United States Army Corps of Engineers

DRAFT ENVIRONMENTAL ASSESSMENT – RENEWABLE ENERGY DEVELOPMENT PROJECT

Holloman Air Force Base (HAFB), New Mexico

June 2020

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Prepared for:

U.S. Army Corps of Engineers
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ACRONYMS AND ABBREVIATIONS

AF	Air Force
AFI	Air Force Instruction
APE	Area of Potential Effect
Arcadis	Arcadis-US, Inc.
BISON-M	Biota Information System of New Mexico
BLM	Bureau of Land Management
BMP	Best Management Practice
BSC	Biological Soil Crust
C	Celsius

CEQ	Council on Environmental Quality
CDP	Census Designated Place
CFR	Code of Federal Regulations
CWA	Clean Water Act
dB	Decibels
dBA	Adjusted Decibels
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOPAA	Description of Proposed Actions and Alternatives
EA	Environmental Assessment
EBS	Environmental Baseline Survey
EIAP	Environmental Impact Analysis Process
EGS	Enhanced Geothermal Systems
EIS	Environmental Impact Statement
EJSCREEN	Environmental Justice Screen and Mapping Tool
EPA	Environmental Protection Agency
EPEC	El Paso Electric Company
ESA	Endangered Species Act
EO	Executive Order
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FONPA	Findings of No Practicable Alternative
FONSI	Findings of No Significant Impact
GIS	Geographic Information System
GW	Gigawatt
GWh	Gigawatt hour
HAFB	Holloman Air Force Base
HTF	Heat Transfer Fluid
HUC	Hydrologic Unit Code
IICEP	Interagency and Intergovernmental Coordination for Environmental Planning
IPaC	Information for Planning and Consultation
ITP	Incidental Take Permit
km	Kilometer
kW	Kilowatt
MBTA	Migratory Bird Treaty Act
mm/yr	Millimeters per year
mps	Meters per Second
MW	Megawatt
MW/m^2	Megawatts per square meter
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NATA	National-scale Air Toxics Assessment
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset

NHPA	National Historic Preservation Act
NMAC	New Mexico Administrative Code
NMCRIS	New Mexico Cultural Records Information System
NMDGF	New Mexico Department of Game and Fish
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
OCEC	Otero County Electric Cooperative
OSHA	Occupational Health and Safety Administration
PM	Particulate Matter
PPA	Power Purchase Agreement
PPB	Parts Per Billion
PPM	Parts Per Million
PREIAP	Planning Requirements in EIAP
PV	Photovoltaic
RMP	Risk Management Plan
SHPO	State Historic Preservation Office
SOC	Species of Concern
SWPPP	Stormwater Pollution Prevention Plan
TDS	Total Dissolved Solids
T&E	Threatened and Endangered
US	United States Highway
USACE	United States Army Corps of Engineers
USC	United States Code
USCB	Census Bureau for the United States
USDA	United Stated Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WHO	World Health Organization

1.0 INTRODUCTION

Arcadis U.S., Inc. (Arcadis) was subcontracted by Perikin Enterprises, LLC (hereafter referred to as the Contractor) to provide environmental consulting support services for the Renewable Energy Development Environmental Assessment (EA) project, located at Holloman Air Force Base (HAFB), New Mexico (**Figure 1**). Included in the project is the preparation of a Description of Proposed Action and Alternatives (DOPAA) and an EA in support of the Environmental Impact Analysis Process (EIAP) program at HAFB.

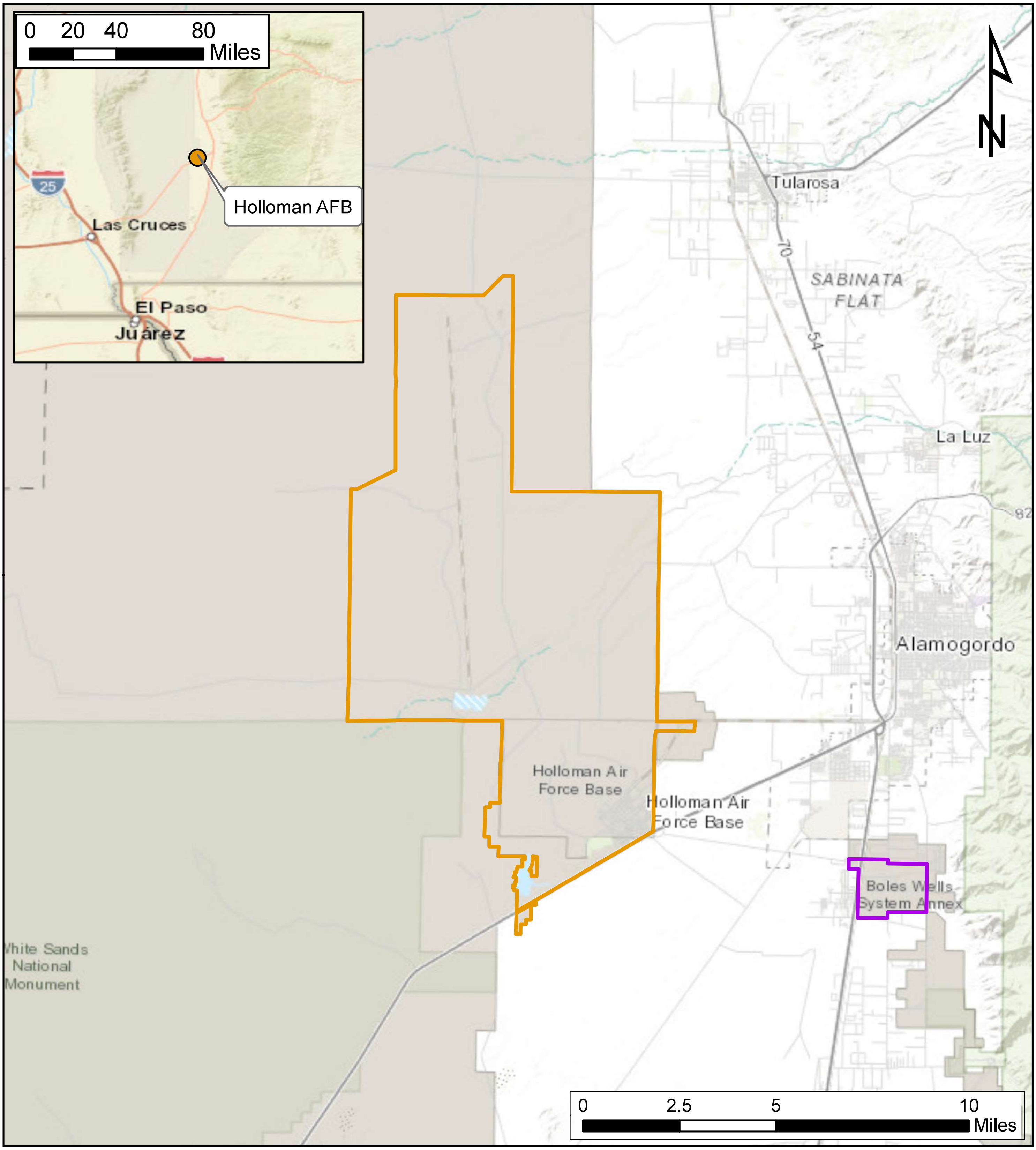
The service objective is support of the EIAP program at HAFB for the completion of an EA that analyzes the potential impacts associated with the development of renewable energy production on property owned by HAFB, located south of Alamogordo, New Mexico. The overarching objective of the EIAP project is to rapidly enable the installation of renewable energy projects and execute any future renewable energy production opportunities without having to conduct substantial further National Environmental Policy Act (NEPA) analysis. This document has been prepared to describe the approach to the development of the EA as well as its results, which will ultimately provide sufficient documented information to result in one of three possibilities. If there are no significant impacts affecting the quality of human health and the environment associated with the planned actions, either a Findings of No Significant Impact (FONSI) or a FONSI/Findings of No Practicable Alternative (FONPA) would be prepared.

If there are significant impacts affecting the quality of human health and the environment associated with the planned actions, the Contractor will recommend that an Environmental Impact Statement (EIS) be prepared. Otherwise, a FONSI or FONSI/FONPA will be prepared, as appropriate.

2.0 PROJECT DESCRIPTION

HAFB is the fee-simple owner of approximately 1,591 acres (hereafter referred to as the study area) south of Alamogordo, New Mexico (**Figure 2**) and currently leverages the land solely for the purposes of producing potable water from a system of wells located on the property. Site photographs are provided in **Appendix A**. HAFB would like to explore further use of this property to offset energy consumption associated with the wells and provide increased energy resiliency through the installation of renewable energy infrastructure. The specific type of renewable energy to be used is not limited at this time but should be expected to include solar or wind energy production methods, either grid-tied or off-grid, leveraging emerging energy storage technologies. This effort will also include a feasibility analysis of potential impacts associated with each type of renewable energy production and/or storage/tie-in method. The Air Force (AF) complies with all Federal environmental laws and regulations, including NEPA, National Historic Preservation Act (NHPA), Endangered Species Act (ESA), Clean Water Act (CWA), and other federally mandated regulations.

To meet federal requirements outlined in both NEPA and the President's Council on Environmental Quality (CEQ) Regulations, the Air Force codified their formal NEPA analysis process in 32 CFR Part 989 – EIAP. The EIAP is the Air Force's NEPA compliance program. The HAFB environmental office requires support for tracking and execution of EIAP efforts to ensure that AF, federal, and state environmental regulations are met. In support of EIAP requirements, the Contractor will prepare EIAP documents in accordance with NEPA of 1969 (Public Law 91-190); the President's CEQ Regulations Implementing NEPA [Title 40 Code of Federal Regulations (CFR) Parts 1500-1508]; 32 CFR 989; the AF Planning Requirements in EIAP (PREIAP) Guidance; and the AF EIAP Desk Reference.



