

DRAFT FINDING OF NO SIGNIFICANT IMPACT

NAME OF THE PROPOSED ACTION: The National Aeronautics and Space Administration (NASA) Commercial Crew Transportation System Supplemental Environmental Assessment for the Boeing Starliner Landing and Recovery at the U.S Army White Sands Missile Range (WSMR).

INTRODUCTION: NASA and the White Sands Missile Range gives notice that a draft Supplemental Environmental Assessment (SEA) was prepared and a draft Finding of No Significant Impact (FONSI) has been issued for the landing and recovery of the Boeing Starliner spacecraft at WSMR, New Mexico. The draft SEA was developed pursuant to the following regulations:

- National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code 4321, et. seq.)
- The Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal Regulations (CFR) Parts 1500-1508)
- NASA policies and procedures (14 CFR Part 1216, Subpart 1216.3)
- The Environmental Analysis of Army Actions (32 CFR 651)

The draft SEA augments the findings in the *Commercial Crew Transportation System Environmental Assessment for the Boeing Starliner Launch from Cape Canaveral Air Force Station and Landing and Recovery at the U.S Army White Sands Missile Range (June 2019)*. NASA, the Federal Aviation Administration (FAA), and the U. S. Army are all involved with this action with NASA being the lead agency.

DESCRIPTION OF THE PROPOSED ACTION: The proposed action is to allow the NASA Commercial Crew Transportation System initiative to perform landing and recovery operations for an alternate landing site in the northern portion of WSMR (designated WSMR-N). The WSMR-N site will be prepared by Boeing which involves removal of infrastructure (i.e., poles, fences, earthen tanks, minor terrain features, and vegetation) that may pose a safety hazard during landing. The proposed action also includes additional site preparation at WSSH consisting of vegetation clearing. The draft SEA provides environmental analysis for these actions. Site preparations would occur in accordance with Army policy and Federal and State regulations. The action would satisfy the FAA's re-entry license requirement for Boeing's Starliner spacecraft.

This action will include the following:

- 1) Clearing of obstacles (structures and vegetation) at both landing sites that could impact the safety of the Starliner landing at that site.
- 2) Performing a landing simulation prior to any Starliner landing at either site.
- 3) Performing recovery operations for the Starliner following a landing at either site.

PURPOSE AND NEED: The purpose of the proposed action is to allow for the landing and recovery of the flight crew and International Space Station (ISS) cargo at WSMR-N and additional vegetation clearing at WSSH to support two flight tests beginning in the late 2020 timeframe. Routine missions would begin upon completion of these test flights and take place up to two times per year.

ALTERNATIVE TO BE IMPLEMENTED: The Preferred Alternative is to allow preparation of WSMR-N to support Starliner landing and recovery operations up to two times per year

and additional vegetation removal at WSSH. This alternative best meets the purpose and need of the Proposed Action and the draft SEA concludes that its implementation would not significantly impact the human or natural environment.

ENVIRONMENTAL CONSEQUENCES: The draft SEA contains the results of an environmental impact analysis of the proposed action and alternative on the affected environment. Mitigation actions are also identified, including avoiding historic properties, replacement of wildlife water sources, dust control, avoiding site preparation activities during bird nesting season, and environmental monitoring of activities to minimize environmental impacts of the proposed action.

CONCLUSION: Based on the analysis in this draft SEA and consideration of the described mitigation measures and best management practices listed, NASA and WSMR have concluded that the preparation of the WSMR-N landing site and additional vegetation clearance at WSSH will not result in a significant effect on the environment. No significant impacts on the environment have been identified for the landing and recovery activities and no significant cumulative impacts are expected. The NASA and WSMR have determined that an EIS pursuant to the NEPA is not required, and this draft Finding of No Significant Impact is hereby submitted.

DRAFT AVAILABILITY AND POINT OF CONTACT:

The Draft EA is available in Acrobat® format at
<https://environmental.ksc.nasa.gov/EnvironmentalPlanning/NEPA>

The June 2019 EA is also available at this link.

The Draft SEA and FONSI is available to the public at the following information repositories:

Thomas Branigan Memorial Library - 200 E. Picacho Avenue, Las Cruces, New Mexico 88001

Socorro Public Library - 401 Park St, Socorro, NM 87801

Alamogordo Public Library - 920 Oregon Ave. Alamogordo NM 88310

Due to closures of public libraries caused by the novel coronavirus (COVID 19) pandemic some libraries have reduced hours and services. Individuals without internet access can request a copy of the SEA by contacting:

Mr. Donald Dankert
KSC Environmental Management Branch
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Kennedy Space Center, FL 32899
E-mail: donald.j.dankert@nasa.gov

DATES: Interested parties are invited to submit written comments on environmental concerns to Mr. Dankert, at the above address, within 30 days from the date of this public notice.

**Draft Commercial Crew Transportation System (CCTS)
Supplemental Environmental Assessment
For the Boeing Starliner
Landing and Recovery at the
U.S. Army White Sands Missile Range
June 2020**

**National Aeronautics and Space Administration
John F. Kennedy Space Center
Kennedy Space Center, Florida**



**Prepared by:
The Boeing Company**



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1.0 Executive Summary

1.1 Introduction

This document is a supplement to the *Commercial Crew Transportation System (CCTS) Environmental Assessment for the Boeing Starliner Launch from Cape Canaveral Air Force Station and Landing and Recovery at the U.S. Army White Sands Missile Range* dated June 4, 2019 (June 2019 EA). The June 2019 EA documented the impacts for landing the Boeing Starliner spacecraft at two U.S. Army White Sands Missile Range (WSMR) landing sites in New Mexico, designed WSMR-649 and White Sands Space Harbor (WSSH). It also documented the unique impacts for launching the Starliner from Cape Canaveral Air Force Station (CCAFS) in Florida. An additional landing site at WSMR is necessary due to issues encountered with the WSMR-649 site, after completion of the June 2019 EA, that made it unsuitable for landing.

This Supplemental Environmental Assessment (SEA) has been prepared to evaluate the environmental impacts from landing and recovery of the Starliner crew module (CM) at a new site at WSMR (designated WSMR-N), which would be used instead of the WSMR-649 site documented in the June 2019 EA, as well as additional vegetation clearing at the WSSH landing site in areas not included in the June 2019 EA. The additional vegetation clearing at the WSSH site is required to ensure the landing site is free of potential hazards that could affect the safety of the Starliner.

Boeing is developing the Starliner to ferry astronauts to and from the International Space Station (ISS) as part of the National Aeronautics and Space Administration (NASA) funded Commercial Crew Development (CCDev) initiative. The WSMR-N site would supplement other landing sites provided at WSMR (WSSH site), Edwards Air Force Base in California, Ft. Huachuca's Willcox Playa in Arizona, and Dugway Proving Grounds in Utah.

1.2 Background

The additional landing site is designated WSMR-N and is shown as the green circle on Figure 1-1. The terrain at the landing site is shown in Figure 1-2. The original WSSH site documented in the June 2019 EA is shown as the blue circle in Figure 1-1.

Each landing site consists of a circle with a radius of approximately 4 kilometers that provides a relatively flat surface free of any buildings or above ground obstructions that could cause a hazard to the landing spacecraft. Objects currently within the landing site at each site that could affect the safety of the Starliner landing would be cleared by WSMR. Several pieces jettisoned during the landing sequence could land outside this 4km radius circle in an area approved by WSMR.

WHITE SANDS MISSILE RANGE

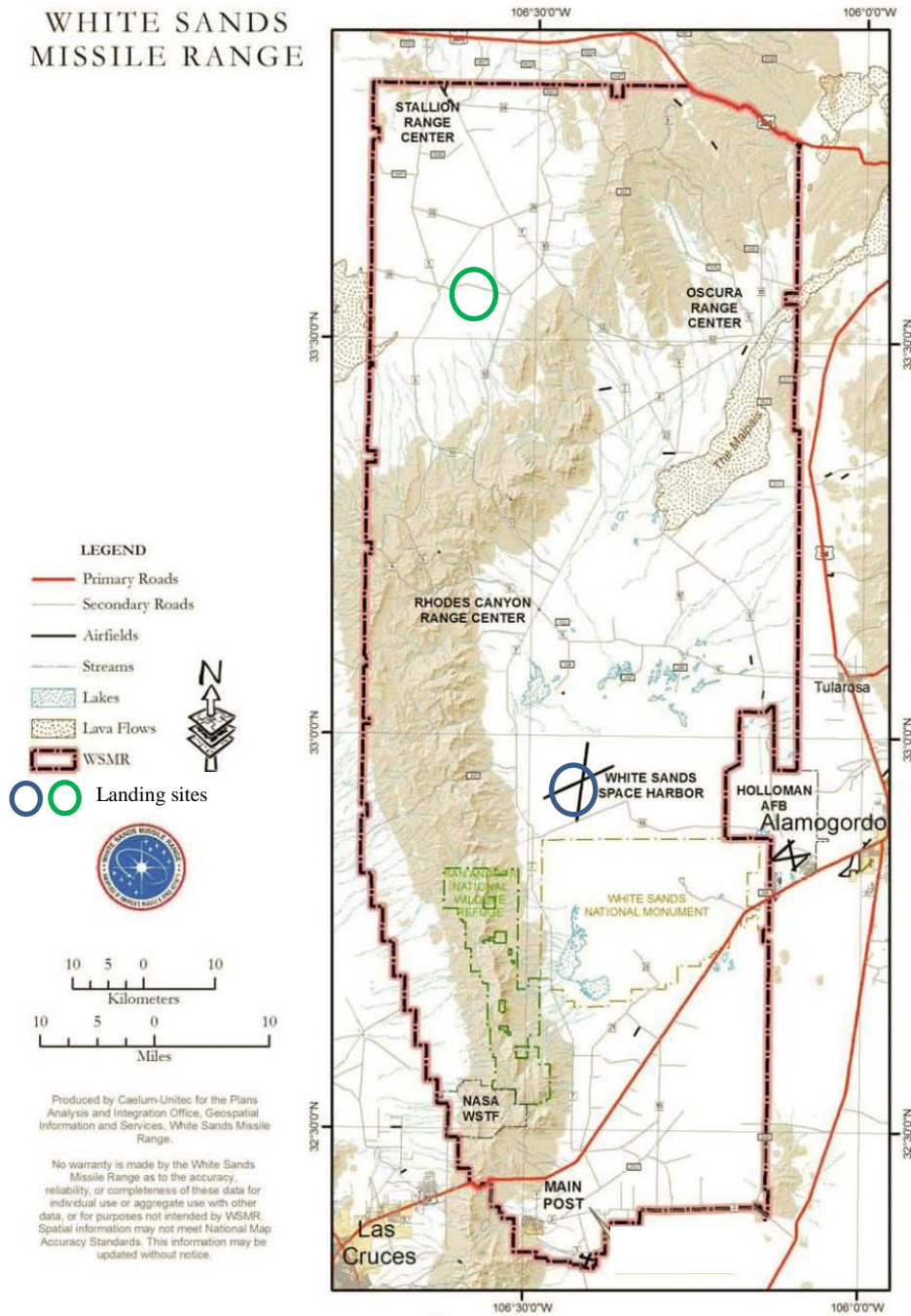


Figure 1-1 White Sand Missile Range



Figure 1-2: WSMR-N Landing Site

1.3 Proposed Action

For NASA and the DoD, the proposed action is to allow the CCTS to perform landing and recovery operations for the Boeing Starliner at the WSMR landing sites. The impacts were analyzed for three phases:

- 4) Clearing of obstacles (structures and vegetation) at both landing sites that could impact the safety of the Starliner landing at that site.
- 5) Performing a landing simulation prior to any Starliner landing at either site.
- 6) Performing recovery operations for the Starliner following a landing at either site.

In order for Boeing to conduct commercial Starliner missions, Boeing will have to obtain a reentry license from the FAA. The FAA's action of issuing Boeing a reentry license for Starliner reentries and landings is considered part of the proposed action analyzed in this SEA. ULA has already obtained a launch license from the FAA for launching the Atlas V at LC-41 at Cape Canaveral Air Force Station in Florida. The environmental impacts of launching the Atlas V, among several other rockets, from LC-41 were analyzed in the 1998 U.S. Air Force (USAF) Final Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program and 2000 USAF Final Supplemental Environmental Impact Statement for the Evolved Expendable Launch Vehicle Program (USAF 1998, 2000). The FAA was a cooperating agency on both Environmental Impact Statements (EISs) and formally adopted them to support issuing launch licenses to vehicle operators for launch operations described in the EISs. At the time the 1998 and 2000 EISs were prepared, Starliner reentry was not anticipated, and thus was not included in the analyses. In 2018, as part of the environmental review for evaluating ULA's launch license application for Atlas V launches at LC-41, the FAA prepared a Written Re-evaluation (WR) of the

EISs. The WR concluded that the contents of the EISs remained current and substantially valid and the decision to issue a launch license to ULA for Atlas V launches from LC-41 did not require the preparation of a new or supplemental EA or EIS. The FAA issued ULA a license on June 1, 2018, and the license expires on May 31, 2023. This license authorizes ULA to conduct Atlas V launches at LC-41 with payloads, including the Starliner. The 1998 and 2000 EISs are incorporated by reference in this SEA.

1.4 Process

Three federal agencies (NASA, DoD, and FAA) are directly involved in the SEA for this proposed action, with NASA acting as the lead agency. For the roles of the three agencies, reference section 1.4 of the June 2019 EA.

1.5 Environmental Effects

The proposed action incorporates several measures and practices to minimize potential impacts on the environmental resources at WSMR. An evaluation was made of the following resources to assess the significance of potential impacts for the Proposed Action:

- Air Quality
- Biological Resources (fish, wildlife, plants, threatened and endangered species, and critical habitat)
- Climate
- Department of Transportation Act, Section 4(f)
- Land Use and Airspace
- Physical Resources (including water, topography, geology, and soil)
- Cultural Resources (Architectural, Archeological, and Area of Tribal Interest)
- Noise and Noise-Compatible Land Use
- Socioeconomics
- Environmental Justice and Children's Environmental Health and Safety Risks
- Visual Effects
- Infrastructure and Utilities
- Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention
- Human Health and Environment

With the exception of Biological, Physical, and Cultural Resources, all environmental impacts at the new WSMR-N landing site are equivalent to those documented in the June 2019 EA for the 649 site due to their proximity to one another. The environmental impacts at WSSH for the additional vegetation clearing are also equivalent to those documented in the June 2019 EA with the exception of these same three resources. Therefore only Biological, Physical, and Cultural Resource impacts are documented in this SEA.

Impacts to farmland, coastal areas, and floodplains were not assessed, as none of these features are present at the landing sites. In addition, natural resources¹ were not analyzed in detail in this SEA because the proposed action would not result in consumption of natural resources other than the fuel used by the WSMR and Landing Recovery Team (LRT) vehicles. The only new facilities to be built as part of the

¹ Per FAA Order 1050.1F, the FAA is required to consider the potential impacts on "natural resources and energy supply." Energy supply is discussed under "Infrastructure and Utilities" in this EA. In the context of FAA's NEPA impact assessment, the FAA must consider the amount of natural resources—such as water, asphalt, aggregate, and wood—a project would use in the construction, operation, and maintenance of a project.

proposed action are two water collection facilities WSMR would construct to replace two water collection berms removed within the landing site.

Each environmental resource was evaluated according to a list of activities that were determined to be necessary to accomplish the proposed action. The primary areas of concern for landing and recovery operations are potential loss of soil and/or vegetation, dust generation, and ensuring human safety. As discussed in chapter 3, the assessment identified no significant impacts.

1.6 Alternatives Considered but Not Carried Forward

Boeing evaluated two landing sites in the northern range of WSMR as possible alternatives to the WSMR-649 location. The one site considered but not carried forward was to the south east of the Stallion gate and Range Road 7. This site had rough terrain that would make clearing difficult and a large instrument berm close to the center of the landing site that WSMR utilizes for other programs and cannot be removed.

1.7 No Action Alternative

Under the No Action Alternative, there would be no proposed action activities at WSMR-N, no additional vegetation clearing at WSSH, and no environmental impacts from the proposed action. This would reduce landing opportunities for the Starliner by eliminating a landing site, which would have adverse impacts to both the Starliner and International Space Station programs. Under this alternative, the FAA would not issue Boeing a reentry license for Starliner operations at WSMR-N.

1.8 Conclusion

This SEA provides NASA, the DoD, and the FAA with the documentation of environmental impacts associated with the Starliner landing and recovery at WSMR-N as well as clearing of vegetation at WSSH. The decision to be made is either: (1) Approve a FONSI based upon the proposed analysis contained within the EA; or (2) Determine a FONSI is not applicable, resulting in the need for an EIS.

2.0 Description of the Proposed Action and Alternatives

2.1 Purpose and Need for Proposed Action

The purpose of the proposed action is to allow for the landing recovery at WSMR-N beginning in 2020 and additional vegetation clearing at WSSH, not covered by the June 2019 EA, that could impact the safety of the Starliner landing. One flight test was completed in December of 2019. A second flight test is scheduled for 2020. Routine missions would begin upon completion of the second test flight and take place 1-2 times per year with all five landing sites being available to support depending on the trajectory of the ISS at the end of the Starliner mission.

The purpose of FAA's Proposed Action is to fulfill the FAA's responsibilities as authorized by Commercial Space Launch Act (51 U.S.C. Subtitle V, ch. 509, §§ 50901-50923) for oversight of commercial space launch activities, including licensing launch and reentry activities. The need for FAA's Proposed Action results from the statutory direction from Congress under the Commercial Space Launch Act, 51 U.S.C 50901(b) to, in part, "protect the public health and safety, safety of property, and national security and foreign policy interests of the United States" while "strengthening and [expanding] the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities.

2.2 Proposed Action Details

The proposed action for NASA and the DoD is to perform landing and recovery operations of the Starliner and its flight crew. These operations would take place in the following phases:

- A. Clearing of the necessary terrain within the 4 km landing sites at both WSMR-N and WSSH by removal of obstructions (such as utility poles and fence posts) at WSMR-N, removal of vegetation at both sites within the 4km landing site that could affect the safety of the Starliner landing (see section 2.4 for details), and improving an access road at WSMR-N (from a dirt path to a gravel road) per internal WSMR procedures and processes.
- B. Simulation of landing and recovery operations within the landing site two days before the scheduled landing of the Starliner.
- C. Landing and recovery of the Starliner and its crew.

All operations would be scheduled through WSMR to ensure Boeing activities to not interfere with other Army programs and vice versa. For the Starliner landings, all necessary recovery support would be transported to the landing site on the day of landing and removed following completion of recovery operations.

For a commercial (i.e., non-NASA) mission, Boeing would be required to apply to the FAA for a reentry license. Therefore, the FAA action of issuing Boeing a reentry license for Starliner operations at the WSMR is considered part of the proposed action analyzed in this EA.

2.3 WSMR-N Landing Location

The WSMR-N landing site is centered at latitude 33.54 degrees North and longitude 106.60 West. (Figure 2-1).

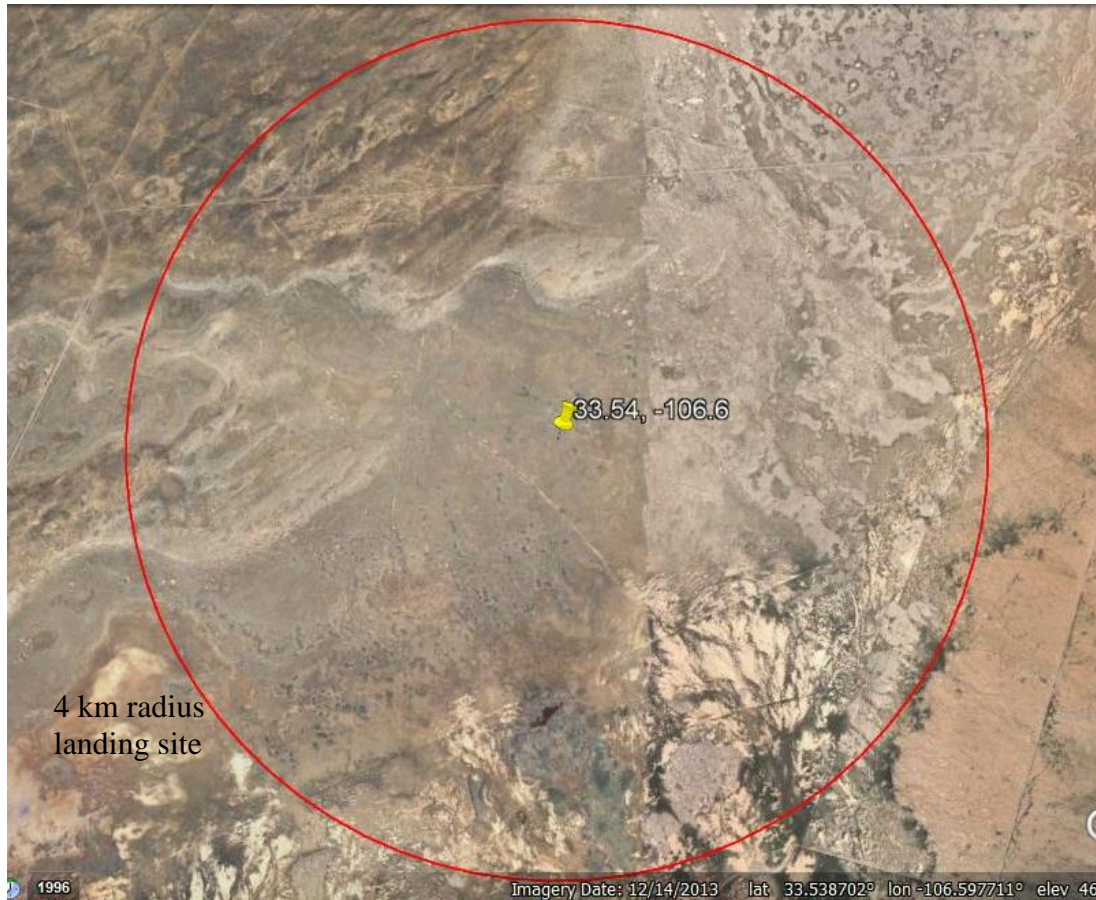


Figure 2-1: WSMR-N Landing site

2.3.1 Targeted Landing Points

The wind forecast for the time of landing will be utilized to target the CM landing within a 1 km radius circle around the above center point shown center point of the landing site. To allow margin based on the potential for changing winds, a 4 km radius landing site would be cleared of any obstacles or large vegetation that could affect the safety of the Starliner landing. Several pieces jettisoned during the landing sequence could land outside this 4km radius circle in a larger area approved by WSMR. Impacts for these activities are listed in Section 4.

2.3.2 Operational Controls for Landing

The operational controls documented in section 2.4.4 of the June 2019 EA would be applicable to landings at WSMR-N. These controls would ensure the Starliner and jettisoned pieces stay within the landing area.

2.4 Preparing of Landing site

Obstacles and vegetation that could affect the safety of the Starliner at landing would be removed from both 4km radius landing sites. At WSMR-N several lengths of old fencing, utility poles, and two water collection earthen berms would be removed. The center 1 km radius plus an additional approximately 1 acre in the southern portion of the landing site, consisting mostly of Vegetated Gypsum Outcrop, Sandsage Shrubland and Lowland Basin Grassland, would be mowed to a height of 6-8 inches utilizing brush hogs. Approximately 20 acres of large trees and yuccas would be cut down using hand tools. Some berms along existing roads would be tapered and an access road from an existing WSMR road into the WSMR-N landing site, up to 6 miles in length, would be improved from the current two-track road to a gravel road suitable for supporting the CM recovery utilizing a crane and flatbed trailer. At WSSH clearing of larger vegetation, consisting of up to 300 acres total of pickleweed and non-native salt cedar, and leveling of any large dunes that have built up around this vegetation would be performed, either by mowing or blading. Mowing is the preferred method where it provides an adequate surface. These activities would require the use of heavy equipment traveling to the areas within the landing sites where removal of obstacles and traversing back and forth across the areas requiring mowing or blading. Vegetation removal would occur outside of the migratory bird nesting season (nesting takes place from March through August) if possible. If not possible, the WSMR Environmental Division would perform a nesting bird survey before any work begins. Dust control methods would be utilized where needed, including scheduling the activities during periods when the soil contains moisture or utilizing dust suppression methods. WSMR would work within existing base procedures and processes to evaluate and approve the final plans for making these modifications according to Army Policy, and Federal or State regulations. As a result, only high-level information relative to these activities is included in this SEA.

There are some large sand dunes on the eastern edge of the 4km landing site at WSSH. These would not require removal. There is also an historical ranch site in the southeast portion of WSMR-N that would not be removed. Black Gama grass, which is a key food source for local wildlife and slow to recover from mowing, is mostly found in the northern portion of the WSMR-N landing site where mowing would not be required.

Two new water collection facilities would be constructed as part of this proposed action to replace the two earthen berms that would be removed. These would be placed outside the 4 km radius landing site and would provide a source of water for local wildlife. WSMR would select the location of these facilities.

2.5 Starliner and Landing Recovery Description

For a description of the Starliner and the Landing Recovery Forces, see Section 2.7 of the June 2019 EA.

2.6 No Action Alternative

Under the No Action Alternative, there would be no Starliner reentry at WSMR-N, no additional clearing of vegetation at WSSH, and thus no environmental impacts. This would reduce landing opportunities for the Starliner by eliminating a landing site, which would have adverse impacts to both the Starliner and International Space Station programs. Under this alternative, the FAA would not issue a reentry license for Starliner operations at WSMR-N.

2.7 Alternatives Considered but Not Carried Forward and Determination of Significance

In addition to the site that is the subject of this SEA, Boeing evaluated a second site in the northern range of WSMR to the east of Range Road 7. This second site was determined to be unacceptable for landings due to a large instrument berm and heavy dunes with large vegetation being close to the center.

3.0 Summary of Affected Environment and Environmental Consequences

This SEA provides necessary details and mitigation for the new landing area at WSMR-N and additional vegetation removal required at WSSH.

Due to the proximity of the WSMR-N landing site to the WSMR-649 site evaluated in the June 2019 EA, the Affected Environments, Environmental Consequences and Mitigation Measures for the environmental resources listed in the bullets below are equivalent to those documented in the June 2019 EA for the WSMR-649 landing site. At WSSH these same bullets have no additional impacts from those documented in the June 2019 EA due to the additional vegetation removal. Therefore for this SEA only Biological Resources, Physical Resources, and Cultural Resources are included.

The region of influence for all affected environments for this SEA is the area within the boundaries of WSMR.

- Air Quality (June EA section 5.1)
- Climate (June EA section 5.3)
- Land Use and Airspace (June EA section 5.5)
- Department of Transportation Act, Section 4(f) (June EA section 5.4)
- Noise and Noise-Compatible Land Use (June EA section 5.8)
- Socioeconomics (June EA section 5.9)
- Environmental Justice and Children's Environmental Health and Safety Risks (June EA section 5.10)
- Visual Effects (June EA section 5.11)
- Infrastructure and Utilities (June EA section 5.12)
- Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention (June EA section 5.13)
- Human Health and Environment (June EA section 5.14)

Table 3-1: Summary of Environmental Analysis

Environment (EA Section)	Proposed Action	Proposed Action Impact
Biological Resources (4.1)	At WSMR-N: A 1km radius area (approximately 775 acres) plus approximately 1 acre in the southern part of the landing site would be mowed and some vegetation, mainly large clumps of yuccas, large individual yuccas, and a small number of trees present would be removed from the remainder of the 4 km radius landing sites. Yucca and tree removal is anticipated to be approximately 20 acres total. The berms along existing roads would also be tapered to provide a smooth transition at the road edges if required. Two earthen water berms used by wildlife as a water resource would be removed and replaced with two constructed wildlife water units outside of the landing area. The impacts to rangeland health due to mowing of vegetation and vehicle traffic would not be significant. The mowed areas are mostly grasses, which would recover. At WSSH: Some areas of large vegetation, mostly non-native salt cedar, would be removed. The removal of non-native salt cedar at WSSH would be a benefit.	Insignificant Impact

	<p>At both sites: Activities would utilize existing roads where possible to minimize the impact to vegetation and wildlife. Wildlife could be affected by Starliner landing and recovery activities and vehicle noise. Wildlife populations would not be significantly impacted because the activity would affect only a limited portion of the total available habitat and is very short term in nature.</p> <p>There would be no significant impacts to vegetation or to wildlife.</p>	
Physical Resources (4.2)	<p>At WSMR-N: Two earthen water tanks within the 4 km landing site used by wildlife as a water resource would be removed and replaced with two constructed wildlife water units outside of the landing area. Biological crusts are present in a large portion of the landing site, including the center 1 km radius that would be mowed and areas where vegetation removal would be required. Vehicle traffic could impact the biological soil crusts, which are very slow to recover. Clearing activities are a one-time event, with the exception of mowing at WSMR-N that would only be required when that location is selected as a landing site. Based on the infrequency of the vehicle traffic and the area of biological crust impacted being small in comparison to the overall area of the landing site that contains this soil, the overall impacts would be insignificant.</p> <p>At both sites: Ground water resources would not be impacted by the landing and recovery operations. Soils would be impacted by the removal of obstacles and vegetation, which would require the utilization of heavy equipment, and recovery of the Starliner, which requires multiple vehicles and trailers. These would generate dust, however these are either one-time events or happen at most twice per year. Dust control practices would be utilized if required. All but emergency landings would be called off if the terrain is too wet. The potential for soil contamination exists should a failure occur that causes a leak of hazardous material or POL, but processes are in place to mitigate contamination and appropriately clean up any contamination that may occur.</p> <p>Overall, the topography, soil, soil quality, and water resources would not be significantly affected.</p>	Insignificant Impact
Cultural Resources (4.3)	<p>At WSMR-N: Previous cultural surveys of the proposed landing site were reviewed and additional surveys were conducted as part of the development of this SEA. There are 3 eligible sites and 6 sites that were recommended as eligible inside the 4km radius landing area. None are within the one kilometer radius where the Starliner landing would be targeted and most of the recovery activities would take place. None are affected by the obstacle removal. WMSR would monitor clearing activities that take place in areas of the 4km landing sites where no cultural surveys have been completed to provide direction should unknown cultural resources be found. WSMR selected a location for the road improvement to avoid impacts to cultural resources. Maintenance of roads in the landing site would be planned to avoid cultural resources.</p> <p>At WSSH: Monitoring by the WSMR Environmental Division would take place during vegetation clearance to ensure no damage is</p>	Insignificant Impact

	<p>done to known mega fauna fossil tracks and to provide direction should unknown cultural resources be found.</p> <p>At both sites: The chances of the Starliner or a jettisoned part landing on any cultural resources is inherently low. However, the landing recovery team would be trained to avoid areas of known resources during recovery operations. Should any part of the spacecraft come to rest on any cultural resource, WSMR archeologists would be notified for guidance on how to proceed. SHPO and tribal consultation results would be included in the final SEA. Overall the cultural resources would not be significantly impacted.</p>	
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4.0 WSMR Affected Environments and Environmental Impacts

For a description of the Affected Environment and Environmental Consequences for landing and recovery of the Starliner at WSSH for the below bulleted list of environmental resources, see Section 5 of the June 2019 EA. The SEA documents only those impact to Biological, Physical, and Cultural Resources at WSSH caused by the removal of vegetation in areas not covered June 2019 EA.

At WSMR-N, the Affected Environments, Environmental Consequences, and Mitigation Measures for the below bulleted list of environmental resources are equivalent to those documented in the June 2019 EA for the WSMR-649 landing site. Therefore these are not included in this SEA. The SEA documents only those impact to Biological, Physical, and Cultural Resources at WSMR-N.

