuel, dye
Chrysothamnus viscidiflorus	green rabbitbrush	medicine, gum
Descurainia pinnata	western tansymustard	food, medicine
Descurainia sophia	herb sophia	food, medicine
Ericameria nauseosus	rubber rabbitbrush	medicine, gum
Lappula occidentalis	flatspine stickseed	food
Opuntia polyacantha	pricklypear	food
Poa secunda	Sandberg bluegrass	food, medicine
Salsola kali	Russian thistle	food

3.1.3 Invasive and Non-Native Plant Species

A total of eleven Idaho Noxious Weeds have been identified on the INL Site. No noxious weeds were identified at the SOX Range location. Musk thistle (*Carduus nutans)* has been observed in the area in the past but was not located in September 2010. In a literature survey, Pyke (1999) identified 46 exotic species that are capable of invading sagebrush steppe ecosystems, with as many as 20 of these classed as highly invasive and competitive. Other significant non-native and/or invasive plants found on or near the proposed location include cheatgrass (*Bromus tectorum*), Russian thistle (*Salsola kali*), halogeton (*Halogeton glomeratus*), tumble mustard (*Sysimbrium altissimum*) and crested wheatgrass (*Agropyron cristatum*, *A. desertorum*, *A. sibericum*).

Non-native species present a challenge in disturbed areas. They establish very quickly and successfully compete with the native species. Crested wheatgrass and halogeton are abundant at the proposed site. These non-native species are very quick to colonize any new disturbance and are very difficult to eradicate once they are present.

3.2 Wildlife

Scientists on the INL have been collecting wildlife data for more than 40 years and have recorded a total of 219 vertebrate species (Reynolds et al. 1986) occurring on the INL, many of which are directly associated with sagebrush steppe habitat. Species that permanently reside within the alternative areas include small and medium sized mammals (bushy-tailed woodrat [*Neotoma cinerea*], Ord's kangaroo rat [*Dipodomys ordii*], pygmy rabbit [*Brachylagus idahoensis*], black-tail jackrabbit [*Lepus californicus*], long-tailed weasel [*Mustela frenata*], badger [*Taxidea taxus*]), and reptiles (sage brush lizard [*Sceloporus graciosus*] and gopher snake [*Pituophis catenifer*]). Such species have small home ranges, limited mobility, or a social structure that restricts movements. With the exception of pygmy rabbit, each of these species can be found in both sagebrush and grassland habitats. Birds (horned lark [*Eremophila alpestris*], sage sparrow [*Amphispiza bilineata*], rough-legged hawk [*Buteo lagopus*], and red-tailed hawk [*Buteo jamaicensis*]) and large mammals (elk [*Cervus elaphus*], mule deer [*Odocoileus hemionus*], and pronghorn [*Antilocapra americana*]) use the areas in a seasonal transitory manner.

At the SOX Range location, a wide variety of species were either seen or indication of their presence was evident. These species included: badger, coyote (*Canis latrans*), pronghorn, jack rabbit, horned lizard (*Phrynosoma* spp.), ground squirrel (*Spermophilus* spp.), cottontail (*Sylvilagus* spp.), jack rabbit, chipmunk (*Tamias* spp.), kangaroo rat, pygmy rabbit, and various bird species.

Wildlife species of concern addressed in this analysis include greater sage-grouse (*Centrocercus urophasianus*), pygmy rabbits, all migratory birds (including raptors), and all large mammal species. At this time, the gray wolf is protected under the Endangered Species Act. However, the gray wolves in the region are listed as an Experimental/non-essential population. They have not been documented at or near the project site, but could reach the area by dispersing from established packs to the north and east.

3.2.1 Greater Sage-Grouse

The U.S. Fish and Wildlife Service (USFWS) recently released a finding that greater sage-grouse warrant protection under the Endangered Species Act, but are precluded due to other listing priorities (DOI-FWS 2010). Breeding habitats, primarily leks, have become a focal point for managing this species. Lyon (2000) estimated the average distance from nests to the nearest lek varied from 0.6-3.9 mi (1.1 to 6.2 km) but may be as great as 12.5 mi (20 km). Sage-grouse guidelines from Connelly et al. (2000) suggest that all sagebrush habitats within 2 miles of occupied leks be protected.

The Environmental Surveillance, Education, and Research (ESER) program is conducting a sage-grouse radio telemetry study on the INL site. The results of this research will be incorporated into the INL Conservation Management Plan and a Candidate Conservation Agreement with the U.S. Fish and Wildlife Service. Sage-grouse were captured and fitted with radio transmitters at numerous leks throughout the INL in 2008 and 2009. No birds in that study have been reported to use the areas associated with the Alternative sites for proposed action (ESER unpublished data).

No historical sage-grouse leks have been reported in the vicinity of the site (Shurtliff and Whiting 2009a). Because leks are focal points for conservation of this species, we included the survey results done for the adjacent Radiological Response Training Range (RRTR) which is located nearby at the TAN/T-28 gravel pit (Figure 1) (Blew et al. 2010). In that survey the T-28 Gravel Pit was visited on April 30, May 8, and May 13 to document the potential presence of sage-grouse at or near these locations. The visits occurred during the morning hours between 0640 and 0800 to coincide with the time when sage-grouse display on leks, generally being one-half hour before sunrise to an hour and one half after sunrise. Sunrise times were based on estimates for Arco, ID. Sampling locations at the T-28 Gravel Pit were chosen at the outermost points on the lobes of the gravel pit and resulted in six sampling points.

At each sampling point we documented the UTM coordinates (NAD83), date, time, wind speed, temperature, cloud cover; as well as if grouse were present, heard, or if any grouse sign (i.e., scat, feathers, or tracks) was observed. The UTM coordinates were obtained using a hand-held Garmin Legend GPS receiver. Next, we attempted to detect sage-grouse displaying using both the unaided ear and a parabolic microphone. This microphone allowed us to hear and locate sage-grouse up to 1.6 km (1 mi) away. If no grouse were detected, we walked outward ~100 meters from the center of the sampling point and then listened again for male grouse calls for two minutes using the parabolic microphone and searched the ground for evidence of grouse sign.

Sage-grouse were not observed or heard at any of the sampling locations (Blew et al. 2010). Additionally, no grouse sign (scat) was observed at the SOX Range.