Legend

Holloman AFB

Study Area

Holloman Air Force Base
Otero County, New Mexico

Vicinity Map

HAFB Renewable Energy - Draft EA

ARCADIS

FIGURE
1

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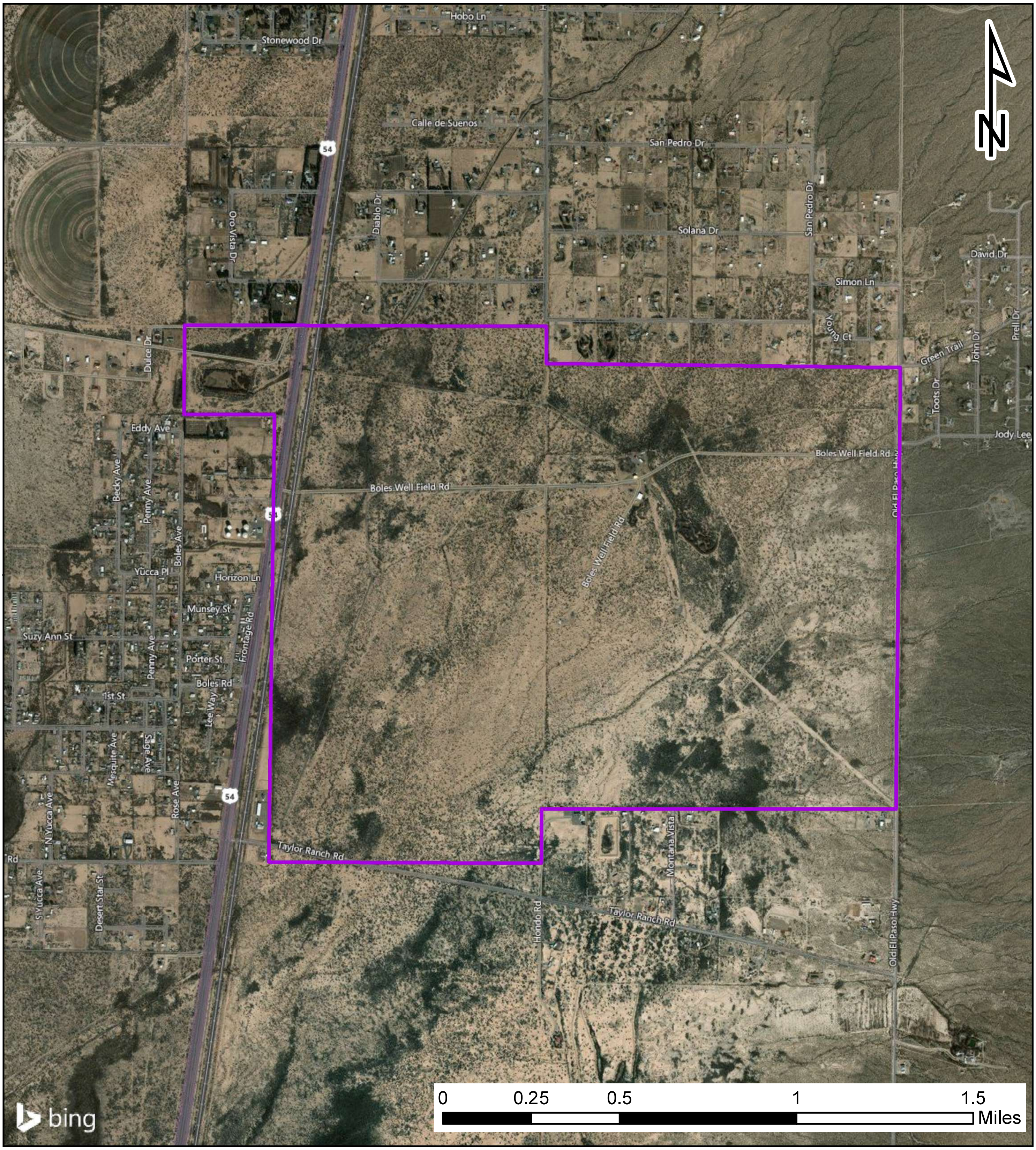

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Study Area

Holloman Air Force Base
Otero County, New Mexico

STUDY AREA MAP

HAFB Renewable Energy - Draft EA

FIGURE

2

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2.1 Purpose and Need

As previously indicated, HAFB seeks to explore further use of the subject property to offset energy consumption associated with the operation of existing potable water wells and provide increased energy resiliency through the installation of renewable energy infrastructure. At present, HAFB has only one source of electrical power, which makes it vulnerable to power outages, high energy demands, and high energy costs. Energy costs for the well field can be even higher when supplied and maintained over long distance from the power source. Installing a power source for the wells, at the well field, provides a time- and cost-effective source of energy. Further, the Department of Defense (DOD) is obligated to make the best use of available resources, financial and otherwise. Thus, HAFB proposes to improve energy resiliency while reducing energy costs and better using available land resources.

2.2 Scoping and Public Information

In accordance with the NEPA process, the development of this EA requires the completion of Interagency/Intergovernmental Coordination for Environmental Planning (IICEP). As part of the IICEP process, public input is requested on the proposed project to identify general or specific issues or areas of concern that should be addressed in the EA. External scoping consisted of requests for input mailed to heads of local city, village, and county governments; Tribal entities; and state and federal agencies in June 2020 (**Appendix A**). No responses have been received to date. The full Draft EA, and a request for public comment on the development of this EA, are also posted on the HAFB website and Notice of Availability press releases will be published to initiate the public comment period contemporary with release of this Draft EA.

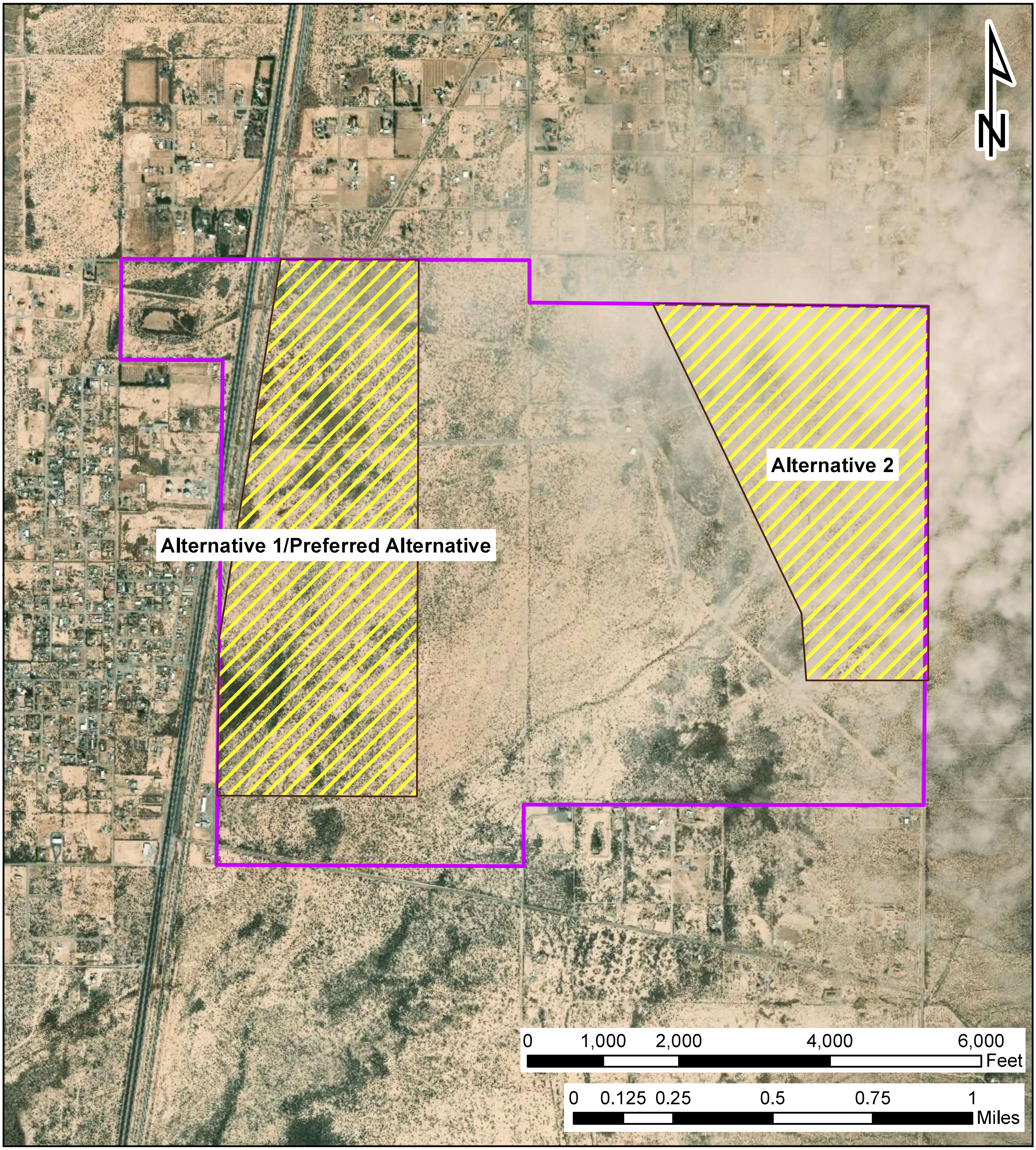
2.3 Environmental Impact Analysis

The purpose of this EA is to assess impacts that could occur related to a proposed project to install a renewable energy production facility on a 1,591-acre tract of land owned by HAFB. This EA relies upon existing environmental resource documents, prior field survey reports, publicly available database files, published literature, and a site reconnaissance survey to support the analysis. Geographic information system (GIS) data layers provided by HAFB were also used to inform this EA. Based on the proposed project and identified potential environmental impacts, the following resources have been assessed: geology, seismicity, soils, air quality, aesthetics, noise, land use, water resources, biological resources, cultural resources, socioeconomics, environmental justice, solid wastes, hazardous wastes, and toxic substances.

3.0 PROPOSED ACTION AND ALTERNATIVES

3.1 Proposed Action

The proposed action is the development of a renewable energy production facility, such as photovoltaic (PV), wind, or geothermal energy, within the study area to generate a minimum of 500 kilowatts (kW) of supplemental electricity to provide power for the operation of the well field pumps and associated infrastructure (**Figure 3**). If viable, the renewable energy power generation capacity could be increased to 5 megawatts (MW) for added base resiliency. Multiple factors were involved in determining whether a project



Legend

- Project Area
- Study Area

Holloman Air Force Base
Otero County, New Mexico

PROPOSED PROJECT AREA

HAFB Renewable Energy - Draft EA

ARCADIS

FIGURE
3

PROJECT: PATH: G:\PROJECTS_ENV\Perikin Enterprises\GIS\HAFB_8.5x11_Figure3_ProposedProjectArea.mxd alternative was considered viable and carried forward for analysis. Those factors were compared to the desired objective of the proposed project, resource availability, and previous renewable energy projects in the region. The following screening criteria were included in an EA prepared by HAFB in 2015 for a 42-acre PV system that is currently operating in the northeast portion of HAFB and were also included in this analysis.

- Electrical Grid Tie-in Potential – The proposed renewable energy alternatives will be evaluated for proximity to existing electrical grid infrastructure (e.g., transmission lines and/or transmission substations) and grid-tie potential. If connected, the grid infrastructure must be capable of supporting and carrying electricity generated by the renewable energy development. If the infrastructure is not currently capable of supporting the generated electricity, it must be suitable for upgrade and subsequent support of the generated electricity. Alternatively, if grid-tie capabilities are not available or practical, off-grid energy storage will be evaluated. From an energy resiliency standpoint, the proposed system may include a combination of grid-tie and energy storage technology.
- Geophysical Factors – The proposed site development must have suitable topography, aspect, slope, and soils to support the development of renewable technologies and infrastructure.
- Cultural Resources – The proposed project area must not adversely affect known archeological and cultural resources, such as those protected under the Native American Graves Protection and Repatriation Act (NAGPRA), or properties eligible for inclusion on the National Register of Historic Places (NRHP).
- Environmental/Biological Resources – The proposed site development must not adversely affect sensitive natural resources, such as threatened and endangered species, critical habitat, or otherwise protected or at-risk natural resources.
- Hazardous Materials/Remediation Sites – The proposed site development must not be exposed to known or discovered hazardous materials, which would create unsuitable conditions for site development. Proper hazardous materials remediation methods would be necessary to provide suitable site development conditions, and compliance with all applicable hazardous materials regulations and due-diligence planning criteria must be followed.

3.2 Alternative 1 – Preferred Alternative

Photovoltaic technology captures solar energy from sunlight and converts it to electricity by generating an electrical field across layers of semi-conductive material. As solar intensity increases, the electrical field being generated also increases. There is a wide variety of PV technology available, including PV panels, multiple operating systems, and numerous installation methods. The chosen PV technology largely depends on the availability of solar resources, landscape, site access, array design, intended output, and desired utility infrastructure interconnection. Based on the environmental site conditions of the study area, paired with available renewable energy natural resources (i.e., solar radiation, wind, water, and geothermal energy), development of a PV energy production facility within the western portion of the study area (approximately 382 acres) is considered the most effective use of the study area and provides the greatest potential for energy production.