- Air Quality
- Climate
- Land Use and Airspace
- Noise and Noise-Compatible Land Use
- Department of Transportation Act, Section 4(f)
- Socioeconomics
- Environmental Justice and Children's Environmental Health and Safety Risks
- Visual Effects
- Infrastructure and Utilities
- Hazardous Materials, Hazardous Waste, Solid Waste, and Pollution Prevention
- Human Health and Environment

4.1 Biological Resources

4.1.1 Affected Environment

A literature search was performed to compile existing data relating to biological surveys that have been previously conducted at or near the proposed landing sites. Additionally, the U.S. Fish and Wildlife Service (USFWS) website was consulted to complete an Information for Planning and Conservation (IPaC) search. The IPaC search is a useful tool for compiling a current list of potential threatened and endangered species that may occur at the proposed landing sites. Natural resource surveys were conducted at each of the proposed landing sites. This information was augmented with an additional physical resources survey performed by Ama Terra in August, 2019.

The IPaC system was also queried to obtain a list of fauna and critical habitat that is within the footprint of the sonic boom, which is equivalent to the sonic boom footprint for the WSMR 649 landing site documented in Appendix D of the June 2019 EA. Impacts of the sonic boom on biological resources are documented in the June 2019 EA.

Rangeland health was also assessed at both sites and was measured in terms of soil and site stability, hydrologic function, and biotic integrity using the Rangeland Health Assessment (Pellant et al. 2000). This assessment gives an indication of the status of the three attributes chosen to represent the health of the "area of interest." The first attribute, soil and site stability, is the capacity of the site to limit redistribution and loss of soil resources by wind and water. The second attribute, hydrologic function, is the capacity of the site to capture, store, and safely release water from rainfall, run-on, and snowmelt, to resist a reduction in this capacity, and to recover this capacity following degradation. The third attribute, biotic integrity, is the capacity of the site to support characteristic functional and structural communities in the context of normal variability, to resist loss of this function and structure due to disturbance, and to recover following disturbance. Base measure information was gathered from the appropriate ecological site description for the area of interest.

A general discussion on biological resources found on WSMR is available in Section 3.7 of the WSMR EIS and the WSMR Integrated Natural and Cultural Resources Management Plan and Environmental Assessment (U.S. Army, 2009; US Army, 2015).

The report generated as a result of the 2019 survey is found in Appendix B of this document.

WSMR-N Landing Site

At the WSMR-N site, a one-percent survey of a four-kilometer (km) radius landing site was conducted on May 9 through 12, 2019. Ten, 425-foot radius plots were chosen within this site to achieve the one-percent survey goal (Figure 4-1). These plots were selected to include areas in the center 1 km radius of the landing site that would be mowed to a height of 6-8 inches and where most of the recovery activity would take place, and other areas with heavy vegetation (mainly clumps of yuccas and a small number of trees) that would need to be cleared. Based on these parameters, plot locations were also chosen based off soil types and different vegetation communities viewed from aerial photographs. One of the plots (#8) selected was a u-shaped water collection berm, and three other plots were selected by using the USFWS's National Wetlands Inventory (NWI) where wetlands were indicated, however these are not jurisdictional wetlands. Two additional water collection berms are present in the landing site and provide seasonal water to local fauna.

Flora

Of the 35 major map units delineated by Muldavin et al. (2000), ten were delineated at the WSMR-N Site: alluvial flats-barren, creosote bush shrub land, desert plains grasslands, lowland basin grasslands, mesquite shrub land, mixed foothill-piedmont desert grasslands, mixed lowland desert scrub, piedmont desert grasslands, sandsage shrub land, and vegetated gypsum outcrop (Figure 4-2).

The species assemblage in the ten plots at the WSMR-N Site closely compares with Muldavin et al.'s (2000). Observed plant associations (PA's) that occur within the sub desert shrub land category include: the Fourwing saltbush/Alkali Sacaton, the Fourwing saltbush/Burrograss, the Fourwing saltbush/Gyp dropseed, the Fourwing saltbush/Bush muhly, the Sand Sagebrush/Alkali Sacaton, and the Sand sagebrush/black grama. Observed associations that occur within the sub polar grassland category include: the Alkali Sacaton/Burrograss, the Tobosagrass/ Alkali sacaton, the Gyp dropseed/Alkali sacaton, Black grama/Soaptree yucca, Gyp dropseed/Hairy crinklemat, and the Black grama/Alkali Sacaton. PA's, species of vegetation identified, and vegetation coverage within the survey areas are summarized in Appendix B.

Soaptree yucca and fourwing saltbush are the dominant shrub species within the landing site. Depriving soaptree yucca of shoots through fire or mechanical means results in regeneration rates that equal or exceed previous regeneration rates within a year or two (Groen et al. 2005), indicating that soaptree yuccas that are mowed would regenerate. Although fourwing saltbush responds to partial removal of branches with vigorous growth (a browsing response), limited research shows a weak ability to sprout after heavy branch removal or complete removal of top-growth (Howard et al. 2003), indicating that fourwing saltbush has a more difficult time recovering from mowing activities. Alkali sacaton, black grama, burrograss, tobosagrass, and gyp dropseed are the dominant grass species within the WSMR-N site. Black grama is one of the most nutritious desert winter grasses for livestock and wildlife (Simonin et al., 2000) and is impacted by mowing due to its slow recovery. Black grama was found in the northern part of the landing site. The other species are perennial species, indicating that these species would grow back the next growing season after mowing occurs.

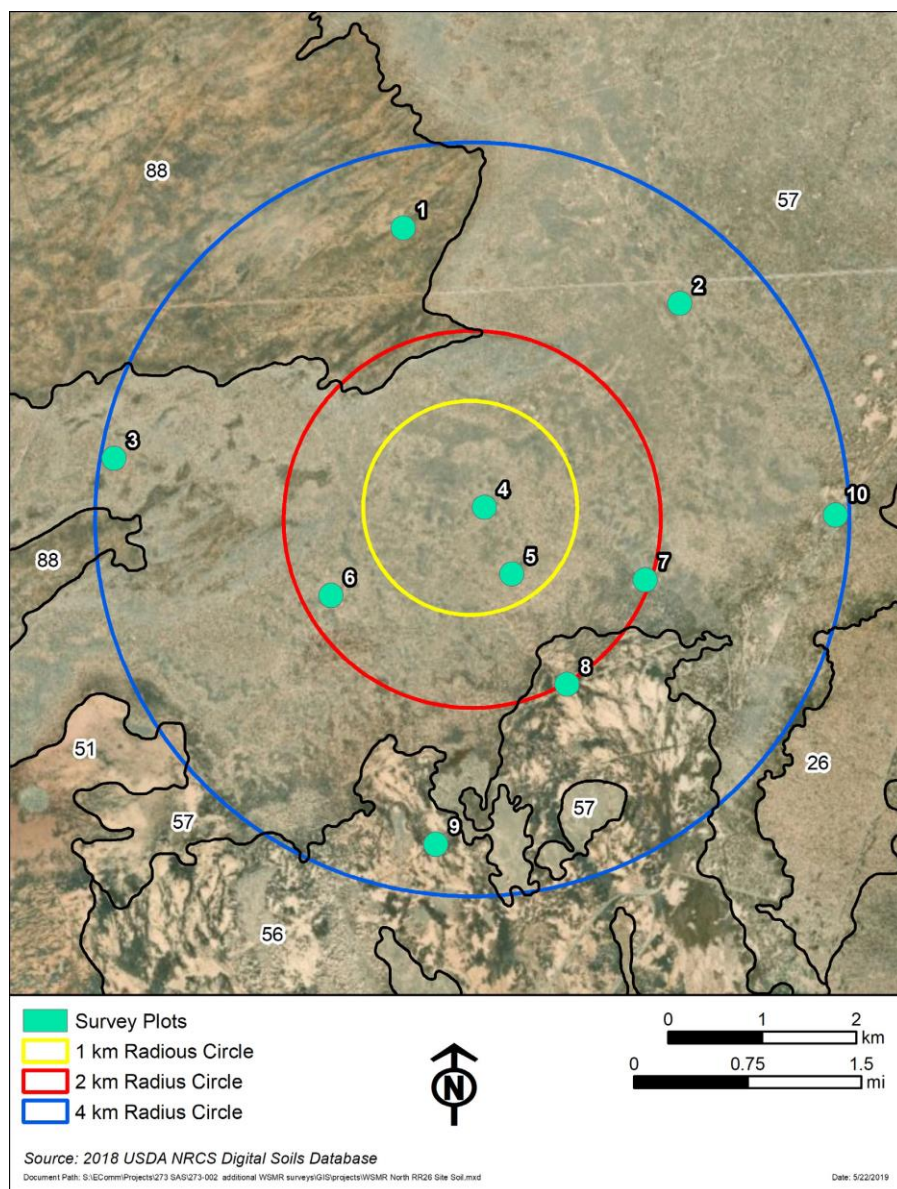


Figure 4-1: WSMR-North Survey Plot Locations

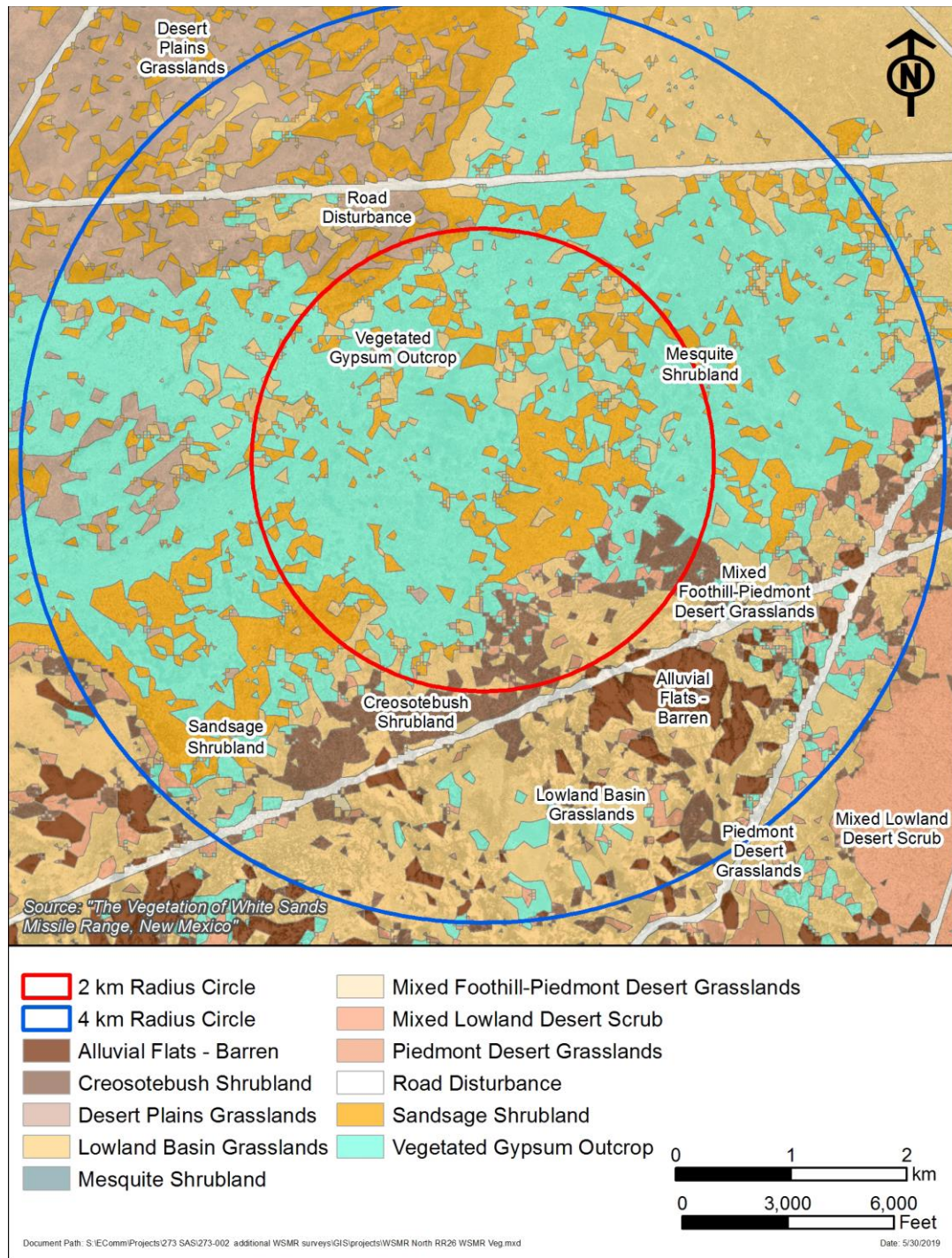


Figure 4-2: WSMR-North Vegetation Areas

Fauna and Threatened and Endangered Species

The USFWS IPaC produced a total of 15 potential Threatened and Endangered species that exist in Socorro County. Species effect determinations were made after analyzing information from the literature search, consultation with resource experts, and assessing existing habitat conditions during the field investigation. No critical habitats are located within the landing site. Species identified are:

Mammals: New Mexico Meadow Jumping Mouse

Birds: Least Tern, Mexican Spotted Owl, Northern Aplomado Falcon, Piping Plover, Southwestern Willow Flycatcher, Yellow-billed Cuckoo, Golden Eagle

Amphibians: Chiricahua Leopard Frog

Fishes: Rio Grande Silvery Minnow

Snails: Alamosa Springsnail, Chupadera Springsnail, Socorro Springsnail

Crustaceans: Socorro Isopod

Flowering Plants: Pecos Sunflower, Wright's Marsh Thistle

Amma Terra identified six bird species in their natural resources report (all but the Golden Eagle) for this site that have the potential to fly through the area, particularly during the spring and fall migration. The WSMR Environmental Division reported Golden Eagles also have the potential to fly through the area to forage. Desert plains grassland habitat with yucca association is known to provide habitat for the northern aplomado falcon. No suitable habitat exists at the WSMR-N site for the other bird species.. No wetlands, springs, streams or riparian habitat suitable for the New Mexico meadow jumping mouse, Chiricahua leopard frog, Rio Grande silvery minnow, Alamosa springsnail, Chupadera springsnail, Socorro springsnail, Socorro isopod, Pecos sunflower, and Wright's marsh thistle, exist within the site. A single observation of an aplomado falcon was recorded in the Stallion basin near Gallegos Site in 2005 (Burkett 2005). Other observations of aplomado falcons in the Stallion basin were the result of the reintroduction program, which is no longer being conducted. The Peregrine Fund (2014) has determined that this region of the Chihuahuan Desert is not currently suitable for the aplomado falcon due to prolonged drought. This analysis supports the conclusion that Starliner reentry and landing at the WSMR-N site would have no effect on federally threatened or endangered species.

Active and abandoned burrows were located throughout the WSMR-N site. Although no species were physically observed utilizing the burrows, signs of American badger (*Taxidea taxus*) and spotted ground squirrel (*Xerospermophilus spilosoma*) were observed around the active burrow openings. Many of the abandoned burrows were filled in or had spider webs obstructing the entrance, indicating that nothing has recently entered the burrows however burrowing owls are known to utilize abandoned burrows.

A complete list of species identified at WSMR-N can be found in the natural resources report in Appendix B.

Rangeland Health

Three ecological sites occur within the WSMR-N site, therefore three rangeland health assessments were conducted (Shown in Appendix B).

WSSH Landing Site

At WSSH only those areas of known vegetation that would need removed to allow for a safe landing of the Starliner were surveyed (Figure 4-4). The results of a larger 1% survey of the 4 km radius landing site at WSSH can be found in the June 2019 EA .

Flora

Muldavin et al. (2000) classified the vegetation at the WSSH Site as a succulent, extremely xeromorphic evergreen shrub land consisting of various pickleweed plant associations. These communities are characterized as open-canopied shrub lands of pickleweed with under stories that are poor in diversity and cover (Muldavin et al. 2000). Pickleweed is an excellent indicator of highly alkaline soils (Muldavin et al. 2000). Species diversity appears to be naturally low in this community, with only a limited set of salt-tolerant species able to occupy these areas (Burkett 1997, WSMR 2015, Muldavin et al. 2000, Tazik et al. 1992).

Surveys at the WSSH Site revealed very low species diversity and large areas of bare ground (exceeding 95 percent) in each vegetation area. Only two dominant species of vegetation were identified within the survey areas: pickleweed and non-native saltcedar (*Tamarix ramosissima*), although two other species occasionally occurred: alkali sacaton and fourwing saltbush.

Saltcedar is the dominant vegetation species that would be removed at the WSSH Site. Since saltcedar is an invasive, it would be beneficial to the site to remove this species as long as pickleweed is not completely removed throughout the site.

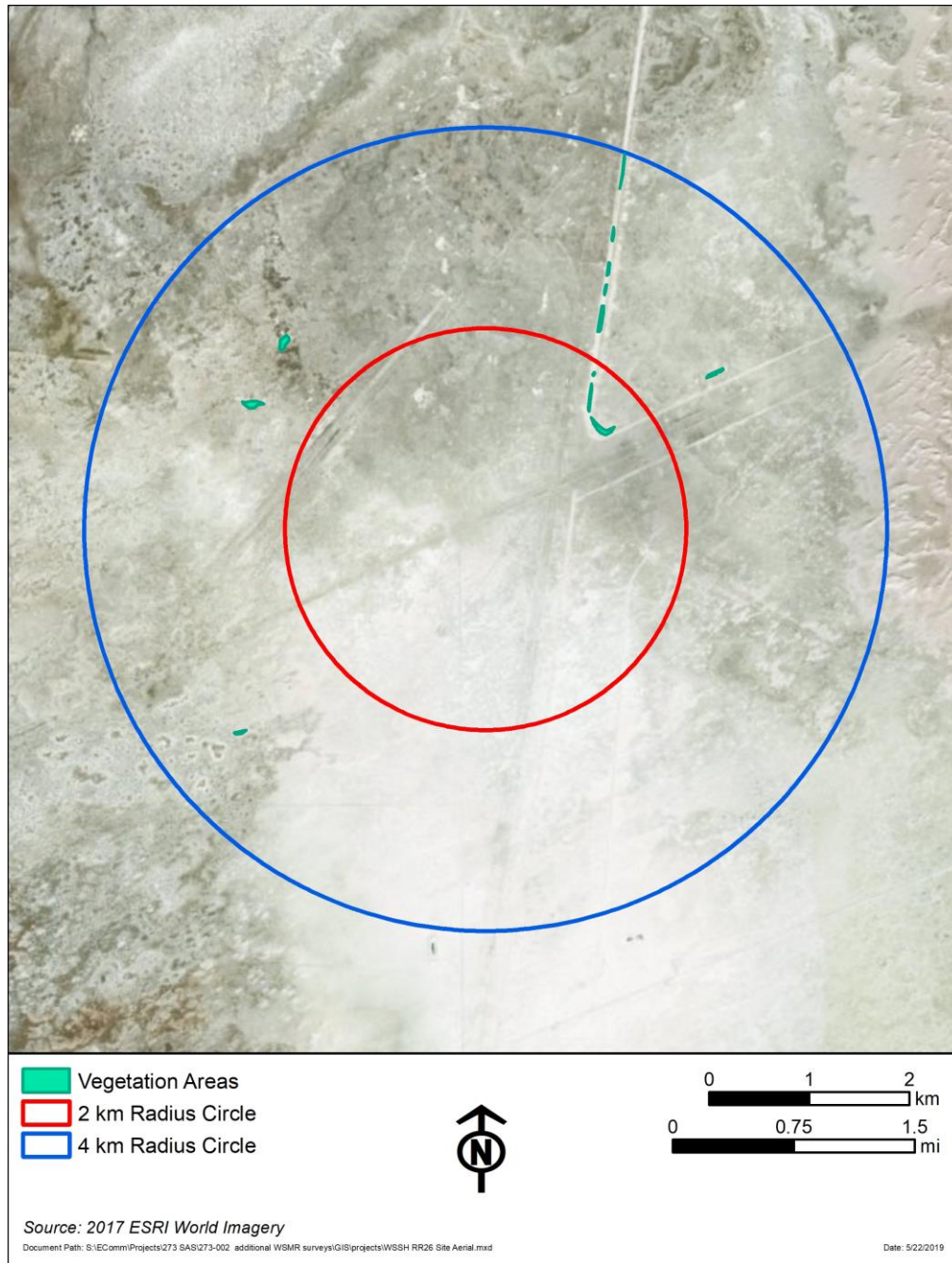


Figure 4-3: WSSH Vegetation Areas

Fauna and Threatened and Endangered Species

The USFWS IPaC produced a total of five potential Threatened and Endangered species that exist in Doña Ana County. Species effect determinations were made after analyzing information from the literature search, consultation with resource experts, and assessing existing habitat conditions during the field investigation. No critical habitats are located within the landing site. Species identified are:

Birds: Least Tern, Northern Aplomado Falcon, Southwestern Willow Flycatcher, Yellow-billed Cuckoo
Flowering Plants: Sneed Pincushion Cactus

All four bird species have the potential to fly through the area, particularly during the spring and fall migration. Least terns are known to use broad open sandy habitats but always in association with river and lake habitats where they forage for fish. The Sneed's pincushion cactus occurs on limestone and grows in cracks on vertical cliffs and ledges. No suitable habitats occur for any of these four bird species or the Sneed's pincushion cactus at the WSSH site. Therefore, Starliner reentry and landing at the WSSH site would have no effect on threatened or endangered species. Faunal surveys conducted in this habitat type have resulted in detection of very few faunal and floral species (Burkett 1997, Tazik et al. 1992). Eighteen faunal species were detected during the survey with the majority of these species being invertebrates.

Active and abandoned burrows were located within some of the dunes at the northwest vegetation areas. No species were physically observed using the burrows and no recent signs of animals using the burrows were observed. WMSR would survey for burrowing owls and other birds prior to the start of any activities included in this SEA.

A complete list of species identified at the WSSH landing site can be found in the natural resources report in Appendix B.

Rangeland Health

Since the entire WSSH site is similar throughout only one assessment was conducted (Shown in Appendix B).

4.1.2 Environmental Consequences

Impacts resulting from the proposed action would be considered significant if:

1. The U.S. Fish and Wildlife Service determines that the action would be likely to jeopardize the continued existence of a federally listed TES, or would result in the destruction or adverse modification of federally designated critical habitat (FAA Order 1050.1F)
2. The proposed action would cause substantial mortality or displacement of species
3. The proposed action would cause substantial damage to vegetation communities

The environmental effects analyzed in the following sections were not significant.

Disturbance and/or removal of vegetation would occur in areas around the obstacle removal and road improvements at WSMR-N, due to mowing or removal of vegetation at both WSMR-N and WSSH, and during recovery activities getting to and working around the Starliner. All impacts will be within the 4 km landing site.

At WSMR-N, mowing the center of the landing site and another area south of the center of approximately 1 acre, removal of any large stands of yuccas (multiple yuccas growing close together in a cluster regardless of height) or individual yuccas tall enough to potentially damage the Starliner (approximately 4 feet tall or higher), cutting down a small number of other individual trees present, and off-road vehicle traffic are the activities most likely to affect biological resources. Various grasses are the dominant species present in the center 1 km that would be mowed. These species are perennial species,

indicating that they grow back the next growing season after mowing occurs. Fauna who use this area for burrows or nesting may need to relocate. Some shrubs will also be mowed. These are slower to recover from mowing but only represent less than 15% of the vegetation. The yuccas cut down would recover as the root base would remain. Only a small number of trees are present and would require clearing. Mowing of the center of landing site and an approximately 1 acre area south of the center would be done to a height of 6-8 inches and would take place at most twice per year (but probably much less often based on the availability of five landing sites) and only when WSMR-N is selected as a prime or backup landing site. The removal of yuccas and trees is anticipated to total approximately 20 acres and would only need to be done once unless any regrow to a height that could impact the safety of the Starliner landing. Mowing would not be required in the northern part of the landing site where Black Grama (the grass that is slow to recovery from mowing) is present. The loss of vegetation would not be significant because these vegetation communities are well represented and extensively distributed within WSMR and elsewhere throughout the region.

At WSSH saltcedar is the dominant vegetation species that would be removed. Since saltcedar is an invasive, removal would be beneficial to the area. Some pickleweed would also be removed from the landing site but the total area is small compared to the overall area where pickleweed is present at WSMR. All impacts will be within the 4 km landing site.

At both sites some vegetation, if present, would be disturbed at the Starliner landing site and during the recovery of jettisoned pieces, but only a small area (approximately 5 acres) would be affected. In all proposed recovery activities, ground vehicles would use existing roads when available. When traveling off-road the convoy would follow direction from the WSMR Environmental Division to minimize soil impacts. All recovery vehicles utilized at WSMR are wheeled vehicles.

There is a small possibility of a grass fire due to the latent heat of the spacecraft following reentry, primarily at the WSMR-N site due to the amount of vegetation present. The chances of a fire would be minimized by mowing the center of the landing site. A fire is still extremely unlikely to occur at WSSH due to the limited vegetation present there. However, should one occur at either site, WSMR has appropriate equipment and existing processes to control and extinguish fires. Best management practices to minimize erosion would be included in the recovery plan if a fire were to occur.

The only debris generated is from the pieces of the spacecraft that jettison during landing and any trash generated as part of the landing and recovery operations. All jettisoned pieces, if found, and trash would be collected as efficiently as possible to minimize the impact to surrounding vegetation and wildlife. It may not be possible to find all of the jettisoned pieces due to their small size and the size of the overall landing site. The jettisoned items do not pose any environmental concerns should they be left in the field.

Fauna could be affected by construction activities, the elimination of two water collecting earthen berms, vehicle landing, and recovery activities. Replacement of the two water berms, that are seasonally used by local wildlife, with two water collection facilities constructed outside the zone would eliminate any impacts to local fauna from the removal of these two berms. Noise from sources, such as vehicles, heavy machinery, and general human activities, related to construction and recovery activities would lead to species-specific faunal reactions. Factors influencing faunal responses may be time and length of the noise, seasonality, time of day, stress and physiological effects, life history, naturally occurring and background noise, and habituation. Noise from the sonic boom, vehicles, and general human activities would cause some disruption to wildlife found in the project areas. Many small mammals and reptiles would likely react to unexpected noise by retreating underground. Larger mammals and birds would likely temporarily vacate the area (Larkin 1996). Therefore, the localized and temporary nature of increased noise and activity would not have a significant long-term effect on fauna inhabiting the landing areas.

Small mammals, ground-nesting birds, reptiles, and amphibians could be injured or killed by vehicles during removal of obstacles and vegetation. To minimize project-related mortality of wildlife, the initial clearing activities would be scheduled outside the nesting season (nesting takes place from March through August) if possible. If not possible, the WSMR Environmental Division would perform a nesting bird survey before any work begins. In addition, vehicles would keep to existing roadways whenever possible. Construction personnel would be instructed not to collect, harm or harass any wildlife species. When any follow-on maintenance activities (such as re-mowing of the center) must take place during the nesting season, the WSMR Environmental Division would survey the area for nests so they can be avoided if possible.

Fauna could be affected by the Starliner landing and recovery activities. The probability of directly hitting fauna with the spacecraft or jettisoned pieces is inherently low. Small mammals, ground-nesting birds, reptiles, and amphibians could be injured or killed by vehicles during landing and recovery operations. Any active bird nests found during landing recovery operations would be marked for avoidance and reported to WSMR biologists, as would any injured or dead birds. To minimize project-related mortality of wildlife, vehicles would keep to existing roadways whenever possible. Landing and recovery personnel would be instructed not to collect, harm or harass any wildlife species. For night operations that require portable lighting, WSMR portable lighting guidelines would be followed to ensure they don't attract migrating birds.

While individual mortality may occur to non-protected wildlife species, regional populations of species would not be affected. Construction and landing activities would affect only a limited portion of the total available habitat within WSMR.

Overall, rangeland health indicates WSMR-N is fairly healthy for its type and should recover from the proposed activities. Habitat associations within the WSSH site are extremely biologically unproductive and large expanses of the area is completely barren. Removal of salt cedar at WSSH would improve the site. No negative effects to natural resources are anticipated from the proposed action at the WSSH Site.

Therefore, the proposed action would not have any significant impacts to biological resources.

4.1.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR-N and no additional vegetation clearing would take place at WSSH. Therefore, the No Action Alternative would not result in biological resource impacts at the WSMR-N landing site or at WSSH beyond those identified in the June 2019 EA.

4.1.4 Mitigation Measures

During all activities vehicles would use existing roads when available, and follow the WSMR Environmental Division recommendation. Geodetic markers would be marked prior to mowing and vegetation removal so they can be avoided to prevent damage. Monitoring, including photographs of the recovery vehicle travel path, would also take place after each mission to develop recommendations for follow-on missions to minimize future impacts. If any listed species are found following the completion of this EA, the WSMR Environmental Division would be consulted to determine if additional mitigation is necessary to prevent impact to the listed species' populations. Mowing and vegetation clearing activities would take place outside the nesting season (nesting takes place from March through August), if possible, to ensure no nesting birds or active animal burrows would be disturbed. If not possible, the WSMR Environmental Division would perform a nesting bird survey before any work begins.

4.2 Physical Resources

4.2.1 Affected Environment

The proposed action would not affect floodplains or wild and scenic rivers as none of these are located within the area affected by the proposed action. Therefore, these resources are not considered further. This section focuses on wetlands, surface water, groundwater, water quality and soils. Water quality is protected under the Clean Water Act 1972 (Federal Water Pollution Control Act), Safe Drinking Water Act 1974, and New Mexico Water Quality Regulations (20 New Mexico Administrative Code 6.2). As all of the proposed action takes place above or on the surface, the underlying geology is also not affected.

Water

The WSMR-N landing site is located in the Jornada del Muerto Basin. The WSSH landing site is located in the Tularosa Valley Basin. Both are closed basins and lack effective external surface drainage to the Rio Grande. Thick alluvial basin deposits comprise most of the aquifers in the region. Ground water quality varies throughout the region, but is generally of low quality and high in sulfates (Roybal, 1991). Groundwater wells that exist in the area are historic water sources for livestock. A few of these wells are wildlife water units. No wells are within the landing and recovery areas.

Rainfall can infiltrate rapidly to the subsurface (Weir, 1965). Heavy rainstorms can create short-duration overland flows, and ponding can result in formation of shallow playa lakes. There are no perennial streams in either landing site.

There are two main basin-fill aquifers that underlie WSMR. They are the Rio Grande aquifer and the Tularosa Basin aquifer. The main sources of groundwater for WSMR are wells that tap into regional aquifers located within these basin-fill aquifers.

There are no potable water locations within either landing site.

Table 4-1 summarizes the water resources at the landing sites.

Table 4-1: WSMR Water Resources

Landing Site	Hydrologic Basin	Avg. Precipitation (in. /yr.)	Approx. Depth to Groundwater (ft.)
WSMR-N	Jornada del Muerto	11	100
WSSH	Tularosa	8	10

Wetlands

At WSMR-N the NWI has mapped three water bodies within the site boundary: a 231.68-acre lacustrine Wetland (L2USC), a 1.71-acre palustrine pond (PUBH), and a 1.75-acre riverine habitat (R4SBC) (Figure 4-5). No riparian obligate or wetland plant species or permanent surface water, or signs of water, were observed at plots 3 and 10. A small channel leading into the u-shaped berm was observed during the field investigation at plot 9. The channel did not exhibit any riparian obligate or wetland plant species and is considered to be ephemeral, meaning that the channel has flowing water only during, and for a short duration after, precipitation events in a typical year. There are no wetlands within the landing site that are under USFWS jurisdiction. There are no NWI-mapped wetlands at the WSSH Site. The site investigation confirmed that no wetlands exist at this site. Therefore, the Proposed Action would not affect wetlands.