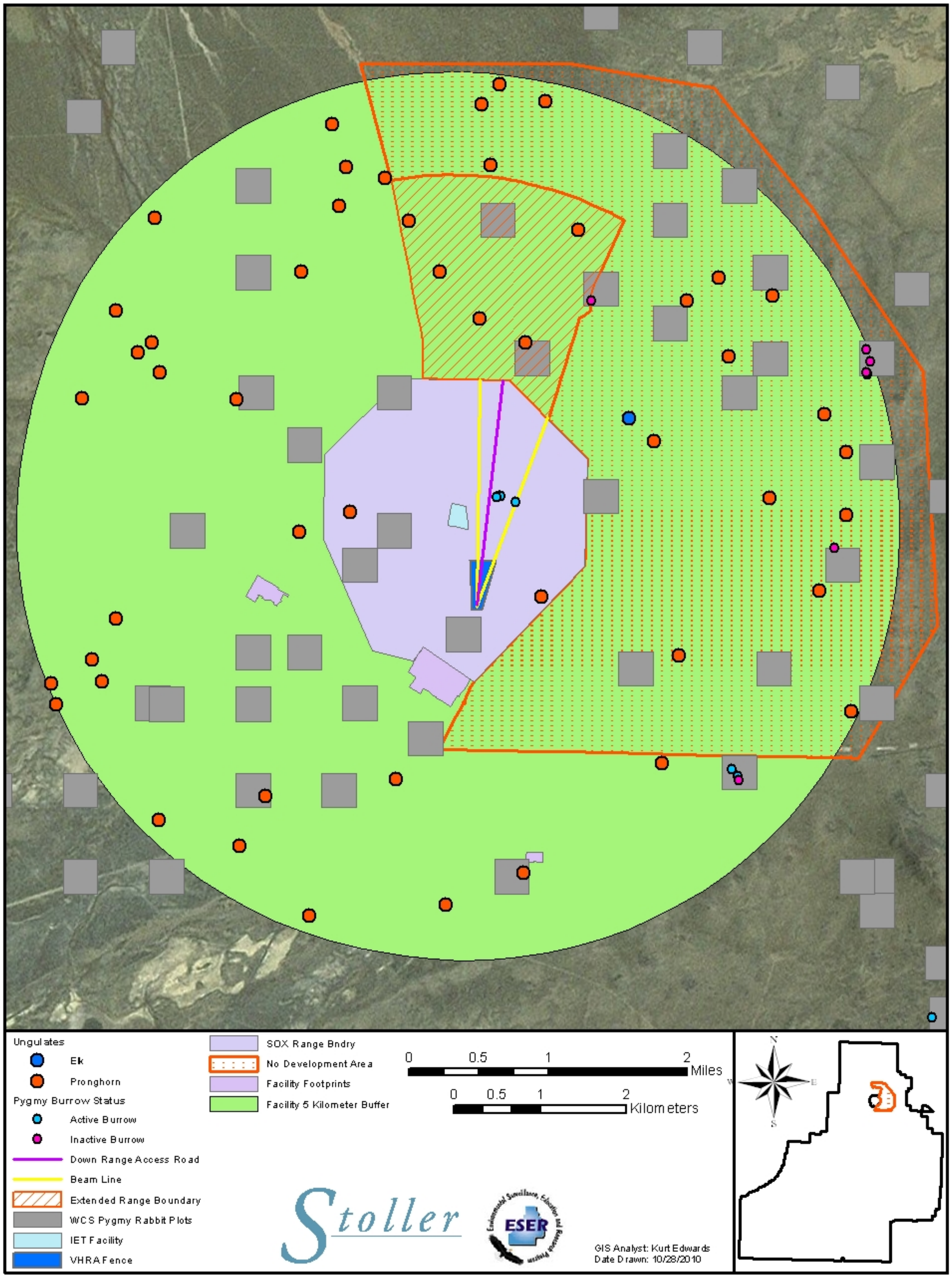

Figure 1. Biological Resources in the vicinity of the SOX Range.

3.2.2 Pygmy Rabbit

Pygmy rabbits depend on sagebrush for cover and forage. Once sagebrush is removed from an area pygmy rabbits disappear (Green and Flinders 1980, Katzner et al. 1997). Populations of pygmy rabbits on the INL may be relatively stable because much of the site remains undisturbed; however, little is currently known about the status of pygmy rabbit populations on the INL Site. The USFWS recently announced that pygmy rabbits do not warrant protection under the Endangered Species Act.

Surveys for pygmy rabbits using 400 x 400 m plots have occurred across the Site since 2006 (Figure 1). From those surveys, no active burrows systems have been located in the SOX range area or in the proposed exclusion area. One pygmy rabbit burrow system, however, was discovered in September during surveys conducted in the area between the down range access road and the 20-degree beam line (Figure 1). The burrow is approximately 1.27 km from the building location at the SOX Range. Investigators set a motion-sensor camera at this burrow from 14 September to 22 September 2010 to document the potential presence of pygmy rabbits at this burrow system. During the time the camera was set, we documented 851 pictures of at least one pygmy rabbit on 3 days (Figure 2). This burrow, however, appears to be relatively isolated with little surrounding sagebrush habitat needed by pygmy rabbits.

Figure 2. Pygmy rabbit photos from camera set within SOX Range.

3.2.3 Birds

Most avian species occupying the INL Site use both sagebrush and grassland habitats from a few days for feeding and resting during migration to several months for breeding and raising young. Many bird species utilize specific habitats for foraging and reproduction. Species that primarily use sagebrush include the greater sage-grouse, sage sparrow, Brewer's sparrow (*Spizella breweri*), sage thrasher (*Oreoscoptes montanus*), and loggerhead shrike (*Lanius ludovicianus*). Species that occur mainly in grassland habitats include horned lark, western meadowlark (*Sturnella neglecta*), vesper sparrow (*Pooecetes gramineus*), and grasshopper sparrow (*Ammodramus bairdii*). Although most raptors use the site indiscriminately for foraging, nesting structures are a limiting factor in population abundance and species diversity.

Bird species observed at the SOX Range included western meadowlark, horned lark, mourning dove (*Zenaida macroura*), pigeon, and other unidentified sparrow species.

3.2.4 Large Mammals

Since 1985, pronghorn, and on one occasion elk, have been observed during semi-annual surveys within the general area of the SOX Range during summer and winter. Pronghorn are found throughout the INL Site, with concentrations being greater near the Big Lost River Sinks, which is not far from the TAN facility.

At the proposed site, sign of pronghorn use of the area was observed during the survey conducted in September of 2010.

3.3 Ecological Research and Monitoring

Thirteen Breeding Bird Survey (BBS) routes were established on the INL Site in 1985 (Shurtliff and Whiting 2009b). Each of these routes is surveyed once each June. Each route requires one day to complete the survey. Five of the routes are in remote areas and the data from these are reported to the U.S. Geological Survey Biological Resources Division as part of a national effort to monitor the status of bird populations. The other eight BBS routes are associated with facilities and are used to monitor the effects of INL Site activities on bird populations. The BBS route at TAN follows the perimeter fence and surrounds the area designated for the SOX Range.

4.0 Environmental Consequences

Biological Resources

Operational controls would be implemented prior to and during the facility construction and operation to minimize the potential for adverse direct and indirect impacts to ecological resources in the area of potential effects. A tiered approach with initial efforts focusing on identification and assessment, followed by various protection strategies, as necessary, would be adopted as summarized below.

4.1 Vegetation

4.1.1 Plant Communities

Some of the proposed activities would result in vegetation and soil disturbance, and vegetation community fragmentation, as well as direct loss to some of the vegetation communities in and around the SOX Range due to construction activities. An increase in soil disturbance would likely lead to an associated increase in weedy non-native species. The potential to displace native species in the communities adjacent to the selected site also would be amplified. This impact would be greatest associated with the construction of a new road between the 0 and 20 degree beam lines (approximately on the 5 degree beam line).

Potential impacts to the vegetation communities at locations where vegetation removal is proposed could be minimized by limiting the size of the footprint of the disturbance. Weed management would also be necessary because even the slightest amount of soil disturbance would lead to non-native species invasions. Prompt revegetation of disturbed areas with native species would limit the potential impact to native plant communities.

Use of the Extended Range could lead to habitat fragmentation and increased invasive species even though planned use in that area is minimal. Three sides are existing two-track roads which will help alleviate disturbance in the Extended Range. Continual visual surveillance of the area after use for the life of the project will allow the project to treat any non-native infestations that may occur or to revegetate areas that are not recovering adequately.

4.1.2 Invasive and Non-Native Species

Soil disturbance is a primary contributor to the spread of invasive plants. Invasive and non-native plants are present at the building location and could be spread by mowing, blading, grubbing, and any other means used to remove the vegetation as described for some of the proposed activities. If the proposed activity schedule coincided with or immediately followed seed ripening for certain invasive plants, spreading would likely occur. Similarly, disturbed soils would be open and available to receive seeds through much of the seed dispersal period for nearly all of the invasive species found in this survey. Any time a large area of soil is disturbed, there is potential for non-native infestations is the area. As more facilities are being built in native communities, the community structure is weakened and invasives continue to multiply and spread in all directions. Once these species gain a foothold, they can be extremely difficult and expensive to eradicate. Operational controls to minimize invasive and non-native species would include the development and implementation of a weed management plan.