The proposed solar technology is based on a similar 42-acre PV system currently operating in the northeast portion of HAFB, as described in the associated EA prepared by HAFB (2015), as well as a 42-acre PV installation at the White Sands Missile Range in 2012 (Siemens, 2013). According to data from the National Oceanic and Atmospheric Administration (NOAA), HAFB typically receives over 300 days a year of sunshine, providing approximately 80 percent of the averaged annually possible sunshine (NOAA, 2017). Additionally, according to the National Renewable Energy Laboratory (NREL), HAFB is located in a high zone of direct normal solar radiation (insolation), ranging from approximately 6.5 to 7 kilowatt-hours per square meter per day (kWh/m2/day) (NREL 2017a; HAFB, 2015), thereby providing exceptional conditions for the development of a solar power facility to meet the purpose and need of the project.

A grid-tie development scenario would require a Power Purchase Agreement (PPA) between HAFB, El Paso Electric Company (EPEC), and/or Otero County Electric Cooperative, Inc. (OCEC) to develop, operate, and maintain the electrical generation facility, with HAFB as the customer. A PPA would require environmental documentation known as an Environmental Baseline Survey (EBS). Although previous base wide research has found no indications of hazardous concerns associated with the proposed development location, an EBS would be prepared prior to initiation of the proposed action. The development would also require interconnection with existing utility infrastructure and long-term access for operations and maintenance. An off-grid energy storage development scenario would not require a PPA or an associated EBS. The proposed off-grid development would be developed, operated, and maintained by HAFB or a designated contractor.

Development of the western portion of the study area was chosen as the Preferred Alternative due to the following factors:

- Proximity to U.S. Highway (US) – 54 and Boles Well Field Road, which would provide easier access to the site without the need to construct new access roads.
- The area is slightly higher in elevation than the central portion of the study area, as evident by surface drainage patterns, which may reduce adverse impacts from surface water runoff during rain events and minimize the need for advanced surface water management.
- Proximity to existing transmission line infrastructure along US-54 and north of Boles Well Field Road, which may reduce the need for additional electrical infrastructure to connect to the electrical grid.
- Proximity to existing water wells, which may reduce the degree of service and maintenance to the power generation system.
- Maximum amount of solar exposure due to further distance from the Sacramento Mountains to the east. As the sun rises in the east, the western portion of the study area will receive solar exposure first, followed by the eastern portions of the study area as the sun rises over the mountains. Due to a lack of solar obstruction to the west, the study area would theoretically receive equitable afternoon solar exposure.
- Proximity to long-term preexisting habitat disturbance from the adjacent Boles Acres community, which may reduce potential adverse impacts to sensitive flora and fauna communities within the study area due to reduced habitat availability or suitability.

The choice of panels, mounting design, and array configuration for the project area will depend upon the developer's design, cost, and panel efficiency decisions. Depending upon configuration of the PV panels and the desired power output, the project would require clearing, grading, cable trenching, and foundation excavations throughout the PV development site addressed by this analysis. Due to the installation methods and site requirements for a ground-mounted solar PV array, the proposed action would result in broad disturbance over the entirety of the project development area.

3.3 Alternative 2 – Eastern Study Area PV Development

Although other renewable energy technologies were considered and are evaluated in this analysis, Alternative 2 would include a ground-mounted solar PV system similar to the Preferred Alternative, but it would be constructed in an alternative location on the eastern side of the study area (approximately 280 acres) (**Figure 3**). Development in the eastern portion of the study area was not chosen as the Preferred Alternative due to the following factors, but is still suitable as a project alternative:

- Located further away from US-54 and Boles Well Field Road, which may increase the difficulty of site access and require the construction of new access roads.
- The area is located near the base of the Sacramento Mountains, with increased topographic variation, which may require advanced site preparation, facility engineering, and surface water management.
- The area is further away from existing transmission line infrastructure along US-54 and north of Boles Well Field Road, which may require the construction of additional electrical infrastructure to connect to the electrical grid.
- The area is further away from existing water wells, which may increase the degree of service and maintenance to the power generation system.
- Reduced solar exposure due to proximity to the Sacramento Mountains to the east. As the sun rises in the east and above the mountain ridge, the eastern portion of the study area will receive a slightly shorter duration of solar exposure than the western portion of the study area. Due to a lack of solar obstruction to the west, the study area would theoretically receive equitable afternoon solar exposure.
- The area is further away from long-term preexisting habitat disturbance from the adjacent Boles Acres community, which may increase potential adverse impacts to sensitive flora and fauna communities within the study area due to increased habitat availability or suitability.

3.4 Alternative 3 – Wind Energy

According to the Wind Energy Resource Atlas of the United States, the study area is located in the Southern Rocky Mountain Region (Elliott et al., 1986). This region consists of Arizona, Colorado, New Mexico, and Utah. The region is dissected by the Continental Divide, which extends southward through western New Mexico. Wind energy resources are based on surface wind data and upper air data, paired with three qualitative indicators of potential wind speed or power: topographic/meteorological indicators (e.g. gorges, mountain summits, sheltered valleys); wind-deformed vegetation; and aeolian landforms (e.g. playas, sand dunes) (NREL, 2017b). Once the data are evaluated, the wind energy resources are categorized by class on a scale ranging from 1 to 7, with 7 providing the greatest wind resources and wind energy potential.

Hilltops, ridgelines, mountain summits, large clearings, and other unobstructed locations typically provide greater wind resources. Conversely, locations in narrow valleys or canyons, downwind obstructions, or in forested or urban areas are likely to have poor wind exposure and thereby provide fewer wind resources (NREL, 2017b). Class 3 or higher areas are located in New Mexico, including in and around the Sacramento Mountains located east of the study area. However, the study area is located on the desert floor near the western foothills of the Sacramento Mountains, which does not provide adequate exposure to industrial-scale wind resources. The NREL United States Wind Resource Map (2009) indicates the study area is considered Class 1 or 2, with annual average wind speed estimates at a height of 30, 50, and 100 meters to be less than 5.5 meters per second (mps) (NREL, 2009; 2012a; 2013).

According to the U.S. Department of Energy (DOE) (2017a) and U.S. Department of the Interior (DOI) (2017), viable industrial-scale wind resources are considered Class 3 or above, with minimum average wind speeds of approximately 6 mps. Because the study area is located in a region where wind speeds average less than 5.5 mps, and it is in a low wind-exposure area at the base of the Sacramento Mountains, wind energy development is not considered an efficient or effective option for HAFB unless low-wind speed technologies can be effectively employed on an industrial energy scale.

Additionally, industry standard horizontal-axis wind energy turbines feature blades that average 116 feet in length, atop a 212-foot tower, for a structure that totals 328 feet (NREL, 2012b). Turbines of this height could interfere with air traffic operation and training, if they occur in the project area, which would create potentially serious safety hazards if wind turbines were constructed proximal to an airfield or active airspace. Blade rotations can disrupt critical navigational radar signals and further adversely affect air traffic operations and airspace management (Lemmon et al., 2008). This potential impact should also be considered if future airfield land development or flight operations are planned in the project area.

3.5 Alternative 4 – Geothermal Energy

Geothermal power plants produce electricity from existing reservoirs of hot water found beneath the Earth's surface. By drilling wells deep into heated subsurface water reservoirs or bedrock, the heat energy can be captured or used to produce steam to operate steam turbine electrical generators. Of the available geothermal power plant technologies, there are three primary types of power plants: dry steam, flash steam, and binary cycle (DOE, 2017b).

Dry steam power plants draw underground steam directly from wells and the steam is piped to the power plant where it is directed into a turbine/generator unit (NREL, 2017c). There are only two known underground resources of steam in the United States, with one being The Geysers in northern California and the other being Yellowstone National Park in Wyoming.

Flash steam power plants utilize reservoirs of geothermal water with temperatures greater than 182 degrees Celsius (C). These are among the most common geothermal power plants and take advantage of natural upward pressure of the heated water to produce steam, which then powers a turbine/generator.

Binary cycle power plants utilize geothermal water at lower temperatures, approximately 107-182 degrees C, to boil a working fluid, which is usually an organic compound with a low boiling point. The working fluid is vaporized in a heat exchanger and used to turn a turbine to produce electricity. Then the geothermal water is injected back into the ground to be reheated, completing a renewable energy loop. The water and the working fluid are separated in different piping systems during the process to prevent cross-contamination (DOE, 2017b).

According to the U.S. Geological Survey (USGS), the United States has nearly 40 GW of power generation potential from identified and unidentified conventional geothermal resources (Williams et al., 2008). However, numerous barriers within the industry, and limitations inherent to the technology, often prohibit geothermal energy development. In particular, geothermal exploration and development costs are high and come with potentially high risk if adequate geothermal resources are not identified or available. This often makes initial financing for geothermal energy facilities difficult when compared to other renewable energy sources (NREL, 2014; Salmon et al., 2011). **Table 1** provides a comparison of the initial construction cost, investment payback period, and construction time for the different renewable energy sources based on analysis of geothermal, wind, and solar power generation systems construction (Kenny and Pearce, 2014; Kewen et al., (2014).

Table 1. Comparison of Construction Cost, Payback Time, and Construction Time for PV, Wind, and Geothermal Energy Sources

Energy Type	Construction Cost (US/kW h)	Payback Time (years)	Construction Time (years)
PV	$0.24	1-2.7	0.3-0.5
Wind	$0.07	0.4-1.4	<1
Geothermal	$0.07	5.7	3-5

Source: Kenny et al., 2010

The geothermal technology that would be used for electricity generation under this alternative has not yet been determined and is dependent upon exploration and identification of resource viability. According to the USGS online GIS web-viewer of regions of known or potential geothermal resources in New Mexico (USGS, 2019a), the study area is located near the eastern margin of a large geothermal resource region that bisects central New Mexico. The region is indicated by NREL (2009) as a favorable area for deep Enhanced Geothermal Systems (EGS), and springs within 25 miles of Alamogordo are reported to have temperatures of greater than 50 degrees C (Laney and Brizzee, 2003). A geothermal heat flow study conducted by Southern Methodist University indicates the region can provide approximately 75-100 megawatts per square meter (MW/m^2) of geothermal energy (Blackwell et al., 2011). That study also indicated that subsurface temperatures at 3.5 kilometers (km) below the ground surface range from approximately 100 to 150 degrees C, and temperatures at a depth of 10 km range from approximately 250 to 350 degrees C.

Since the primary purpose of energy production within the study area would be to power the existing water wells and associated infrastructure, a binary cycle system would likely be the most applicable because it can operate at lower geothermal water temperatures. Additionally, co-produced resources (sometimes referred to as hybrid geothermal systems) may be a suitable option, whereby geothermal and solar resources are used in tandem to produce electrical energy (DOE, 2017b). If geothermal energy were determined to be viable, the energy production facility would be sized to match desired production output and expected load.

Benefits of geothermal power include constant production of electricity, producing 24 hours per day / 7 days per week, regardless of weather conditions. Additionally, geothermal power plants have a relatively small footprint, occupying less land per gigawatt hour (GWh) (404 m^2) than coal (3642 m^2), wind (1335 m^2), or solar PV with center station (3237 m^2) (DOE, 2017b). Geothermal power plants are also closed-loop systems and emit no greenhouse gasses. However, the production of geothermal power would require costly time and resource allocation. A power production facility would need to be constructed, including the primary electrical generating plant, production and injection wells, and ancillary facilities. Pipelines would be required to transport geothermal fluid from production wells to the primary facility, and from the facility to injection wells. If sufficient fluid does not exist naturally below the study area, fluid would need to be pumped in from an outside source. Additionally, steam is generated to rotate the turbine that activates the generator, central to electrical production. From this process, excess water vapor is released through a cooling tower or towers, often resulting in obscuring steam clouds that could pose a potential hazard to air traffic.