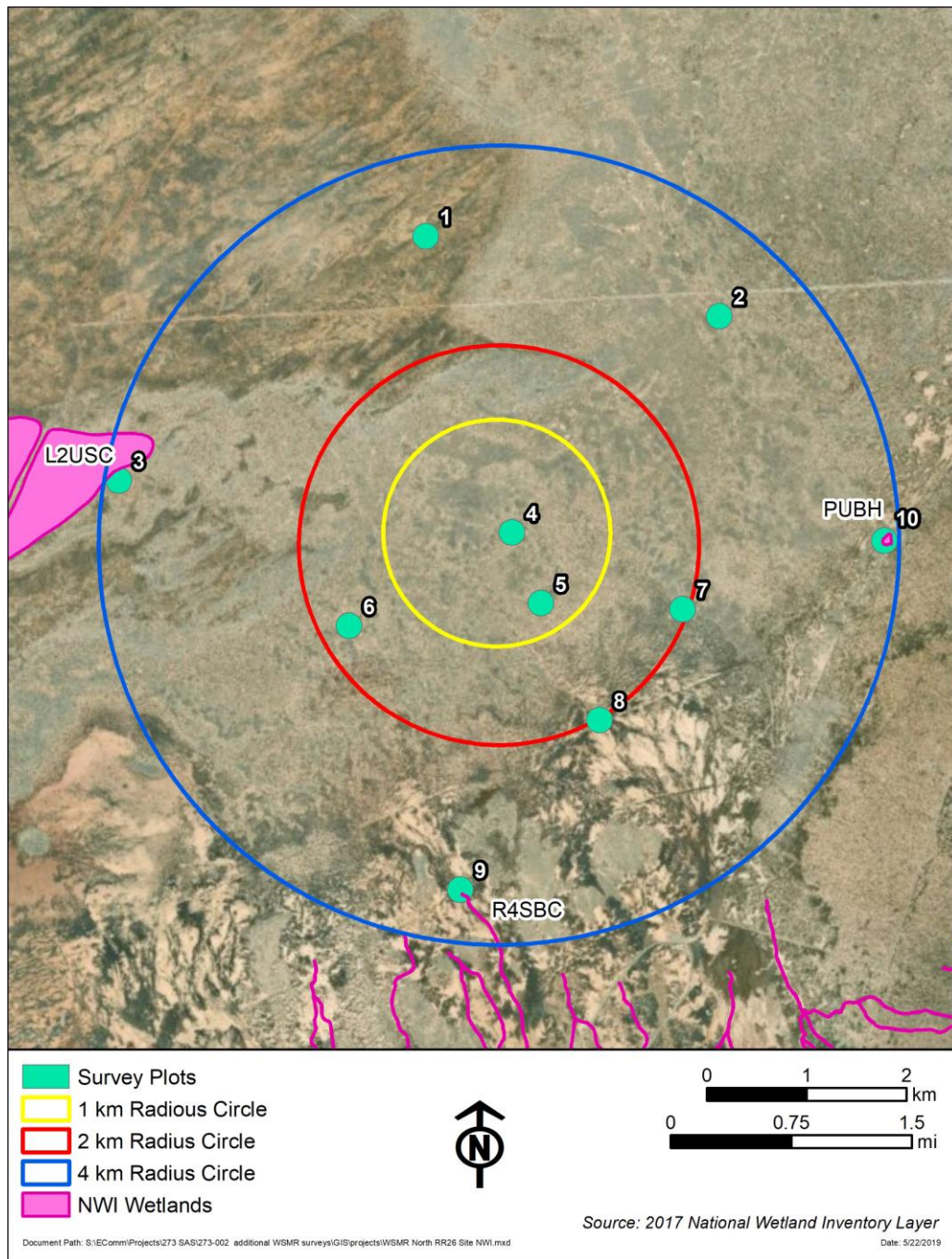


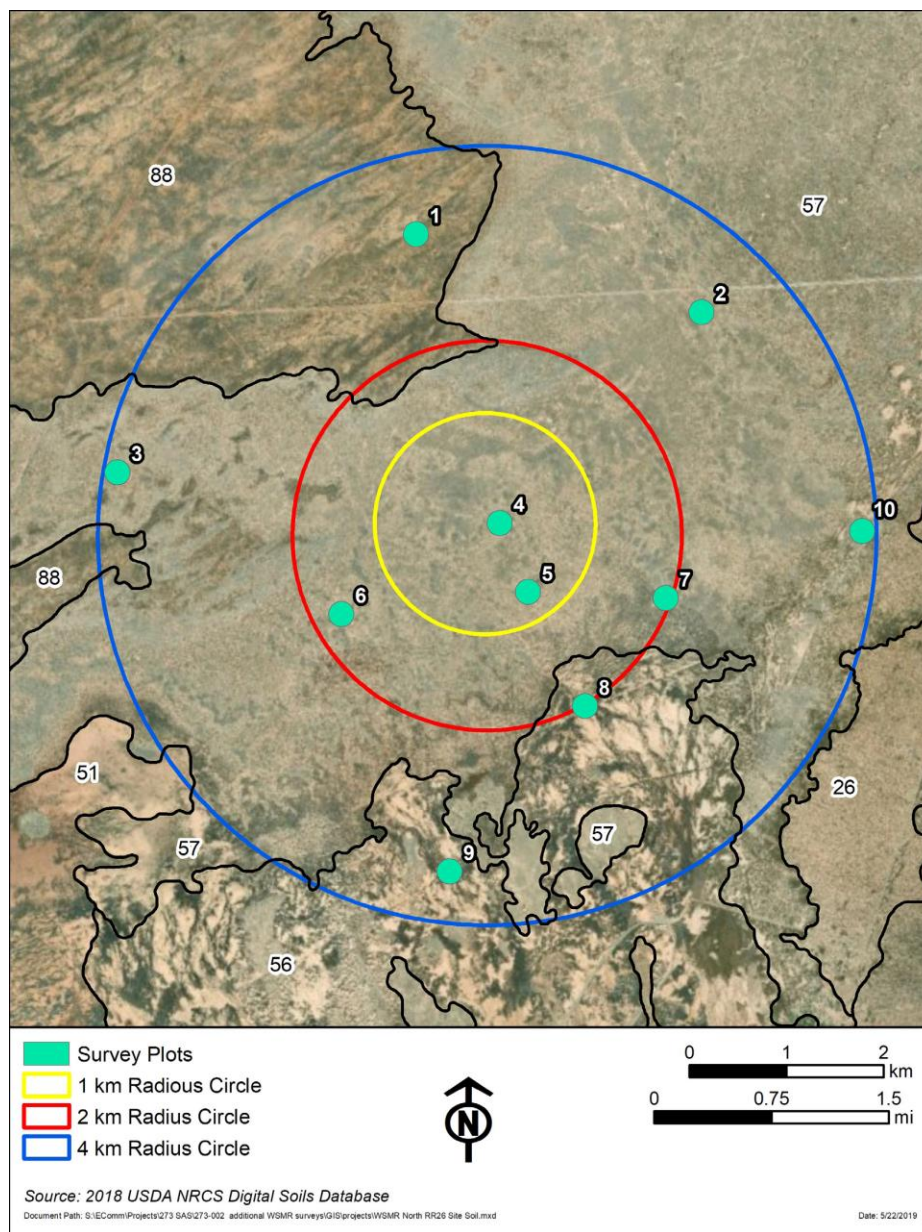
Figure 4-4: WSMR-North Wetland Areas

Soils

According to the United States Department of Agriculture- Natural Resources Conservation Service's (NRCS) Web Soil Survey, Nasa-Yesum complex, Whitlock- Pajarito-Nations complex, and Mimbres-Chutum-Ybar complex make up the dominant soils within the WSMR-N site (Figure 4-5). Biological soil crusts are also present within the WSMR-N landing site.

The Dona Ana-Chutum complex and Marconi-Prelo-Fluventic Haplocambids complex are present in minute amounts near the outside border of the site. Llano-Ratscat complex is the only soil that is present within the WSSH Site.

Details on these soil types can be found in Appendix B.



Map Unit Symbol	Map Unit Name
26	Dona Ana-Chutum-Ybar complex, 0–5 percent slopes
51	Marconi-Prelo-Fluventic Haplocambids complex, 0–5 percent slopes
56	Mimbres-Chutum-Ybar complex, 0–5 percent slopes
57	Nasa-Yesum complex, 0–6 percent slopes
88	Whitlock-Pajarito-Nations complex, 1–8 percent slopes

Figure 4-5 WSMR-N Soils

Rangeland Health

The rangeland health assessments discussed in section 4.1.1 included soil and site stability. The results for the three ecological site assessments at WSMR-N and the one ecological site assessment at WSSH can be found in Appendix B.

4.2.2 Environmental Consequences

A copy of the natural resources report generated in support of the development of this EA can be found in Appendix B.

Water

Impacts to surface waters would be significant if the proposed action would (1) exceed water quality standards established by federal, state, local, and tribal regulatory agencies; or (2) contaminate public drinking water supply such that public health may be adversely affected (FAA Order 1050.1F). Impacts to groundwater would be significant if the proposed action would (1) exceed groundwater quality standards established by federal, state, local, and tribal regulatory agencies or (2) contaminate an aquifer used for public water supply such that public health may be adversely affected (FAA Order 1050.1F).

No permanent water bodies (e.g. stream, creeks) occur within the landing area. Therefore, surface water would not be affected by any of the proposed operations. Minor amounts of water could temporarily accumulate in low lying areas and within the two water collection earthen berms that would be removed, especially during the summer rainy season. This seasonal source of water for local wildlife would be replaced by two new water collection facilities built outside the landing site. The fence and pole removal activities would only take place when the area is dry enough to allow access to the site. Should standing water be expected for the planned Starliner landing, an alternate landing site would be selected unless an emergency landing has been declared and either WSSH or WSMR-N are the only viable alternatives. Given the lack of water resources, it is unlikely that the proposed action would impact water resources.

All water needed for the recovery activities would be transported to the landing site by the landing recovery convoy. All wastewater generated by the recovery operations would be collected and removed by the LRT and disposed of in accordance with applicable WSMR regulations.

Soils

Mowing at the WSMR-N landing site would reduce vegetation coverage, which could lead to an increase in wind and water erosion which in turn could lead to an increase in windblown dust. Mowing would only take place prior to the first selection of this landing site as a PLS or BLS and would only need to be repeated if the vegetation has regrown to a height that could impact the landing of the Starliner when this site is selected again as a PLS and BLS. Mowing would take place at most twice per year but would probably be much less often based on the availability of five landing sites.

Vehicle and foot traffic would cause some degradation to the biological crust, which are very slow to recover from impacts. Some crust would be disturbed during the removal of obstacles and vegetation that could impact the safety of the Starliner landing and mowing of the center of the landing site when needed. Removal would be a one-time event. During CM recovery the crust, where present, would be disturbed only from the place the convoy leaves the road until arrival at the Starliner and around the Starliner during the recovery. This would be minimized by the improvements that would allow travel to the center of the landing site on a gravel road. The convoy would use the lightest wheeled vehicles practical and follow direction from WSMR to minimize disturbance to the soils. Due to the low probability of the Starliner landing in the same place twice this disturbance should be a one-time event. The site preparation and recovery activities would disturb a small area of the biological crust when compared to the overall area within the landing site containing this crust so the overall impacts would not be significant.

Equipment used for demolition, road improvement, and landing recovery activities would be inspected in accordance with established site procedures for petroleum, oil, and lubricant (POL) leaks and, if necessary, appropriate containment would be placed underneath equipment when not in use. In the unlikely event of an accidental POL spill, contaminated soil would be cleaned using established site procedures. Likewise, should an unlikely failure occur in the Starliner or GCUs, any contaminants would be cleaned up utilizing applicable WSMR regulations. As a result, groundwater would not be contaminated such that water quality standards would be exceeded, and no aquifers used for public water supply would be affected.

The road improvement at WSMR-N would impact the soil around the current two-track road that would be improved to allow better access to the center of the landing site. Up to 6 miles would be converted into a gravel road. In all proposed activities, ground vehicles would use existing roads when available. When traveling off-road the convoy would follow direction from the WSMR Environmental Division to minimize soil impacts. Off-road traffic would be restricted in accordance with WSMR regulations to minimize disturbance to the soil. All of the construction and the vast majority of the landing recovery activities would take place within the 4km radius landing site so the soils in those areas were assessed in detail. The only disturbance to the soil outside this would be from ATVs traversing the land to recover any jettisoned items that landed outside the 4km landing site. As a result, soils were not analyzed outside the 4 km radius landing site.

Overall, the proposed action would not significantly affect the water resources or soils at either landing site. The action would not significantly affect rangeland health at WSSH. There could be a minor impact to rangeland health for the area mowed at WSMR-N due to loss of vegetation causing increased erosion, however the majority of the vegetation is perennial grasses which would recover after mowing.

4.2.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR. Therefore, the No Action Alternative would not result in water resource or soil impacts at the WSMR-N landing site and no additional impacts at WSSH above those documented in the June 21019 EA.

4.2.4 Mitigation Measures

Equipment used for landing and recovery activities would be inspected frequently for petroleum, oil, and lubricant leaks and, if needed, appropriate containment would be placed underneath equipment when not in use. Best practices would be utilized to minimize dust and erosion control including use of dust control measures if needed, utilizing existing roads to the extent possible, and scheduling mowing and vegetation removal to take place when the soil contains some moisture. Mowing and vegetation removal would be done outside the nesting season (nesting takes place from March through August) if possible to prevent disturbance of active nests. Heavy equipment would be washed where practical to minimize incursion of non-native plant seeds. The mowed area at WSMR-N would be monitored to determine how well it recovers and whether any changes to the operations are needed for future missions.

4.3 Cultural Resources (Architectural, Archaeological, and Tribal Areas of Interest)

4.3.1 Affected Environment

WSMR-N Landing Site

Previous Archeological Investigations

According to the New Mexico Cultural Resource Information System (NMCRIS) digital files and the WSMR cultural database and GIS files, a total of 10 previous investigations have been conducted

covering approximately 685 acres, or 5.5 percent, of the 4-km radius landing site (Table 4-2 and Figure 4-6). As part of this SEA, an additional 1,004 acres at the center of the target landing site and a proposed access corridor were surveyed.

All of the projects have been conducted in compliance with National Historic Preservation Act (NHPA) requirements and in support of various military missions at WSMR. Eight of the previous 10 projects were surveys, ranging in size from less than 5 acres to over 5,000 acres; however, only a small portion of the larger inventories fall within the landing site area of potential effect (APE).

Table 4-2: Previous Archaeological Investigations within the WSMR N Landing Site

NMCRIS Activity; Project Number	Project Type; Size*	Reference
NMCRIS 35759; HSR 9025	Sample survey and NRHP evaluation of 14 historic site locations; 4,522 acres	The Aerial Cable Test Capability Project: An Archaeological Evaluation of the Jim Site and Fairview Alternatives, White Sands Missile Range, NM (2 volumes) (HSR Staff 1991)
NMCRIS 45067; TRC 800	Survey; 185 acres	A Cultural Resources Survey of 185 Acres for the Proposed DNA High Explosive Testing Site (Crawford 1992)
NMCRIS 44650; HSR 9141	Survey; 4,522 acres	Archaeological Clearance Survey for the BAT Test Area, White Sands Missile Range, Socorro County, New Mexico (Browning 1993)
NMCRIS 44926; HSR 9332	Survey; 2,020 acres	Archaeological Survey at the BAT Test Area, White Sands Missile Range, Socorro and Sierra Counties, NM, Phase II (2 volumes) (Browning 1994)
NMCRIS 45606; HSR 9226-B	Survey and testing of 3 sites; 4.6 acres	Archaeological Survey of an Access Corridor and Testing of Three Sites for the DNA Dipole Test Bed (Webb 1993)
NMCRIS 56460 HSR 9615	Survey; 5,270 acres	From Playas to Highlands: Paleo-Indian Adaptations to the Region of the Tularosa (Wessel et al. 1997)
NMCRIS 64583; HSR 9833	Survey, monitoring, damage assessment 137.54 acres	Archaeological Survey, Monitoring, and Damage Assessment on Parcels Near Range Routes 13 and 26 and along Roads at EMRE Facility (Knight 1999)
NMCRIS 138751; WSMR 804	Survey; 56.10 acres	Cultural Resource Survey for a QF- 4 SM6 Recovery Near Zumwalt (Burt 2017)

NMCRIS 139621; WSMR 939	Survey; 7 acres	Cultural Resource Survey for the Recovery of a Roland Short-Range Ground-to-Air Missile (Ralph et al. 2017)
NMCRIS 129568	Site specific visits; 29 sites	In progress

*Note: Includes portions outside WSMR N Landing site area.

In addition to the surveys, 14 potential historic site locations were specifically targeted for NRHP evaluation during the Aerial Cable Test Capability (ACTC) project, and three sites were specifically targeted for test excavations during the DNA Dipole Test Bed project. The two remaining studies consisted of two site-specific evaluations focused on Historic period cultural properties.

Recorded Cultural Resources

During the surveys conducted within the 4-km-radius landing site, 18 cultural resources have been reported, with two of these being reported as part of the survey done in support of this SEA. Of the 18 cultural properties, 6 are historic sites reflecting ranching efforts during the 20th century; two of these sites also contain one or more prehistoric components. Historic use of the area was limited to ranching activities initiated near the beginning of the twentieth century and terminated by 1945 with acquisition of the area by the Army. Extant ranch houses, fence lines, corrals, watering facilities, and trash scatters documented throughout the area reflect subsistence efforts, predominantly by American ranchers in this relatively remote portion of WSMR. None of the recorded sites is within the 1km radius center of the landing site.

Sites attributable to prehistoric activities comprise the remaining 12 properties, with 8 lacking temporally diagnostic items. These archaeological sites are temporally classified as Prehistoric Unknown, typically consist of lithic scatters lacking features, and are most prevalent within the surrounding area. One of the two remaining sites is a lithic scatter with two hearth features that contains diagnostic projectile points suggesting Late Archaic period associations that also contains a historic trash dump, and the last two prehistoric sites are a pot drop and a lithic and ceramic scatter attributed to the Formative period.

Three of the 18 sites within the 4-km radius landing site have been determined eligible for inclusion on the NRHP and three have been determined not eligible for inclusion by the NM SHPO; the 12 remaining sites have no official eligibility determination on record, including the two found during the most recent survey. Six of the sites with undetermined eligibility were recommended eligible by the recorders (including one from the most recent survey), three were recommended not eligible (including one from the most recent survey), the status of three is listed as “to be determined,” and the final site is a historic ranch that is part of a project that is in progress and currently has no eligibility recommendation.

The three sites determined eligible for inclusion on the NRHP are associated with ranching activities. One contains historic glass, metal, and ceramics, as well as a prehistoric lithic and ceramic scatter associated with the Late Archaic and Formative periods. The second is a ranching-related site that contains two house foundations, two tanks, and two wells, as well as an unknown prehistoric lithic scatter. The third is a ranching-related site that contains two extant houses, two structural foundations, two tanks, a corral, three windmills, and various debris (i.e., glass, metal, ceramics, faunal remains, botanical remains).

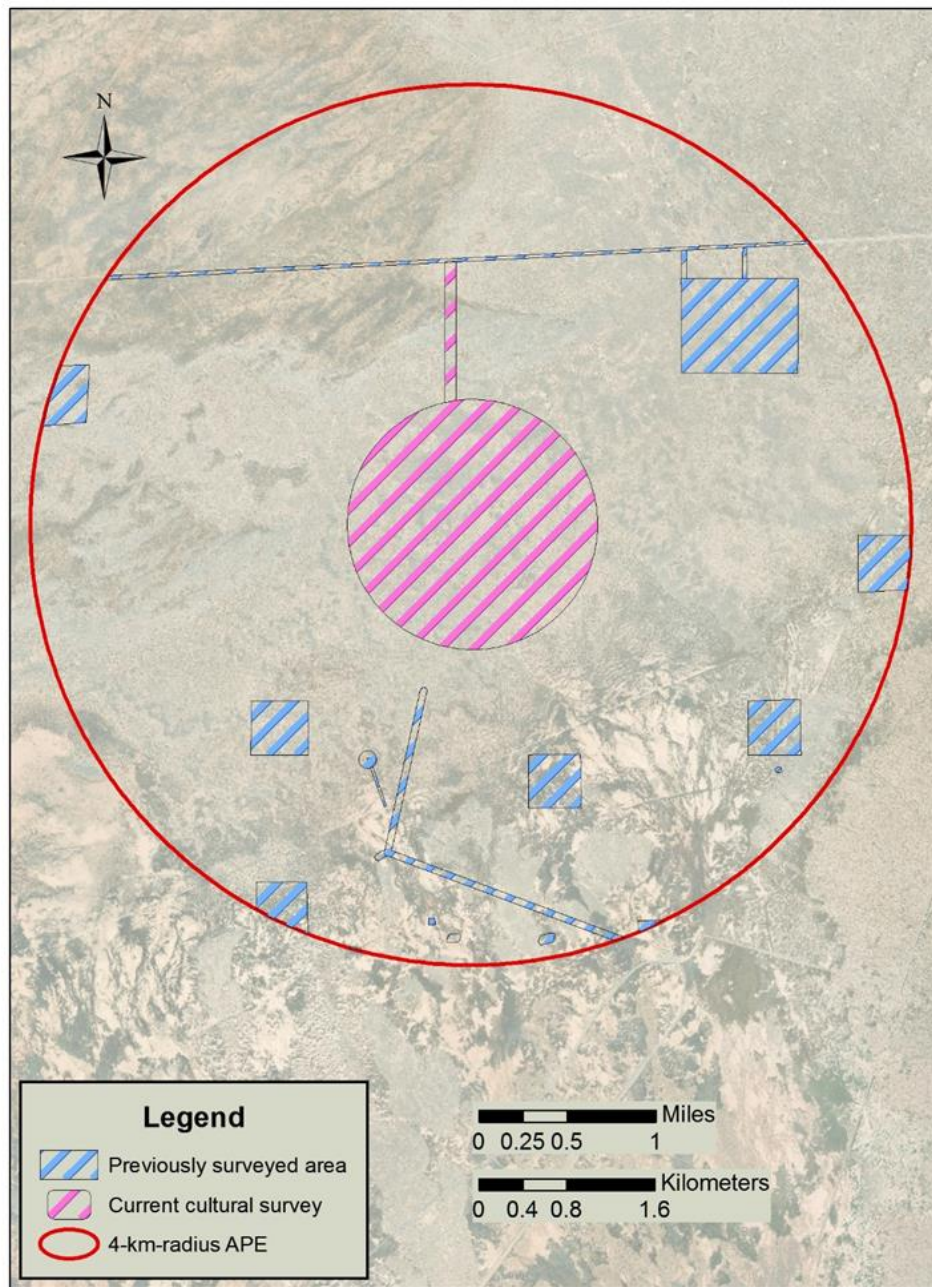


Figure 4-6: Survey Areas at WSMR-N

WSSH Landing Site

The cultural resource that could be impacted by the additional vegetation removal are mega fauna tracks that occur within the landing site. Information about these fossils can be found in the June 2019 EA.

4.3.2 Environmental Consequences

Impacts resulting from the proposed action would be considered significant if they were to:

1. Adversely affect known cultural resources eligible for inclusion into the NRHP.
2. Damage or impact previously unknown and recorded cultural resources eligible for inclusion in the NRHP.
3. Cause substantial unauthorized artifact collection by personnel.
4. Adversely affect known Traditional Cultural Properties on WSMR. These are eligible for inclusion in the National Register because of an association with cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community.

At WSMR-N there are no known culturally sensitive areas within the 1 km radius center of the landing site that would be mowed and where the CM landing would be targeted and the majority of recovery activities would take place. There are 3 eligible sites and 6 sites that were recommended as eligible within the greater 4 km radius landing site. Neither of the water collecting earthen berms that would be removed are eligible or recommended eligible. The historic ranch in the southeast part of the landing site would not be removed or modified as part of the proposed action. A WSMR Environmental Division archeologist would be present when obstruction and vegetation removal activities are taking place in the areas of WSMR-N that have not been surveyed for cultural resources and would provide direction should any unknown cultural resources be encountered. This includes the approximately 1 acre area in the southern part of the landing site that would be mowed. A WSMR archeologist would also be present during vegetation removal at WSSH to ensure no damage is done to the mega fauna fossil tracks. Should any unknown resources be encountered or work begin to imping on the areas containing fossil tracks, the work would halt until a recommendation is provided by the archeologist on how to proceed.

The LRT would be instructed prior to landing to avoid known cultural areas and to not disturb prehistoric or historic artifacts. Due to the small number of eligible cultural sites within the landing site, and the small number of landings expected to take place at any given site, the probability of the Starliner or any of the jettisoned pieces impacting a culturally eligible site is inherently low. However, should the Starliner come to rest on or near a cultural site, it would be marked for avoidance, WSMR archaeologists would be notified immediately, and only the minimum disturbances necessary to get the crew and critical cargo out of the spacecraft would take place. Further ground disturbing activity would cease until the WSMR archaeologists determine how to proceed. Should any of the jettisoned parts land on or near a cultural site, it would be marked for avoidance, WSMR archaeologists would be notified immediately, and ground disturbing activity would cease until the archaeologists determine how to proceed.

Figure 4-7 shows in green the location of the road improvements that would be made as part of this action. This would consist of making improvements to convert a previously bladed road to a gravel road. The improvements would cover up to 6 miles from Range Road 26, past the center point of the 4 km landing site, and then east to connect with Range Road 13. The improvement would include areas allowing trucks to turn around during the construction. This would allow a crane and transport vehicle to access the center of the landing site for retrieval of the Starliner post landing. WSMR surveyed this route and determined there are no cultural resources that would be impacted by this activity.

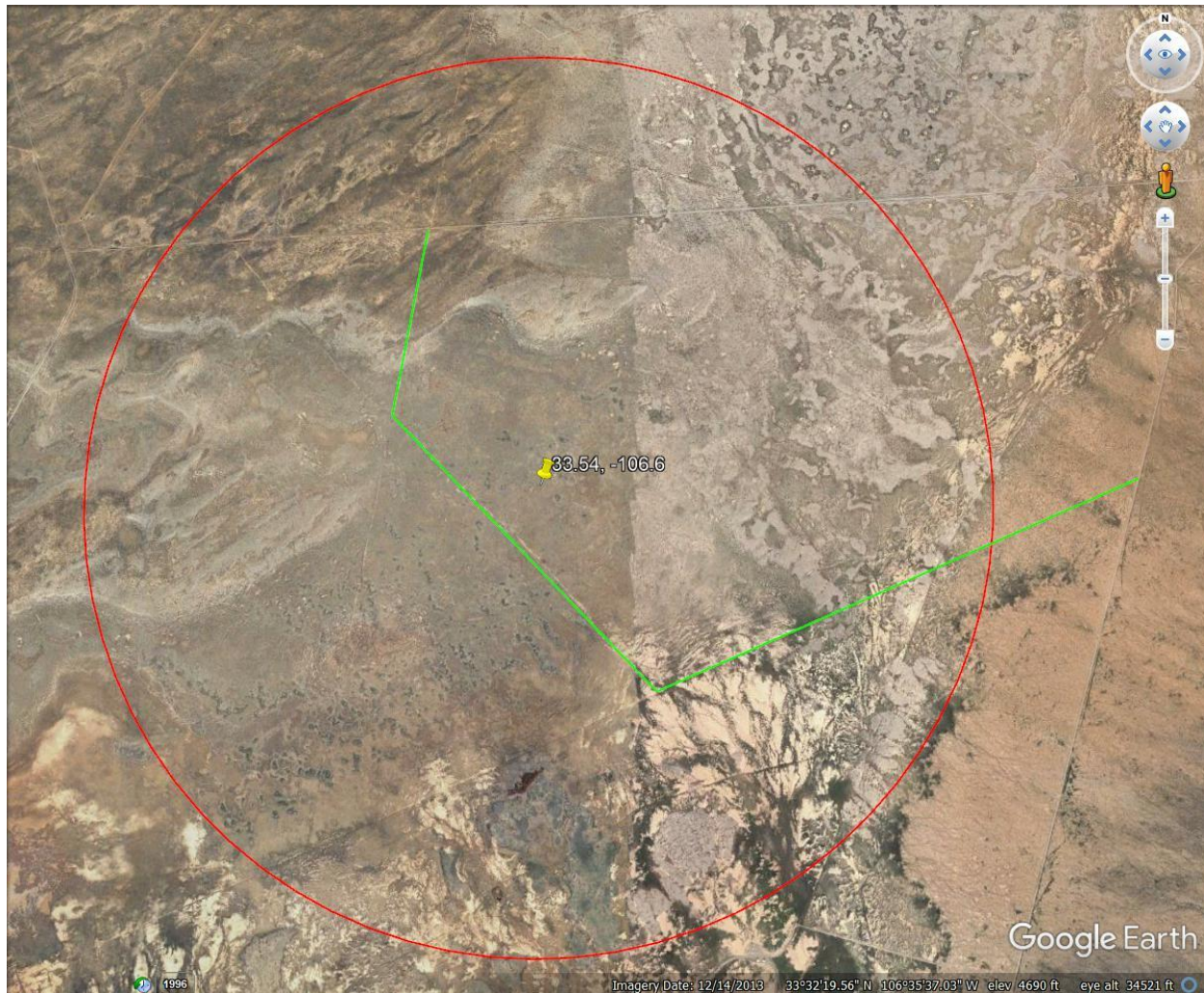


Figure 4-7: Road Improvements at WSMR-N

The WSMR Environmental Division would conduct any required tribal and SHPO consultations. The results of these consultations would be included in the final SEA.

4.3.3 No Action Alternative

Under the No Action Alternative, no Starliner reentry activities would occur at WSMR-N and no additional vegetation removal would take place at WSSH. Therefore, the No Action Alternative would not result in cultural resource impacts at the WSMR-N landing site or any additional impact at the WSSH landing site beyond those documented in the June 2019 EA.

4.3.4 Mitigation Measures

A WSMR Environmental Division archeologist would be present when obstruction and vegetation removal activities are taking place in the areas of WSMR-N that have not been surveyed for cultural resources and in areas of WSSH that include the mega faunal fossil tracks. Should any unknown resources be encountered, the work would halt until a recommendation is provided by the observer on how to proceed.

Landing and recovery efforts would be monitored. Should a falling piece of the spacecraft impact a site a damage assessment would be required. The WSMR Environmental Division may also require NRHP testing if a site with undetermined NRHP status is damaged. Maintenance of roads in the landing site would be planned to avoid cultural resources. In the event that any project activities are required outside the proposed areas in this EA, these activities would be coordinated with site archeologists and additional archeological surveys would be conducted if necessary.

5.0 Irretrievable and Irreversible Commitment of Resources and Cumulative Impacts

5.1 Irretrievable and Irreversible Commitment of Resources

The proposed landing, and recovery of the Starliner spacecraft would cause no losses to natural, cultural, or human resources. Some irreversible and irretrievable commitment of resources would be expected from the use of vehicles, fuel, energy, and labor. The landing and recovery activities at the WSMR landing sites would not commit natural resources in unacceptable quantities nor cause resources to become inaccessible for other uses.

5.2 Cumulative Impacts

Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Past, present, and future activities at WSMR include providing critical testing for the nation's nuclear bomb program, development of testing/training facilities and infrastructure, expansion of current programs, addition of new training assets and new testing initiatives, and support to training and test groups from Holloman Air Force Base and Fort Bliss.

Refer to Section 34.19 of the WSMR EIS for a general discussion of cumulative impacts (U.S. Army, 2009).

The activities needed to remove structures within the 4 km radius landing sites are a one-time event, take place in a relatively small section of WSMR, and are relatively short in duration.

Mowing of the center 1km (3200 ft.) radius landing site at WSMR-N would add to the total area of vegetation cleared in the northern part of WSMR. The 649 Weapon Impact Target (WIT) (9400 ft. radius) and Stallion WIT (10,000 ft. radius) have both been cleared of vegetation and are used for munitions impact. This would increase the area prone to wind and water erosion due to a reduction in vegetation coverage, both of which could also increase wind generated dust in the area.

Removal of large vegetation within the landing sites would only take place prior to their first use and then only when a site is selected as the prime or backup landing site and the vegetation has grown to the point where it could impact the Starliner landing. Mowing would only take place at the WSMR-N site when it is selected as a prime or backup landing site.

The landing recovery operations are infrequent (1-2 times per year, spread out over the five landing sites). Standard operating procedures would be developed to ensure adherence to all Army, state, and federal regulations.

Established WSMR coordinating and scheduling procedures would be utilized to ensure Boeing clearing and landing and recovery operations do not impact other Army operations taking place in the area and vice versa.