4.1.3 Ethnobotany

Ten plant species of ethnobotanical interest were found at the proposed SOX Range (Table 4). The impacts of vegetation and soil disturbance would likely be greater on less common species than they would be on abundant species. Frequently occurring species are generally quite abundant; thus, removing several individuals would not greatly affect the larger population. Populations of species with more isolated distributions, however, are much more sensitive to the loss of several individuals.

Because the soil and vegetation disturbance and risk of non-native species invasion would impact populations of species of ethnobotanical concern, the most effective operational control to protect those populations would be to minimize the amount of soil disturbed. Potential impacts to populations of plant species of ethnobotanical concern also may be minimized by revegetating disturbed areas. Seeds or seedlings are commercially available for about one-third of the species listed in Table 4; therefore, those species may be directly replanted, provided care is taken to choose appropriate subspecies and cultivars. Using a diverse mix of native species for revegetation would be important if species of concern, for which seed or stock is not available, are to re-establish voluntarily. Finally, weed control would be critical to facilitate re-establishment of native communities, including species of ethnobotanical concern.

4.1.4 Sensitive Plant Species

Because the occurrence of sensitive plants is unlikely, no direct impacts to sensitive plant species would be anticipated due to the development and operation of the SOX Range.

4.2 Wildlife

Vegetation and soil disturbance would have common unavoidable impacts to wildlife, including loss of certain ground-dwelling wildlife species and associated habitat, and displacement of certain wildlife species due to increased habitat fragmentation. These impacts can be minimized by limiting the disturbance footprint, implementing a weed management strategy and promptly revegetating the disturbed areas. Between May 1st and September 1st, any activity potentially disturbing vegetation or soils would require a nesting bird survey prior to disturbance.

4.2.1 Sage-Grouse

Although suitable habitat was found, minimal impacts to sage-grouse are anticipated due to the limited amount of disturbance planned in the areas with habitat. However, adding perch locations, such as tall fencing and power poles, would give raptors and ravens more places from which to hunt sage-grouse.

4.2.2 Pygmy Rabbit

While the activities associated with the SOX Range may have negative consequences on the individuals that occupy the active burrow system within the range, the protection of the area in the exclusion zone from further development will provide habitat for pygmy rabbits and potentially sage-grouse. Indeed, some inactive burrow systems have been located in the exclusion zone, indicating that this area likely has been suitable pygmy rabbit habitat. Additionally, active burrow systems exist directly south of the exclusion zone (Figure 1). The addition of poles and fences will give raptors and ravens additional places from which to hunt pygmy rabbits.

4.2.3 Habitat Fragmentation

Nearly all of the sites where the proposed activities could impact habitat have been previously disturbed as the facility is within the TAN boundaries and is accessed via the gravel road to IET. The exception is the proposed gravel road that will travel the length of the 5 degree beam line. The first half of this road is disturbed, as evidenced by the crested wheatgrass monoculture. It is also bisected numerous times by the old security two tracks that run in circles around the facility. This road already will exert some force on fragmentation, but the potential for increasing that effect would be increased by the potential loss of vegetation to extend the road. This impact could be reduced by minimizing the footprint of the disturbance, promptly revegetating the areas that have been disturbed, and implementing a weed management plan.

Construction of fences can impede the movements and at times may trap mule deer and pronghorn within the enclosed area (Kie et al. 1996). A 328 ft. wide by up to 10 ft. high chain-link fence will be constructed around the SOX building perimeter and possibly extend up to 1,640 ft. north to create a boundary for the Very High Radiation Area (VHRA). This fence will prevent access to the VHRA by humans as well as by wildlife (Figure 1). This new fence will be built within the existing TAN 3-strand barbed wire perimeter fence (Figure 1). A potential exists for trapping ungulates within the chain-link fence area depending on its exact height; however, since 1985 only 2 pronghorn and no elk or mule deer have been observed within the TAN perimeter fence (Figure 1). Further, this new fence will not be left open and the area within the fence will be patrolled for humans and ungulates prior to initiating operation. If humans or ungulates are observed within the VHRA, they will be allowed to exit the area prior to initiating operations.

Constructing the powerline would add to the perching sites available for raptors and ravens. The exponential growth in the raven population on the INL Site (Shurtliff and Whiting 2009b) suggests concern for the potential for increased predation on sage-grouse nests and pygmy rabbits. Adding perch-deterrent devices has been shown to be an effective means for reducing effects on prey species (Oles 2007).

4.2.4 Radiological Impacts

To assess the full extent of environmental impacts of the proposed action, radiological impacts to biota must be considered [DOE Orders 450.1a (2008) and 5400.5 (1993)]. The impact of environmental radioactivity at the INL Site on nonhuman biota can be assessed using *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002) and the associated software, RESRAD-Biota (ISCORS 2004). The graded approach evaluates the impacts of a given set of radionuclides on aquatic and terrestrial ecosystems by comparing available concentration data in soils and water with biota concentration guides. A biota concentration guide is defined as the environmental concentration of a given radionuclide in soil or water that, under the assumptions of the model, would result in a dose rate less than 1 rad/day (10 mGy/day) to aquatic animals (aquatic animals are not considered in this assessment) or terrestrial plants or 0.1 rad/day (1 mGy/day) to terrestrial animals. If the sum of the measured environmental concentrations divided by the biota concentration guides (the combined sum of fractions) is less than one, no negative impact to plant or animal populations is expected. No doses are calculated unless the screening process indicates a more detailed analysis is necessary.

The doses from the proposed action will be direct radiation dose primarily from Bremsstrahlung X-rays with a calculated maximum of 10,780,000 rad/hr at 1 meter in front of the LINAC at 60 MeV and 100 microamps average beam current (ECAR 2007). To meet regulatory limits, the LINAC would operate at a maximum of 1400 hours/yr and generally well below the maximum levels assessed (M. Sandvig, personal communication October 21, 2010). The LINAC beam will be approximately 2 meters above the ground surface. Because there will be little or no long-term soil contamination, the use of RESRAD Biota to assess the radiological impacts of the proposed action is not applicable. However, the dose rate limits are applicable to assessing the potential radiological impacts of the proposed action.

The maximum potential dose of over 10 million rad/hr in the LINAC beam far exceeds the 1 and 0.1 rad/day protective limits and would be damaging to individual terrestrial plants or animals, respectively, exposed for even a short period.

The guidance on the use of time averaging in applying the daily dose limits for biota is based on reviews and evaluations of existing data and discussions of daily dose limits in IAEA (1992), and Barnthouse (1995). The rationale for the guidance is summarized as follows:

- The daily dose limits for biota are intended to provide protection of whole populations of individual species, rather than individual members of the population. Furthermore, the primary health effect of concern in protecting whole populations of individual species is impairment of reproductive capability over the normal reproductive lifetime.
- The data on radiation effects in biota that provided the basis for the daily dose limits were obtained primarily from studies involving *chronic* exposure, in which the average dose rate in the population varied substantially, often by an order of magnitude or more, over exposure times ranging from several months to several years. In the studies involving chronic exposure, the dose rate in individual organisms also varied substantially due to spatial inhomogeneities in the dose rate and/or the movement and burrowing habits of organisms.