3.6 No Action Alternative

As required by NEPA and the EIAP, the No Action Alternative is considered a possible alternative. Under the No Action Alternative, the area would remain in its current undeveloped state and there would be no renewable energy production. There would be no ground disturbing activities associated with site development, thereby, there would be no impacts to local natural and cultural resources. Additionally, the project would not contribute to an increase in jobs in the HAFB area or an overall reduction in regional air pollutant emissions due to reduced dependence on energy produced from conventional fossil fuels.

4.0 ALTERNATIVES ELIMINATED FROM DETAILED STUDY

4.1 Solar Trough Array

A parabolic solar trough array would require landscape level modifications similar to those of a PV system, and would generate an equivalent amount of electricity. A solar trough array system works by concentrating and reflecting solar radiation into pipes that carry heat transfer fluid (HTF). A heat exchanger then generates steam from the HTF, which in turn powers an electrical turbine/generator. After the steam passes through the turbine, it is cooled and recycled with the use of cooling water (DOE, 1998).

The array would be constructed and operated in a manner that would track with the solar aspect and reflect the maximum amount of solar radiation possible throughout the day. Unlike a photovoltaic array, parabolic solar trough systems are mechanized and involve moving parts that would require maintenance and eventual replacement (NREL 2015). Because the parabolic trough panels are reflective, rather than absorptive like PV panels, the highly reflective surface could adversely impact air traffic by reflecting sunlight at aircraft and impairing pilot vision.

Additionally, HTF and cooling water need to be high-quality, clarified water, typically originating as groundwater within the local watershed. Depending on the dissolved solids and chemically bound compounds within the source water, expensive reverse osmosis or distillation would be required prior to use in the solar trough array system. Wastewater generated from the purification process may also be prohibitive to dispose of properly, both from an economic and environmental standpoint. In addition to water purification complications and reflected light impacts, high installation costs would also be expected with the solar trough array. Due to the potential high cost of implementation and the potential for air traffic impacts, this alternative was eliminated from the study.

4.2 Solar Tower Array

Solar tower, parabolic trough, and PV arrays would all generate comparable electrical output and require similar areas of surface disturbance. Unlike parabolic trough or PV systems, the solar tower array consists of an extensive field of mirrors surrounding a central tower. Within the tower, water is heated to steam by the concentrated solar energy from the mirrors. As with a parabolic trough array, steam would power turbine/generators to create electric energy. Therefore, similar component maintenance and replacement could be anticipated with the tower system as with the parabolic trough system. Additionally, comparable water purification complications, reflected light impacts, and high installation costs would also be expected with the solar tower array. Due to the potential high cost of implementation and the potential for air traffic impacts, this alternative was eliminated from the study.

4.3 Biomass Generation

The study area is situated within a low-population desert, limiting the supply of suitable biomass in the surrounding area, and making transportation costs from an appropriate source excessively costly. Like the solar parabolic trough and tower arrays, electrical power from a biomass source would require the use of high-quality water and would require similar ongoing considerations. However, unlike the solar systems, water is heated to steam through continued incineration of biomass materials. Therefore, air quality would need to be monitored and solid waste properly disposed of for the life of the system. Due to the potentially limited quantity of suitable biomass material in the region (and high cost of shipping biomass to the site), paired with the potential air quality concerns associated with continued biomass incineration, this alternative was eliminated from the study.

5.0 AFFECTED ENVIRONMENT

Section 5 describes the existing environmental and socioeconomic conditions within and surrounding the study area. The information provided in this section serves as a baseline from which to identify and evaluate environmental changes that are likely to result from the execution and operation of the proposed action.

In compliance with NEPA and CEQ guidelines (40 CFR 1501.7[3]), only those resources and conditions having the potential to be affected by the action are discussed within this section. Additionally, the impacts to those resources and conditions are analyzed in Section 6.

5.1 Geology and Seismicity

5.1.1 Definition of Resources

This section describes the existing geologic conditions within the study area as they pertain to the Proposed Action and alternatives. At a minimum, the general topographic and geologic setting, significant features and landforms, and known geologic hazards within the study area are identified. Geologic hazards include such things as highly erodible soils, debris flows, and seismic hazards (e.g. faults). Information was gathered from existing geologic maps; available geologic and geotechnical reports; and associated information from the USGS.

5.1.2 Existing Conditions

5.1.2.1 Geology

The study area occurs within the Tularosa Valley, which is a closed desert basin that does not support surface water flow outside of the basin and is not hydrologically connected to any other surface water. The underlying Geology consists of a large anticline of Paleozoic sedimentary rock between the San Andres and Sacramento Mountains. The basin was subsequently formed by rift action along the Rio Grande to the west, which pulled the region apart and created a central basin where the lithology collapsed below the level of the surrounding terrain (HAFB, 2015; Chronic, 1987).

Following the collapse, the Rio Grande ran through the early Tularosa Basin. However, gradual uplift of the basin, paired with the presence of the Organ Mountains, diverted the Rio Grande back to the west resulting in a higher elevation valley.

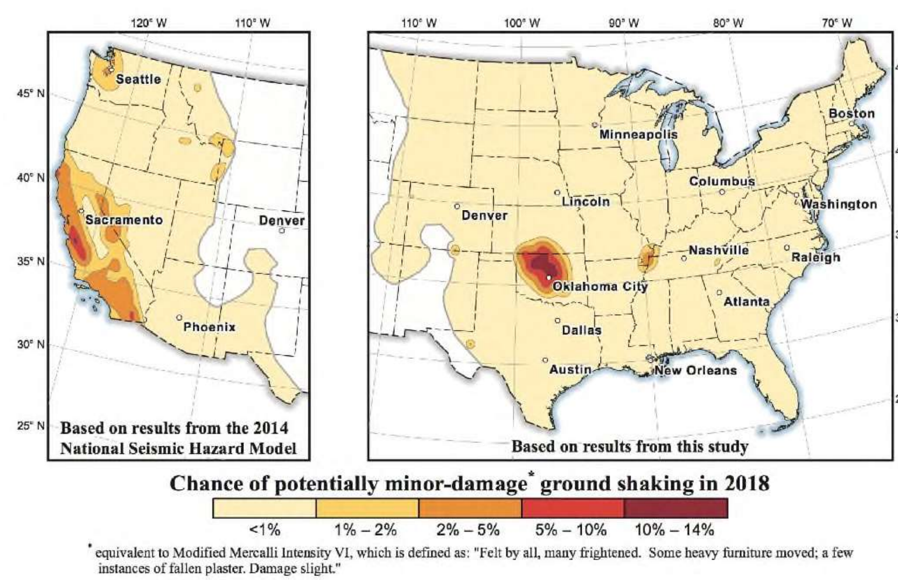
The Tularosa Valley is primarily comprised of alluvial sediment that was eroded from the surrounding topography and deposited within the valley. The valley's alluvial sediment originated from the Organ Mountains in the southwest; the San Andres Mountains in the west; the Chupadero Mesa and the New Mexico Highlands in the north; and the Carrizo Mountains, Sierra Blanca Mountains, and the Sacramento Mountains to the east.

5.1.2.2 Seismicity

The Tularosa Valley is bounded by two normal faults on the eastern and western margins. The eastern margin is bounded by the Alamogordo fault of Latest Quaternary (<15,000 years) age and has a slip rate of less than 0.2 millimeters per year (mm/yr) (USGS, 2019b). The western margin is bounded by the San Andres Mountains fault of Latest and Late Quaternary (<15,000-130,000 years) age and has a slip rate of less than 0.2 mm/yr. According to the USGS, both the Alamogordo and the San Andres Mountains fault have not had any historic faulting with the last 150 years. (USGS, 2019a)

Seismicity within the proposed project area and region is of low probability on a year to year basis. Based on the USGS Forecast for Damage from Natural and Induced Earthquakes in 2018 (USGS, 2018), the project area had less than 1% chance of potentially minor-damage ground shaking in 2018 (**Figure 4**). The USGS defines minor-damage as: "Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight." Based on the USGS short term model for the preceding years, the project area's chance of potentially minor-damage ground shaking did not change.

Figure 4. Chance of Potentially Minor-Damage Ground Shaking in 2018



5.2 Soils

5.2.1 Definition of Resource

Soil data and information was gathered from the Web Soil Survey operated by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS). Soil is an essential component of biotic resources on land and may be defined as a thin layer of the earth's surface that serves as a natural medium for plants to grow and organisms to survive. Natural soil consists of mineral solids and organic matter, liquid, and gases that occur on the land surface. Over time, soil forms horizons, or layers, that are distinguishable from the initial material as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment (NRCS, 1999). The upper limit of soil is the boundary between soil and air, shallow water, live plants, or plant materials that have not begun to decompose. The lower boundary of soil is the interface that separates soil from the underlying bedrock or parent material. Soil horizons differ from the underlying parent material by their level of alteration from regional climate, topographic relief, and living organisms over time. The lower boundary of soil is frequently devoid of living animals, roots, or other biological activity, and although functional soil depth differs across the globe, the lower boundary of soil units is generally considered to be approximately 200 centimeters (NRCS, 1999).

An important feature of desert soils in the Tularosa Valley region is cryptogamic crusts. Cryptogamic crusts are a collection of living organisms (cyanobacteria, algae, micro fungi, and bryophytes) that create a biological soil crust (BSC) that lives within, or on top of, the uppermost millimeters of soil (Rosentreter et al., 2007). These communities have been known by a variety of names, including cryptobiotic, cryptogamic, and micro-biotic soil crusts. They form a strong matrix that is more resistant to erosion and beneficial in nutrient cycling for plants. Biological soil crusts can also increase soil stability, contribute carbon to those soils below the crust, convert nitrogen from the atmosphere into nitrogen available within the soil, and add phosphorus back into the soil. They are found in all dryland regions of the world, including the polar regions, and in all vegetation types, although they predominate in arid areas with limited vegetation. Within the contiguous U.S., they are largely found in the semi-arid western regions, including the Tularosa Valley.

Because BSC organisms are only metabolically active when wet, as the amount of precipitation increases, so does the level of BSC development and lichen and moss cover. However, BSC cover is restricted in areas where vascular plant cover is high because BSC organisms have a limited ability to grow upwards from the soil surface and cannot compete for light. Thus, the most conspicuous development of BSCs occurs in hot, cool, and cold drylands where plants are widely spaced (Rosentreter et al., 2007).