When taken in conjunction with other current, planned, and reasonably foreseeable activities at WSMR, the impacts from the proposed action would result in insignificant cumulative impacts to the existing environment at WSMR and the surrounding area.

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7.0 Appendices

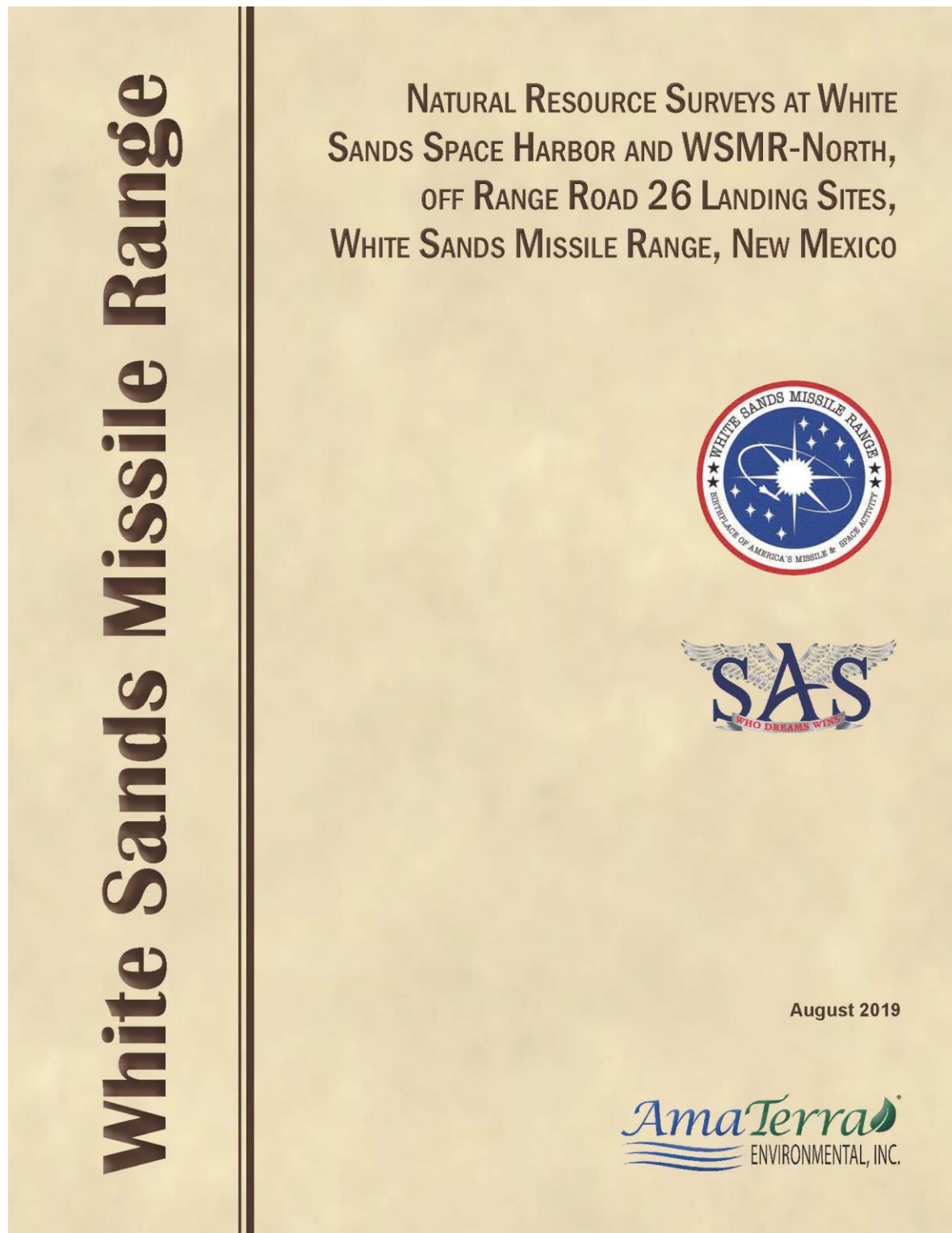
Appendix A – Abbreviations and Acronyms

BLS	Backup Landing Site
CCAFS	Cape Canaveral Air Force Station
CCDev	Commercial Crew Development
CCTS	Commercial Crew Transportation System
CDC	Centers for Disease Control and Prevention
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CFT	Crewed Flight Test
CM	Crew Module
DoD	Department of Defense
EA	Environmental Assessment
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
INCRMP	Integrated Natural and Cultural Resources Management Plan
IPaC	Information for Planning and Conservation
ISS	International Space Station
km	kilometers
KSC	Kennedy Space Center
LRT	Landing Recovery Team
mi	Miles
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NHPA	National Historic Preservation Act
NMCRIS	New Mexico Cultural Resources Information System
NMDGF	New Mexico Department of Game and Fish
NMED	New Mexico Environmental Department
NOAA	National Oceanic and Atmospheric Administration
NPR	NASA Procedural Requirement
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
OSHA	Occupational Safety and Health Administration

PA	Plant Associations
PLS	Primary Landing Site
RCRA	Resource Conservation and Recovery Act
SLS	Space Launch System
SM	Service Module
TES	Threatened, Endangered, or Sensitive
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance
WSMR	White Sands Missile Range
WSSH	White Sands Space Harbor

Appendix B – Natural Resource Survey Report

Note: the numbers in the black circles of the appendices of this report are from a template and are not page numbers for that section. All pages are present.



**NATURAL RESOURCE SURVEYS AT WHITE SANDS
SPACE HARBOR AND WSMR-NORTH, OFF
RANGE ROAD 26 LANDING SITES, WHITE
SANDS MISSILE RANGE, NEW MEXICO**

Prepared for



Special Aerospace Services, LLC

and



**White Sands Missile Range
Directorate of Public Works,
Environmental Division, Cultural Resources
White Sands, New Mexico**

by



Austin, Texas

August 2019



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Technical Report No. 275

AmaTerra Project No. 273-002

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CHAPTER 1

INTRODUCTION

The White Sands Missile Range (WSMR) is the Department of Defense's (DoD) largest single land holding and covers 2.28 million acres (922,000 hectares) in south-central New Mexico (WSMR 2015). WSMR is located at the northern margin of the Chihuahuan Desert Ecoregion and encompasses two mountain ranges: the San Andres and Oscura Mountains. The installation is managed by the U.S. Department of Army and is operated to support DoD readiness programs, including research, development, testing and evaluation of weapons and space systems, and military training (WSMR 2015).

The Boeing Company (Boeing) and the National Aeronautics and Space Administration (NASA) have requested to use areas on WSMR for two potential Commercial Crew Transportation System Starliner spacecraft landing sites within WSMR. The spacecraft will parachute to earth and land at one of two potential sites on WSMR at the end of its mission to the International Space Station. One site is located within the central Tularosa Basin at the White Sands Space Harbor (WSSH Site) and one is located in the Stallion Basin of northern WSMR (WSMR North- RR26 Site) (**Figures 1-1 and 1-2**). To meet the requirements of the National Environmental Policy Act (NEPA) and to obtain permission to perform the landing and recovery of the Starliner spacecraft, a Supplemental Environmental Assessment (EA) is being completed by Special Aerospace Services (SAS). The EA will also be used to support Boeing's requirements to obtain a commercial spaceflight license from the Federal Aviation Administration. AmaTerra Environmental, Inc. (AmaTerra) was contracted by SAS to perform the natural resources surveys required for inclusion in the EA.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

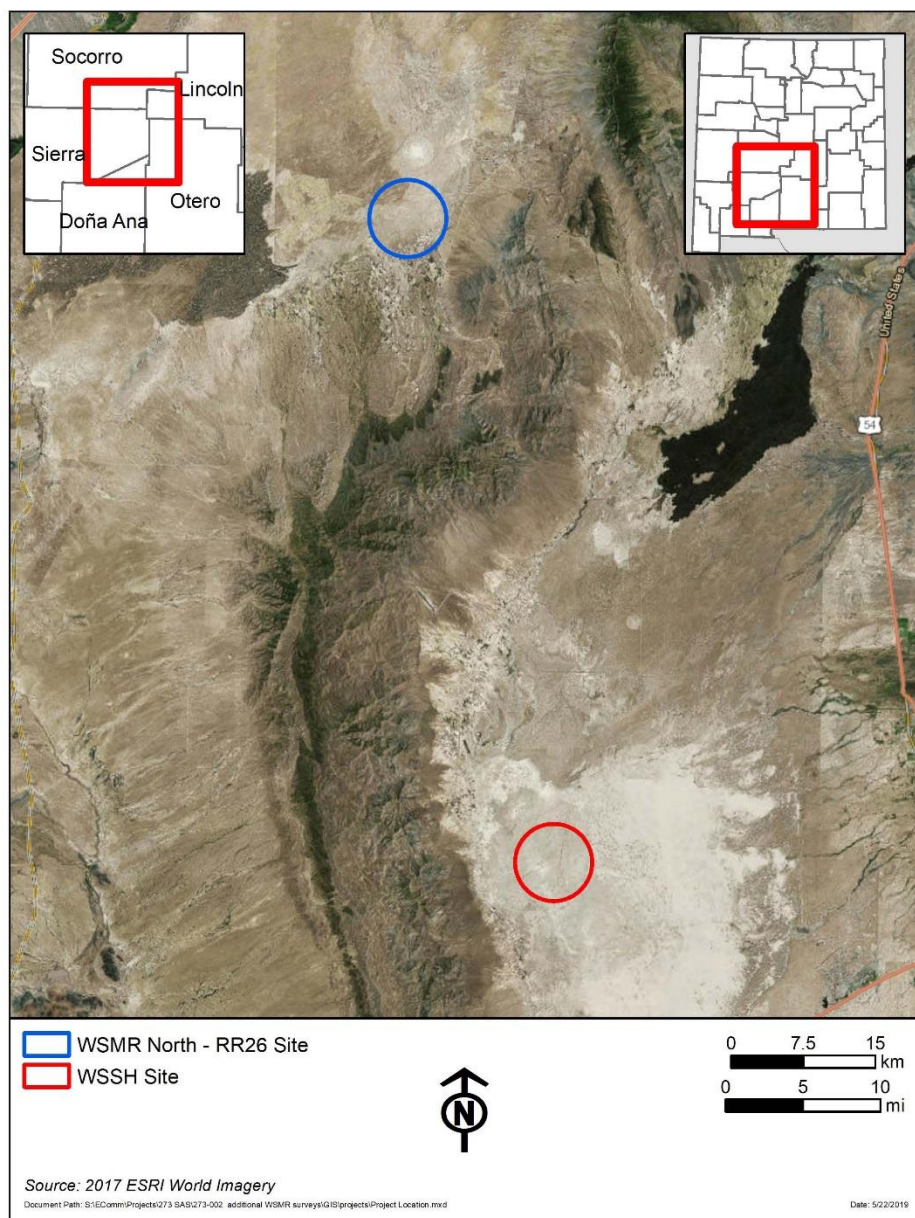


Figure 1-1. Aerial map of the WSMR North- RR26 Site and WSSH Site.

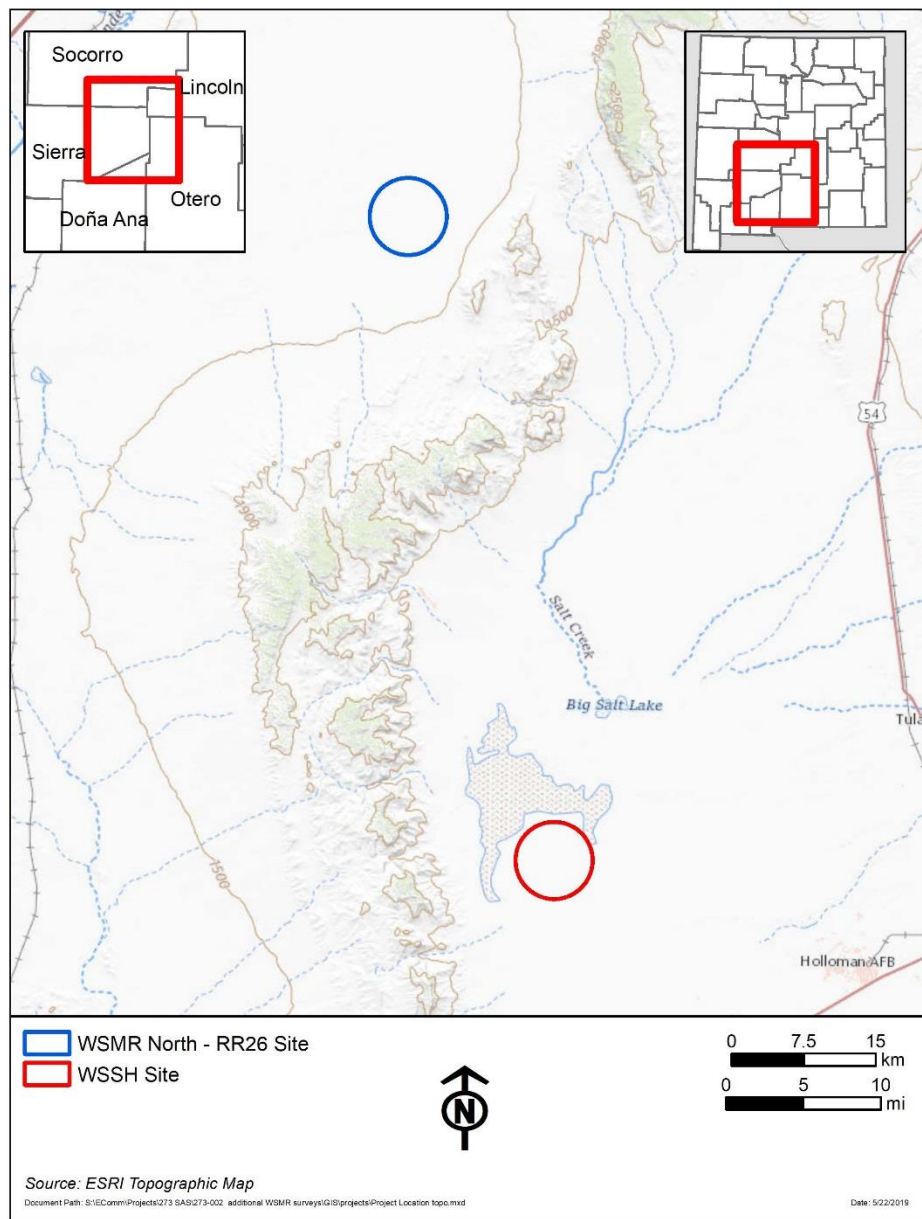


Figure 1-2. Topographic map of the WSMR North- RR26 Site and WSSH Site.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

CHAPTER 2

METHODS

2.1 LITERATURE SEARCH

A literature search was performed to compile existing data relating to surveys that have been previously conducted at or near the proposed landing sites. Additionally, the U.S. Fish and Wildlife Service (USFWS) website was consulted to complete an Information for Planning and Conservation (IPaC) search. The IPaC search is a useful tool for compiling a current list of potential threatened and endangered species that may occur at the proposed landing sites. The USFWS's National Wetlands Inventory (NWI) was used to locate any potential wetlands and waters in the project areas.

Information from AmaTerra's natural resource surveys in 2016 at the WSSH site and at the 649 Weapons Impact Target (WIT) Site, located north of the WSMR North- RR26 Site, was utilized for this report. During these surveys, AmaTerra and ECO Inc. concluded that habitat associations within the 649 WIT Site are varied and support a broad diversity of animal life. Surveys revealed that no federally or state listed species inhabit or are likely to inhabit the site. Conclusions were also made that habitat associations within the WSSH Site are extremely biologically unproductive and large expanses of the area are completely barren. It was determined at both sites in 2016 that no negative effects on natural resources are anticipated from the proposed action.

2.2 SURVEYS

Natural resource surveys were conducted at each of the proposed landing sites. At both sites, survey areas were surveyed by AmaTerra biologists by walking transects and making observations using binoculars throughout the area and recording fauna, flora, and soil characteristics to assess rangeland health on datasheets and in notes (**Photographs 1–20**).

At the WSMR North- RR26 Site, a one-percent survey of a four-kilometer (km) radius landing zone was conducted on May 9 through 12, 2019. Ten, 425-foot radius plots were chosen within this site to achieve the one-percent survey goal (**Table 2-1**) (**Figures 2-1** and **2-2**).

Table 2-1. Center Point of Plots at WSMR North-RR26 Site.

Sample Plot	Latitude	Longitude
1	33.567776°N	-106.608390°W
2	33.560980°N	-106.576659°W
3	33.545332°N	-106.641070°W
4	33.541175°N	-106.598626°W
5	33.534837°N	-106.595381°W
6	33.532522°N	-106.615996°W
7	33.534472°N	-106.580139°W
8	33.524365°N	-106.588879°W
9	33.508865°N	-106.603585°W
10	33.541050°N	-106.558077°W

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
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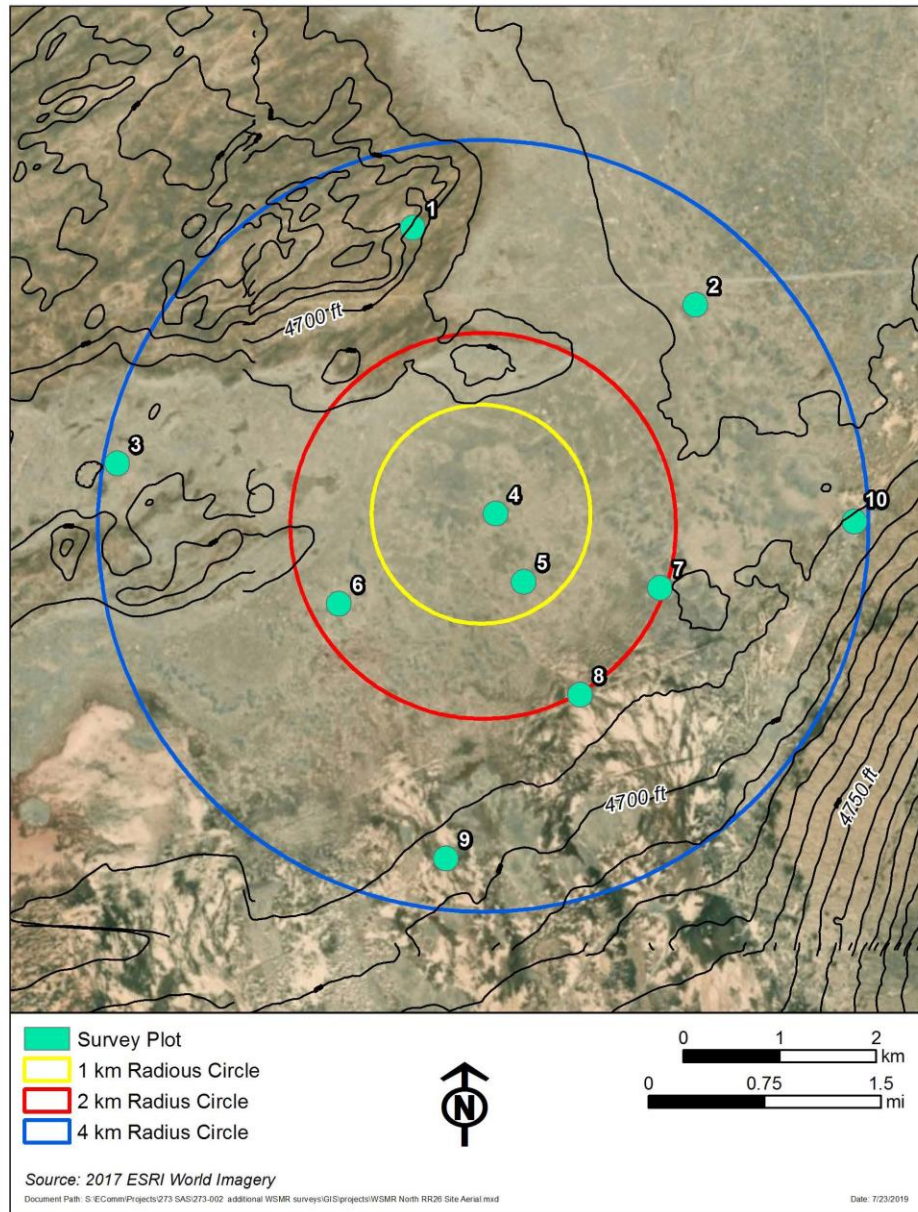


Figure 2-1. Aerial map of the WSMR North- RR26 Site showing the ten plot locations.

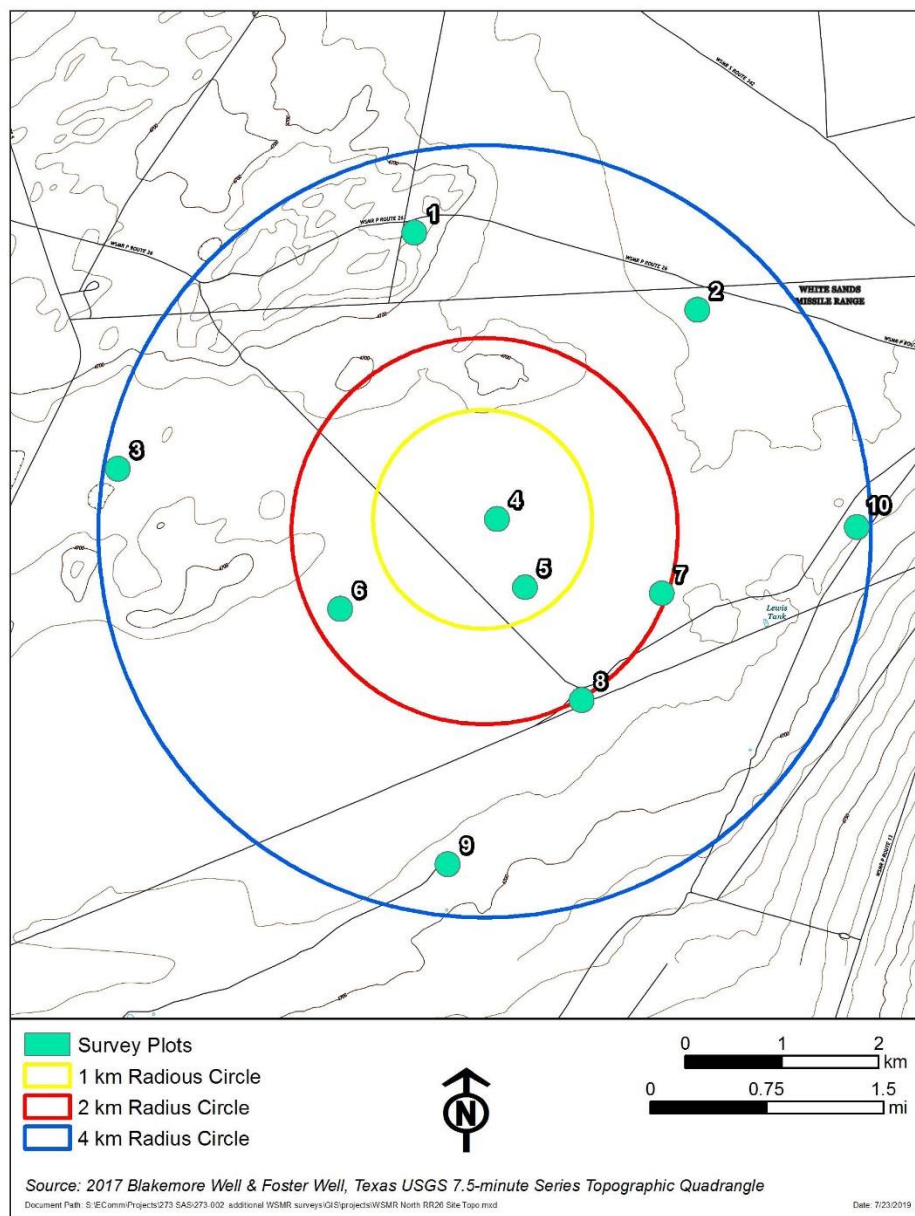


Figure 2-2. Topographic map of the WSMR North- RR26 Site showing the ten plot locations.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

These plots were biased toward a one-km radius circle that will be mowed and bladed to a height of six inches, the remainder of the two-km radius center where most of the recovery activity will take place, and other areas within the four-km radius circle with heavy vegetation such as yuccas and salt cedars that will need to be cut to avoid damage should the Starliner land in those areas. Large groupings of yuccas will be cut down and left in place and salt cedars near the u-shaped berms will be cut down and placed outside of the four-km circle. Based on these parameters, plot locations were also chosen based on soil types and different vegetation communities viewed from aerial photographs. One of the plots selected was a u-shaped water collection berm located at 33.52435°N, -106.58890°W, and three other plots were selected by using the NWI where wetlands were indicated.

The WSSH Site consist of a four-km radius landing zone and was surveyed on May 13, 2019. At the WSSH Site, survey plots were chosen by Boeing engineers that consisted of groupings of large vegetation that is over one foot tall, including the height of any dunes containing the vegetation (**Table 2-2**) (**Figures 2-3** and **2-4**). Twelve plots were chosen totaling 11.73 acres, although other areas were observed throughout the landing zone during the survey.

Table 2-2. Center Point of Plots at WSSH Site.

Vegetation Area	Latitude	Longitude
1	32.972305°N	-106.413014°W
2	32.966469°N	-106.413962°W
3	32.963381°N	-106.414420°W
4	32.961579°N	-106.414715°W
5	32.958947°N	-106.415142°W
6	32.953950°N	-106.415839°W
7	32.951778°N	-106.416206°W
8	32.948868°N	-106.414863°W
9	32.954170°N	-106.402904°W
10	32.956459°N	-106.448870°W
11	32.950770°N	-106.452182°W
12	32.921314°N	-106.453076°W

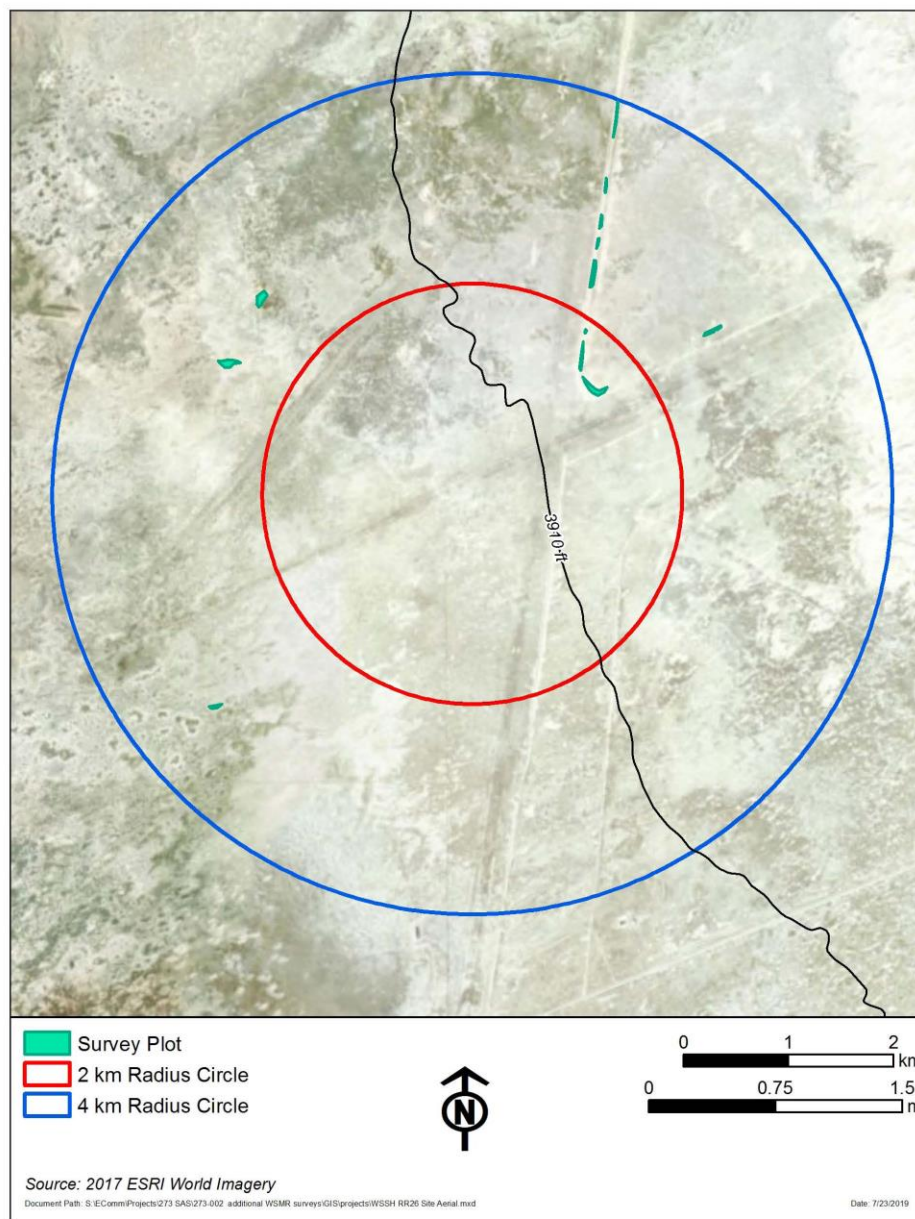


Figure 2-3. Aerial map of the WSSH Site showing the plots.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

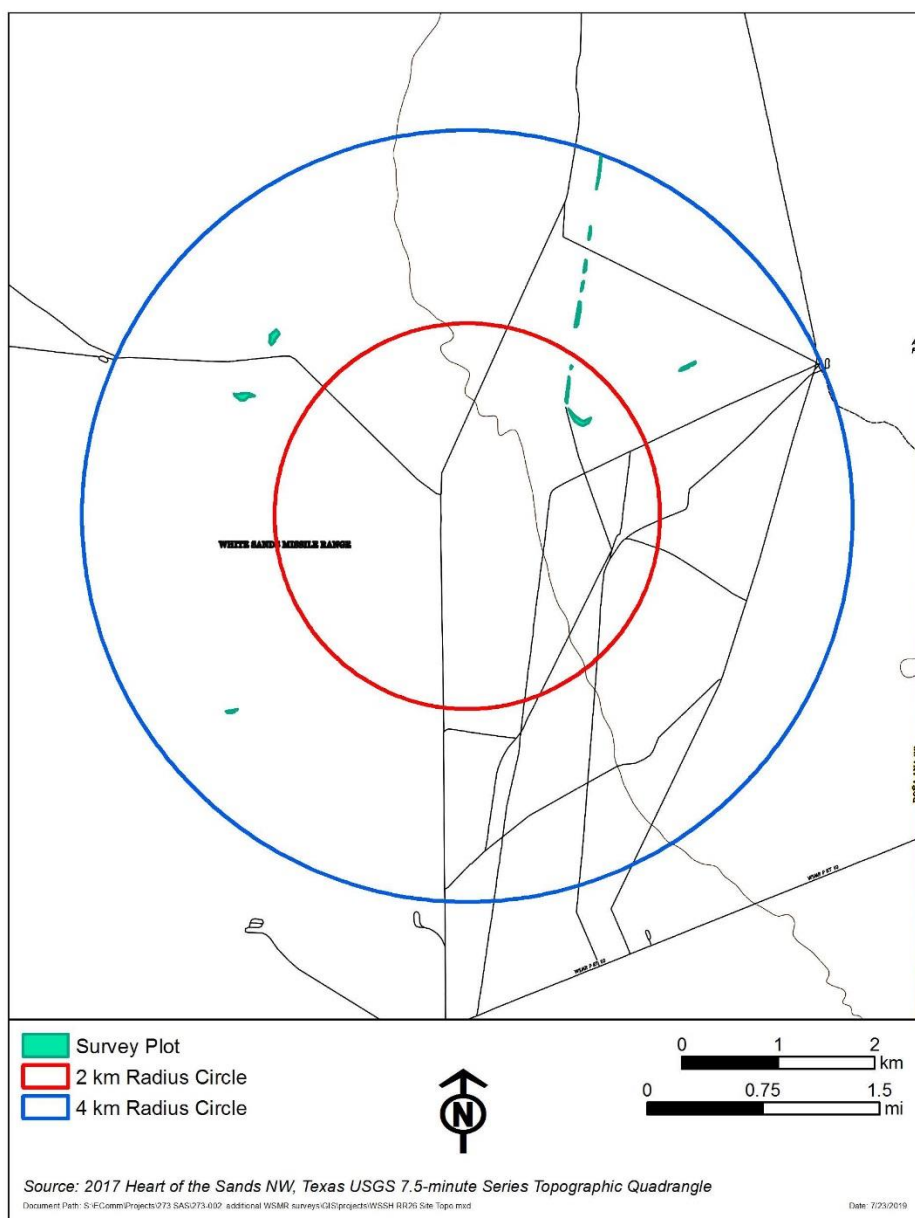


Figure 2-4. Topographic map of the WSSH Site showing the plots.