- Based on studies involving short-term exposures, dose rates about 2-5 times higher than the daily limits for biota appear to be tolerable for short periods of time (e.g., 30 days) if the daily dose rate averaged over the lifetime of the exposed population is limited in accordance with the standards. Single acute doses about 10-30 times higher than the daily dose limit appear to be tolerable (a) if the recovery time between such doses is sufficiently long (e.g., 30-60 days) and (b) if the daily dose rate averaged over the lifetime of the exposed population is limited in accordance with the standards.
- The *average* doses in populations of study organisms was the primary basis for reporting dose-response relationships for deterministic effects, including early mortality and impairment of reproductive capability, and for developing standards for radiation exposure of biota. Thus, time averaging, as well as spatial averaging, of dose rates was inherent in the development of daily dose limits. The dose limits were not intended as limits for each day of exposure but, rather, as limits on the average daily dose rates encountered from conception through reproductive age. Therefore, averaging times as long as 1 year may be appropriate for reproducing members of populations of the most radiosensitive organisms (vertebrate animals and some higher plants).
- Radioecological studies at highly contaminated sites in the former Soviet Union (Polikarpov 1994) suggest that radiation effects are observed at the population and community level only for annual doses greater than about 400 rad (4 Gy) or an average daily dose of about 1 rad (0.01 Gy). Thus, effects attributable to radiation exposure were observed only for average daily doses over 1 year equal to the dose limit for aquatic animals and terrestrial plants and 10 times the dose limit for terrestrial animals (DOE 2002).

As demonstrated in previous sections, the terrestrial plant and animal species present in the area under consideration for the proposed action are common not only INL-wide but region-wide. Wildlife species of concern that have been documented in the area of consideration include pygmy rabbits, all migratory birds (including raptors), and all large mammal species. There are no threatened or endangered species in the proposed action area.

Radiological impacts to large mammal species will be negated due automatic shut-off of the accelerator when they breach the exclusion zone (Figure A-1) as well as their inherent mobility. It is very unlikely that large mammals would spend enough time in the highest radiation zone to exceed the recommended 0.1 rad/day limit. The same would be true for migratory birds or raptors unless they nest in the radiologically impacted areas. If nesting occurs, the LINAC beam will be above ground nests so only those placing nest in the tallest sagebrush may be impacted. However, since sagebrush is not abundant until 3000 meters from the source, it is unlikely that nesting birds would receive a significant radiation dose from operations. As long as the annual averaged dose does not exceed 36.5 rad, the operations will not exceed the recommended dose. Again, birds are mobile and it is unlikely that any bird species would remain in the impacted area for an extended period of time. Neither large mammal nor bird populations would be impacted because they are present site and region-wide.

Individual terrestrial plants in the area could be impacted by the high exposures. However, much of the vegetation is invasives and poor quality native vegetation adjacent to of the with good quality native vegetation being present at about 3 km (3000 m) from the proposed action. This would result in an approximate dose of 7.55 millirad/hr from the 60 MeV beam if the vegetation is in the beam. Averaged over a year, the dose would be 0.029 rad/day assuming 1400 hours of operation annually. Since the beam is 2 meters above ground, it would be further attenuated reducing the maximum dose to 0.024 mrad/hr, 0.03 rad/yr or 0.092 mrad/day, a factor of over 1000 below the regulatory guidelines for terrestrial plants. Because none of the plant species present are considered rare and are common INL- and region-wide, radiological impact to the population is unlikely.

The pygmy rabbit is the only sensitive species found in the proposed action area and is listed under Idaho Species of Greatest Need (http://fishandgame.idaho.gov/cms/tech/CDC/cwcs_pdf/appendix%20b.pdf). However, it is a game animal and can be hunted. There is an active burrow about 1300 m from the accelerator in direct line of the beam. Pygmy rabbits in this location could receive a direct beam dose of about 0.711 rad/hr or 995 rad/yr (at 1400 hours of operation) at 2 m above ground level (ECAR 2007). The beam will be quite dispersed at 1300 m and ground radiation is extremely unlikely. However, if doses are considered 90 degrees from the direct beam at ground surface, they would be 0.78 mrad/hr and 1.1 mrad/yr or 3E-3 mrad/day (including the reduction by the 2 m from the beam to the ground). Pygmy rabbits are generally most active 3 hours before and 3 hours after sunrise as well as after sunset (Lee et al. 2010; Larrucea and Brussard 2009) so would likely be in their burrow during LINAC operations. Burrow depth is approximately 44 cm (1.4 feet) below surface (Rachlow et al. 2005). Therefore, time, distance and shielding would further protect pygmy rabbits from radiation dose. It is likely that if pygmy rabbits received any dose it would be negligible and well below the 0.1 rad/day guideline.

4.3 Ecological Research and Monitoring

Limiting access to the large area surrounding the SOX Range could impact the continuity and utility of the BBS route at TAN. Coordinating timing of access to this route as an operational control would eliminate this impact. Continuation of the monitoring route would also provide information on the potential impacts the proposed action could be having on local bird populations.

4.4 Cumulative Impacts

The impacts associated with the proposed action would appear to have a small footprint, have low intensity, and be located in or near areas with much larger impacts to ecological resources. Because of that, no cumulative effects are anticipated.

Table 5. Project controls to avoid or lessen impacts to natural, ecological, and cultural resources.

Activity	Control
Vegetation removal or soil disturbance	• Nesting bird surveys prior to disturbance between May 1 and September 1 • Limit size of areas disturbed • Prompt revegetation with native species • Weed management
Release of radionuclides to the environment	Prepare a biota dose assessment
Limiting access to the TAN BBS route	Coordination of timing to allow access for the BBS survey

Construction of poles and fences	Place anti-perch devices on any structure that could be used as a perch

4.5 Permits and Regulatory Requirements

Soil and vegetation disturbing activities, including those associated with mowing, blading and grubbing, have the potential to increase noxious weeds and invasive plant species that would be managed according to 7 USC § 2814, "Management of Undesirable Plants on Federal Lands" and Executive Order 13112, "Invasive Species." The INL would follow the applicable requirements to manage undesirable plants.

In analyzing the potential ecological impacts of the action alternative for this project, DOE-ID has followed the requirements of the Endangered Species Act (16 USC §1531 et seq.) and has reviewed the most current lists for threatened and endangered plant and animal species. Other federal laws that could apply include: the Fish and Wildlife Coordination Act (16 USC § 661 et seq.), Bald Eagle Protection Act (16 USC § 668), and the Migratory Bird Treaty Act (16 USC § 715–715s).

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*Refer to those references provided by the SOX Range project personnel and have not been changed (content) or edited in any way.