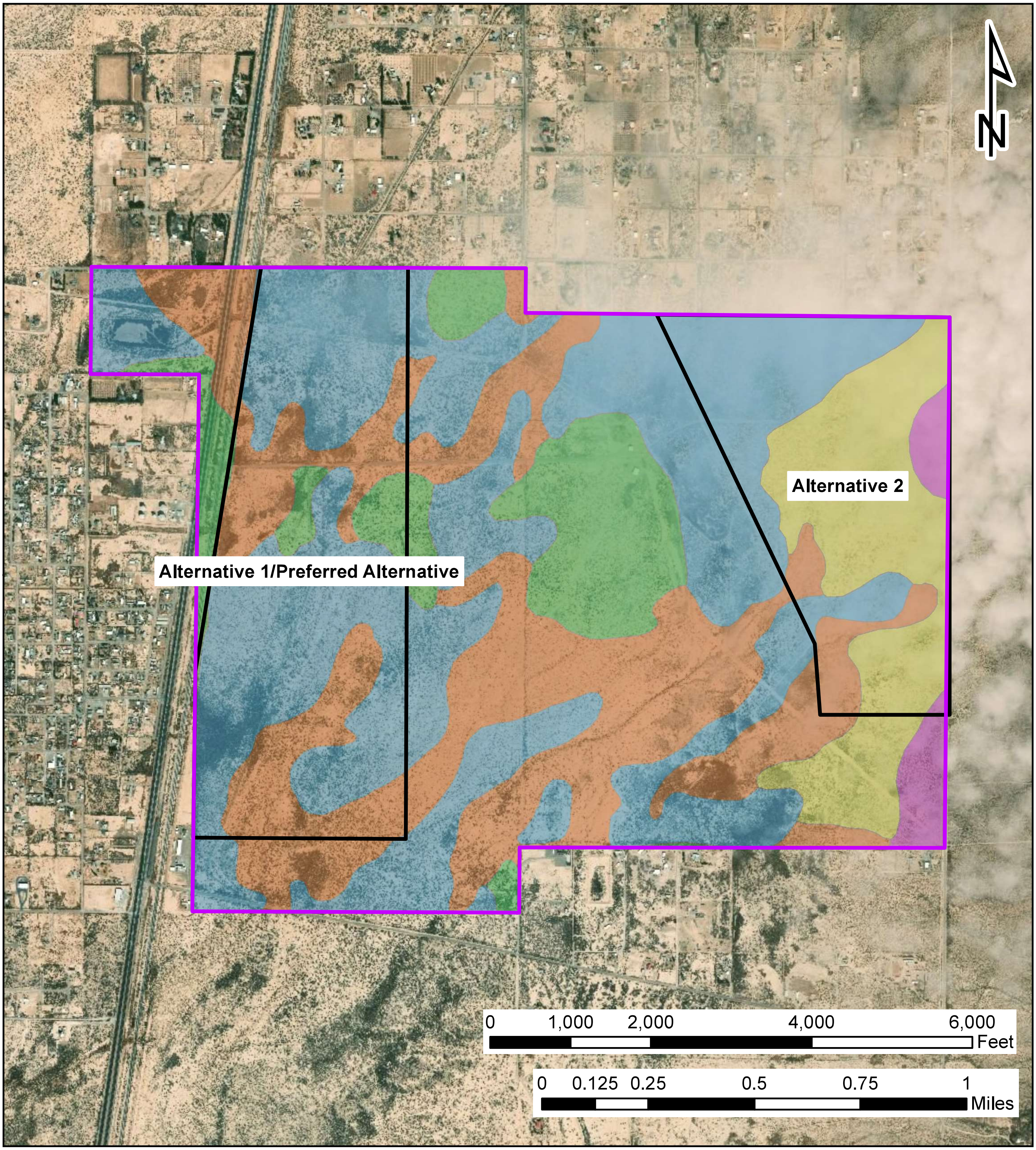
As described in the HAFB Integrated Natural Resources Management Plan (INRAMP) (HAFB, 1999; 2011), eventual re-growth of BSC depends on the severity and extent of the disturbance, the local vegetation availability, the texture of the soil, and the general climate. Disturbed BSC may take several years, with adequate precipitation, to begin to regenerate.

5.2.2 Existing Conditions

Based on review of the NRCS Web Soil Survey (NRCS, 2019), the study area is underlain by five soil mapping units, four of which belong to the Tome soil series (**Figure 5**). Approximately 98% of the study area is underlain by the Tome soil series, which consist of moderately permeable soil with slow to rapid runoff. Tome soil textures within the area vary from silt loam to very fine sandy loam alluvium, which were deposited in the valley floor from the surrounding orogeny. Of that 98%, 45% is Tome silt loam; 41% is Tome very fine sandy loam; and 12% is Tome-Emot complex. The remaining approximate 2% of the study area is underlain by the Stagecoach-Vado complex, which is characterized as an excessively drained gravelly loam. Based on NRCS review, the soils within the study area are not of importance for conservation and are not protected under the Farmland Protection Policy Act. Applicable soil mapping units are further described below in **Table 2**.

Table 2. Description and Spatial Extent of Individual Soil Mapping Units Identified within the Study Area

Soil Mapping Unit	Acres in Study Area	Description
Stagecoach-Vado complex, 0-15% slopes (6000)	33.7	Deep gravelly and sandy loam that is well-drained with moderately rapid permeability and medium run-off. Stagecoach soils are found on fan remnants with slopes of 0 to 60% and are formed of mixed alluvium (NRCS 2019).
Tome-Emot complex, 0-3% slopes (TfB)	183.6	Very deep very fine sandy and silt loam that is well-drained with moderately rapid permeability and medium run-off. Tome silt loam soils are found on fan piedmonts at elevations from 4,000 to 5,500 feet and are formed of mixed fine-silty alluvium (NRCS, 2019).
Tome silt loam, 0-1% slopes (TbA)	724.8	Very deep very fine sandy and silt loam that is well-drained with moderately rapid permeability and medium run-off. Tome silt loam soils are found on fan piedmonts at elevations from 4,000 to 5,500 feet and are formed of mixed fine-silty alluvium (NRCS, 2019).
Tome very fine sandy loam, 0-1% slopes (TcA)	187.4	Very deep very fine sandy and silt loam that is well-drained with moderately rapid permeability and medium run-off. Tome silt loam soils are found on fan piedmonts at elevations from 4,000 to 5,500 feet and are formed of mixed fine-silty alluvium (NRCS, 2019).
Tome very fine sandy loam. 1-3% slopes (TcB)	473	Very deep very fine sandy and silt loam that is well-drained with moderately rapid permeability and medium run-off. Tome silt loam soils are found on fan piedmonts at elevations from 4,000 to 5,500 feet and are formed of mixed fine-silty alluvium (NRCS, 2019).



Legend

- Project Area
- Study Area
- 6000 - Stagecoach-Vado complex, 1 to 15 percent slopes
- TcA - Tome very sandy loam, 0 to 1 percent slopes
- TcB - Tome very fine sandy loam, 1 to 3 percent slopes, eroded
- TeB - Tome silt loam, frequent overflow, 1 to 3 percent slopes
- TfB - Tome-Emot complex, 0 to 3 percent slopes

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NRCS Soil Resources Map

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Soil texture is one of the major factors in determining erosion, runoff, and sediment control at sites undergoing construction disturbance or land use changes. Tome silt loam and very fine sandy loam soil types are known to be vulnerable to water erosion and regional landowners have had challenges controlling the surface flow of water and managing the associated displacement of soil in the Tularosa Valley (Otero Soil and Water Conservation District, 2016). Tome soil types are susceptible to rapid erosion in response to exposure to wind when not held in place with vegetation or cryptobiotic crusts. Cryptobiotic crusts and roots are then pedestalled, exposed, and eventually eroded away through a combination of water and wind erosion activity.

Based on conditions observed during the March 10, 2020 site visit, and personal communication with HAFB planning staff, the study area was cleared for agricultural use and surface water collection in the 1950s. The clearing of vegetation likely exposed more soil surface to drought, rainfall, surface water runoff, and erosion over time. Because the study area is located at the base of the adjacent mountains, high volume rapid rainfall runoff enters the study area from the east/northeast and flows across the central portion of the study area to the southwest. This historical challenge led to the creation of diversionary channels throughout much of the region in order to alleviate flooding in the residential Boles Acres neighborhood. The continued erosional disturbance, paired with the arid climate and relatively slow growth rate of xeric desert species, appears to have reduced the study area's ability to regenerate native vegetation communities over time and stabilize local soils. The current vegetative community was sparse when compared to adjacent properties and exhibited low species diversity and extensive signs of soil scour and resultant plant hummocks. Once the surface soil is weakened and the vegetative community is no longer able to stabilize soils, high winds during dry periods are able to further erode and displace soils in addition to the runoff related soil erosion.

5.3 Air Quality

5.3.1 Definition of Resource

The United States Environmental Protection Agency (EPA) regulates air quality and sets air quality standards. However, the New Mexico Environment Department (NMED) Air Quality Bureau (AQB) is responsible for enforcement of the federal Clean Air Act in New Mexico. The EPA classifies areas based on pollutant concentrations compared to established levels called National Ambient Air Quality Standards (NAAQS). Standards are set for six criteria pollutants: carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), lead (Pb), and particulate matter ($PM_{2.5}$ and PM_{10}) (**Table 3**). Based on the pollutant levels within an Air Quality Control Region, the EPA designates the attainment status of an area for each criteria pollutant based on whether an area meets the NAAQS. Areas that meet the NAAQS are termed "attainment areas." Areas that do not meet the NAAQS are termed "nonattainment areas." Areas for which insufficient data are available to determine attainment status are termed "unclassified areas"; these areas are treated as attainment areas for air permitting purposes. Nonattainment areas may also be classified by degree (extreme, severe, serious, moderate, and marginal).

NAAQS, defined by concentration over various periods of time, represent the maximum levels of air pollution that are considered safe for public health and safety. Short-term standards (1-hour, 8-hour, or 24-hour periods) were created for pollutants with acute health effects, whereas long-term standards (annual periods) were developed for pollutants with chronic health effects.

Table 3. National Ambient Air Quality Standards (NAAQS)

Pollutant	Primary Standards*		Secondary Standards*		Form Notes
	Level	Averaging Time	Level	Averaging Time	
Carbon Monoxide (CO)	9 ppm	8 hours	None		Not to be exceeded more than once per year
	35 ppm	1 hour			
Lead (Pb)	1.5 µg/m^3	Rolling 3-month average	1.5 µg/m^3	Rolling 3-month average	Not to be exceeded
Nitrogen Dioxide (NO_2)	100 ppb	1 hour	None		98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	53 ppb	1 year	53 ppb	1 year	Annual mean
Particulate Matter (PM_{10})	150 µg/m^3	24 hours	150 µg/m^3	24 hours	Not to be exceeded more than once per year on average over 3 years
Particulate Matter ($PM_{2.5}$)	12.0 µg/m^3	1 year	15.0 µg/m^3	1 year	Annual mean, averaged over 3 years
	35 µg/m^3	24 hours	35 µg/m^3	24 hours	98th percentile, averaged over 3 years
Ozone (O_3)	0.07 ppm	8 hours	0.07 ppm	8 hours	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Sulfur Dioxide (SO_2)	75 ppb	1 hour	0.5 ppm	3 hours	Not to be exceeded more than once per year

*ppb = parts per billion; ppm= parts per million; µg/m^3 = micrograms per cubic meter

5.3.2 Existing Conditions

The study area is currently open, relatively undeveloped land. The land is currently only utilized for pumping ground water for use on the base. Within the study area, there are currently no sources of emissions. Most emissions would occur during the construction process, associated with vehicle operations and maintenance activities. However, those emissions would largely be temporary and only occur during construction. Air quality may be periodically affected by dust storms, which occur within the Tularosa Basin during periods of high wind. These dust storms can temporarily generate airborne particulates from the surrounding landscape. Otero County is considered an Air Quality Attainment Area under State and National Ambient Air Quality Standards.