CHAPTER 3

RESULTS

3.1 WSMR NORTH RANGE ROAD 26 (WSMR NORTH-RR26) SITE

Flora

Of the 35 major map units delineated by Muldavin et al. (2000), ten were delineated at the WSMR North- RR26 Site: alluvial flats-barren, creosotebush shrubland, desert plains grasslands, lowland basin grasslands, mesquite shrubland, mixed foothill-piedmont desert grasslands, mixed lowland desert scrub, piedmont desert grasslands, sandsage shrubland, and vegetated gypsum outcrop (**Figure 3-1**).

The species assemblage in the ten plots at the WSMR North- RR26 Site closely compares with Muldavin et al. 's (2000) facultatively deciduous, extremely xeromorphic sub-desert shrubland and the short and medium-tall bunch temperate or subpolar seasonally submerged grassland. Observed plant associations (PA's) that occur within the subdesert shrubland category include the Fourwing saltbush/Alkali Sacaton PA, the Fourwing saltbush/Burrograss PA, the Fourwing saltbush/Gyp dropseed PA, the Fourwing saltbush/Bush muhly PA, the Sand Sagebrush/Alkali Sacaton PA, and the Sand sagebrush/black grama PA. Observed associations that occur within the subpolar grassland category include the Alkali Sacaton/Burrograss PA, the Tobosagrass/Alkali sacaton PA, the Gyp dropseed/Alkali sacaton PA, Black grama/Soaptree yucca PA, Gyp dropseed/Hairy crinklemat PA, and the Black grama/Alkali Sacaton PA. **Table 3-1** lists each plot with one or multiple plant associations in order of descending prominence. Seventy-six species of vegetation were identified within the survey areas (**Table 3-2**) and vegetation coverage is summarized in Appendix A.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

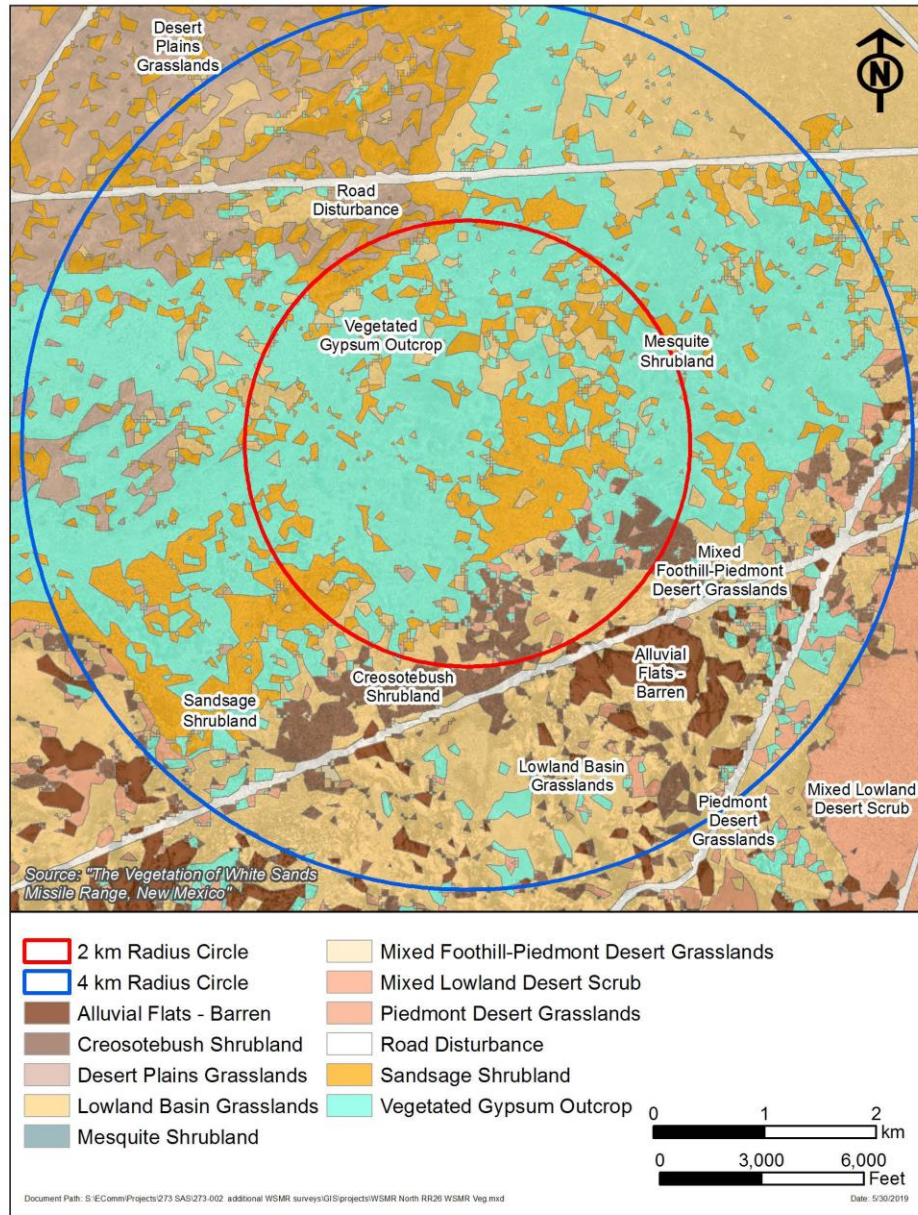


Figure 3-1. Vegetation areas at WSMR North- RR26.

Table 3-1. Muldavin et al.'s (2000) Plant Associations (PA's) Observed within Plots at WSMR North- RR26, Descending from Most Prominent.

Plot and corresponding map unit.	Plant Association(s) (PA)
1 Desert plains grassland/Sandsage shrubland	Alkali Sacaton/Burrograss PA; Black grama/Soap tree yucca PA; Black grama/Alkali sacaton PA; Alkali Sacaton/Burrograss PA; Tobosagrass/Alkali sacaton PA
2 Vegetated gypsum outcrop/Sandsage shrubland	Fourwing Saltbush/Alkali Sacaton PA; Fourwing Saltbush/Gyp dropseed PA; Alkali Sacaton/Burrograss PA
3 Vegetated gypsum outcrop/Desert plains grassland	Fourwing Saltbush/Alkali sacaton PA; Gyp dropseed/Hairy crinklemat PA; Gyp dropseed/Alkali sacaton PA
4 Vegetated gypsum outcrop/Sandsage shrubland	Fourwing Saltbush/Alkali sacaton PA; Fourwing saltbush/Gyp dropseed PA; Sand sagebrush/Alkali sacaton PA; Alkali Sacaton/Burrograss PA
5 Sandsage shrubland/Desert plains grasslands	Sand sagebrush/Alkali Sacaton PA; Gyp dropseed/Alkali sacaton PA
6 Vegetated gypsum outcrop/Sandsage shrubland	Fourwing Saltbush/Alkali sacaton PA; Gyp dropseed/Alkali sacaton PA; Sand sagebrush/Alkali sacaton PA; Gyp dropseed/Hairy crinklemat PA
7 Vegetated gypsum outcrop	Sand sagebrush/Alkali Sacaton PA; Fourwing Saltbush/Alkali Sacaton PA; Gyp dropseed/Hairy crinklemat PA
8 Lowland basin grasslands/Alluvial flats-barren	Fourwing Saltbush/Alkali sacaton PA; Gyp dropseed/Alkali sacaton PA
9 Lowland basin grasslands/Alluvial flats-barren	Fourwing Saltbush/Alkali sacaton PA
10 Vegetated gypsum outcrop/ Mixed foothill-Piedmont desert grasslands	Fourwing Saltbush/Alkali sacaton PA; Gyp dropseed/Hairy crinklemat PA
11 Mixed foothill-Piedmont desert grasslands	Fourwing Saltbush/Alkali sacaton PA

Fauna and Threatened and Endangered Species

The USFWS IPaC produced a total of 15 potential Threatened and Endangered species that exist in Socorro County. Species effect determinations were made after analyzing information from the literature search, consultation with resource experts, and assessing existing habitat conditions during the field investigation (**Table 3-3**). No critical habitats are located within the landing site.

All six bird species considered for this site have the potential to fly through the area, particularly during the spring and fall migration. Desert plains grassland habitat with yucca association is known to provide habitat for the northern aplomado falcon. No suitable habitat exists at the WSMR North- RR26 Site for the other five bird species. No wetlands, springs, streams or riparian habitat exist with the site that is suitable for the New Mexico meadow jumping mouse, Chiricahua leopard frog, Rio Grande silvery minnow, Alamosa springsnail, Chupadera springsnail, Socorro springsnail, Socorro isopod, Pecos sunflower, and Wright's marsh thistle. A single observation of an aplomado falcon was recorded in the Stallion basin near Gallegos Site in 2005 (Burkett 2005). Other observations of aplomado falcons in the Stallion basin were the result of the reintroduction program, which is no longer being conducted. The Peregrine Fund (2014) has determined that this region of the Chihuahuan Desert is not currently suitable for the aplomado falcon due to prolonged drought.

Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
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Table 3-2. Vegetation Areas at WSMR North- RR26

Plant species observed within the ten plots located at the WSMR North- RR26 Site in Socorro County, New Mexico, May 09-12, 2019. Scientific names generally follow the U.S. Department of Agriculture (USDA) PLANTS database (<http://plants.usda.gov/java/>), with synonymy from pertinent manuals appearing in parentheses.

Family	Scientific Name	Common Name	Nativity	Form	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Anacampseridaceae	<i>Talinopsis frutescens</i>	Arroyo famelflower	N	FP										X
Anacardiaceae	<i>Rhus microphylla</i>	Littleleaf sumac	N	S										X
Amaranthaceae	<i>Amaranthus hybridus</i>	Slim amaranth	N	FA										X
Apocynaceae	<i>Asclepias brachystephana</i>	Bract milkweed	N	FP							X			
Asparagaceae	<i>Yucca elata</i>	Soap tree yucca	N	S	X				X					
Asteraceae	<i>Acourtia nana</i>	Dwarf desertpeony	N	FP										X
Asteraceae	<i>Artemisia filifolia</i>	Sand sagebrush	N	S		X		X	X	X	X			
Asteraceae	<i>Chaetopappa ericoides</i>	Rose heath	N	FP		X		X	X	X	X	X		X
Asteraceae	<i>Conyza canadensis</i>	Canadian horseweed	N	FB				X						
Asteraceae	<i>Cirsium undulatum</i>	Wavyleaf thistle	N	FP	X						X			
Asteraceae	<i>Erigeron divergens</i>	Spreading fleabane	N	FB	X	X		X	X			X	X	X
Asteraceae	<i>Flourensia cernua</i>	American tarwort	N	S						X				
Asteraceae	<i>Gaillardia pinnatifida</i>	Red dome blanketflower	N	FP				X		X				
Asteraceae	<i>Gaillardia pulchella</i>	Firewheel	N	FA	X								X	
Asteraceae	<i>Gutierrezia sarothrae</i>	Broom snakeweed	N	S/FP	X	X	X	X	X	X	X	X		X
Asteraceae	<i>Gutierrezia sphaerocephala</i>	Roundleaf snakeweed	N	FP	X		X	X	X	X				
Asteraceae	<i>Helianthus annuus</i>	Common sunflower	N	FA						X				
Asteraceae	<i>Hymenopappus filifolius</i>	Fineleaf hymenopappus	N	FP	X									
Asteraceae	<i>Hymenoxys richardsonii</i>	Pingue rubberweed	N	FP				X						
Asteraceae	<i>Lactuca serriola</i>	Prickly lettuce	I	FA/FB									X	
Asteraceae	<i>Machaeranthera tanacetifolia</i>	Tansyleaf aster	N	FA										X
Asteraceae	<i>Psilostrophe tagetina</i>	Woolly paperflower	N	FP	X									
Asteraceae	<i>Xanthisma spinulosum</i> var. <i>spinulosum</i>	Common spiny goldenweed	N	FP	X	X								
Boraginaceae	<i>Cryptantha mexicana</i>	Mexican cryptantha	N	FA	X									

Family	Scientific Name	Common Name	Nativity	Form	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Boraginaceae	<i>Tiquilia hispida</i>	Harry crinklemat	N	S	X	X	X	X	X	X	X	X	X	X
Brassicaceae	<i>Descurainia pinnata</i>	Western tansymustard	N	FA/FB	X									
Brassicaceae	<i>Dimorphocarpa wislizenii</i>	Spectacle pod	N	FP	X									
Brassicaceae	<i>Lepidium alyssoides</i>	Mesa peppervort	N	FP	X	X	X	X	X	X	X	X	X	X
Brassicaceae	<i>Nerisyrinia linearifolium</i>	White Sands fanmustard	N	FP	X	X	X	X	X	X	X	X	X	X
Cactaceae	<i>Cylindropuntia imbricata</i>	Cane cholla	N	S	X	X	X	X						
Cactaceae	<i>Grusonia clavata</i>	Club cholla	N	S	X		X	X						
Cactaceae	<i>Opuntia macrocentra</i>	Purple pricklypear	N	S										
Cactaceae	<i>Opuntia phaeacantha</i>	Tulip pricklypear	N	S	X	X	X	X	X	X	X	X	X	X
Chenopodiaceae	<i>Atriplex canescens</i>	Fourwing saltbush	N	S	X	X	X	X	X	X	X	X	X	X
Chenopodiaceae	<i>Salsola tragus</i>	Russian thistle	I	FA	X	X	X	X	X	X				
Cucurbitaceae	<i>Cucurbita foetidissima</i>	Missouri gourd	N	FP										
Ephedraceae	<i>Ephedra torreyana</i>	Torrey's jointfir	N	S	X	X	X	X	X					
Euphorbiaceae	<i>Euphorbia albomarginata</i>	Whitemargin sandmat	N	FP	X	X								
Fabaceae	<i>Astragalus allochrous</i>	Halfmoon milkvetch	N	FP										
Fabaceae	<i>Astragalus nuttallianus</i>	Smallflowered milkvetch	N	FP	X									
Fabaceae	<i>Dalea jamesii</i>	James' prairie clover	N	FP	X									
Fabaceae	<i>Hoffmanseggia drepanocarpa</i>	Sicklepod holdback	N	FP	X									
Fabaceae	<i>Hoffmanseggia glauca</i>	Indian rushpea	N	FP						X	X	X	X	X
Fabaceae	<i>Pomaria jamesii</i>	James holdback	N	FP	X									
Fabaceae	<i>Prosopis glandulosa</i>	Honey mesquite	N	S										
Hydrophyllaceae	<i>Nama hispida</i>	Bristly nama	N	FA	X									
Hydrophyllaceae	<i>Phacelia integrifolia</i>	Gypsum phacelia	N	FP	X	X	X	X	X	X	X	X	X	X
Liliaceae	<i>Allium macropetalum</i>	Largeflower onion	N	FP	X									
Linaceae	<i>Linum vernale</i>	Chihuahuan flax	N	FA	X					X				
Loasaceae	<i>Mentzelia multiflora</i>	Adonis blazingstar	N	FP			X		X	X	X	X	X	X
Malvaceae	<i>Malvella lepidota</i>	Scurfynallow	N	FP										
Malvaceae	<i>Sphaeralcea incana</i>	Gray globemallow	N	FP	X									
Malvaceae	<i>Sphaeralcea hastulata</i>	Spear globemallow	N	FP	X	X	X	X	X	X	X	X	X	X
Martyniaceae	<i>Proboscidea parvifolia</i>	doubledaw	N	FA	X									

Family	Scientific Name	Common Name	Nativity	Form	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Nyctaginaceae	<i>Acleisanthes longiflora</i>	Angel's trumpets	N	FP			X							
Nyctaginaceae	<i>Boerhavia</i> sp.	spiderling	N	FN			X							
Onagraceae	<i>Oenothera curtiflora</i>	Velvetweed	N	FA						X				
Onagraceae	<i>Oenothera suffrutescens</i>	Scarlet beeblossom	N	FP	X		X	X		X	X			X
Plantaginaceae	<i>Plantago patagonica</i>	Woolly plantain	N	FA	X									
Poaceae	<i>Aristida</i> sp.	Threawn	N	GP	X			X			X			
Poaceae	<i>Bouteloua eriopoda</i>	Black grama	N	GP	X									
Poaceae	<i>Bouteloua hirsuta</i>	Hairy Grama	N	GP	X									
Poaceae	<i>Cynodon dactylon</i>	Bermudagrass	I	GP									X	
Poaceae	<i>Dasychloa pulchella</i>	Low woollygrass	N	GP	X			X						
Poaceae	<i>Muhlenbergia pauciflora</i>	New Mexico muhly	N	GP	X									
Poaceae	<i>Muhlenbergia porteri</i>	Bush muhly	N	GP		X	X	X	X	X	X	X		X
Poaceae	<i>Pleuraphis multica</i>	Tobosagrass	N	GP	X									
Poaceae	<i>Scleropogon brevifolius</i>	Burgrass	N	GP	X	X	X	X	X	X	X	X		X
Poaceae	<i>Sporobolus airoides</i>	Alkali sacaton	N	GP	X	X	X	X	X	X	X	X		X
Poaceae	<i>Sporobolus nealeyi</i>	Gyp dropseed	N	GP	X	X	X	X	X	X	X	X		X
Polemoniaceae	<i>Ipomopsis pumila</i>	Dwarf ipomopsis	N	FA	X					X				X
Polygonaceae	<i>Eriogonum rotundifolium</i>	Roundleaf buckwheat	N	FA	X									
Solanaceae	<i>Physalis heterifolia</i> var. <i>fendleri</i>	Fendler's groundcherry	N	FP									X	
Solanaceae	<i>Solanum elaeagnifolium</i>	Silverleaf nightshade	N	FP	X		X						X	
Tamaricaceae	<i>Tamarix chinensis</i>	Five-stamen saltcedar	I	S/T								X	X	
Verbenaceae	<i>Glandularia bipinnatifida</i> var. <i>bipinnatifida</i>	Dakota mock vervain	N	FP	X			X			X	X	X	

Codes in Nativity column: E = exotic, i.e., not native to New Mexico; I = introduced into (planted in) wild landscape; N = native to New Mexico. Codes in Form column: FA = annual forb; FPV = annual vine forb; FB = biennial forb; FP = perennial forb; GA = annual grass or grasslike plant; GP = perennial grass or grasslike plant; PP = perennial fern or fern ally; S = shrub; T = tree; WV = woody vine.

Table 3-3. Federally Listed Threatened and Endangered Species
Listed by IPaC at WSMR North- RR26 Site.

SPECIES	FEDERAL STATUS	DESCRIPTION OF HABITAT	HABITAT PRESENT	SPECIES EFFECT	PERTINENT PROJECT INFORMATION
MAMMALS					
New Mexico meadow jumping mouse (<i>Zapus hudsonius</i>)	Endangered	Riparian communities along rivers, streams, springs, wetlands, canals, and ditches	No	No effect	Lack of riparian vegetation
BIRDS					
Least Tern (<i>Sterna antillarum</i>)	Endangered	Vegetated sandbars along rivers, sand and gravel pits, and lake and reservoir shorelines.	No	No effect	Lack of vegetated sandbars and water sources
Mexican spotted owl (<i>Strix occidentalis lucida</i>)	Threatened	Old-growth or mature forests that possess complex structural components; also canyons with riparian or conifer communities	No	No effect	Lack of old-growth and mature forests
Northern Aplomado falcon (<i>Falco femoralis septentrionalis</i>)	Endangered, Experimental populations, Non-essential	Palm and oak savannahs, various desert grassland associations, and open pine woodlands	No	No effect	Lack of suitable desert grassland associations
Piping Plover (<i>Charadrius melodus</i>)	Threatened	Wide, flat, open, sandy beaches with very little grass or other vegetation. Nesting territories often include small creeks or wetlands	No	No effect	Lack of sand beaches and nesting territories
Southwestern Willow flycatcher (<i>Empidonax traillii extimus</i>)	Endangered	Nesting habitats include dense riparian habitats with microclimatic conditions dictated by local surroundings including saturated soils, standing water, or nearby streams, pools, or cienegas. Habitat not suitable for nesting may be used for migration and foraging	No	No effect	Lack of dense riparian habitats
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	Threatened	Wooded habitat with dense cover and water nearby	No	No effect	Lack of wooded habitat and water source
AMPHIBIANS					
Chiricahua leopard frog (<i>Rana chiricahuensis</i>)	Threatened	Permanent waters in ponds, tanks, cienegas, and small streams	No	No effect	Lack of permanent water
FISHES					
Rio Grande silvery minnow (<i>Hybognathus amarus</i>)	Endangered	Large streams with slow to moderate current flowing over a mud, gravel substrate or shifting sand-silt substrate bottom	No	No effect	Lack of large streams

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SPECIES	FEDERAL STATUS	DESCRIPTION OF HABITAT	HABITAT PRESENT	SPECIES EFFECT	PERTINENT PROJECT INFORMATION
SNAILS					
Alamosa springsnail (<i>Tryonia alamosae</i>)	Endangered	Springs	No	No effect	Lack of springs
Chupadera springsnail (<i>Pyrgulopsis chupaderae</i>)	Endangered	Springs	No	No effect	Lack of springs
Socorro springsnail (<i>Pyrgulopsis neomexicana</i>)	Endangered	Springs	No	No effect	Lack of springs
CRUSTACEANS					
Socorro isopod (<i>Thermosphaeroma thermophilus</i>)	Endangered	Springs	No	No effect	Lack of springs
FLOWERING PLANTS					
Pecos sunflower (<i>Helianthus paradoxus</i>)	Threatened	Saturated saline soils of desert wetlands; usually associated with ciengas or wetlands created from modifying cienegas	No	No effect	Lack of saturated saline soils of desert wetlands
Wright's marsh thistle (<i>Cirsium wrightii</i>)	Candidate	Wet, alkaline soils in spring seeps and marshy edges of streams and ponds	No	No effect	Lack of wet, alkaline soils in spring seeps and marshy edges

Information obtained from USFWS and New Mexico Rare Plants.

This analysis supports the conclusion that no threatened or endangered species are at potential risk from proposed landing and recovery operations of Boeing spacecraft at the WSMR North-RR26 Site.

Thirty-eight faunal species were detected during the survey (**Table 3-4**). Other important species that inhabit, but were not observed during the field survey include the mule deer (*Odocoileus hemionus*), mountain lion (*Puma concolor*), and the kit fox (*Vulpes macrotis*). Kit foxes, other mesocarnivores, pronghorn (*Antilocapra americana*), mule deer, and other mammals, reptiles, amphibians, and birds will potentially be displaced in areas where vegetation is mowed and bladed. If any of the three u-shaped berms will be removed, it would be recommended that replacing them one to one with water guzzles to mitigate for wildlife impacts.

Multiple bird nests were observed within the ten plots and while driving within the WSMR North-RR26 Site. The site occurs in areas that provide suitable nesting habitat for bird species protected by the Migratory Bird Treaty Act (MBTA). Removal of any vegetation will need to occur outside of the nesting season (September 1 through February 29). If vegetation removal is conducted during the nesting season (March 1 through August 31), a survey of active nests of MBTA protected species will need to be conducted in areas where vegetation will be removed. An "active nest" for the purpose of this project is a nest containing at least one egg known to be laid in the current season and being attended by adults of species protected by the MBTA (16 U.S.C. 703-712, as amended). If vegetation removal is planned to take place in the non-nesting season, no MBTA active nest survey will need to occur. Mowing and blading vegetation within the site may cause negative impacts to bird species that require grasslands for nesting and foraging.

Table 3-4. Faunal Species Observed Within the WSMR North- RR26 Site.

Common Name	Scientific Name	Occurrence	Sighting Type
MAMMALS			
American badger	<i>Taxidea taxus</i>	Common	Burrows
Black-tailed jackrabbit	<i>Lepus californicus</i>	Common	Visual
Bobcat	<i>Lynx rufus</i>	Infrequent	Tracks
Coyote	<i>Canis latrans</i>	Infrequent	Scat and Tracks
Oryx	<i>Oryx gazella</i>	Common	Visual
Pronghorn antelope	<i>Antilocapra americana</i>	Common	Visual
Spotted ground squirrel	<i>Xerospermophilus spilosoma</i>	Common	Burrows
BIRDS			
American kestrel	<i>Falco sparverius</i>	Infrequent	Visual
Black-throated sparrow	<i>Amphispiza bilineata</i>	Infrequent	Visual
Chihuahuan raven	<i>Corvus cryptoleucus</i>	Common	Visual
Cliff swallow	<i>Petrochelidon pyrrhonota</i>	Common	Visual
Golden eagle	<i>Aquila chrysaetos</i>	Infrequent	Visual
Mourning Dove	<i>Zenaidura macroura</i>	Common	Visual
Northern harrier	<i>Circus hudsonius</i>	Common	Visual
Northern mockingbird	<i>Mimus polyglottos</i>	Common	Visual
Say's phoebe	<i>Sayornis saya</i>	Infrequent	Visual
Turkey vulture	<i>Cathartes aura</i>	Common	Visual
Western meadowlark	<i>Sturnella neglecta</i>	Common	Visual
INVERTEBRATES			
Black bladder-bodied meloid	<i>Cysteodemus wislizeni</i>	Common	Visual
Cabbage white butterfly	<i>Pieris rapae</i>	Common	Visual
Cochineal scale	<i>Dactylopius coccus</i>	Infrequent	Visual
Convergent lady beetle	<i>Hippodamia convergens</i>	Common	Visual
Darkling beetle	Various spp.	Common	Visual
Dung beetle	<i>Orizabus clunalis</i>	Common	Visual
Field cricket	<i>Gryllus</i> spp.	Common	Visual
Fritillary caterpillar	<i>Euptoieta</i> spp.	Infrequent	Visual
Funnel-web spider	<i>Agelenopsis longistylus</i>	Common	Visual
Grasshopper	<i>Orthoptera</i> spp.	Common	Visual
Harvester ant	<i>Pogonomyrmex</i> spp.	Common	Visual
Horse fly	<i>Tabanus proximus</i>	Infrequent	Visual
Tarantula hawk	<i>Pepsini grossa</i>	Infrequent	Visual
REPTILES			
Lesser earless lizard	<i>Holbrookia maculata</i>	Common	Visual
Longnose leopard lizard	<i>Gambelia wislizenii</i>	Infrequent	Visual
New Mexico whiptail	<i>Aspidoscelis neomexicana</i>	Common	Visual
Prairie rattlesnake	<i>Crotalus viridis</i>	Infrequent	Visual
Western Chihuahuan green toad	<i>Anaxyrus debilis insidiosus</i>	Infrequent	Visual
Western coachwhip	<i>Coluber flagellum testaceus</i>	Infrequent	Snake skin

Active and abandoned burrows were located throughout the WSMR North- RR26 Site. Although no species were physically observed utilizing the burrows, signs of American badger (*Taxidea taxus*) and spotted ground squirrel (*Xerospermophilus spilosoma*) were observed around the active burrow openings. Many of the abandoned burrows were filled in or had spider webs obstructing the entrance, indicating that nothing has recently entered the burrows. Burrowing owls (*Athene cunicularia*) are known to utilize abandoned burrows. A survey for active burrows should be conducted prior to mowing and blading activities and recovery efforts.

Wetlands

The NWI has mapped three water bodies within the site boundary: a 231.68-acre lacustrine wetland, a 1.71-acre palustrine pond, and a 1.75-acre riverine habitat (**Figure 3-2**). Survey plots 3, 9, and 10 were strategically placed within these NWI-indicated wetlands to record any wetland characteristics. No riparian obligate or facultative wetland plant species or permanent surface water, or signs of water, were observed at plots 3 and 10. During the field investigation, a pond was not observed in plot 10. A small channel leading into the u-shaped berm was observed during the field investigation at plot 9. The channel did not exhibit any riparian obligate or facultative wetland plant species and is considered to be ephemeral, meaning that the channel has flowing water only during, and for a short duration after, precipitation events in a typical year.

Soils

According to the United States Department of Agriculture- Natural Resources Conservation Service's (NRCS) Web Soil Survey, Nasa-Yesum complex, 0 to 6 percent slopes, Whitlock-Pajarito-Nations complex, 1–8 percent slopes, and Mimbres-Chutum-Ybar complex, 0–5 percent slopes make up the dominant soils within the WSMR North- RR26 Site (**Figure 3-3**). The Dona Ana-Chutum complex, 1–10 percent slopes and Marconi-Prelo-Fluentic Haplocambids complex, 0–8 percent slopes are present in minute amounts near the outside border of the site.

The Nasa soil series consists of moderately deep to petrogypsic, well drained soils that formed in coarse-loamy gypsiferous eolian deposits. The Yesum soil series consists of very deep, well drained, moderately permeable soils that formed in medium to coarse textured gypsiferous alluvial and eolian deposits. The Whitlock soil series consist of deep, well drained soils that formed in alluvium from mixed sources. The Pajarito soil series consist of very deep and well drained soils that formed in a sandy to moderately sandy mixed sediments from mixed sources. The Nations soil series consists of moderately deep and well drained soils formed from recent eolian material and sandy and loamy sediments.

The Mimbres soil series consists of very deep, well drained soils that formed in medium to moderately fine textured silty sediments derived from igneous, metamorphic, and small amounts of sedimentary rocks. The Chutum soil series consists of very deep, well drained soils formed in mixed stream alluvium and fan alluvium.