Appendix A
SOX Range Footprint and Operational Characteristics

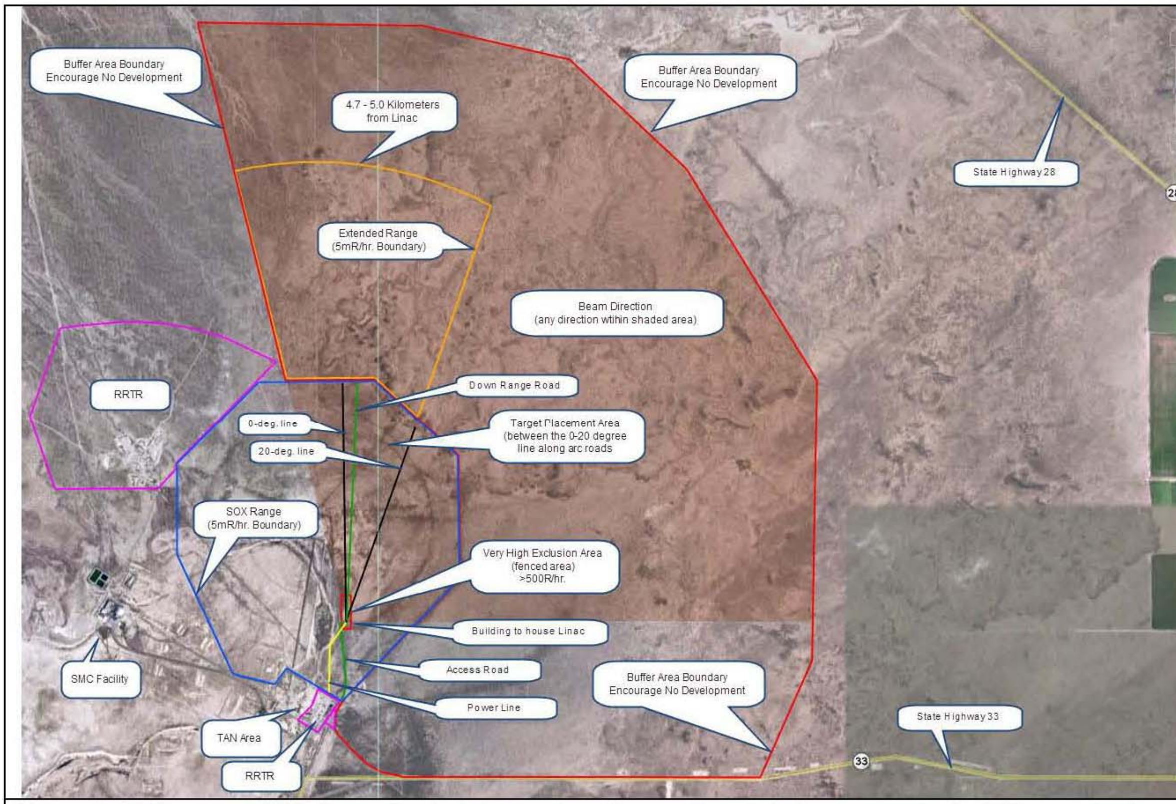


Figure A-1. Proposed SOX Range footprint showing all operational features; nearby facilities, projects, and infrastructure; and surrounding area. See following figures for more detail.

Figure A-2. SOX Range showing locations of SMC and TAN/TSF areas and fence surrounded the proposed range.

All construction activities would occur within the outer fenced boundary.

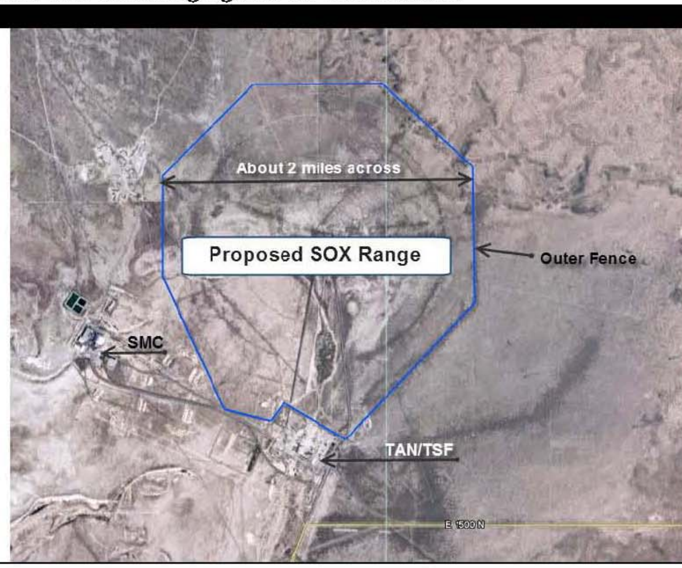


Figure A-3. SOX Range showing down range access road, building housing linacs and proposed utility route (power and water)

Figure A-4. Closer view of SOX Range support facilities showing such as the 40' x 40' building, gravel pads, down range road, and very high radiation area

Figure A-5. Closer view of SOX Range support facilities detailing proposed very high radiation areas depending on the size of the accelerator

Figure A-6. Example of trailer housing the acceleration control station; this trailer would south of the support building on the gravel pad

Figure A-7. Example of beam stops assembled using concrete blocks; this picture shows a typical beam stop for the Varitron-III shielding. Each block is 2' thick, 2'tall and 6' long. The delivery and placement of shield blocks require forklifts and semi-trucks. The movement of a large number of blocks usually only happens once every few year.

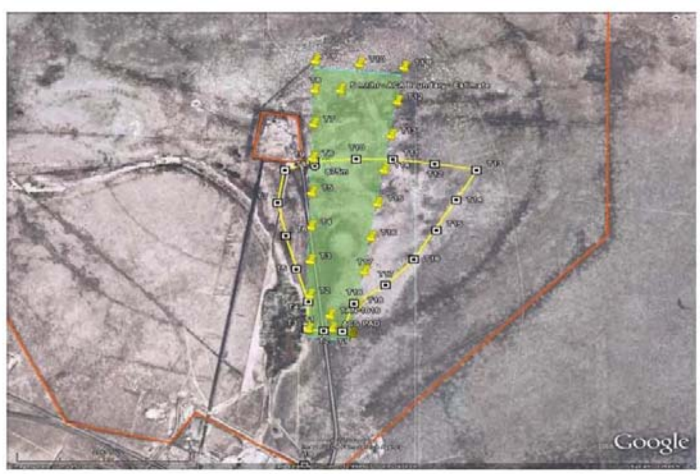


Figure A-8. Example of possible layout for the Intrusion Detection System around the very high radiation area.

Examples for the location of the IDS perimeter at the 5 mrem/hr boundary for an INL accelerator. This IDS system has small tower that can be located about 700 feet apart. These towers are small and self contained; receiving power via photocell mounted on top of the tower and transmits its status wirelessly. These towers are about 6 feet tall, and have a very small footprint. Two installation configuration that are being considered to minimize foot print; installing guy wires into the ground to hold the plastic tower directly to the ground; and/or using a 2' square 4" thick pre-poured concrete base and running guy wires to the corners of the base.

Figure A-9. Location of the extended range to the north of the proposed SOX range. This Extended Range provides just over 3,500 meters and is expected to be used only on a very infrequent (maybe 3 weeks per year on average) basis. During these operations it is likely that traffic candle will be used with radiation rope to demark the 5 mrem/hr boundary. An intrusion detection system may or may not be used depending on approved method used and radiation dose rates.

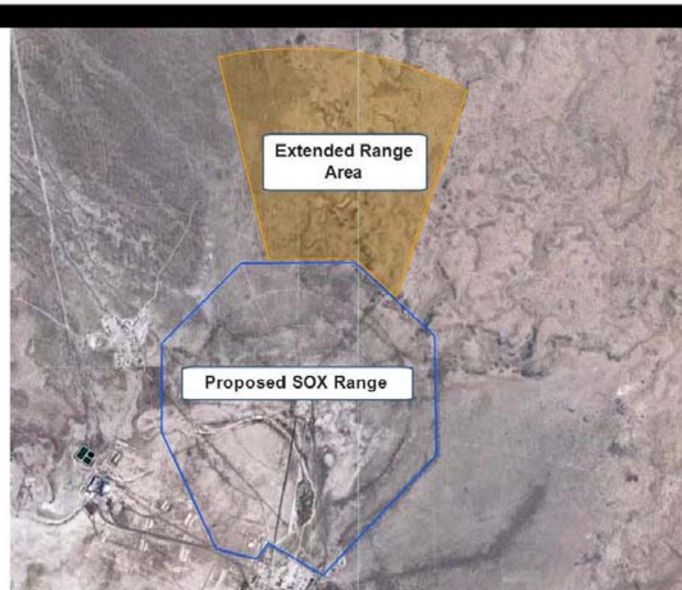
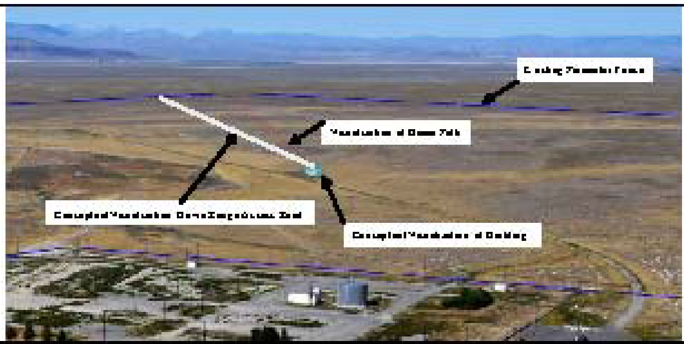