5.4 Aesthetic Resources

5.4.1 Definition of Resource

Aesthetic resources are the natural and visual features of the landscape that can be seen or experienced and that contribute to the public's appreciation of the environment. The value of these resources is often determined by contrasts exhibited by the natural environment (e.g., geology, hydrology, vegetation, and wildlife), as well as man-made features and the aesthetic value of an area is a measure of its visual character and quality combined with the viewer's response to the area. Visual resources or aesthetic impacts are generally defined in terms of a project's physical characteristics and potential visibility and the extent to which the project's presence would change the perceived visual character and quality of the environment in which it is located.

5.4.2 Existing Conditions

The proposed project area is currently a relatively flat, undeveloped parcel of land located between US-54 and the west side of the Sacramento Mountain Range. There are sparse water wells located throughout the parcel, along with associated power lines to power the water pumps and a limited number of paved roads for access. Based on current aerial photographic interpretation, the study area is relatively similar to the naturally vegetated communities in the surrounding area and region. The study area is not located within a sensitive viewshed.

5.5 Noise Resources

5.5.1 Definition of Resource

Sound is a physical phenomenon consisting of pressure fluctuations and resultant sound waves that travel through other physical media, such as air, and are received by the human ear. Noise is typically considered objective or subjective unwanted sound that interferes with normal activities (e.g., sleep patterns, conversion, and concentration) or otherwise diminishes the quality or aesthetics of the environment. It may be intermittent or continuous, steady or impulsive, stationary or transient. In addition to normal disruptive noise environments, there are also special noise sensitivities with respect to certain resources such as national parks, wilderness areas, and other public spaces that are designed for public use and relaxation.

According to the Occupational Safety and Health Administration (OSHA, 1996), the threshold of human hearing discomfort or pain is approximately 120 decibels (dB) (**Table 4**). However, noise levels are typically measured in dBA, which are decibels adjusted to reflect the ear's response to different frequencies of sound (OSHA, 2019). Sudden, brief impulse sounds, like many of those shown at 120 dB or greater, are often described in dB. Weighted decibels are better for interpreting noise impacts associated with low-frequency sound due to the human ear being less sensitive in this range.

Table 4. OSHA Daily Permissible Noise Exposure for Human Hearing

Duration per day (hours)	8	6	4	3	2	1 ½	1	½	¼ or less

A-Scale Sound level, slow response (dBA)	90	92	95	97	100	102	105	110	115

5.5.2 Existing Conditions

Noise levels within the study area are currently low due to the undeveloped nature of the land. Highway traffic from US-54 contributes some background noise in the project area, as well as those produced from residential areas immediately west and north of the proposed project area. Existing aircraft noise can also be heard from HAFB and from the Alamogordo White Sands Regional Airport located seven miles northwest of the project area. The study area is not located within a sensitive viewshed, nor are sensitive noise receptors located within or adjacent to the study area.

5.6 Water Resources

5.6.1 Definition of Resources

The CWA was passed in 1972 to regulate the discharge of pollutants into waters of the United States and provide quality standards that could be monitored and enforced by the EPA. Within New Mexico, water quality is regulated at both the federal and the state level. Under the New Mexico Administrative Code [NMAC] 20.6.4, the State of New Mexico has adopted water quality standards that "protect the public health or welfare, enhance the quality of water, and are consistent with and serve the purposes of the New Mexico Water Quality Act and the Federal CWA". As defined, water resources include rivers, lakes, wetlands, aquifers, and floodplains.

Under Federal Executive Order (EO) 11988, federal agencies must consider and evaluate potential effects that a proposed action may have on floodplains. Where applicable, actions should reduce the risk of flood loss, minimize the impact of floods on human safety, and restore and preserve the natural and beneficial values provided by floodplains. The 100-year floodplain is defined as those areas having a one percent annual chance of flooding and the Federal Emergency Management Agency (FEMA) publishes Flood Insurance Rate Maps (FIRM) that delimit zones based on annual flood chances.

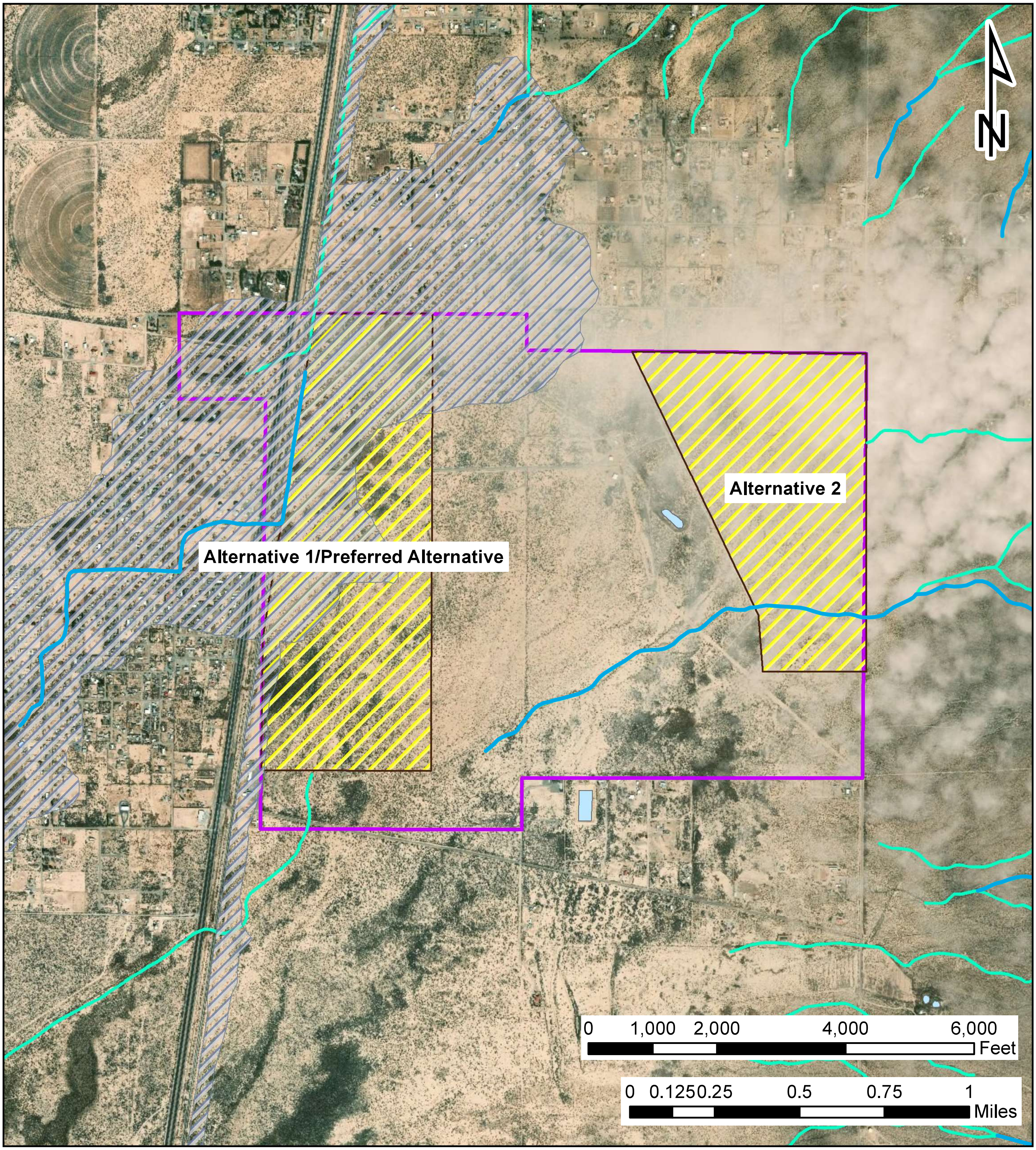
Similarly, Under EO 11990, federal agencies must consider potential impacts to wetland resources. Wetlands are defined under 33 CFR 328.3, 1986 and 40 CFR 230.3, 1980 as "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Many wetlands are considered Waters of the U.S. and are deemed jurisdictional under Section 404 of the CWA, which is regulated by the U.S. Army Corps of Engineers (USACE).

5.6.2 Existing Conditions

5.6.2.1 Surface Water

The proposed project area is located in the Tularosa Valley watershed (8-digit hydrologic unit code [HUC] 13050003) (USGS, 2019c). Based on review of publicly available aerial imagery, the National Hydrography Dataset (NHD), U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI), and USGS

7.5-minute topographic quadrangle maps, two flowlines (streams) and one surface pond occur within the study area (**Figure 6**).



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Legend

- Project Area
- Study Area
- NHD Flowline
- FEMA 100-Year Flood Zone
- NWI Freshwater Pond
- NWI Riverine

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Otero County, New Mexico

Surface Water Resources Map

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FIGURE
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The streams are depicted on the (USFWS, 2019a) layer as being intermittent, which is indicative of arid west seasonally flooded stream channels. Further review of the area reveals these intermittent streams are isolated features not connected to jurisdictional Waters of the U.S. The NWI data also depicts ephemeral arroyos draining the adjacent Sacramento Mountains from the north and east to the south and west. Surface hydrology from these drainages originates in the Sacramento Mountains to the east in the form of rainfall or snowmelt.

Huff (2005) stated the Tularosa Basin is a closed basin with no through-flowing surface water features (p.4). The only perennial water in the Tularosa Basin is found in small streams along the eastern side of the basin, which are fed by snowmelt and precipitation in the Sacramento Mountains (Waltemeyer, 2001). There are no perennial streams within the nearby study area and no surface waters within the study area are considered jurisdictional Waters of the U.S. by the USACE.

5.6.2.2 Ground Water

Groundwater recharge occurs largely from rainfall and snowmelt in the Sacramento and San Andres mountains, where intermittent streamflow infiltrates into the coarse, loosely consolidated alluvial fan material at the base of the mountains. Although streamflow is greatest during the summer monsoons, most recharge occurs in the winter months (Wilkins, 1986). Recharge for the Tularosa Basin is estimated to be greater than 100,000 acre-feet per year with the greatest portion accumulating at the base of the Sacramento Mountains (Meinzer and Hare, 1915). The USAF *Delineations of Jurisdictional Waters of the United States and Wetlands on Holloman Air Force Base, New Mexico* (as cited in HAFB, 1999; 2011) states HAFB lies within the groundflow gradient from the Sacramento foothills to the lowest point within the basin, Lake Lucero, to the southwest of the Main Base. Groundwater at the margins of the basin within the bajada of the Sacramento Mountains grade from fresh water (containing less than 1,000 milligrams per liter [mg/L] total dissolved solids [TDS]) to highly alkaline sources near the center of the basin with more than 100,000 mg/L TDS.

As reported by HAFB (1999; 2011), the Boles Well Field groundwater is the primary source for potable water for HAFB. The depth to groundwater is approximately 270 feet, which is considered sufficient to prevent contamination by sewage effluent from adjacent residential communities and the only significant drawdowns of the aquifer was recorded during the drought of 1982. The wells produce water from between approximately 100 to 1,750 gallons per minute. The wells pump sand mixed with water into a sand trap that separates the sands from the water, subsequently depositing water into the Boles Well tank. From the tank, pipelines carry the water to HAFB via gravity flow (HAFB, 1999; 2011).

5.6.2.3 Floodplains

The northwest portion of the study area is located within FEMA Floodplain Zone A, as depicted on FEMA Flood Insurance Rate Map (FIRM) 35035C1180D and 35035C1200D (FEMA, 2019) (**Figure 6**). The remainder of the study area is not located within the 100-year or 500-year floodplain and is designated as Zone X. This designation refers to areas of minimal flood hazard, which are outside the 100-year and 500-year floodplains and higher than the elevation of the 0.2-percent-annual-chance flood.