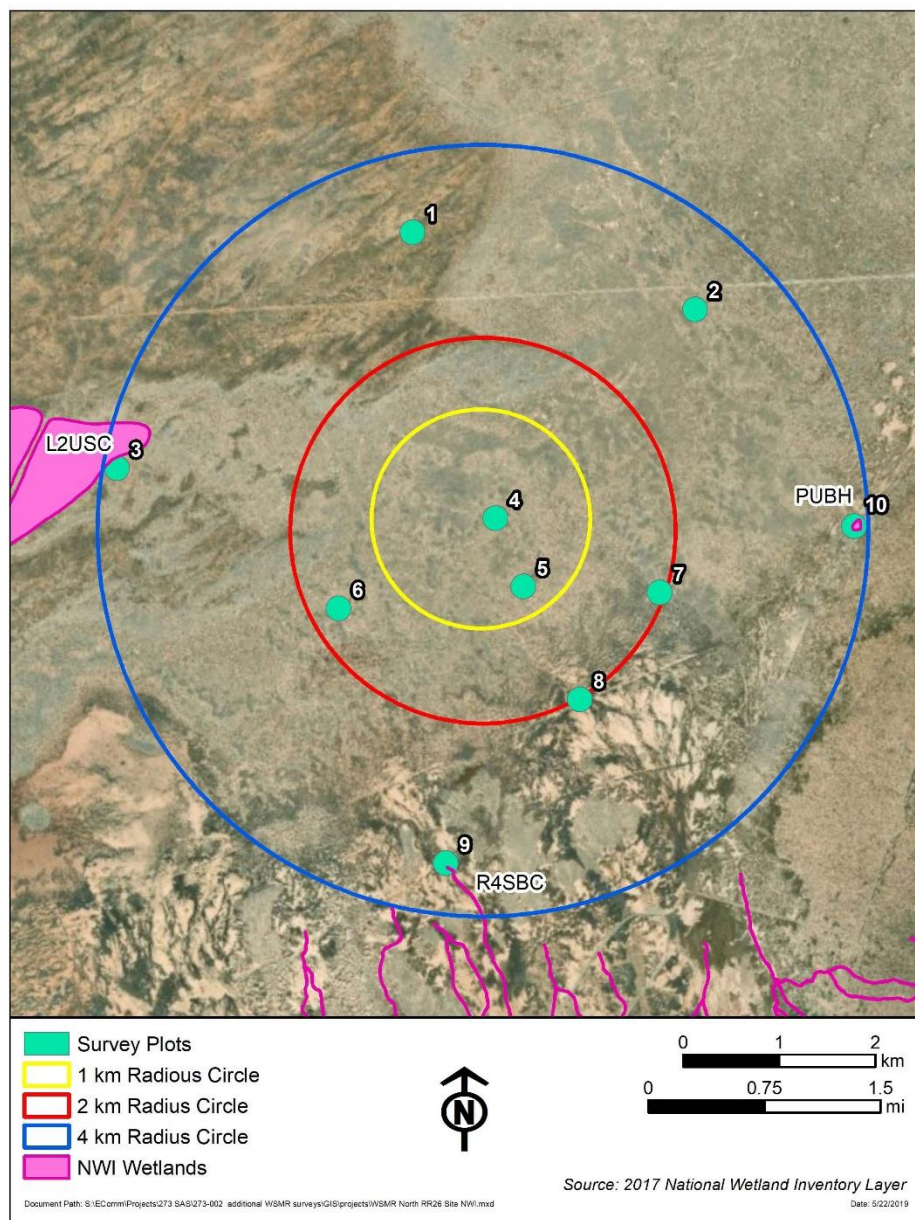


Figure 3-2. NWI map of the WSMR North-RR26 Site.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

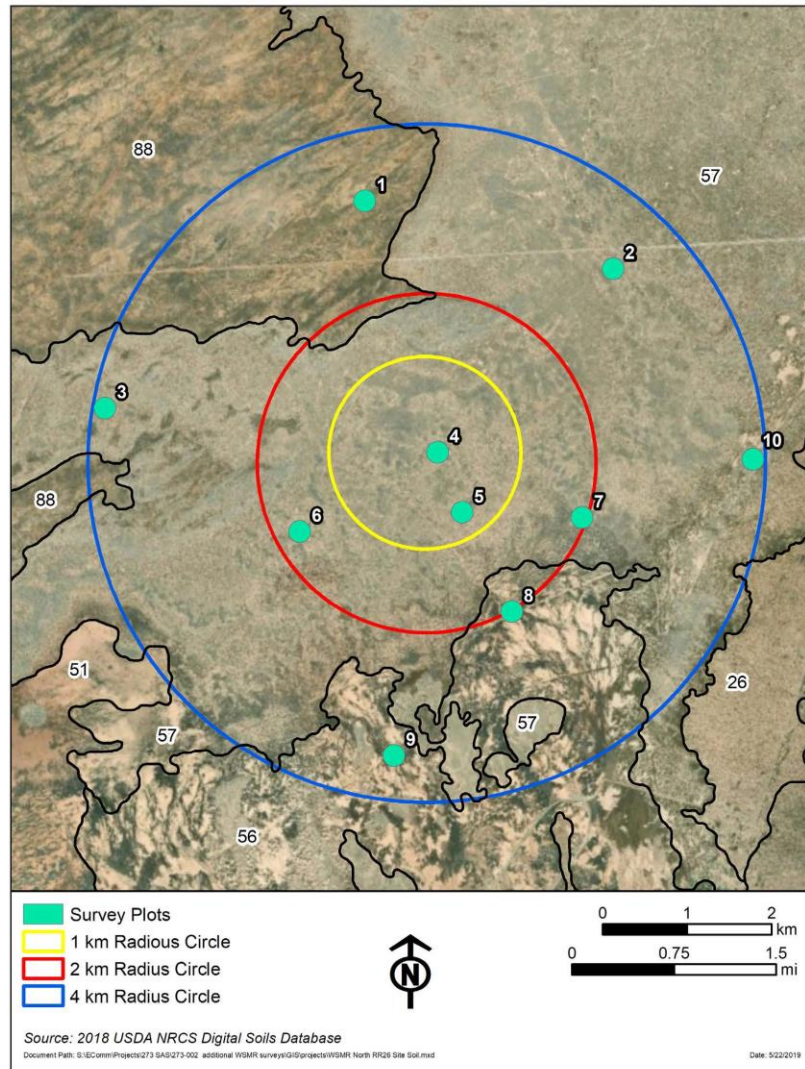


Figure 3-3. Soil map of the WSMR North- RR26 Site.

Map Unit Symbol	Map Unit Name
26	Dona Ana-Chutum-Ybar complex, 0–5 percent slopes
51	Marconi-Prelo-Fluventic Haplocambids complex, 0–5 percent slopes
56	Mimbres-Chutum-Ybar complex, 0–5 percent slopes
57	Nasa-Yesum complex, 0–6 percent slopes
88	Whitlock-Pajarito-Nations complex, 1–8 percent slopes

The Ybar soil series consists of very deep, well drained soils formed in clayey alluvium. The Dona Ana soil series consists of very deep, well drained soils that formed in alluvial sediments derived from sedimentary rocks. The Marconi soil series consists of deep, well drained, slowly permeable soils that were formed in alluvium derived from sedimentary rocks on broad floodplains. The Prelo soil series consists of deep, moderately well drained soils that formed in fine textured alluvium weathered from shale, siltstone, and consolidated alluvium.

According to the NRCS, Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation and the Revised Universal Soil Loss Equation to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. The wind erodibility index (WEI) is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion. The Nasa-Yesum complex, 0–8 percent slopes has a K-factor of 0.32 and a WEI rating of 86 tons per acre per year. The Whitlock-Pajarito-Nations complex, 1–8 percent slopes has a K-factor of 0.20 and a WEI rating of 134 tons per acre per year. The Mimbres-Chutum-Ybar complex, 0–5 percent slopes has a K-factor of 0.49 and a WEI rating of 86 tons per acre per year.

A biological crust was present in Plots 2, 3, 4, 5, 6, 7, and 10. Biological soil crusts are a living community of cyanobacteria, mosses, and lichens that occur in most arid and semi-arid regions. They affect local hydrologic patterns by either increasing or decreasing infiltration and by retarding evaporation of soil moisture. The polysaccharide material extruded by these organisms binds soil particles together, provide protection from raindrop-induced erosion and physical crusting and creating soil aggregates (Belnap et al. 2002). Within these plots, the crust existed in open areas in-between bunch grasses and shrubs. Activities at the site would touch a large area of biological crusts due to compaction from tires, mowers, and clearing machinery, especially if activities occur at a frequent rate. According to the NRCS, the recovery of biological crusts may take decades to hundreds of years; therefore, these areas should be avoided as much as possible. Once the biological crust has been damaged or removed, the soil is more vulnerable to wind and water erosion, thereby decreasing the rangeland health.

With the removal of vegetation by mowing and blading in some areas of the site, windblown soil erosion will increase. With the expected conversion of some areas from a grassland to a shrubland due to mowing and blading activities, bare areas will be more prone to wind erosion. Soil particles will be blown into the air and potentially cause effects on testing activities on the range due to visual impacts. According to The Natural Events Action Plan for High Wind Events for Doña Ana County, part of the weapons research involves the use of optical instruments and lasers, and dust can adversely affect the use of this equipment. This Plan also states that soil disturbance during construction projects; disturbed land areas that are vacant, where construction is pending or due to recreational activities; and undisturbed desert areas during the highest winds are three of several major sources of windborne dust sources in the western U.S.

Rangeland Health

Rangeland health was measured in terms of soil and site stability, hydrologic function, and biotic integrity using the Rangeland Health Assessment (Pellant et al. 2000). This assessment gives an indication of the status of the three attributes chosen to represent the health of the “area of interest.” The first attribute, soil and site stability, is the capacity of the site to limit redistribution and loss of soil resources by wind and water.

The second attribute, hydrologic function, is the capacity of the site to capture, store, and safely release water from rainfall, run-on, and snowmelt, to resist a reduction in this capacity, and to recover this capacity following degradation. The third attribute, biotic integrity, is the capacity of the site to support characteristic functional and structural communities in the context of normal variability, to resist loss of this function and structure due to disturbance, and to recover following disturbance. Base measure information was gathered from the appropriate ecological site description for the area of interest. Three ecological sites occur within the WSMR North-RR26 Site; therefore, three rangeland health assessments were conducted (**Appendix B**).

Since Nasa-Yesum soils make up approximately 80 percent of the WSMR North-RR26 Site, and this soil type mostly encompasses the one-km and two-km radius circle, seven plots were placed within this soil type (Plots 2, 3, 4, 5, 6, 7, and 10). These plots occur in the Gyp Upland Ecological Site. This site is characterized by very patchy and variable vegetation over shallow to very shallow loam and fine sandy loam soils. The underlying materials are dense layers of soft or cemented gypsum material and gypsiferous earth. Historically, plant communities commonly associated with this site are alkali sacaton (*Sporobolus airoides*) and black grama (*Bouteloua eriopoda*) or blue grama (*Bouteloua gracilis*) dominated associated with soils having relatively deep (greater than ten inches) gypic horizons. Gyp grama (*Bouteloua breviseta*) and gyp dropseed (*Sporobolus nealleyi*) dominated communities historically occupied soils with shallow (less than ten inches) gypic horizons. During the field investigation, alkali sacaton communities and alkali sacaton-fourwing saltbush communities dominated these areas. Alkali sacaton was continuous in run-in settings surrounded by sparsely vegetated areas throughout this site. Soil and site stability was determined to be no different to slightly different from the ecological site description. The major factors in this determination was that the site is generally flat and vegetation cover prevents erosion to occur in these areas. Hydrologic function was determined to be slightly to moderately different from the ecological site description due to the conversion of these sites to a more shrub dominated community. Biotic integrity was determined to be slightly to moderately different from the ecological site description largely due the conversion of a more shrub dominated community and soil characteristics such as reduced soil horizon and biological crust.

Plot 1 was located in the Whitlock-Pajarito-Nations Complex soil type and is located in the Sandy Ecological Site. This site is characterized by moderately deep to deep soils and occurs largely on eolian or fluvial deposits of various ages derived from river sediments. Sandy soils are usually old enough to have developed calcic or argillic horizons. The historic vegetation community was dominated by black grama and depending on texture variations and rainfall patterns, may feature subdominance by dropseed (*Sporobolus cryptandrus* and *flexuosus*),

Indian ricegrass (*Achnatherum hymenoides*), or galleta (*Pleuraphis jamesii*). During the field investigation, Plot 1 was dominated by black grama, alkali sacaton, burrograss, tobosagrass, and soaptree yucca (*Yucca elata*). Soil and site stability were determined to be no different to slightly different from the ecological site description. The major factors in this determination were that the site is generally flat and vegetation cover prevents erosion to occur in these areas. Hydrologic function was determined to be no different to slightly different from the ecological site description due to the site generally matching the ecological site description, although, an increase in bare ground was observed. Biotic integrity was determined to be slightly to moderately different from the ecological site description largely due the increase in soaptree yuccas and soil characteristics such as reduced soil horizon.

Plots 8 and 9 occur in Mimbres-Chutum-Ybar Complex soil type and are located within the Bottomland, Limy, and Salt Flats Ecological Sites. Upon review of all three of NRCS' Ecological Site Descriptions, Plots 8 and 9 closely matched the Salt Flats Ecological Site. This site is characterized by shallow to deep, moderately-fine to medium textured in the surface and have moderately to slowly permeable subsoils. These soils contain amounts of salt and alkali accumulations which are inhibitory to certain plant species. The historic plant community of this site was dominated by alkali sacaton and scattered small shrubs such as fourwing saltbush and pickleweed (*Allenrolfea occidentalis*). Alkali sacaton was patchily distributed in this site, and large patches of bare ground were common.

During the field investigation, Plots 8 and 9 exhibited very similar characteristics to the historic plant communities. Soil and site stability were determined to be slightly to moderately different from the ecological site description, due to the presence of the u-shaped berms within the plots and the effects they have on the soil. Hydrologic function was determined to be no different to slightly different from the ecological site description due to the site generally matching the ecological site description, although, bare ground and small washes were present around the u-shaped berms within the plot. Biotic integrity was determined to be no different to slightly different from the ecological site description since it matched closely to the ecological site description, although fewer shrubs were present within the plots. Outside of the plots, the range appeared to be similar to the ecological site description.

Soaptree yucca and fourwing saltbush are the dominant shrub species within the landing site. Depriving soaptree yucca of shoots through fire or mechanical means results in regeneration rates that equal or exceed previous regeneration rates within a year or two (Groen et al. 2005), indicating that soaptree yuccas that are mowed will regenerate. Although fourwing saltbush responds to partial removal of branches with vigorous growth (a browsing response), limited research shows a weak ability to sprout after heavy branch removal or complete removal of top-growth (Howard et al. 2003), indicating that fourwing saltbush has a more difficult time recovering from mowing activities.

Alkali sacaton, burrograss, tobosagrass, and gyp dropseed are the dominant grass species within the WSMR North- RR26 Site. These species are perennial species, indicating that these species will grow back the next growing season after mowing occurs. In areas where blading occurs, it is expected that negative impacts to the range will occur. Non-native species such

as Lehman's lovegrass (*Eragrostis lehmanniana*), forbs, and shrubs are expected to sparsely dominate these bladed areas and these areas would be expected to become sparsely vegetated with shrubs and few grasses or not recover at all. Bare ground will increase if the grasslands are converted to shrublands, causing an increase in soil erosion in these areas.

Black grama was observed in the northern portion of the site near Plot 1. Black grama is one of the most nutritious desert winter grasses for livestock and wildlife (Simonin et al. 2000). This species typically regenerates by stolons and since the stolons grow horizontally outward from the tuft, they are susceptible to grazing and trampling damage (Simonin et al. 2000), but in this project's case, mowing, blading, and driving. Mowing black grama can have detrimental impacts to this species and the range. A simulated grazing study was conducted in the Jornada Experimental Range of New Mexico. Clippings left one-inch and two-inch black grama stubble heights. After 11 years, neither one-inch nor two-inch clipping treatments produced as much as four percent the original tuft area, and there were severe declines in stolon regeneration. The decreased tuft area allowed for wind erosion of the upper loose soil mulch, which is required for successful stolon rooting (Canfield et al. 1939). It would be recommended that permanent vegetation transects be established in areas that have been mowed and/or bladed throughout the site to monitor the effects of these activities over time.

3.2 WHITE SANDS SPACE HARBOR (WSSH) SITE

Flora

Muldavin et al. (2000) classified the vegetation at the WSSH Site as a succulent, extremely xeromorphic evergreen shrubland consisting of various pickleweed plant associations. These communities are characterized as open-canopied shrublands of pickleweed with under stories that are poor in diversity and cover (Muldavin et al. 2000). Pickleweed is an excellent indicator of highly alkaline soils (Muldavin et al. 2000). Species diversity appears to be naturally low in this community, with only a limited set of salt-tolerant species able to occupy these areas (Burkett 1997, WSMR 2015, Muldavin et al. 2000, Tazik et al. 1992).

Surveys at the WSSH Site revealed very low species diversity and large areas of bare ground (exceeding 95 percent) in each survey plot. Only two dominant species of vegetation were identified within the survey areas: pickleweed and non-native saltcedar (*Tamarix ramosissima*), although two other species—alkali sacaton and fourwing saltbush—occasionally occurred.

Fauna and Threatened and Endangered Species

The USFWS IPaC produced a total of five potential Threatened and Endangered species that exist in Doña Ana County. Species effect determinations were made after analyzing information from the literature search, consultation with resource experts, and assessing existing habitat conditions during the field investigation (**Table 3-5**). No critical habitats are located within the landing site.

All four bird species have the potential to fly through the area, particularly during the spring and fall migration. Least terns are known to use broad open sandy habitats but always in association with river and lake habitats where they forage for fish. The Sneed's pincushion cactus occurs on limestone and grows in cracks on vertical cliffs and ledges. No suitable habitats occur for any of these four bird species or the Sneed's pincushion cactus at the WSSH Site; therefore, no threatened or endangered species are at potential risk from proposed landing and recovery operations of Boeing spacecraft at the WSSH Site.

Faunal surveys conducted in this habitat type have resulted in detection of very few faunal and floral species (Burkett 1997, Tazik et al. 1992). Eighteen faunal species were detected during the survey with the majority of these species being invertebrates (Table 3-6).

Active and abandoned burrows were located within some of the dunes at the northwest plots. Although no species were physically observed using the burrows, no recent signs of animals using the burrows were observed.

Several old military bunkers exist within the site and are proposed to be removed. According to WSMR's wildlife biologist Cristina Rodden, recent camera traps were set at the bunkers and captured adult kit foxes using the area at various times of the year. Ms. Rodden also indicated that nesting birds such as Say's phoebe (*Sayornis saya*) were observed near the bunkers.

Table 3-5. Federally Listed Threatened and Endangered Species Listed by IPaC at WSSH Site.

SPECIES	FEDERAL STATUS	DESCRIPTION OF HABITAT	HABITAT PRESENT	SPECIES EFFECT	PERTINENT PROJECT INFORMATION
BIRDS					
Least Tern (<i>Sterna antillarum</i>)	Endangered	Vegetated sandbars along rivers, sand and gravel pits, and lake and reservoir shorelines.	No	No effect	Lack of vegetated sandbars and water sources
Northern Aplomado falcon (<i>Falco femoralis septentrionalis</i>)	Endangered, Experimental populations, Non-essential	Palm and oak savannahs, various desert grassland associations, and open pine woodlands	No	No effect	Lack of suitable desert grassland associations
Southwestern Willow flycatcher (<i>Empidonax traillii extimus</i>)	Endangered	Nesting habitats include dense riparian habitats with microclimatic conditions dictated by local surroundings including saturated soils, standing water, or nearby streams, pools, or cienegas. Habitat not suitable for nesting may be used for migration and foraging	No	No effect	Lack of dense riparian habitats
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	Threatened	Wooded habitat with dense cover and water nearby	No	No effect	Lack of wooded habitat and water source
FLOWERING PLANTS					
Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>)	Endangered	Restricted to limestone and grows in cracks on vertical cliffs or ledges in Chihuahuan desert scrub at elevations of 3,900 to 7,700 feet	No	No effect	Lack of limestone cliffs and ledges

Information obtained from USFWS and New Mexico Rare Plants.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

Table 3-6. Faunal Species Observed Within the WSSH Site.

COMMON NAME	SCIENTIFIC NAME		
MAMMALS			
Coyote	<i>Canis latrans</i>	Infrequent	Scat
Oryx	<i>Oryx gazella</i>	Infrequent	Tracks
BIRDS			
Cliff swallow	<i>Petrochelidon pyrrhonota</i>	Infrequent	Visual
INVERTEBRATES			
Convergent lady beetle	<i>Hippodamia convergens</i>	Common	Visual
Dragonfly	<i>Odonata spp.</i>	Infrequent	Visual
Dung beetle	<i>Orizabus clunalis</i>	Infrequent	Visual
Golden paper wasp	<i>Polistes aurifer</i>	Infrequent	Visual
Grasshopper	<i>Orthoptera spp.</i>	Common	Visual
Gulf fritillary	<i>Agraulis vanillae</i>	Infrequent	Visual
Harvester ant	<i>Pogonomyrmex spp.</i>	Infrequent	Visual
Hister beetle	<i>Acritus spp.</i>	Infrequent	Visual
Orb weaver	<i>Araneus spp.</i>	Infrequent	Visual
Steel-blue cricket hunter	<i>Chlorion aerarium</i>	Infrequent	Visual
Twice-stabbed ladybird beetle	<i>Chilocorus stigma</i>	Infrequent	Visual
Tarantula hawk	<i>Pepsini grossa</i>	Infrequent	Visual
Thread-waisted wasp	<i>Ammophila spp.</i>	Infrequent	Visual
Velvet ant	<i>Dasymutilla vestita</i>	Infrequent	Visual
REPTILES			
Bleached earless lizard	<i>Holbrookia maculata ruthveni</i>	Infrequent	Visual

Wetlands

No NWI-indicated wetlands occur within the WSSH Site. The site investigation confirmed that no wetlands exist at this site.

Soils

According to the NRCS Web Soil Survey, Llano-Ratscat complex, 0–7 percent slopes is the only soil that is present within the WSSH Site. The Llano soil series consist of very deep, somewhat poorly drained soils that formed in gypsiferous lacustrine deposits. The Ratscat soil series consists of very deep, moderately well drained soils that formed in gypsiferous lacustrine deposits. The Llano-Ratscat complex, 0-7 percent slopes has a K-factor of 0.37 and a WEI rating of 134 tons per acre per year.

Rangeland Health

According to NRCS's Alkali Flat Ecological Site Description, the soils that are typical to this site are crystalline gypsiferous loamy coarse sands overlying a petrogypsic horizon. Alkali flats occur on large deflation basins where the sediments consist mostly of gypsum and other evaporites. These sites receive salts from groundwater flow sources and runoff from adjoining piedmont slopes. These salts are concentrated on the surface due to evaporation and act as a

supply source of downwind gypsum dune formations. Erosion, high salt content, ponding, and seasonal water tables combine to make alkali flats an extreme, harsh environment, often devoid of vegetation.

Rangeland health was measured in terms of soil and site stability, hydrologic function, and biotic integrity using the Rangeland Health Assessment (Pellant et al. 2000). This assessment gives an indication of the status of the three attributes chosen to represent the health of the “area of interest.” Base measure information was gathered from the appropriate ecological site description for the area of interest. Since the entire WSSH site is similar throughout and occurs within the Alkali Flat Ecological Site, one assessment was conducted (**Appendix C**). Soil and site stability is the capacity of the site to limit redistribution and loss of soil resources by wind and water. This factor was determined to be no different to slightly different from the ecological site description. The major factors in this determination were that the site is almost completely flat, except for occasional moving dunes, and wind erosion is typical for this type of site. Hydrologic function is the capacity of the site to capture, store, and safely release water from rainfall, run-on, and snowmelt, to resist a reduction in this capacity, and to recover this capacity following degradation. This factor was determined to be no different to slightly different from the ecological site description. Again, the WSSH site is almost completely flat and is approximately 95 percent bare ground. Biotic integrity is the capacity of the site to support characteristic functional and structural communities in the context of normal variability, to resist loss of this function and structure due to disturbance, and to recover following disturbance. This factor was determined to be slightly to moderately different from the ecological site description largely due to the runways compacting the soil, the presence of the invasive saltcedar, and low production.

Saltcedar is the dominant vegetation species that will be removed at the WSSH Site. Since saltcedar is an invasive, it would be beneficial to cut and remove the salt cedar and only mow or blade the pickleweed in areas that are required. Removal of salt cedar will improve the site so that it closely resembles the Alkali Flat Ecological Site Description.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

CHAPTER 4

CONCLUSION

Habitat associations within the WSMR North-RR26 Site are varied and support a broad diversity of animal life. Analysis of past surveys and information gathered during current survey efforts at this site revealed no federally or state listed species inhabiting or likely to inhabit the site. As no riparian obligate wetland areas, facultative vegetative species, or permanent surface water exists in or around the WSMR North- RR26 Site, there are no negative impacts on wetlands or other water resources expected. Overall, rangeland health of the site is slightly different from the ecological sites described by NRCS, indicating that this range is fairly healthy for its type. Negative effects on vegetation can potentially occur in areas that will be mowed or bladed. Since some areas of this site are already naturally converting to a shrubland from a grassland, it would be expected that activities at the site would further convert these areas to a shrubland and/or bare ground, therefore increasing wind and water erosion. If large areas of the WSMR North- RR26 Site are bladed, expected future conditions would be similar to areas at WSMR such as Stallion WIT and 649 WIT. Kit foxes, other mesocarnivores, pronghorn, mule deer, and other mammals, reptiles, and birds will potentially be displaced in areas where vegetation is mowed and bladed.

Habitat associations within the WSSH Site are extremely biologically unproductive and large expanses of the area are completely barren. No negative effects on natural resources are anticipated from the proposed action at the WSSH Site, although some species such as the kit fox and Say's phoebe may potentially be displaced if structures and vegetation are removed. Field investigations confirmed that there are no wetland areas within the WSSH Site; therefore, there will be no impacts on wetlands or other water resources. The WSSH Site is slightly different from the ecological site description provided by NRCS, indicating that this range is fairly healthy for its type. Since the tall vegetation within the plots consist of the invasive saltcedar, no major impacts should occur at the site.

If vegetation removal at either site is conducted during the nesting season (March 1 through August 31), a survey of active nests of MBTA protected species will need to be conducted in areas where vegetation and structures will be removed.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

PHOTOGRAPHS



Photo 1. Typical view of Plot 1 at WSMR North-RR26 Site.



Photo 2. Typical view of Plot 2 at WSMR North-RR26 Site.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*



Photo 3. Typical view of Plot 3 at WSMR North-RR26 Site.



Photo 4. Typical view of Plot 4 at WSMR North-RR26 Site.

Photographs



Photo 5. Typical view of Plot 5 at WSMR North-RR26 Site.



Photo 6. Typical view of Plot 6 at WSMR North-RR26 Site.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*



Photo 7. Typical view of Plot 7 at WSMR North-RR26 Site.



Photo 8. View of the u-shaped berm in Plot 8 at WSMR North-RR26 Site.

Photographs



Photo 9. Typical view of areas not affected by the u-shaped berm at Plot 8 at WSMR North-RR26 Site.



Photo 10. View of u-shaped berm in Plot 9 at WSMR North-RR26 Site.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*



Photo 11. Typical view of areas not affected by the u-shape berm in Plot 9 at WSMR North-RR26 Site.



Photo 12. Typical view of Plot 10 at WSMR North-RR26 Site.

Photographs



Photo 13. View of u-shaped berm at 33.53176°N, -106.56858°W at WSMR North-RR26 Site.



Photo 14. Typical view of the northern vegetation removal areas containing pickleweed at the WSSH Site.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*



Photo 15. Typical view of conditions to the east of the northern vegetation removal areas containing pickleweed at the WSSH Site.



Photo 16. Typical view of the northern vegetation removal areas containing saltcedar and pickleweed at the WSSH Site.

Photographs



Photo 17. Typical view of the central vegetation removal areas containing dunes, pickleweed, and saltcedar at the WSSH Site.



Photo 18. Typical view of the eastern vegetation removal area containing pickleweed at the WSSH Site.

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*



Photo 19. Typical view of the northwestern vegetation removal areas containing dunes, saltcedar, and pickleweed at the WSSH Site.



Photo 20. Typical view of the southwestern vegetation removal area containing pickleweed and alkali sacaton at the WSSH Site.

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APPENDIX A
PERCENT COVERAGE OF VEGETATIVE LAYERS
FOR THE WSMR NORTH-RR26 PLOTS

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

Appendix A

Table 1. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 1.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Black grama	<i>Bouteloua eriopoda</i>	20			
Burrograss	<i>Scleropogon brevifolius</i>	5			
Alkali sacaton	<i>Sporobolus airoides</i>	50			
Soaptree yucca	<i>Yucca elata</i>			5	
Other species (collectively)		5			
Total Cover		80		0	

Table 2. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 2.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Burrograss	<i>Scleropogon brevifolius</i>	5			
Fourwing saltbush	<i>Atriplex canescens</i>		25		
Alkali sacaton	<i>Sporobolus airoides</i>	20			
Gyp dropseed	<i>Sporobolus nealleyi</i>	5			
Other species (collectively)		5			
Total Cover		35	25		

Table 3. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 3.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Alkali sacaton	<i>Sporobolus airoides</i>		35		
Fourwing saltbush	<i>Atriplex canescens</i>		5		
Gyp dropseed	<i>Sporobolus nealleyi</i>	10			
Hairy crinklemat	<i>Tiquilia hispidissima</i>	10			
Other species (collectively)		5			
Total Cover		25	40		

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A-3

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

Table 4. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 4.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Fourwing saltbush	<i>Atriplex canescens</i>		10		
Sand sagebrush	<i>Artemisia filifolia</i>		5		
Burrograss	<i>Scleropogon brevifolius</i>	5			
Alkali sacaton	<i>Sporobolus airoides</i>	10			
Gyp dropseed	<i>Sporobolus nealleyi</i>	20			
Other species (collectively)		5			
Total Cover		40	15		

Table 5. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 5.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Fourwing saltbush	<i>Atriplex canescens</i>		<1		
Sand sagebrush	<i>Artemisia filifolia</i>		10		
Alkali sacaton	<i>Sporobolus airoides</i>	55			
Gyp dropseed	<i>Sporobolus nealleyi</i>	10			
Soaptree yucca	<i>Yucca elata</i>			<1	
Other species (collectively)		5			
Total Cover		70	10		

Table 6. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 6.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Fourwing saltbush	<i>Atriplex canescens</i>		15		
Sand sagebrush	<i>Artemisia filifolia</i>		5		
Alkali sacaton	<i>Sporobolus airoides</i>	35			
Gyp dropseed	<i>Sporobolus nealleyi</i>	10			
Hairy crinklemat	<i>Tiquilia hispidissima</i>	5			
Other species (collectively)		5			
Total Cover		55	20		

Table 7. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 7.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Fourwing saltbush	<i>Atriplex canescens</i>		5		
Sand sagebrush	<i>Artemisia filifolia</i>		5		
Alkali sacaton	<i>Sporobolus airoides</i>	45			
Gyp dropseed	<i>Sporobolus nealleyi</i>	5			
Hairy Crinklemat	<i>Tiquilia hispidissima</i>	5			
Other species (collectively)		5			
Total Cover		60	10		

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

Table 8. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 8.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Fourwing saltbush	<i>Atriplex canescens</i>		10		
Alkali sacaton	<i>Sporobolus airoides</i>	50			
Gyp dropseed	<i>Sporobolus nealleyi</i>	10			
Five-stamen saltcedar	<i>Tamarix chinensis</i>				5
Other species (collectively)		5			
Total Cover		65	10		5

Table 9. Observed Species and Estimated Percent Coverage of Vegetative Layers WSMR North- RR26 Plot 9.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Fourwing saltbush	<i>Atriplex canescens</i>		15		
Velvetweed	<i>Oenothera curtiflora</i>	10			
Alkali sacaton	<i>Sporobolus airoides</i>	55			
Five-stamen saltcedar	<i>Tamarix chinensis</i>				5
Other species (collectively)		10			
Total Cover		75	15		5

Table 10. Observed Species and Estimated Percent Coverage of Vegetative Layers at WSMR North- RR26 Plot 10.

Common Name	Scientific Name	% Herbaceous Layer	% Shrub Layer	% Understory	% Overstory
Fourwing saltbush	<i>Atriplex canescens</i>		20		
Alkali sacaton	<i>Sporobolus airoides</i>	35			
Hairy crinklemat	<i>Tiquilia hispidissima</i>	5			
Other species (collectively)		5			
Total Cover		45	20		

Appendix B

APPENDIX B
RANGELAND HEALTH ASSESSMENT FOR
THE WSMR NORTH-RR26 SITE

AmaTerra Environmental, Inc.