Figure A-10. The shaded area to the east and north of the SOX Range indicates a 'No Development' area

Figure A-11. Visualization of SOX Range with building, down-range road, and possible beam path and with TAN/TSF in foreground	
Figure A-12. Acceptable directions for linac beam operations as it is pointed from the support building	
Figure A-13. Proposed SOX Range showing the 'linac' building, 0- and 20-degree beam direction, and down range road. Also shown for reference are two beam lines with azimuths of 0 and 20 degrees but any approved azimuth beam lines could also be used. The down range access road will be used year-round. This type of configuration allows the off-axis dose to be measured using the down range access road while the beam is not going down the same angle.	

Appendix B
Suggested Text for the Environmental Consequences

4.0 Environmental Consequences

Potential impacts to vegetation communities, sensitive plant species and species of ethnobotanical concern associated with the proposed activity would be minimizing by limiting the footprint of the disturbance, revegetating the areas that have been disturbed, and implementing a weed management plan. Revegetating with a diverse mix of native species similar in composition to the existing plant community may help maintain the diversity of those communities. Revegetation in sagebrush steppe is generally successful in only one of three years because of the variability in availability and timing of precipitation.

Certain of the proposed activities would have unavoidable impacts to wildlife such as: (1) loss of ground-dwelling wildlife species and associated habitat, (2) displacement of certain wildlife species due to increased habitat fragmentation, and (3) an increase in the potential for negative interaction between wildlife and humans (Blew et al., Hafla et al. 2010). The control measures that would reduce the impact on wildlife include seasonal timing of activities, nesting bird surveys and awareness programs.

Wildlife species of concern include Greater sage-grouse, all migratory birds (including raptors), pygmy rabbits, Great Basin rattlesnakes, and all large mammal species (Blew et al. 2010, Hafla et al. 2010). Nesting bird surveys would be conducted prior to any soil or vegetation disturbance occurring between May 1 and September 1. No critical habitat for threatened or endangered species, as defined in the Endangered Species Act (ESA), exists on the INL site. Greater sage-grouse is a Candidate species for listing under ESA. It is likely the proposed activity would have an impact directly on pygmy rabbits and indirect effects on sage-grouse, pygmy rabbits or other sensitive species through habitat alteration (Blew et al. 2010, Hafla et al. 2010). If a species such as the Greater sage-grouse is listed before or during construction of the facility, DOE would initiate formal consultation with the U.S. Fish and Wildlife Service.

4.1 Biological Resources

4.1.1 Vegetation

Plant Communities

Some of the proposed activities would result in vegetation and soil disturbance, and vegetation community fragmentation. An increase in soil disturbance would likely lead to an associated increase in weedy non-native species. The potential to displace native species in the communities adjacent to the selected site also would be amplified. This impact would be greatest associated with the construction of a new road between the 0 and 20 degree beam lines (approximately on the 5 degree beam line).

Potential impacts to the vegetation communities at locations where vegetation removal is proposed could be minimized by limiting the size of the footprint of the disturbance. Weed management would also be necessary because even the slightest amount of soil disturbance would lead to non-native species invasions. Prompt revegetation of disturbed areas with native species would limit the potential impact to native plant communities.

Use of the Extended Range could lead to habitat fragmentation and increased invasive species even though planned use in that area is minimal. Three sides are existing two-track roads which will help alleviate disturbance in the Extended Range. Visual surveillance of the area after use for the next year will allow the project to treat any non-native infestations that may occur or to revegetate areas that are not recovering adequately.

Invasive and Non-Native Species

Soil disturbance is a primary contributor to the spread of invasive plants. Invasive and non-native plants are present at the building location and could be spread by mowing, blading, grubbing, and any other means used to remove the vegetation as described for some of the proposed activities. If the proposed activity schedule coincided with or immediately followed seed ripening for certain invasive plants, spreading would likely occur. Similarly, disturbed soils would be open and available to receive seeds through much of the seed dispersal period for nearly all of the invasive species found in this survey. Any time a large area of soil is disturbed, there is potential for non-native infestations is the area. As more facilities are being built in native communities, the community structure is weakened and invasives continue to multiply and spread in all directions. Once these species gain a foothold, they can be extremely difficult and expensive to eradicate. Operational controls to minimize invasive and non-native species would include the development and implementation of a weed management plan.

Ethnobotany

Ten plant species of ethnobotanical interest were found at the proposed SOX Range (Hafla et al. 2010). The impacts of vegetation and soil disturbance would likely be greater on less common species than they would be on abundant species. Frequently occurring species are generally quite abundant; thus, removing several individuals would not greatly affect the larger population. Populations of species with more isolated distributions, however, are much more sensitive to the loss of several individuals.

Because the soil and vegetation disturbance and risk of non-native species invasion would impact populations of species of ethnobotanical concern, the most effective operational control to protect those populations would be to minimize the amount of soil disturbed. Potential impacts to local populations of plant species of ethnobotanical concern also may be minimized by revegetating disturbed areas. Seeds or seedlings are commercially available for some of the species; therefore, those species may be directly replanted, provided care is taken to choose appropriate subspecies and cultivars. Using a diverse mix of native species for revegetation would be important if species of concern, for which seed or stock is not available, are to re-establish voluntarily. Finally, weed control would be critical to facilitate re-establishment of native communities, including species of ethnobotanical concern.

Sensitive Plant Species

Because the occurrence of sensitive plants is unlikely, no direct impacts to sensitive plant species would be anticipated due to the development and operation of the SOX Range (Hafla et al. 2010).

4.1.2 Wildlife

Vegetation and soil disturbance would have unavoidable impacts to wildlife, including loss of certain ground-dwelling wildlife species and associated habitat, and displacement of certain wildlife species due to increased habitat fragmentation. These impacts can be minimized by limiting the disturbance footprint, implementing a weed management strategy and promptly revegetating the disturbed areas. Any activity potentially disturbing vegetation or soils would require a nesting bird survey prior to disturbance.

Sage-Grouse

Although suitable habitat was found, minimal impacts to sage-grouse are anticipated due to the limited amount of disturbance planned in the areas with habitat. However, adding perch locations, such as tall fencing and power poles, would give raptors and ravens more places from which to hunt sage grouse (Hafla et al. 2010).

Pygmy Rabbit

While the activities associated with the SOX Range may have negative consequences on the individuals that occupy the active burrow system within the range, the protection of the area in the exclusion zone from further development will provide habitat for pygmy rabbits and potentially sage-grouse. Indeed, some inactive burrow systems have been located in the exclusion zone, indicating that this area likely has been suitable pygmy rabbit habitat. Additionally, active burrow systems exist directly south of the exclusion zone (Figure 1). The addition of poles and fences will give raptors and ravens additional places from which to hunt pygmy rabbits.