5.6.2.4 Wetlands

The study area was assessed utilizing the USFWS wetlands mapper which provides NWI data layers for project planning purposes (USFWS, 2019a). Review of the NWI layers do not indicate the presence of wetlands within the study area.

5.7 Biological Resources

5.7.1 Definition of Resources

Biological resources include local and regional flora, fauna, and their associated habitats. The study area occurs in the Chihuahuan Deserts EPA Level III Ecoregion and Chihuahuan Basins and Playas Level IV Ecoregion (Griffith et al., 2004). This ecoregion includes alluvial fans, internally drained basins, and river valleys below 3,500 feet. These low elevation areas represent the hottest and most arid habitats in Texas, with less than 12 inches of precipitation per year. Precipitation amounts are highest in July, August, and September, and winter precipitation is relatively sparse. The playas and basin floors have saline or alkaline soils and areas of salt flats, dunes, and windblown sand. The typical desert shrubs and grasses growing in these environments, such as creosotebush (*Larrea tridentata*), tarbush (*Flourensia cernua*), fourwing saltbush (*Atriplex canescens*), blackbrush (*Acacia rigidula*), gypsum grama (*Bouteloua breviseta*), and alkalai sacaton (*Sporbolus airoides*), must withstand large diurnal ranges in temperature, low available moisture, and an extremely high evapotranspiration rate.

5.7.2 Existing Conditions

The study area encompasses approximately 1,591 acres of desert shrubland within the Boles Well Field. The Boles Well Field is a broad, nearly level, slope of alluvial material located on the western Sacramento Mountains bajada. The area is dissected by natural ephemeral streams, channelized drainages, and excavated basins (HAFB, 1999; 2011). The landscape is largely undeveloped but was historically used for farming and livestock grazing. The vegetation community is consistent with existing native communities in the area that form the Chihuahuan Desert Ecoregion. Typical vegetation and wildlife communities within the study are described below.

5.7.2.1 Vegetation

Vegetation surveys conducted in 2004-2005 by the Natural Heritage New Mexico (NHNM) found that the dominant vegetation community within the study area was sparse creosotebush shrubland with mesquite as a subdominant species (Esteben et al., 2006). This vegetation community consists of creosote bush, honey mesquite (*Prosopis glandulosa*), mariola (*Parthenium incanum*), and ocotillo (*Fouquieria splendens*). Some grassland elements are supported such as black grama (*Bouteloua eriopoda*) and bush muhly (*Muhlenbergia porteri*). Feather fingergrass (*Chloris virgata*) exists within the understory of the honey mesquite, sometimes with scattered clumps of alkali sacaton and is quick to colonize disturbed areas (HAFB, 1999; 2011). However, based on conditions observed during the March 10, 2020 site visit, and personal communication with HAFB planning staff, the study area was cleared for agricultural use and surface water collection in the 1950s. The clearing of vegetation likely exposed more soil surface to drought, rainfall, surface water runoff, and erosion over time. The continued erosional disturbance, paired with the arid climate and relatively slow growth rate of xeric desert species, appears to have reduced the study area's ability to regenerate native vegetation communities over time and stabilize local soils. The current vegetative community was sparse when compared to adjacent properties and exhibited low species diversity and extensive signs of soil scour and resultant plant hummocks. Once the surface soil is weakened and the vegetative community is no longer able to stabilize soils, high winds during dry periods are able to further erode and displace soils in addition to the runoff related soil erosion. Dominant plant species within the study area included honey mesquite, creosotebush, and prickleypear (*Opuntia* spp.) and the more intact vegetative communities were observed in slightly elevated portions of the study area that are less susceptible to surface runoff and erosion, as depicted on **Figure 7**. **Figure 8** provides similar vegetative cover estimates but overlays these layers on a digital elevation model to depict the subtle surface drainage patterns with the study area and the potential reason for the subsequent erosional and vegetative growth patterns. These areas were largely located in the western and eastern portions of the study area, in the Preferred Alternative and Alternative 2 project areas.

New Mexico Territorial Laws Chapter 76 Article 7, the New Mexico Noxious Weed Act of 1963, and the Federal Noxious Weed Act of 1974 direct how noxious weeds are to be managed throughout the state and the nation. Noxious weeds within New Mexico are distinguished by a class ranking system in which Class A are those species currently not present, or having a limited distribution in the State; Class B are those species limited to portions of the State; and Class C are those species that are widespread throughout the State. Preferred management means include eradication, prevention, and control.

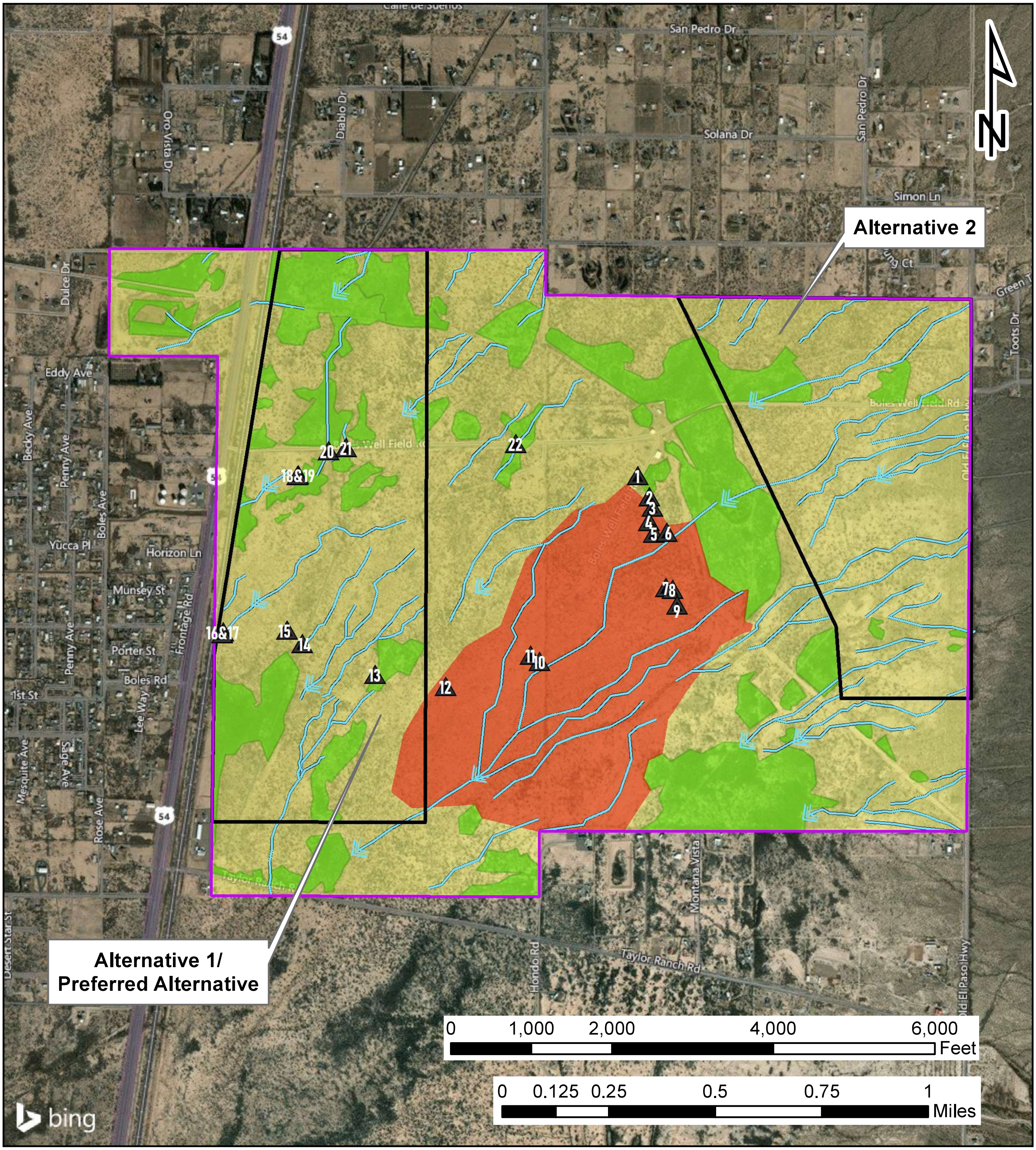
African rue (*Peganum harmala*) and saltcedar (*Tamarix ramosissima*) are plant species targeted by the New Mexico Department of Agriculture as noxious weeds (HAFB, 2015). African rue and saltcedar are Class B and Class C weeds, respectively. Other, unclassified introduced species, such as Lehmann's lovegrass (*Eragrostis lehmanniana*) and bermudagrass (*Cynodon dactylon)* were identified around disturbed sites such as wellheads and along roads. Vehicular disturbances into undisturbed sites may potentially lead to further spread of these invasive species.

5.7.2.2 Wildlife

Multiple wildlife observations have been recorded in the region, including porcupine (*Erethizon dorsatum*) and mule deer (*Odocoileus hemionus*) near the facilities within the Boles Well Field (HAFB, 1999; 2011). Other wildlife species common to the area include coyote (*Canis latrans*), black-tailed jackrabbit (*Lepus californicus*), and the Texas horned lizard (*Phrynosoma cornutum*).The silty loams and sparsely vegetated shrublands of the lower alluvial fans provide good burrowing habitat and provide an adequate food supply of harvester ants (*Pogonomyrmex* spp.). According to the INRMP, common birds sighted within the Boles Well Field are: Gambel's quail (*Callipela gambelii*), common nighthawk (*Chordeiles acutipennis*), common poorwill (*Phalaenoptilus nuttallii*), white-throated swift (*Aeronautes saxatalis*), broad-tailed hummingbird (*Selasphoros platycercus*), Bewick's wren (*Thryomanes bewickii*), and bronzed cowbird (*Molothrus aeneus*) (HAFB, 1999; 2011).