B-1

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

Rangeland Health Evaluation Summary Worksheet

Part 1. Area of Interest Documentation (Bold items require completion, other information is optional)

State New Mexico **Office** _____ **Management Unit** _____
 Pasture/Watershed WSMR North- RR26 ID# _____ Major Land Resource Area 042X
Location (description) Plots 2, 3, 4, 5, 6, 7, and 10 at WSMR North- RR26
 Legal T _____, R _____, Sec _____, _____ 1/4, _____ 1/4 or Lat _____^{33.54}, Long _____^{-106.60} or UTM Coord _____
Size of Evaluation Area 86.8 acres **Photo(s) Taken** Yes ☒ No _____
Observer(s) Joshua Zatopek & Jeffrey Keeling **Date** 5/9-12/2019
Ecological Site Gyp Upland R042XB006NM Soil Map Unit Name Nasa-Yesum complex, 0-6% slopes

Soil/Site Verification

Rangeland Ecological Site Description and/or Soil Survey Surface Texture sandy loam Area of Interest Determination Surface Texture sandy loam
 Depth: Very Shallow ☐ Shallow ☐ Moderate ☐ Deep ☒ Depth: Very Shallow ☐ Shallow ☐ Moderate ☐ Deep ☒
 (<10") (10"-20") (20"-40") (>40") (<10") (10"-20") (20"-40") (>40")
 List diagnostic horizons in profile and depth List diagnostic horizons in profile and depth
 1 0-4.5" 7.5YR5/4 3 15-27" 7.5YR8/1 1 0-1" 7.5YR6/4 3 _____
 2 4.5-15" 7.5YR8/2 4 27-31.5" 7.5YR8/1 2 1-6" 7.5YR4/4 4 _____

Parent Material _____ **Slope** 0 % Elevation 4685 ft Topographic Position _____ **Aspect** none

Avg Annual Precip 7-12" **Recent Weather (last 2 years)** Drought _____ Normal ☒ Wet _____

Describe wildlife and livestock use and recent disturbances 38 faunal species were detected: 7 mammals, 12 birds, 13 invertebrates, and 6 reptiles. No livestock grazing occurs in area but oryx present.

Describe offsite influences on area of interest Surrounding areas occur in Sandy sites and Salf Flats sites.

Part 2. Indicator Rating

Attribute	Indicators	Departure from Ecological Site Description/ Ecological Reference Area(s)				
		Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
S,H	1. Rills					X
Comments: No rills present; topography is generally flat						
S,H	2. Water Flow Patterns					X
Comments: No water flow patterns present; topography is generally flat						
S,H	3. Pedestals and/or Terracettes				X	
Comments: Pedestals are rare in sparsely vegetated areas						
S,H	4. Bare Ground					X
Comments: 50-70% bare ground present as expected						
S,H	5. Gullies					X
Comments: No gullies present; topography is generally flat						
S	6. Wind-Scoured, Blowouts, and/or Deposition Areas					X
Comments: Wind erosion occurs at the amount as expected, especially in sparsely vegetated areas						

Part 2. Indicator Rating (continued)

Attribute	Indicators	Departure from Ecological Site Description/ Ecological Reference Area(s)				
		Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
H	7. Litter Movement					X
Comments: Matches to what is expected: alkali sacaton florets observed in shrubs						
S,H,B	8. Soil Surface Resistance to Erosion				X	
Comments: Cryptogamic crust stabilizes soils when present, otherwise, no stabilization occurs in the sparsely vegetated areas						
S,H,B	9. Soil Surface Loss or Degradation			X		
Comments: Typically, soil horizon is reduced or gone, especially in sparsely vegetated areas. Some degradation occurs around plants.						
H	10. Plant Community Composition and Distribution Relative to Infiltration and Runoff				X	
Comments: Historically, this site was dominated by perennial grasses, but currently is dominated by perennial grasses and shrubs						
S,H,B	11. Compaction Layer					X
Comments: No soil compaction present						
B	12. Functional/Structural Groups				X	
Comments: Shrubs are now dominant F/S groups						
B	13. Plant Mortality/Decadence					X
Comments: Plant mortality/decadence matches what was expected						
H,B	14. Litter Amount				X	
Comments: Litter amount is slightly more due to the increase of fourwing saltbush						
B	15. Annual Production				X	
Comments: Increase in shrubs increase the potential production						
B	16. Invasive Plants					X
Comments: Invasive plants were rare to non-existent						
B	17. Reproductive Capability of Perennial Plants				X	
Comments:						

Part 3. SummaryDeparture from Ecological Site Description/
Ecological Reference Area(s)**A. Indicator Summary**

Rangeland Health Attributes		Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight	Σ
S	Soil/Site Stability (Indicators 1-6, 8, 9 & 11)			X	XX	XXXXXX	9
H	Hydrologic Function (Indicators 1-5, 7-11 & 14)			X	XXXX	XXXXXX	11
B	Biotic Integrity (Indicators 8-9 & 11-17)			X	XXXXX	XXX	9

B. Attribute Summary - Check the category that best fits the "preponderance of evidence" for each of the three attributes relative to the distribution of indicator ratings in the preceding Indicator Summary table.

Attribute	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
Soil/Site Stability Rationale:					X
Hydrologic Function Rationale:				X	
Biotic Integrity Rationale:				X	

Cover Worksheet

State New Mexico Office _____ Ecological Site Gyp Upland
 Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5/9-12/2019 Site ID Plots 2, 3, 4, 5, 6 7, & 10

LIFE FORMS ¹	COVER CLASSES (% Canopy)							
	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Grass								
Annual	X							
Native Perennial						X		
Exotic Perennial	X							
II - Forb								
Annual			X					
Perennial			X					
III - Shrub				X				
IV - Tree	X							
V - Succulent		X						
VI - Biological Crust			X					
% GROUND COVER²	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Vascular Plants							X	
II - Standing Dead Vegetation			X					
III - Litter (in contact with the soil surface)		X						
IV - Biological Crust			X					
V - Rock/Gravel	X							
VI - Bare Ground						X		

¹ **Life Forms Cover** - Record multiple canopy cover classes; total plant canopy may exceed 100%. Small openings (less than 2" in diameter) are included as cover.

² **Ground Cover** - Category I is an estimate of total vascular plant cover; overlapping canopies are counted as only **one** canopy (record life form with first point of contact). Total vascular plant cover (I) together with the sum of cover in Categories II-VI should total to approximately 100%.

Notes: Include source of cover data (e.g., estimates or measurements)

Species Dominance Worksheet

Part 1 (Required)

The most common species, noxious weeds (state-listed plants), invasive natives, invasive exotics (non-noxious) are **ranked** according to dominance using cover ☒ or weight ☐.

Dominant Species on Site

- 1 fourwing saltbush
- 2 alkali sacaton
- 3 ring muhly
- 4 hairy crinklemat

Noxious Weeds

- 1
- 2
- 3

Invasive Natives

- 1
- 2
- 3

Invasive Exotics

- 1
- 2
- 3

Part 2 (Optional) Dominant Species by Life Form

The most common species are ranked according to dominance using cover ☐ or weight ☐ by life form.

Annual Grasses

- 1
- 2
- 3

Annual Forbs

- 1
- 2
- 3

Perennial Grasses

- 1 alkali sacaton
- 2 ring muhly
- 3

Perennial Forbs

- 1
- 2
- 3

Shrubs and Trees

- 1 fourwing saltbush
- 2 hairy crinklemat
- 3

Succulents

- 1
- 2
- 3

Biological Crust (rate by component not species, e.g., lichen, moss, or algae)

- 1 cryptogamic crust
- 2
- 3

Functional/Structural Groups Worksheet

State New Mexico Office _____ Ecological Site Gyp Upland Site ID Plots 2, 3, 4, 5, 6, 7, & 10
 Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5/9-12/2019

Functional/Structural Groups			Species List for Functional/Structural Groups
Name	Potential ¹	Actual ²	Plant Names
Warm season perennial grass	D	D	alkali sacaton, low woolygrass, bush muhly, ring muhly, burrograss
Tall shrubs	M	D	fourwing saltbush, sand sagebrush, American tarwort
Half shrubs	T	M	Torrey's jointfir, hairy crinklemat, Chihuahuan flax
Succulent	T	T	Cane cholla, club cholla, purple pricklypear, tulip pricklypear
Perennial forb	M	M	bract milkweed, dwarf desertpeony, rose health, wavyleaf thistle, red dome blanketflower, broom snakeweed, pingue rubberweed, common spiny goldenweed, whitesands fanmustard, Whitelamarg sandmat, halfmoon milkvetch, Indian rushpea Gypsum phacelia, Adonis blazingstar, spear globemallow, Angel's trumpets, scarlet beeblissom, silverleaf nightshade, Dakota rock vervain
Annual forb	T	T	Common sunflower, tansyleaf aster, Russian thistle, dwarf ipomopsis
Biennial forb	T	T	Canadian horseweed
Biological Crust ³	T	T	cryptogamic crust

Indicate whether each "structural/functional group" is a **Dominant (D)** (roughly 41-100% composition), a **Subdominant (S)** (roughly 11-40% composition), a **Minor Component (M)** (roughly 3-10% composition), or a **Trace Component (T)** (<3 % composition) based on weight or cover composition in the area of interest (e.g., "Actual²" column) relative to the "Potential¹" column derived from information found in the ecological site description and/or at the ecological reference area.

Biological Crust³ dominance is evaluated solely on **cover** not composition by weight.

Rangeland Health Indicator Evaluation Matrix

State New Mexico Office _____ Ecological Site Gyp Upland Site ID Plots 2, 3, 4, 5, 6, 7, & 10
 If indicator(s) revised - Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5/9-12/2019

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
1. Rills (Default Descriptor)	Rill formation is severe and well defined throughout most of the area.	Rill formation is moderately active and well defined throughout most of the area.	Active rill formation is slight at infrequent intervals, mostly in exposed areas.	No recent formation of rills; old rills have blunted or muted features.	Current or past formation of rills as expected for the site.
1. Rills (Revised Descriptor)					
2. Water Flow Patterns (Default Descriptor)	Extensive and numerous; unstable with active erosion; usually connected.	More numerous than expected; deposition and cut areas common; occasionally connected.	Nearly matches what is expected for the site; erosion is minor with some instability and deposition.	Matches what is expected for the site; some evidence of minor erosion. Flow patterns are stable and short.	Matches what is expected for the site; minimal evidence of past or current soil deposition or erosion.
2. Water Flow Patterns (Revised Descriptor)					
3. Pedestals and/or Terracettes (Default Descriptor)	Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestalled; exposed plant roots are common.	Moderate active pedestalling; terracettes common. Some rocks and plants are pedestalled with occasional exposed roots.	Slight active pedestalling; most pedestals are in flow paths and interspaces and/or on exposed slopes. Occasional terracettes present.	Active pedestalling or terracette formation is rare; some evidence of past pedestal formation, especially in water flow patterns and/or on exposed slopes.	Current or past evidence of pedestalled plants or rocks as expected for the site. Terracettes absent or uncommon.
3. Pedestals and/or Terracettes (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
4. Bare Ground (Default Descriptor)	Much higher than expected for the site. Bare areas are large and generally connected.	Moderately to much higher than expected for the site. Bare areas are large and occasionally connected.	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected.	Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected.	Amount and size of bare areas nearly to totally match that expected for the site.
4. Bare Ground (Revised Descriptor)					
5. Gullies (Default Descriptor)	Common with indications of active erosion and downcutting; vegetation is infrequent on slopes and/or bed. Nickpoints and headcuts are numerous and active.	Moderate to common with indications of active erosion; vegetation is intermittent on slopes and/or bed. Headcuts are active; downcutting is not apparent.	Moderate in number with indications of active erosion; vegetation is intermittent on slopes and/or bed. Occasional headcuts may be present.	Uncommon with vegetation stabilizing the bed and slopes; no signs of active headcuts, nickpoints, or bed erosion.	Drainages are represented as natural stable channels; no signs of erosion with vegetation common.
5. Gullies (Revised Descriptor)					
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Default Descriptor)	Extensive.	Common.	Occasionally present.	Infrequent and few.	Matches what is expected for the site.
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
7. Litter Movement (wind or water) (Default Descriptor)	Extreme; concentrated around obstructions. Most size classes of litter have been displaced.	Moderate to extreme; loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced.	Moderate movement of smaller size classes in scattered concentrations around obstructions and in depressions.	Slightly to moderately more than expected for the site with only small size classes of litter being displaced.	Matches that expected for the site with a fairly uniform distribution of litter.
7. Litter Movement (wind or water) (Revised Descriptor)					
8. Soil Surface Resistance to Erosion (Default Descriptor)	Extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent.	Significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches.	Significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site.	Some reduction in soil surface stability in plant interspaces or slight reduction throughout the site. Stabilizing agents reduced below expected.	Matches that expected for the site. Surface soil is stabilized by organic matter decomposition products and/or a biological crust.
8. Soil Surface Resistance to Erosion (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
9. Soil Surface Loss or Degradation (Default Descriptor)	Soil surface horizon absent. Soil structure near surface is similar to, or more degraded than, that in subsurface horizons. No distinguishable difference in subsurface organic matter content.	Soil loss or degradation severe throughout site. Minimal differences in soil organic matter content and structure of surface and subsurface layers.	Moderate soil loss or degradation in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced.	Some soil loss has occurred and/or soil structure shows signs of degradation, especially in plant interspaces.	Soil surface horizon intact. Soil structure and organic matter content match that expected for the site.
9. Soil Surface Loss or Degradation (Revised Descriptor)					
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Default Descriptor)	Infiltration is severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred.	Infiltration is greatly decreased due to adverse changes in plant community composition and/or distribution. Detrimental plant cover changes have occurred.	Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. Plant cover changes negatively affect infiltration.	Infiltration is slightly to moderately affected by minor changes in plant community composition and/or distribution. Plant cover changes have only a minor effect on infiltration.	Infiltration and runoff are equal to that expected for the site. Plant cover (distribution and amount) adequate for site protection.
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
11. Compaction Layer (below soil surface) (Default Descriptor)	Extensive; severely restricts water movement and root penetration.	Widespread; greatly restricts water movement and root penetration.	Moderately widespread; moderately restricts water movement and root penetration.	Rarely present or is thin and weakly restrictive to water movement and root penetration.	None to minimal; not restrictive to water movement and root penetration.
11. Compaction Layer (below soil surface) (Revised Descriptor)					
12. Functional/ Structural Groups (F/S Groups) (Default Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)	Number of F/S groups greatly reduced; and/or relative dominance of F/S groups has been dramatically altered; and/or number of species within F/S groups dramatically reduced.	Number of F/S groups reduced; and/or one dominant group and/or one or more subdominant groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups significantly reduced.	Number of F/S groups moderately reduced; and/or one or more subdominant F/S groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups moderately reduced.	Number of F/S groups slightly reduced; and/or relative dominance of F/S groups has been modified from that expected for the site; and/or number of species within F/S groups slightly reduced.	F/S groups and number of species in each group closely match that expected for the site.
12. Functional/ Structural Groups (F/S Groups) (Revised Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
13. Plant Mortality/Decadence (Default Descriptor)	Dead and/or decadent plants are common.	Dead and/or decadent plants are somewhat common.	Some dead and/or decadent plants are present.	Slight plant mortality and/or decadence.	Plant mortality and decadence matches that expected for the site.
13. Plant Mortality/Decadence (Revised Descriptor)					
14. Litter Amount (Default Descriptor)	Largely absent or dominant relative to site potential and weather.	Greatly reduced or increased relative to site potential and weather.	Moderately more or less relative to site potential and weather.	Slightly more or less relative to site potential and weather.	Amount is what is expected for the site potential and weather.
14. Litter Amount (Revised Descriptor)					
15. Annual Production (Default Descriptor)	Less than 20% of potential production.	20-40% of potential production.	40-60% of potential production.	60-80% of potential production.	Exceeds 80% of potential production.
15. Annual Production (Revised Descriptor)					
16. Invasive Plants (Default Descriptor)	Dominate the site.	Common throughout the site.	Scattered throughout the site.	Present primarily on disturbed sites.	Rarely present on the site.
16. Invasive Plants (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(concluded)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
17. Reproductive Capability of Perennial Plants (native or seeded) (Default Descriptor)	Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is greatly reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is somewhat limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is only slightly limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is not limited relative to recent climatic conditions.
17. Reproductive Capability of Perennial Plants (native or seeded) (Revised Descriptor)					

Rangeland Health Evaluation Summary Worksheet

Part 1. Area of Interest Documentation (Bold items require completion, other information is optional)

State New Mexico **Office** _____ **Management Unit** _____
Pasture/Watershed WSMR North- RR26 **ID#** _____ **Major Land Resource Area** 042X
Location (description) Plot 1 at WSMR North- RR26
Legal T _____ **R** _____ **Sec** _____ **1/4** _____ **1/4** or Lat 33.57 **Long** -106.61 or UTM Coord _____
Size of Evaluation Area 12.4 acres **Photo(s) Taken** Yes ☒ No ☐
Observer(s) Joshua Zatopek & Jeffrey Keeling **Date** 5-10-2019
Ecological Site Sandy R042XA051NM **Soil Map Unit Name** Whitlock-Pajarito-Nations Complex, 1-8% slopes

Soil/Site Verification

Rangeland Ecological Site Description and/or Soil Survey **Area of Interest Determination**
Surface Texture Sandy loam **Surface Texture** Sandy loam
Depth: Very Shallow ☐ Shallow ☐ Moderate ☐ Deep ☒ **Depth:** Very Shallow ☐ Shallow ☐ Moderate ☐ Deep ☒
(<10") (10"-20") (20"-40") (>40") (<10") (10"-20") (20"-40") (>40")
List diagnostic horizons in profile and depth **List diagnostic horizons in profile and depth**
1 0-12" 7.5YR6/4 3 29-60" 7.5YR6/4 1 0-2" 7.5YR5/4 3
2 12-29" 7.5YR7/4 4 2 2-6" 7.5YR4/6 4

Parent Material _____ **Slope** 0-2 % **Elevation** 4725 ft **Topographic Position** _____ **Aspect** northerly

Avg Annual Precip 8-10" **Recent Weather (last 2 years)** Drought _____ Normal ☒ Wet _____

Describe wildlife and livestock use and recent disturbances No livestock grazing occurs but oryx and pronghorn antelope were spotted near the area.

Describe offsite influences on area of interest The plot occurs within a large area with the same characteristics, but the gyp upland site is nearby to the east.

Part 2. Indicator Rating

		Departure from Ecological Site Description/ Ecological Reference Area(s)				
Attribute	Indicators	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
S,H	1. Rills					X
Comments: No rills present						
S,H	2. Water Flow Patterns					X
Comments: No water flow patterns present, even on slope of ridge						
S,H	3. Pedestals and/or Terracettes					X
Comments: Pedestals and Terracettes were not observed						
S,H	4. Bare Ground				X	
Comments: 50-70% bare ground present, expected to be slightly less						
S,H	5. Gullies					X
Comments: No gullies present						
S	6. Wind-Scoured, Blowouts, and/or Deposition Areas					X
Comments: Although soils are sandy, wind erosion occurs at the expected amount						

Part 2. Indicator Rating (continued)

		Departure from Ecological Site Description/ Ecological Reference Area(s)				
Attribute	Indicators	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
H	7. Litter Movement					X
Comments: <u>Matches to what is expected; grass florets observed (especially alkali sacaton)</u>						
S,H,B	8. Soil Surface Resistance to Erosion					X
Comments: <u>No biological crusts or organic matter observed</u>						
S,H,B	9. Soil Surface Loss or Degradation				X	
Comments: <u>Some degradation occurs in open areas</u>						
H	10. Plant Community Composition and Distribution Relative to Infiltration and Runoff				X	
Comments: <u>Both black grama and soap tree yucca occurred at this site, but bare ground is now higher</u>						
S,H,B	11. Compaction Layer					X
Comments: <u>No soil compaction present</u>						
B	12. Functional/Structural Groups				X	
Comments: <u>Increase in the amount of shrubs and perennial forbs</u>						
B	13. Plant Mortality/Decadence					X
Comments: <u>Plant mortality/decadence is similar to what is expected</u>						
H,B	14. Litter Amount				X	
Comments: <u>Litter amount is slightly less than what is expected</u>						
B	15. Annual Production				X	
Comments: <u>Since the plot was dominated by grasses, annual production was slightly lower</u>						
B	16. Invasive Plants					X
Comments: <u>Invasive plants were rare to non-existent</u>						
B	17. Reproductive Capability of Perennial Plants				X	
Comments:						

Part 3. Summary**A. Indicator Summary**Departure from Ecological Site Description/
Ecological Reference Area(s)

Rangeland Health Attributes		Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight	Σ
S	Soil/Site Stability (Indicators 1-6, 8, 9 & 11)				XX	XXXXXXX	9
H	Hydrologic Function (Indicators 1-5, 7-11 & 14)				XXXX	XXXXXXX	11
B	Biotic Integrity (Indicators 8-9 & 11-17)				XXXXX	XXXX	9

B. Attribute Summary - Check the category that best fits the "preponderance of evidence" for each of the three attributes relative to the distribution of indicator ratings in the preceding Indicator Summary table.

Attribute	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
Soil/Site Stability Rationale:					X
Hydrologic Function Rationale:					X
Biotic Integrity Rationale:				X	

Cover Worksheet

State New Mexico **Office** _____ **Ecological Site** Sandy
Observer(s) Joshua Zatopek & Jeffrey Keeling **Date** 5-10-2019 **Site ID** Plot 1

LIFE FORMS ¹	COVER CLASSES (% Canopy)							
	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Grass								
Annual	X							
Native Perennial							X	
Exotic Perennial	X							
II - Forb								
Annual			X					
Perennial			X					
III - Shrub			X					
IV - Tree	X							
V - Succulent		X						
VI - Biological Crust	X							
% GROUND COVER²	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Vascular Plants								X
II - Standing Dead Vegetation			X					
III - Litter (in contact with the soil surface)		X						
IV - Biological Crust	X							
V - Rock/Gravel	X							
VI - Bare Ground					X			

¹ **Life Forms Cover** - Record multiple canopy cover classes; total plant canopy may exceed 100%. Small openings (less than 2" in diameter) are included as cover.

² **Ground Cover** - Category I is an estimate of total vascular plant cover; overlapping canopies are counted as only **one** canopy (record life form with first point of contact). Total vascular plant cover (I) together with the sum of cover in Categories II-VI should total to approximately 100%.

Notes: Include source of cover data (e.g., estimates or measurements)

Species Dominance Worksheet

Part 1 (Required)

The most common species, noxious weeds (state-listed plants), invasive natives, invasive exotics (non-noxious) are **ranked** according to dominance using cover ☒ or weight ☐.

Dominant Species on Site

- 1 Soaptree yucca
- 2 black grama
- 3 _____
- 4 _____

Noxious Weeds

- 1 _____
- 2 _____
- 3 _____

Invasive Natives

- 1 _____
- 2 _____
- 3 _____

Invasive Exotics

- 1 _____
- 2 _____
- 3 _____

Part 2 (Optional) Dominant Species by Life Form

The most common species are ranked according to dominance using cover ☒ or weight ☐ by life form.

Annual Grasses

- 1 _____
- 2 _____
- 3 _____

Annual Forbs

- 1 _____
- 2 _____
- 3 _____

Perennial Grasses

- 1 black grama
- 2 _____
- 3 _____

Perennial Forbs

- 1 _____
- 2 _____
- 3 _____

Shrubs and Trees

- 1 Soaptree yucca
- 2 _____
- 3 _____

Succulents

- 1 _____
- 2 _____
- 3 _____

Biological Crust (rate by component not species, e.g., lichen, moss, or algae)

- 1 _____
- 2 _____
- 3 _____

Functional/Structural Groups Worksheet

State New Mexico Office _____ Ecological Site Sandy Site ID Plot 1
 Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-10-2019

Functional/Structural Groups			Species List for Functional/Structural Groups
Name	Potential ¹	Actual ²	Plant Names
Warm season perennial grass	D	D	black grama, threeawn, hairy grama, low woollygrass, ring muhly, tobosagrass, burrograss, alkali sacaton
Tall shrubs	T	S	soaptree yucca
Half shrubs	T	T	broom snakeweed, hairy crinklemat, Torrey's jointfir
Succulent	T	T	cane cholla, club cholla, tulip pricklypear
Perennial forb	T	M	wavyleaf thistle, fineleaf hymenopappus, wooly paperflower, common spiny goldenweed, spectacle pod, white sands fanmussard, Whitemargin sandmat, Jame's prairie clover, gypsum phacelia, largeflower onion, gray globemallow, spear globemallow, scarlet beeblissom
Annual forb	T	T	firewheel, Mexican cryptantha, Russian thistle, bristly nama, Chihuahuan flax, double claw, wooly plantain, dwarf ipomopsis, roundleaf buckwheat
Biennial forb	T	T	spreading fleabane
Biological Crust ³			

Indicate whether each "structural/functional group" is a **Dominant (D)** (roughly 41-100% composition), a **Subdominant (S)** (roughly 11-40% composition), a **Minor Component (M)** (roughly 3-10% composition), or a **Trace Component (T)** (<3 % composition) based on weight or cover composition in the area of interest (e.g., "Actual²" column) relative to the "Potential¹" column derived from information found in the ecological site description and/or at the ecological reference area.

Biological Crust³ dominance is evaluated solely on **cover** not composition by weight.

Rangeland Health Indicator Evaluation Matrix

State New Mexico Office _____ Ecological Site Sandy Site ID Plot 1
 If indicator(s) revised - Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-10-2019

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
1. Rills (Default Descriptor)	Rill formation is severe and well defined throughout most of the area.	Rill formation is moderately active and well defined throughout most of the area.	Active rill formation is slight at infrequent intervals, mostly in exposed areas.	No recent formation of rills; old rills have blunted or muted features.	Current or past formation of rills as expected for the site.
1. Rills (Revised Descriptor)					
2. Water Flow Patterns (Default Descriptor)	Extensive and numerous; unstable with active erosion; usually connected.	More numerous than expected; deposition and cut areas common; occasionally connected.	Nearly matches what is expected for the site; erosion is minor with some instability and deposition.	Matches what is expected for the site; some evidence of minor erosion. Flow patterns are stable and short.	Matches what is expected for the site; minimal evidence of past or current soil deposition or erosion.
2. Water Flow Patterns (Revised Descriptor)					
3. Pedestals and/or Terracettes (Default Descriptor)	Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestalled; exposed plant roots are common.	Moderate active pedestalling; terracettes common. Some rocks and plants are pedestalled with occasional exposed roots.	Slight active pedestalling; most pedestals are in flow paths and interspaces and/or on exposed slopes. Occasional terracettes present.	Active pedestalling or terracette formation is rare; some evidence of past pedestal formation, especially in water flow patterns and/or on exposed slopes.	Current or past evidence of pedestalled plants or rocks as expected for the site. Terracettes absent or uncommon.
3. Pedestals and/or Terracettes (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
4. Bare Ground (Default Descriptor)	Much higher than expected for the site. Bare areas are large and generally connected.	Moderately to much higher than expected for the site. Bare areas are large and occasionally connected.	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected.	Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected.	Amount and size of bare areas nearly to totally match that expected for the site.
4. Bare Ground (Revised Descriptor)					
5. Gullies (Default Descriptor)	Common with indications of active erosion and downcutting; vegetation is infrequent on slopes and/or bed. Nickpoints and headcuts are numerous and active.	Moderate to common with indications of active erosion; vegetation is intermittent on slopes and/or bed. Headcuts are active; downcutting is not apparent.	Moderate in number with indications of active erosion; vegetation is intermittent on slopes and/or bed. Occasional headcuts may be present.	Uncommon with vegetation stabilizing the bed and slopes; no signs of active headcuts, nickpoints, or bed erosion.	Drainages are represented as natural stable channels; no signs of erosion with vegetation common.
5. Gullies (Revised Descriptor)					
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Default Descriptor)	Extensive.	Common.	Occasionally present.	Infrequent and few.	Matches what is expected for the site.
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
7. Litter Movement (wind or water) (Default Descriptor)	Extreme; concentrated around obstructions. Most size classes of litter have been displaced.	Moderate to extreme; loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced.	Moderate movement of smaller size classes in scattered concentrations around obstructions and in depressions.	Slightly to moderately more than expected for the site with only small size classes of litter being displaced.	Matches that expected for the site with a fairly uniform distribution of litter.
7. Litter Movement (wind or water) (Revised Descriptor)					
8. Soil Surface Resistance to Erosion (Default Descriptor)	Extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent.	Significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches.	Significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site.	Some reduction in soil surface stability in plant interspaces or slight reduction throughout the site. Stabilizing agents reduced below expected.	Matches that expected for the site. Surface soil is stabilized by organic matter decomposition products and/or a biological crust.
8. Soil Surface Resistance to Erosion (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
9. Soil Surface Loss or Degradation (Default Descriptor)	Soil surface horizon absent. Soil structure near surface is similar to, or more degraded than, that in subsurface horizons. No distinguishable difference in subsurface organic matter content.	Soil loss or degradation severe throughout site. Minimal differences in soil organic matter content and structure of surface and subsurface layers.	Moderate soil loss or degradation in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced.	Some soil loss has occurred and/or soil structure shows signs of degradation, especially in plant interspaces.	Soil surface horizon intact. Soil structure and organic matter content match that expected for the site.
9. Soil Surface Loss or Degradation (Revised Descriptor)					
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Default Descriptor)	Infiltration is severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred.	Infiltration is greatly decreased due to adverse changes in plant community composition and/or distribution. Detrimental plant cover changes have occurred.	Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. Plant cover changes negatively affect infiltration.	Infiltration is slightly to moderately affected by minor changes in plant community composition and/or distribution. Plant cover changes have only a minor effect on infiltration.	Infiltration and runoff are equal to that expected for the site. Plant cover (distribution and amount) adequate for site protection.
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
11. Compaction Layer (below soil surface) (Default Descriptor)	Extensive; severely restricts water movement and root penetration.	Widespread; greatly restricts water movement and root penetration.	Moderately widespread; moderately restricts water movement and root penetration.	Rarely present or is thin and weakly restrictive to water movement and root penetration.	None to minimal; not restrictive to water movement and root penetration.
11. Compaction Layer (below soil surface) (Revised Descriptor)					
12. Functional/ Structural Groups (F/S Groups) (Default Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)	Number of F/S groups greatly reduced; and/or relative dominance of F/S groups has been dramatically altered; and/or number of species within F/S groups dramatically reduced.	Number of F/S groups reduced; and/or one dominant group and/or one or more subdominant groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups significantly reduced.	Number of F/S groups moderately reduced; and/or one or more subdominant F/S groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups moderately reduced.	Number of F/S groups slightly reduced; and/or relative dominance of F/S groups has been modified from that expected for the site; and/or number of species within F/S groups slightly reduced.	F/S groups and number of species in each group closely match that expected for the site.
12. Functional/ Structural Groups (F/S Groups) (Revised Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
13. Plant Mortality/Decadence (Default Descriptor)	Dead and/or decadent plants are common.	Dead and/or decadent plants are somewhat common.	Some dead and/or decadent plants are present.	Slight plant mortality and/or decadence.	Plant mortality and decadence matches that expected for the site.
13. Plant Mortality/Decadence (Revised Descriptor)					
14. Litter Amount (Default Descriptor)	Largely absent or dominant relative to site potential and weather.	Greatly reduced or increased relative to site potential and weather.	Moderately more or less relative to site potential and weather.	Slightly more or less relative to site potential and weather.	Amount is what is expected for the site potential and weather.
14. Litter Amount (Revised Descriptor)					
15. Annual Production (Default Descriptor)	Less than 20% of potential production.	20-40% of potential production.	40-60% of potential production.	60-80% of potential production.	Exceeds 80% of potential production.
15. Annual Production (Revised Descriptor)					
16. Invasive Plants (Default Descriptor)	Dominate the site.	Common throughout the site.	Scattered throughout the site.	Present primarily on disturbed sites.	Rarely present on the site.
16. Invasive Plants (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(concluded)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
17. Reproductive Capability of Perennial Plants (native or seeded) (Default Descriptor)	Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is greatly reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is somewhat limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is only slightly limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is not limited relative to recent climatic conditions.
17. Reproductive Capability of Perennial Plants (native or seeded) (Revised Descriptor)					

Rangeland Health Evaluation Summary Worksheet

Part 1. Area of Interest Documentation (Bold items require completion, other information is optional)

State New Mexico **Office** _____ **Management Unit** _____
 Pasture/Watershed WSMR North- RR26 ID# _____ Major Land Resource Area 042X
Location (description) Plots 8 and 9 at WSMR North- RR26 Site
 Legal T _____, R _____, Sec _____, _____ 1/4, _____ 1/4 or Lat 33.51 _____, Long -106.60 or UTM Coord _____
Size of Evaluation Area 24.8 acres **Photo(s) Taken** Yes ☒ No _____
Observer(s) Joshua Zatopek & Jeffrey Keeling **Date** 5-11-2019
Ecological Site Salt Flats R042XB036NM Soil Map Unit Name Mimbres-Chutum-Ybar complex, 0-5% slopes

Soil/Site Verification

Rangeland Ecological Site Description and/or Soil Survey Area of Interest Determination
 Surface Texture Silty clay loam Surface Texture Silty clay loam
 Depth: Very Shallow ☐ Shallow ☐ Moderate ☐ Deep ☒ Depth: Very Shallow ☐ Shallow ☐ Moderate ☐ Deep ☒
 (<10") (10"-20") (20"-40") (>40") (<10") (10"-20") (20"-40") (>40")
 List diagnostic horizons in profile and depth List diagnostic horizons in profile and depth
 1 0-3" 10YR6/2 3 16-36" 7.5YR6/4 1 0-1" 7.5YR6/4 3 _____
 2 3-16" 7.5YR6/4 4 36-42" 10YR7/3 2 1-6" 7.5YR5/4 4 _____

Parent Material _____ **Slope** 0 % Elevation 4695 ft Topographic Position _____ **Aspect** none

Avg Annual Precip 7.35-11.9" **Recent Weather (last 2 years)** Drought _____ Normal ☒ Wet _____

Describe wildlife and livestock use and recent disturbances No livestock grazing occurs in the area. Oryx and and pronghorn antelope were observed in the area.