Habitat Fragmentation

Nearly all of the sites where the proposed activities could impact habitat have been previously disturbed as the facility is within the TAN boundaries and is accessed via the gravel road to IET. The exception is the proposed gravel road that will travel the length of the 5 degree beam line. The first half of this road is disturbed, as evidenced by the crested wheatgrass monoculture. It is also bisected numerous times by the old two track roads that run in circles around the facility. This road already will exert some force on fragmentation, but the potential for increasing that effect would be increased by the potential loss of vegetation to extend the road. This impact could be reduced by minimizing the footprint of the disturbance, promptly revegetating the areas that have been disturbed, and implementing a weed management plan.

Construction of fences can impede the movements of and at times may trap mule deer and pronghorn within the enclosed area (Kie et al. 1996). A 10-ft. high chain link fence would be constructed around the SOX building perimeter 328 ft. wide and possibly extend up to 1,640 ft. north to create a boundary for the Very High Radiation Area (VHRA). This fence would prevent access to the VHRA by humans as well as by large wildlife (Figure 1). This new fence will be built within the existing 3-strand barbed wire perimeter fence (Figure 1). A potential exists for trapping ungulates within the chain-link fence area; however, since 1985 only 2 pronghorn and no elk or mule deer have been observed within the existing fence (Figure 1). Further, this new fence would not be left open and the area within the fence would be patrolled for humans and ungulates prior to initiating operation. If humans or ungulates are observed within the VHRA, they will be allowed to exit the area prior to initiating operations.

Constructing the powerline would add to the perching sites available for raptors and ravens. The exponential growth in the raven population on the INL Site (Shurtliff and Whiting 2009b) suggests concern for the potential for increased predation on sage-grouse nests and pygmy rabbits. Adding perch-deterrent devices has been shown to be an effective means for reducing effects on prey species (Oles 2007).

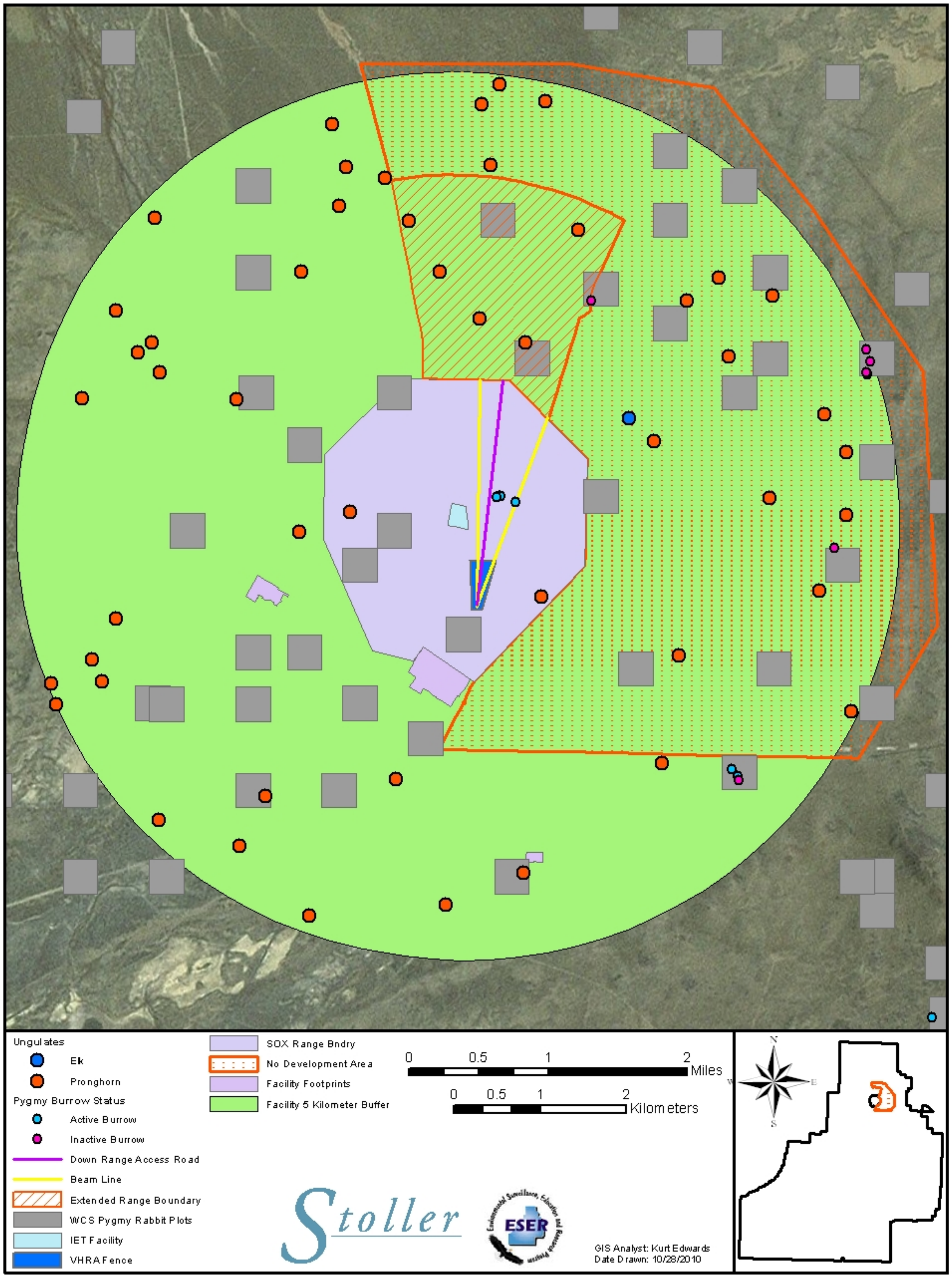


Figure 1. Biological Resources in the vicinity of the SOX Range.

Radiological Impacts

To assess the full extent of environmental impacts of the proposed action, radiological impacts to biota must be considered [DOE Orders 450.1a (2008) and 5400.5 (1993)]. The impact of environmental radioactivity at the INL Site on nonhuman biota can be assessed using *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002) and the associated software, RESRAD-Biota (ISCORS 2004). The graded approach evaluates the impacts of a given set of radionuclides on aquatic and terrestrial ecosystems by comparing available concentration data in soils and water with biota concentration guides. A biota concentration guide is defined as the environmental concentration of a given radionuclide in soil or water that, under the assumptions of the model, would result in a dose rate less than 1 rad/day (10 mGy/day) to aquatic animals (aquatic animals are not considered in this assessment) or terrestrial plants or 0.1 rad/day (1 mGy/day) to terrestrial animals. If the sum of the measured environmental concentrations divided by the biota concentration guides (the combined sum of fractions) is less than one, no negative impact to plant or animal populations is expected. No doses are calculated unless the screening process indicates a more detailed analysis is necessary.

The doses from the proposed action will be direct radiation dose primarily from Bremsstrahlung X-rays with a calculated maximum of 10,780,000 rad/hr at 1 meter in front of the LINAC at 60 MeV and 100 microamps average beam current (ECAR 2007). To meet regulatory limits, the LINAC would operate at a maximum of 1400 hours/yr and generally well below the maximum levels assessed (M. Sandvig, personal communication October 21, 2010). The LINAC beam will be approximately 2 meters above the ground surface. Because there will be little or no long-term soil contamination, the use of RESRAD Biota to assess the radiological impacts of the proposed action is not applicable. However, the dose rate limits are applicable to assessing the potential radiological impacts of the proposed action.

The maximum potential dose of over 10 million rad/hr in the LINAC beam far exceeds the 1 and 0.1 rad/day protective limits and would be damaging to individual terrestrial plants or animals, respectively, exposed for even a short period.

The guidance on the use of time averaging in applying the daily dose limits for biota is based on reviews and evaluations of existing data and discussions of daily dose limits in IAEA (1992), and Barnthouse (1995). The rationale for the guidance is summarized as follows:

- The daily dose limits for biota are intended to provide protection of whole populations of individual species, rather than individual members of the population. Furthermore, the primary health effect of concern in protecting whole populations of individual species is impairment of reproductive capability over the normal reproductive lifetime.
- The data on radiation effects in biota that provided the basis for the daily dose limits were obtained primarily from studies involving *chronic* exposure, in which the average dose rate in the population varied substantially, often by an order of magnitude or more, over exposure times ranging from several months to several years. In the studies involving chronic exposure, the dose rate in individual organisms also varied substantially due to spatial inhomogeneities in the dose rate and/or the movement and burrowing habits of organisms.
- Based on studies involving short-term exposures, dose rates about 2-5 times higher than the daily limits for biota appear to be tolerable for short periods of time (e.g., 30 days) if the daily dose rate averaged over the lifetime of the exposed population is limited in accordance

with the standards. Single acute doses about 10-30 times higher than the daily dose limit appear to be tolerable (a) if the recovery time between such doses is sufficiently long (e.g., 30-60 days) and (b) if the daily dose rate averaged over the lifetime of the exposed population is limited in accordance with the standards.

- The *average* doses in populations of study organisms was the primary basis for reporting dose-response relationships for deterministic effects, including early mortality and impairment of reproductive capability, and for developing standards for radiation exposure of biota. Thus, time averaging, as well as spatial averaging, of dose rates was inherent in the development of daily dose limits. The dose limits were not intended as limits for each day of exposure but, rather, as limits on the average daily dose rates encountered from conception through reproductive age. Therefore, averaging times as long as 1 year may be appropriate for reproducing members of populations of the most radiosensitive organisms (vertebrate animals and some higher plants).
- Radioecological studies at highly contaminated sites in the former Soviet Union (Polikarpov 1994) suggest that radiation effects are observed at the population and community level only for annual doses greater than about 400 rad (4 Gy) or an average daily dose of about 1 rad (0.01 Gy). Thus, effects attributable to radiation exposure were observed only for average daily doses over 1 year equal to the dose limit for aquatic animals and terrestrial plants and 10 times the dose limit for terrestrial animals (DOE 2002).

As demonstrated in previous sections, the terrestrial plant and animal species present in the area under consideration for the proposed action are common not only INL-wide but region-wide. Wildlife species of concern that have been documented in the area of consideration include pygmy rabbits, all migratory birds (including raptors), and all large mammal species. There are no threatened or endangered species in the proposed action area.

Radiological impacts to large mammal species will be negated due automatic shut-off of the accelerator when they breach the exclusion zone (Figure A-1) as well as their inherent mobility. It is very unlikely that large mammals would spend enough time in the highest radiation zone to exceed the recommended 0.1 rad/day limit. The same would be true for migratory birds or raptors unless they nest in the radiologically impacted areas. If nesting occurs, the LINAC beam will be above ground nests so only those placing nest in the tallest sagebrush may be impacted. However, since sagebrush is not abundant until 3000 meters from the source, it is unlikely that nesting birds would receive a significant radiation dose from operations. As long as the annual averaged dose does not exceed 36.5 rad, the operations will not exceed the recommended dose. Again, birds are mobile and it is unlikely that any bird species would remain in the impacted area for an extended period of time. Neither large mammal nor bird populations would be impacted because they are present site and region-wide.

Individual terrestrial plants in the area could be impacted by the high exposures. However, much of the vegetation is invasives and poor quality native vegetation adjacent to of the with good quality native vegetation being present at about 3 km (3000 m) from the proposed action. This would result in an approximate dose of 7.55 millirad/hr from the 60 MeV beam if it in the beam. Averaged over a year, the dose would be 0.029 rad/day assuming 1400 hours of operation annually. Since the beam is 2 meters above ground, it would be further attenuated reducing the maximum dose to 0.024 mrad/hr, 0.03 rad/yr or 0.092 mrad/day, a factor of over 1000 below the regulatory guidelines for terrestrial plants. None of the plant species present are considered rare and are common INL- and region-wide, radiological impact to the population is unlikely.

The pygmy rabbit is the only sensitive species found in the proposed action area and is listed under Idaho Species of Greatest Need (http://fishandgame.idaho.gov/cms/tech/CDC/cwcs_pdf/appendix%20b.pdf). However, it is a game animal and can be hunted. There is an active burrow about 1300 m from the accelerator in direct line of the beam. Pygmy rabbits in this location could receive a direct beam dose of about 0.711 rad/hr or 995 rad/yr (at 1400 hours of operation) at 2 m above ground level (ECAR 2007). The beam will be quite dispersed at 1300 m and ground radiation is extremely unlikely. However, if doses are considered 90 degrees from the direct beam at ground surface, they would be 0.78 mrad/hr and 1.1 mrad/yr or 3E-3 mrad/day (including the reduction by the 2 m from the beam to the ground). Pygmy rabbits are generally most active 3 hours before and 3 hours after sunrise as well as after sunset (Lee et al. 2010; Larrucea and Brussard 2009). Burrow depth is approximately 44 cm (1.4 feet) below surface (Rachlow et al. 2005). Time, distance and shielding would further protect pygmy rabbits from radiation dose. It is likely that if pygmy rabbits received any dose it would be negligible and well below the 0.1 rad/day guideline.

4.1.3 Ecological Research and Monitoring

Limiting access to the large area surrounding the SOX Range would impact the continuity and management utility of the BBS route at TAN. Coordinating timing of access to this route as an operational control would eliminate this impact. Continuation of the monitoring route would also provide information on the potential impacts the proposed action could be having on local bird populations.

4.1.4 Cumulative Impacts

The impacts associated with the proposed action would appear to have a small footprint, have low intensity, and be located in or near areas with much larger impacts to ecological resources. Because of that, no cumulative effects are anticipated.

Table 2. Project controls to avoid or lessen impacts to natural, ecological, and cultural resources.

Activity	Control
Vegetation removal or soil disturbance	• Nesting bird surveys prior to disturbance between May1 and September 1. • Limit size of areas disturbed • Prompt revegetation with native species • Weed management
Release of radionuclides to the environment	Prepare a biota dose assessment
Limiting access to the TAN BBS route	Coordination of timing to allow access for the BBS survey.

Activity	Control
Construction of poles and fences	Place anti-perch devices on any structure that could be used as a perch

4.1.5 Permits and Regulatory Requirements

Soil and vegetation disturbing activities, including those associated with mowing, blading and grubbing, have the potential to increase noxious weeds and invasive plant species that would be managed according to 7 USC § 2814, "Management of Undesirable Plants on Federal Lands" and Executive Order 13112, "Invasive Species." The INL would follow the applicable requirements to manage undesirable plants.

In analyzing the potential ecological impacts of the action alternative for this project, DOE-ID has followed the requirements of the Endangered Species Act (16 USC §1531 et seq.) and has reviewed the most current lists for threatened and endangered plant and animal species. Other federal laws that could apply include: the Fish and Wildlife Coordination Act (16 USC § 661 et seq.), Bald Eagle Protection Act (16 USC § 668), and the Migratory Bird Treaty Act (16 USC § 715–715s).

5.0 References

7 USC § 2814, 2006, "Management of Undesirable Plants on Federal Lands," United States Code.

16 USC § 661 et seq., 1960, "Fish and Wildlife Coordination Act," United States Code.

16 USC § 668, 1940, "Bald Eagle Protection Act," United States Code.

16 USC § 715-715s, 1918, "Migratory Bird Treaty Act," United States Code.

16 USC, § 1531 et seq., 1973, "Endangered Species Act," United States Code.

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