Describe offsite influences on area of interest Gyp uplands occur to the north and east.

Part 2. Indicator Rating

		Departure from Ecological Site Description/ Ecological Reference Area(s)				
Attribute	Indicators	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
S,H	1. Rills					X
Comments: No rills present; topography is flat						
S,H	2. Water Flow Patterns		X			
Comments: 2 small streams were cut across the plot leading into the man-made u-shaped berm						
S,H	3. Pedestals and/or Terracettes					X
Comments: Pedestals and terracettes were not observed						
S,H	4. Bare Ground			X		
Comments: Bare ground was approximately 50-60% but much more around the u-shaped berms						
S,H	5. Gullies					X
Comments: No gullies were present; topography was flat						
S	6. Wind-Scoured, Blowouts, and/or Deposition Areas					X
Comments: Wind erosion occurs at the amount as expected, especially in sparsely vegetated areas						

Part 2. Indicator Rating (continued)

		Departure from Ecological Site Description/ Ecological Reference Area(s)				
Attribute	Indicators	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
H	7. Litter Movement					X
Comments: Matches to what is expected; grass florets observed throughout						
S,H,B	8. Soil Surface Resistance to Erosion					X
Comments: No biological crusts or organic matter observed as expected						
S,H,B	9. Soil Surface Loss or Degradation				X	
Comments: Typically, soil horizon is reduced or gone, especially in sparsely vegetated areas. Some degradation occurs around plants						
H	10. Plant Community Composition and Distribution Relative to Infiltration and Runoff					X
Comments: Vegetation community closely matches historic vegetation community						
S,H,B	11. Compaction Layer				X	
Comments: Compaction is moderate around u-shaped berms but none in natural areas						
B	12. Functional/Structural Groups				X	
Comments: Decrease in the amount of shrubs and perennial forbs						
B	13. Plant Mortality/Decadence					X
Comments: Plant mortality/decadence matches to what is expected						
H,B	14. Litter Amount					X
Comments: Litter amount matches to what is expected						
B	15. Annual Production					X
Comments: Potential production was high						
B	16. Invasive Plants				X	
Comments: Saltcedar was present at u-shaped berms and rare in the natural landscape						
B	17. Reproductive Capability of Perennial Plants					X
Comments:						

Part 3. SummaryDeparture from Ecological Site Description/
Ecological Reference Area(s)**A. Indicator Summary**

Rangeland Health Attributes		Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight	Σ
S	Soil/Site Stability (Indicators 1-6, 8, 9 & 11)		X	X	XX	XXXXX	9
H	Hydrologic Function (Indicators 1-5, 7-11 & 14)		X	X	XX	XXXXXXX	11
B	Biotic Integrity (Indicators 8-9 & 11-17)				XXXX	XXXXX	9

B. Attribute Summary - Check the category that best fits the "preponderance of evidence" for each of the three attributes relative to the distribution of indicator ratings in the preceding Indicator Summary table.

Attribute	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
Soil/Site Stability Rationale:				X	
Hydrologic Function Rationale:					X
Biotic Integrity Rationale:					X

Cover Worksheet

State New Mexico Office _____ Ecological Site Salt Flats
 Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-11-2019 Site ID Plots 8 & 9

LIFE FORMS ¹	COVER CLASSES (% Canopy)							
	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Grass								
Annual	X							
Native Perennial							X	
Exotic Perennial	X							
II - Forb								
Annual			X					
Perennial			X					
III - Shrub				X				
IV - Tree	X							
V - Succulent		X						
VI - Biological Crust	X							
% GROUND COVER²	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Vascular Plants								X
II - Standing Dead Vegetation	X							
III - Litter (in contact with the soil surface)		X						
IV - Biological Crust	X							
V - Rock/Gravel	X							
VI - Bare Ground						X		

¹ **Life Forms Cover** - Record multiple canopy cover classes; total plant canopy may exceed 100%. Small openings (less than 2" in diameter) are included as cover.

² **Ground Cover** - Category I is an estimate of total vascular plant cover; overlapping canopies are counted as only **one** canopy (record life form with first point of contact). Total vascular plant cover (I) together with the sum of cover in Categories II-VI should total to approximately 100%.

Notes: Include source of cover data (e.g., estimates or measurements)

Species Dominance Worksheet

Part 1 (Required)

The most common species, noxious weeds (state-listed plants), invasive natives, invasive exotics (non-noxious) are **ranked** according to dominance using cover ☒ or weight ☐.

Dominant Species on Site

- 1 Alkali sacaton
- 2 _____
- 3 _____
- 4 _____

Noxious Weeds

- 1 _____
- 2 _____
- 3 _____

Invasive Natives

- 1 _____
- 2 _____
- 3 _____

Invasive Exotics

- 1 _____
- 2 _____
- 3 _____

Part 2 (Optional) Dominant Species by Life Form

The most common species are ranked according to dominance using cover ☒ or weight ☐ by life form.

Annual Grasses

- 1 _____
- 2 _____
- 3 _____

Annual Forbs

- 1 _____
- 2 _____
- 3 _____

Perennial Grasses

- 1 Alkali sacaton
- 2 _____
- 3 _____

Perennial Forbs

- 1 _____
- 2 _____
- 3 _____

Shrubs and Trees

- 1 _____
- 2 _____
- 3 _____

Succulents

- 1 _____
- 2 _____
- 3 _____

Biological Crust (rate by component not species, e.g., lichen, moss, or algae)

- 1 _____
- 2 _____
- 3 _____

Functional/Structural Groups Worksheet

State New Mexico Office _____ Ecological Site Salt Flats Site ID Plots 8 & 9
 Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-11-2019

Functional/Structural Groups			Species List for Functional/Structural Groups
Name	Potential ¹	Actual ²	Plant Names
Warm season perennial grass	D	D	alkali sacaton, Bermudagrass, bush muhly, ring muhly, burrograss
Tall shrubs	S	T	fourwing saltbush, littleleaf sumac, honey mesquite, salt cedar
Half shrubs	T	T	broom snakeweed
Succulent	T	T	cane cholla
Perennial forb	M	T	Arroyo flameleaf, rose heath, Missouri gourd, Indian rushpea, scurfymallow, gray globemallow, spear globemallow, Fendler's groundcherry, silverleaf nightshade, Dakota mock vervain
Annual forb	T	T	Slim amaranth, firewheel, prickly lettuce, velvetweed
Biennial forb	T	T	Spreading fleabane, prickly lettuce
Biological Crust ³			

Indicate whether each "structural/functional group" is a **Dominant (D)** (roughly 41-100% composition), a **Subdominant (S)** (roughly 11-40% composition), a **Minor Component (M)** (roughly 3-10% composition), or a **Trace Component (T)** (<3 % composition) based on weight or cover composition in the area of interest (e.g., "Actual²" column) relative to the "Potential¹" column derived from information found in the ecological site description and/or at the ecological reference area.

Biological Crust³ dominance is evaluated solely on **cover** not composition by weight.

Rangeland Health Indicator Evaluation Matrix

State New Mexico Office _____ Ecological Site Salt Flats Site ID Plots 8 & 9
 If indicator(s) revised - Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-11-2019

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
1. Rills (Default Descriptor)	Rill formation is severe and well defined throughout most of the area.	Rill formation is moderately active and well defined throughout most of the area.	Active rill formation is slight at infrequent intervals, mostly in exposed areas.	No recent formation of rills; old rills have blunted or muted features.	Current or past formation of rills as expected for the site.
1. Rills (Revised Descriptor)					
2. Water Flow Patterns (Default Descriptor)	Extensive and numerous; unstable with active erosion; usually connected.	More numerous than expected; deposition and cut areas common; occasionally connected.	Nearly matches what is expected for the site; erosion is minor with some instability and deposition.	Matches what is expected for the site; some evidence of minor erosion. Flow patterns are stable and short.	Matches what is expected for the site; minimal evidence of past or current soil deposition or erosion.
2. Water Flow Patterns (Revised Descriptor)					
3. Pedestals and/or Terracettes (Default Descriptor)	Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestalled; exposed plant roots are common.	Moderate active pedestalling; terracettes common. Some rocks and plants are pedestalled with occasional exposed roots.	Slight active pedestalling; most pedestals are in flow paths and interspaces and/or on exposed slopes. Occasional terracettes present.	Active pedestalling or terracette formation is rare; some evidence of past pedestal formation, especially in water flow patterns and/or on exposed slopes.	Current or past evidence of pedestalled plants or rocks as expected for the site. Terracettes absent or uncommon.
3. Pedestals and/or Terracettes (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
4. Bare Ground (Default Descriptor)	Much higher than expected for the site. Bare areas are large and generally connected.	Moderately to much higher than expected for the site. Bare areas are large and occasionally connected.	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected.	Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected.	Amount and size of bare areas nearly to totally match that expected for the site.
4. Bare Ground (Revised Descriptor)					
5. Gullies (Default Descriptor)	Common with indications of active erosion and downcutting; vegetation is infrequent on slopes and/or bed. Nickpoints and headcuts are numerous and active.	Moderate to common with indications of active erosion; vegetation is intermittent on slopes and/or bed. Headcuts are active; downcutting is not apparent.	Moderate in number with indications of active erosion; vegetation is intermittent on slopes and/or bed. Occasional headcuts may be present.	Uncommon with vegetation stabilizing the bed and slopes; no signs of active headcuts, nickpoints, or bed erosion.	Drainages are represented as natural stable channels; no signs of erosion with vegetation common.
5. Gullies (Revised Descriptor)					
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Default Descriptor)	Extensive.	Common.	Occasionally present.	Infrequent and few.	Matches what is expected for the site.
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
7. Litter Movement (wind or water) (Default Descriptor)	Extreme; concentrated around obstructions. Most size classes of litter have been displaced.	Moderate to extreme; loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced.	Moderate movement of smaller size classes in scattered concentrations around obstructions and in depressions.	Slightly to moderately more than expected for the site with only small size classes of litter being displaced.	Matches that expected for the site with a fairly uniform distribution of litter.
7. Litter Movement (wind or water) (Revised Descriptor)					
8. Soil Surface Resistance to Erosion (Default Descriptor)	Extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent.	Significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches.	Significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site.	Some reduction in soil surface stability in plant interspaces or slight reduction throughout the site. Stabilizing agents reduced below expected.	Matches that expected for the site. Surface soil is stabilized by organic matter decomposition products and/or a biological crust.
8. Soil Surface Resistance to Erosion (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
9. Soil Surface Loss or Degradation (Default Descriptor)	Soil surface horizon absent. Soil structure near surface is similar to, or more degraded than, that in subsurface horizons. No distinguishable difference in subsurface organic matter content.	Soil loss or degradation severe throughout site. Minimal differences in soil organic matter content and structure of surface and subsurface layers.	Moderate soil loss or degradation in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced.	Some soil loss has occurred and/or soil structure shows signs of degradation, especially in plant interspaces.	Soil surface horizon intact. Soil structure and organic matter content match that expected for the site.
9. Soil Surface Loss or Degradation (Revised Descriptor)					
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Default Descriptor)	Infiltration is severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred.	Infiltration is greatly decreased due to adverse changes in plant community composition and/or distribution. Detrimental plant cover changes have occurred.	Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. Plant cover changes negatively affect infiltration.	Infiltration is slightly to moderately affected by minor changes in plant community composition and/or distribution. Plant cover changes have only a minor effect on infiltration.	Infiltration and runoff are equal to that expected for the site. Plant cover (distribution and amount) adequate for site protection.
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
11. Compaction Layer (below soil surface) (Default Descriptor)	Extensive; severely restricts water movement and root penetration.	Widespread; greatly restricts water movement and root penetration.	Moderately widespread; moderately restricts water movement and root penetration.	Rarely present or is thin and weakly restrictive to water movement and root penetration.	None to minimal; not restrictive to water movement and root penetration.
11. Compaction Layer (below soil surface) (Revised Descriptor)					
12. Functional/ Structural Groups (F/S Groups) (Default Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)	Number of F/S groups greatly reduced; and/or relative dominance of F/S groups has been dramatically altered; and/or number of species within F/S groups dramatically reduced.	Number of F/S groups reduced; and/or one dominant group and/or one or more subdominant groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups significantly reduced.	Number of F/S groups moderately reduced; and/or one or more subdominant F/S groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups moderately reduced.	Number of F/S groups slightly reduced; and/or relative dominance of F/S groups has been modified from that expected for the site; and/or number of species within F/S groups slightly reduced.	F/S groups and number of species in each group closely match that expected for the site.
12. Functional/ Structural Groups (F/S Groups) (Revised Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
13. Plant Mortality/Decadence (Default Descriptor)	Dead and/or decadent plants are common.	Dead and/or decadent plants are somewhat common.	Some dead and/or decadent plants are present.	Slight plant mortality and/or decadence.	Plant mortality and decadence matches that expected for the site.
13. Plant Mortality/Decadence (Revised Descriptor)					
14. Litter Amount (Default Descriptor)	Largely absent or dominant relative to site potential and weather.	Greatly reduced or increased relative to site potential and weather.	Moderately more or less relative to site potential and weather.	Slightly more or less relative to site potential and weather.	Amount is what is expected for the site potential and weather.
14. Litter Amount (Revised Descriptor)					
15. Annual Production (Default Descriptor)	Less than 20% of potential production.	20-40% of potential production.	40-60% of potential production.	60-80% of potential production.	Exceeds 80% of potential production.
15. Annual Production (Revised Descriptor)					
16. Invasive Plants (Default Descriptor)	Dominate the site.	Common throughout the site.	Scattered throughout the site.	Present primarily on disturbed sites.	Rarely present on the site.
16. Invasive Plants (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(concluded)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
17. Reproductive Capability of Perennial Plants (native or seeded) (Default Descriptor)	Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is greatly reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is somewhat limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is only slightly limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is not limited relative to recent climatic conditions.
17. Reproductive Capability of Perennial Plants (native or seeded) (Revised Descriptor)					

Appendix C

APPENDIX C
RANGELAND HEALTH ASSESSMENT
FOR THE WSSH SITE

AmaTerra Environmental, Inc.

C-1

*Natural Resource Surveys at White Sands Space Harbor and WSMR-North, off
Range Road 26 Landing Sites, White Sands Missile Range, New Mexico*

Rangeland Health Evaluation Summary Worksheet

Part 1. Area of Interest Documentation (Bold items require completion, other information is optional)

State New Mexico **Office** _____ **Management Unit** _____
Pasture/Watershed WSSH Site **ID#** _____ **Major Land Resource Area** 042X
Location (description) White Sands Space Harbor Landing Site at White Sands Missile Range
Legal T _____ **R** _____ **Sec** _____ **1/4** _____ **1/4** or Lat 32.94 **Long** -106.43 or UTM Coord _____
Size of Evaluation Area 12.420 acres **Photo(s) Taken** Yes ☒ No _____
Observer(s) Joshua Zatopek & Jeffrey Keeling **Date** 5-13-2019
Ecological Site Alkali Flat R042XB001NM **Soil Map Unit Name** Llano-Ratscat complex, 0-7% slopes

Soil/Site Verification

Rangeland Ecological Site Description and/or Soil Survey Surface Texture gypsiferous loamy sand
Area of Interest Determination Surface Texture gypsiferous loamy sand
Depth: Very Shallow ☐ Shallow ☐ Moderate ☐ Deep ☒
 (<10") (10"-20") (20"-40") (>40")
List diagnostic horizons in profile and depth
 1 0-2" 2.5Y8/1 3 13-36" 2.5Y8/2 1 0-1" 10YR8/3 3 _____
 2 2-13" 2.5Y8/1 4 36-52" 10YR8/1 2 1-6" 10YR7/3 4 _____

Parent Material none **Slope** 0 % **Elevation** 3915 ft **Topographic Position** _____ **Aspect** none

Avg Annual Precip 7-12" **Recent Weather (last 2 years)** Drought _____ Normal ☒ Wet _____

Describe wildlife and livestock use and recent disturbances 18 faunal species were detected: 2 mammals, 1 bird, 14 invertebrates, and 1 reptile. No livestock grazing occurs in the area.

Describe offsite influences on area of interest Surrounding areas are similar alkali flats and gypsum dunes to the east.

Part 2. Indicator Rating

Attribute	Indicators	Departure from Ecological Site Description/ Ecological Reference Area(s)				
		Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
S,H	1. Rills					X
Comments: <u>No rills present; topography is flat, except for dune areas</u>						
S,H	2. Water Flow Patterns					X
Comments: <u>No water flow patterns present; topography is flat, except for dune areas</u>						
S,H	3. Pedestals and/or Terracettes					X
Comments: <u>No pedestals present</u>						
S,H	4. Bare Ground					X
Comments: <u>Over 95% of bare ground is present but is expected due to being an alkali flat</u>						
S,H	5. Gullies					X
Comments: <u>No gullies present; topography is flat, except for dune areas</u>						
S	6. Wind-Scoured, Blowouts, and/or Deposition Areas					X
Comments: <u>Dunes are present throughout site, especially against vegetation; as expected</u>						

Part 2. Indicator Rating (continued)

		Departure from Ecological Site Description/ Ecological Reference Area(s)				
Attribute	Indicators	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
H	7. Litter Movement				X	
Comments: <u>Alkali sacaton</u> florets observed blown against pickleweed and saltcedar (obstructions)						
S,H,B	8. Soil Surface Resistance to Erosion					X
Comments: <u>No biological stabilization agents</u> present as expected						
S,H,B	9. Soil Surface Loss or Degradation					X
Comments: <u>No horizon or organic matter content</u> observed as expected						
H	10. Plant Community Composition and Distribution Relative to Infiltration and Runoff					X
Comments: <u>Vegetation distribution</u> is as expected; vegetation is rare (far in between)						
S,H,B	11. Compaction Layer			X		
Comments: <u>Areas on old runways</u> are compacted but other areas are nor						
B	12. Functional/Structural Groups					X
Comments: <u>As expected</u> , shrubs dominated this area						
B	13. Plant Mortality/Decadence					X
Comments: <u>Plant mortality/decadence</u> matches what was expected						
H,B	14. Litter Amount					X
Comments: <u>Litter amount</u> matches what was expected; fairly low						
B	15. Annual Production		X			
Comments: <u>Production was low</u> on pickleweed and moderate on saltcedar						
B	16. Invasive Plants		X			
Comments: <u>Saltcedar was very common</u> and was dominant in some areas						
B	17. Reproductive Capability of Perennial Plants					X
Comments:						

Part 3. Summary**A. Indicator Summary**Departure from Ecological Site Description/
Ecological Reference Area(s)

Rangeland Health Attributes		Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight	Σ
S	Soil/Site Stability (Indicators 1-6, 8, 9 & 11)			X		xxxxxxx	9
H	Hydrologic Function (Indicators 1-5, 7-11 & 14)			X	X	xxxxxxxx	11
B	Biotic Integrity (Indicators 8-9 & 11-17)		XX	X		xxxxxx	9

B. Attribute Summary - Check the category that best fits the "preponderance of evidence" for each of the three attributes relative to the distribution of indicator ratings in the preceding Indicator Summary table.

Attribute	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
Soil/Site Stability Rationale:					X
Hydrologic Function Rationale:					X
Biotic Integrity Rationale:				X	

Cover Worksheet

State New Mexico Office _____ Ecological Site Gyp Upland
 Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-13-2019 Site ID WSSH Site

LIFE FORMS ¹	COVER CLASSES (% Canopy)							
	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Grass								
Annual	X							
Native Perennial		X						
Exotic Perennial	X							
II - Forb								
Annual	X							
Perennial	X							
III - Shrub			X					
IV - Tree	X							
V - Succulent	X							
VI - Biological Crust	X							
% GROUND COVER²	0	0-1	2-5	6-15	16-30	31-50	51-75	76-100
I - Vascular Plants			X					
II - Standing Dead Vegetation		X						
III - Litter (in contact with the soil surface)		X						
IV - Biological Crust	X							
V - Rock/Gravel	X							
VI - Bare Ground	X							

¹ **Life Forms Cover** - Record multiple canopy cover classes; total plant canopy may exceed 100%. Small openings (less than 2" in diameter) are included as cover.

² **Ground Cover** - Category I is an estimate of total vascular plant cover; overlapping canopies are counted as only **one** canopy (record life form with first point of contact). Total vascular plant cover (I) together with the sum of cover in Categories II-VI should total to approximately 100%.

Notes: Include source of cover data (e.g., estimates or measurements)

Species Dominance Worksheet

Part 1 (Required)

The most common species, noxious weeds (state-listed plants), invasive natives, invasive exotics (non-noxious) are **ranked** according to dominance using cover ☒ or weight ☐.

Dominant Species on Site

- 1 pickleweed (Allenrolfea occidentalis)
- 2 _____
- 3 _____
- 4 _____

Noxious Weeds

- 1 _____
- 2 _____
- 3 _____

Invasive Natives

- 1 _____
- 2 _____
- 3 _____

Invasive Exotics

- 1 saltcedar (Tamarix ramosissima)
- 2 _____
- 3 _____

Part 2 (Optional) Dominant Species by Life Form

The most common species are ranked according to dominance using cover ☒ or weight ☐ by life form.

Annual Grasses

- 1 _____
- 2 _____
- 3 _____

Annual Forbs

- 1 _____
- 2 _____
- 3 _____

Perennial Grasses

- 1 _____
- 2 _____
- 3 _____

Perennial Forbs

- 1 _____
- 2 _____
- 3 _____

Shrubs and Trees

- 1 pickleweed (Allenrolfea occidentalis)
- 2 Saltcedar (Tamarix ramosissima)
- 3 _____

Succulents

- 1 _____
- 2 _____
- 3 _____

Biological Crust (rate by component not species, e.g., lichen, moss, or algae)

- 1 _____
- 2 _____
- 3 _____

Functional/Structural Groups Worksheet

State New Mexico Office _____ Ecological Site Alkali flat Site ID WSSH Site
 Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-13-2019

Functional/Structural Groups			Species List for Functional/Structural Groups
Name	Potential ¹	Actual ²	Plant Names
perennial shrub	D	D	Saltcedar, pickleweed, & fourwing saltbush
perennial grass	T	T	alkali sacaton
Biological Crust ³			

Indicate whether each "structural/functional group" is a **Dominant (D)** (roughly 41-100% composition), a **Subdominant (S)** (roughly 11-40% composition), a **Minor Component (M)** (roughly 3-10% composition), or a **Trace Component (T)** (<3 % composition) based on weight or cover composition in the area of interest (e.g., "Actual²" column) relative to the "Potential¹" column derived from information found in the ecological site description and/or at the ecological reference area.

Biological Crust³ dominance is evaluated solely on **cover** not composition by weight.

Rangeland Health Indicator Evaluation Matrix

State New Mexico Office _____ Ecological Site Alkali Flat Site ID WSSH Site
 If indicator(s) revised - Observer(s) Joshua Zatopek & Jeffrey Keeling Date 5-13-2019

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
1. Rills (Default Descriptor)	Rill formation is severe and well defined throughout most of the area.	Rill formation is moderately active and well defined throughout most of the area.	Active rill formation is slight at infrequent intervals, mostly in exposed areas.	No recent formation of rills; old rills have blunted or muted features.	Current or past formation of rills as expected for the site.
1. Rills (Revised Descriptor)					
2. Water Flow Patterns (Default Descriptor)	Extensive and numerous; unstable with active erosion; usually connected.	More numerous than expected; deposition and cut areas common; occasionally connected.	Nearly matches what is expected for the site; erosion is minor with some instability and deposition.	Matches what is expected for the site; some evidence of minor erosion. Flow patterns are stable and short.	Matches what is expected for the site; minimal evidence of past or current soil deposition or erosion.
2. Water Flow Patterns (Revised Descriptor)					
3. Pedestals and/or Terracettes (Default Descriptor)	Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestalled; exposed plant roots are common.	Moderate active pedestalling; terracettes common. Some rocks and plants are pedestalled with occasional exposed roots.	Slight active pedestalling; most pedestals are in flow paths and interspaces and/or on exposed slopes. Occasional terracettes present.	Active pedestalling or terracette formation is rare; some evidence of past pedestal formation, especially in water flow patterns and/or on exposed slopes.	Current or past evidence of pedestalled plants or rocks as expected for the site. Terracettes absent or uncommon.
3. Pedestals and/or Terracettes (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
4. Bare Ground (Default Descriptor)	Much higher than expected for the site. Bare areas are large and generally connected.	Moderately to much higher than expected for the site. Bare areas are large and occasionally connected.	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected.	Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected.	Amount and size of bare areas nearly to totally match that expected for the site.
4. Bare Ground (Revised Descriptor)					
5. Gullies (Default Descriptor)	Common with indications of active erosion and downcutting; vegetation is infrequent on slopes and/or bed. Nickpoints and headcuts are numerous and active.	Moderate to common with indications of active erosion; vegetation is intermittent on slopes and/or bed. Headcuts are active; downcutting is not apparent.	Moderate in number with indications of active erosion; vegetation is intermittent on slopes and/or bed. Occasional headcuts may be present.	Uncommon with vegetation stabilizing the bed and slopes; no signs of active headcuts, nickpoints, or bed erosion.	Drainages are represented as natural stable channels; no signs of erosion with vegetation common.
5. Gullies (Revised Descriptor)					
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Default Descriptor)	Extensive.	Common.	Occasionally present.	Infrequent and few.	Matches what is expected for the site.
6. Wind-Scoured, Blowouts, and/or Deposition Areas (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
7. Litter Movement (wind or water) (Default Descriptor)	Extreme; concentrated around obstructions. Most size classes of litter have been displaced.	Moderate to extreme; loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced.	Moderate movement of smaller size classes in scattered concentrations around obstructions and in depressions.	Slightly to moderately more than expected for the site with only small size classes of litter being displaced.	Matches that expected for the site with a fairly uniform distribution of litter.
7. Litter Movement (wind or water) (Revised Descriptor)					
8. Soil Surface Resistance to Erosion (Default Descriptor)	Extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent.	Significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches.	Significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site.	Some reduction in soil surface stability in plant interspaces or slight reduction throughout the site. Stabilizing agents reduced below expected.	Matches that expected for the site. Surface soil is stabilized by organic matter decomposition products and/or a biological crust.
8. Soil Surface Resistance to Erosion (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
9. Soil Surface Loss or Degradation (Default Descriptor)	Soil surface horizon absent. Soil structure near surface is similar to, or more degraded than, that in subsurface horizons. No distinguishable difference in subsurface organic matter content.	Soil loss or degradation severe throughout site. Minimal differences in soil organic matter content and structure of surface and subsurface layers.	Moderate soil loss or degradation in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced.	Some soil loss has occurred and/or soil structure shows signs of degradation, especially in plant interspaces.	Soil surface horizon intact. Soil structure and organic matter content match that expected for the site.
9. Soil Surface Loss or Degradation (Revised Descriptor)					
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Default Descriptor)	Infiltration is severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred.	Infiltration is greatly decreased due to adverse changes in plant community composition and/or distribution. Detrimental plant cover changes have occurred.	Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. Plant cover changes negatively affect infiltration.	Infiltration is slightly to moderately affected by minor changes in plant community composition and/or distribution. Plant cover changes have only a minor effect on infiltration.	Infiltration and runoff are equal to that expected for the site. Plant cover (distribution and amount) adequate for site protection.
10. Plant Community Composition and Distribution Relative to Infiltration and Runoff (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
11. Compaction Layer (below soil surface) (Default Descriptor)	Extensive; severely restricts water movement and root penetration.	Widespread; greatly restricts water movement and root penetration.	Moderately widespread; moderately restricts water movement and root penetration.	Rarely present or is thin and weakly restrictive to water movement and root penetration.	None to minimal; not restrictive to water movement and root penetration.
11. Compaction Layer (below soil surface) (Revised Descriptor)					
12. Functional/ Structural Groups (F/S Groups) (Default Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)	Number of F/S groups greatly reduced; and/or relative dominance of F/S groups has been dramatically altered; and/or number of species within F/S groups dramatically reduced.	Number of F/S groups reduced; and/or one dominant group and/or one or more subdominant groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups significantly reduced.	Number of F/S groups moderately reduced; and/or one or more subdominant F/S groups replaced by F/S groups not expected for the site; and/or number of species within F/S groups moderately reduced.	Number of F/S groups slightly reduced; and/or relative dominance of F/S groups has been modified from that expected for the site; and/or number of species within F/S groups slightly reduced.	F/S groups and number of species in each group closely match that expected for the site.
12. Functional/ Structural Groups (F/S Groups) (Revised Descriptor) (See Appendix 5 - Functional/ Structural Groups Worksheet)					

Rangeland Health Indicator Evaluation Matrix

(continued)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
13. Plant Mortality/Decadence (Default Descriptor)	Dead and/or decadent plants are common.	Dead and/or decadent plants are somewhat common.	Some dead and/or decadent plants are present.	Slight plant mortality and/or decadence.	Plant mortality and decadence matches that expected for the site.
13. Plant Mortality/Decadence (Revised Descriptor)					
14. Litter Amount (Default Descriptor)	Largely absent or dominant relative to site potential and weather.	Greatly reduced or increased relative to site potential and weather.	Moderately more or less relative to site potential and weather.	Slightly more or less relative to site potential and weather.	Amount is what is expected for the site potential and weather.
14. Litter Amount (Revised Descriptor)					
15. Annual Production (Default Descriptor)	Less than 20% of potential production.	20-40% of potential production.	40-60% of potential production.	60-80% of potential production.	Exceeds 80% of potential production.
15. Annual Production (Revised Descriptor)					
16. Invasive Plants (Default Descriptor)	Dominate the site.	Common throughout the site.	Scattered throughout the site.	Present primarily on disturbed sites.	Rarely present on the site.
16. Invasive Plants (Revised Descriptor)					

Rangeland Health Indicator Evaluation Matrix

(concluded)

Degree of Departure from Ecological Site Description and/or Ecological Reference Area(s)					
Indicator	Extreme	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
17. Reproductive Capability of Perennial Plants (native or seeded) (Default Descriptor)	Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is greatly reduced relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is somewhat limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is only slightly limited relative to recent climatic conditions.	Capability to produce seed or vegetative tillers is not limited relative to recent climatic conditions.
17. Reproductive Capability of Perennial Plants (native or seeded) (Revised Descriptor)					

Appendix C - Consultation Results

To Be Supplied

Appendix D - List of Preparers and Reviewers

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Reviewed by:

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Appendix E – Agency Contacts and Distribution List

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