5.7.2.3 Threatened, Endangered, and Sensitive Species

Congress passed the ESA in 1973, expressing the need and esthetic, ecological, educational, recreational, and scientific value of at-risk biological species to our environment. It further expressed concern that many of our nation's native plants and animals were in danger of becoming extinct. The ESA is administered by the USFWS and the Commerce Department's National Marine Fisheries Service (NMFS). The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend (USFWS,



Legend

Study Area

Project Area

Highest Vegetative Cover* (Erosion Potential Low/Medium**)

Moderate Vegetative Cover* (Erosion Potential Medium/High**)

Limited to No Vegetative Cover* (Erosion Potential High**)

Surface Water Flow Direction*

Photo Reference Points (see Appendix A)

Dominant Erosional Features*

*Based on aerial photo interpretation; **Based on field observations

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Estimated Vegetative Cover

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FIGURE
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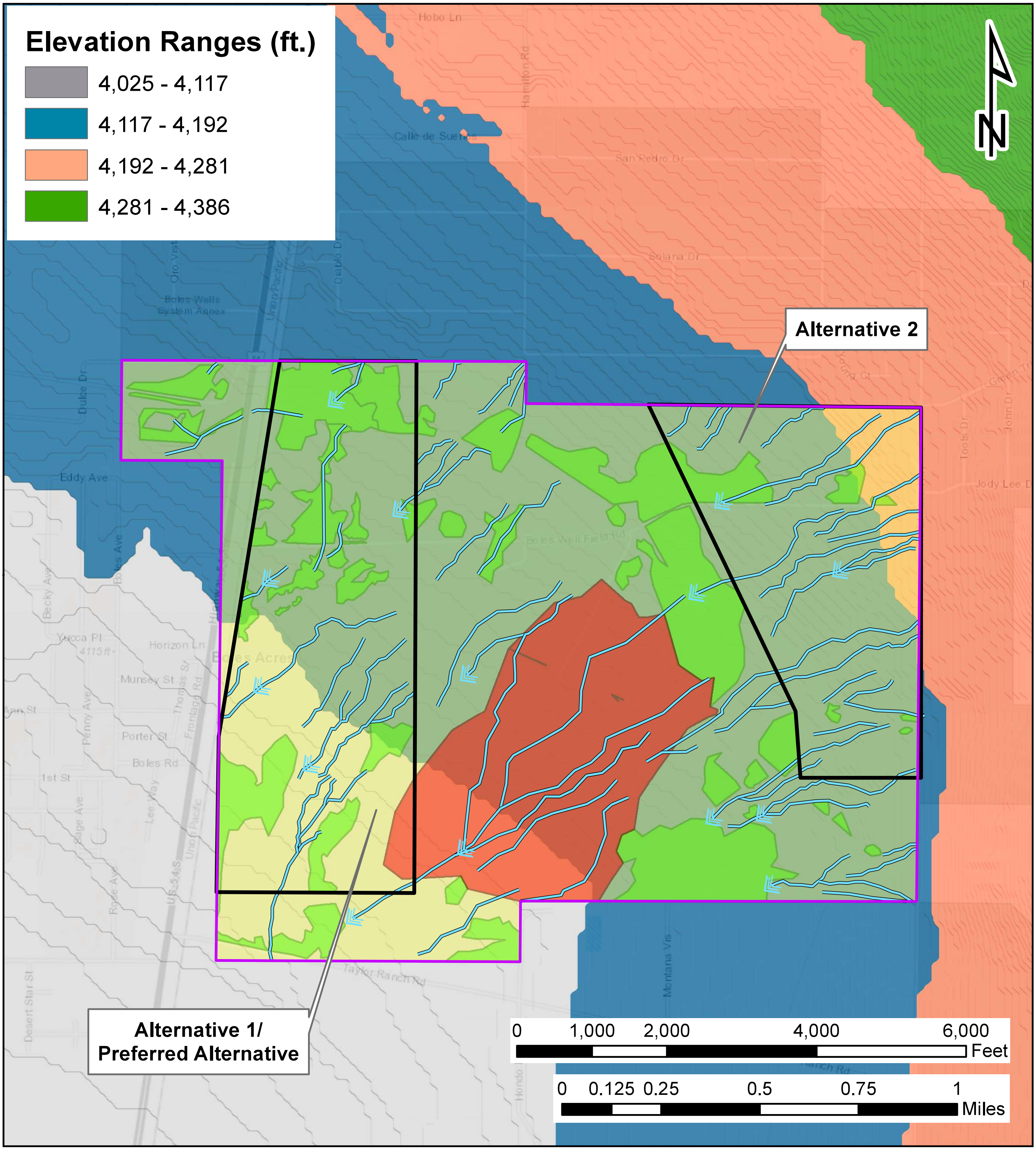

Legend

Study Area

Project Area

Surface Water Flow Direction*

Dominant Erosional Features*

Highest Vegetative Cover* (Erosion Potential Low/Medium**)

Moderate Vegetative Cover* (Erosion Potential Medium/High**)

Limited to No Vegetative Cover* (Erosion Potential High**)

*Based on aerial photo interpretation; **Based on field observations

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Holloman Air Force Base
Otero County, New Mexico

Digital Elevation Model Map

HAFB Renewable Energy - Draft EA

ARCADIS

FIGURE
8

2019b). The Service has primary responsibility for terrestrial and freshwater organisms, while the responsibilities of NMFS are mainly marine wildlife such as whales and anadromous fish (e.g., salmon).

Under the ESA, species may be listed as either threatened or endangered (T&E). Endangered means a species is in danger of extinction throughout all or a significant portion of its range, while the threatened designation means a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. As outlined in the ESA, as well as the New Mexico Wildlife Conservation Act of 1978 and associated agency regulations, T&E species are subject to protection from impacts associated with proposed actions. Protection varies depending upon the State or Federal listing status of each species, whereby an endangered or threatened listing provides Federal and/or State protection for that species throughout all or a significant portion of its range. Candidate species are those for which data has been presented to USFWS in support of a listing determination, but the process of listing has not yet gone to completion or is on hold. Take of federally listed or state-listed T&E species may result in fines and imprisonment if the action occurs without appropriate permits.

Federal Species of Concern (SOC) listings include taxa for which further information is needed to resolve their conservation status. These species are considered unlisted and do not receive federal protective measures, but they are often included in project planning for data gathering purposes and failure to consider these species in project planning may result in project delays. Federal SOC are often also state listed by other agencies as T&E or sensitive species. Voluntary Protection of SOC or sensitive species is typically considered a proactive measure to keep the population from becoming degraded and officially listed as T&E. Extirpated species (as defined by the USFWS and New Mexico Department of Game and Fish [NMDGF]) are species that no longer occur in areas that they previously inhabited. However, the potential for unknown populations of the species to actually remain, or the presence of suitable habitat to re-establish the species, often merits consideration during the project planning process.

Arcadis reviewed the USFWS Information for Planning and Consultation (IPaC) tool, NMDGF BISON-M data, and other available literature to evaluate the likelihood for T&E plant and wildlife species to occur within the study area (USFWS, 2019c; NMDGF, 2019; Esteben et al., 2006; HAFB, 1999; 2011). Representative T&E species lists are provided in **Appendix B** and **Table 5** below provides a consolidated list of state and federally listed T&E species of potential occurrence in Otero County, New Mexico. Of the state and federally listed species of potential occurrence, none are reported to occur within the study area. According to the IPaC report, the study area does not contain critical habitat for any of the federally listed T&E species known to occur in Otero County. However, potentially suitable habitat may occur for some of the species in **Table 5**, Those species are discussed further below.

Table 5. Federal and State-listed Threatened and Endangered Species of Potential Occurrence in Otero County, New Mexico

Common Name	Scientific Name	Federal Status[1]	State Status[2]
T&E Wildlife			
Aplomado falcon	*Falco femoralis*	E, Exp	E
Peregrine falcon	*Falco peregrinus*		T
Bell's vireo	*Vireo bellii*		T

Gray vireo	*Vireo vicinior*		T
Common black hawk	*Buteogallus anthracinus*		T
Mexican spotted owl	*Strix occidentalis lucida*	T	
Loggerhead Shrike	*Lanius ludovicianus*		S
Least tern	*Sterna antillarum*	E	E
Yellow-billed cuckoo	*Coccyzus americanus*	T	
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	E
Spotted bat	*Euderma maculatum*		T
T&E Plants			
Kuenzler's hedgehog cactus	*Echinocereus fendleri* var. *kuenzleri*	T	
Sacramento prickly poppy	*Argemone pleiacantha* ssp. *pinnatisecta*	E	

1 – U.S. Fish and Wildlife Service (USFWS), 2019.

2 – New Mexico Department of Game and Fish (NMDGF) - Biota Information System of New Mexico (BISON-M), 2019.

T=threatened; E=endangered; S=sensitive/candidate; Exp=experimental population, non-essential

T&E Wildlife Species

A total of 11 federal and state listed T&E or sensitive species are species of potential occurrence in Otero County, New Mexico. Of those 11 species, 10 are bird species and one is a bat. Based on habitat requirements and availability, the bell's vireo and loggerhead shrike may utilize the study area, particularly during the breeding season. Bell's vireo (*Vireo bellii*) prefer shrubby, scrubby habitats such as young forests, stands of dense brush on prairies, verdant arroyos or mesquite woods. This species has not been previously observed in the study area. Loggerhead shrike (*Lanius ludovicianus*) prefer semi-open country with shrubs, such as mesquite, in New Mexico. The species often utilizes fence posts and utility lines for lookout posts. According to the 1999 and 2011 INRMP (HAFB, 1999; 2011), this species has been previously observed near the study area.

The remaining listed T&E wildlife bird species have the potential to use the study area as stopover habitat during migration, but are unlikely to nest due to lack of appropriate nesting habitat. Little is known about the preferred roosting habitat for spotted bats (*Euderma maculatum*). The species has not been previously observed within the study area.

T&E Plant Species

Two federally listed T&E species are species of potential occurrence in Otero County, New Mexico. Kuenzler's hedgehog cactus (*Echinocereus fendleri* var. *kuenzleri)* is endemic to the Northwest Sacramento Mountains and grows primarily on gentle, gravelly to rocky slopes and benches with course soil composition to allow for rapid drainage. It is typically associated with the lower fringes of pinyon-juniper woodlands. This species has not previously been observed within the study area.

Sacramento prickly poppy (*Argemone pleiacantha* ssp. *pinnatisecta*) is also endemic to the western slopes of the Sacramento Mountains and grows on loose gravelly soils of disturbed sites, canyon bottoms, and sometimes along roadsides. Its presence is episodic and may only occur during years with sufficient rainfall. The species has not previously been observed within the study area.

5.7.2.4 Migratory Birds

The Migratory Bird Treaty Act (MBTA) of 1918 (16 US Code [USC] 703-712) is administered by the USFWS and is the cornerstone of migratory bird conservation and protection in the U.S. The MBTA authorizes the Secretary of the Interior to regulate the taking of migratory birds; and provides that it shall be unlawful, except as permitted by regulations, “to pursue, take, or kill any migratory bird, or any part, nest, or egg of any such bird” (16 USC 703). The list of species protected by the MBTA was revised in March 2013, and includes almost all bird species (1,026 species) that are native to the U.S. In 2015 the Fifth Circuit Court of Appeals held that the MBTA’s ban on bird “takings” only prohibits intentional acts that directly kill migratory birds (e.g., hunting). The USFWS subsequently published a notice of intent to prepare a programmatic environmental impact statement in support of a new incidental take permit (ITP) program under the MBTA. However, the USFWS has published several provisions of the MBTA and supplemental guidance, including an April 11, 2018 *Guidance on the recent M-Opinion affecting the Migratory Bird Treaty Act* (DOI, 2018).

According to the *Guidance on the recent M-Opinion affecting the Migratory Bird Treaty Act*, the M-Opinion concludes that the take of birds resulting from an activity is not prohibited by the MBTA when the underlying purpose of that activity is not to take birds. USFWS interprets the M-Opinion to mean that the MBTA's prohibitions on take apply when the *purpose* of an action is to take migratory birds, their eggs, or their nests. Conversely, the take of birds, eggs, or nests occurring as the result of an otherwise lawful activity, the purpose of which is not to take birds, eggs or nests, is not prohibited by the MBTA.

The New Mexico burrowing owl (*Athene cunicularia*) is not listed as threatened or endangered by either the state or federal government. However, it is protected by both the MBTA and by New Mexico statute 17-2-14. According to the NMDGF, burrowing owls are known to occur within or near the study area (2019) and the proposed project may disturb ground nests for both wintering and migratory species of burrowing owl. Presence/absence surveys may be needed between the months of April and September, using NMDGF’s burrowing owl survey protocol to determine the potential for impacts to this species related to the proposed action.

5.8 Cultural Resources

5.8.1 Definition of Resources

Cultural resources are any manifestation of human activity, both past and present, in simplest terms. They range from prehistoric artifact scatters and campsites, to historic buildings and structures, Native American sites utilized in the past, and Native American sites utilized in the present to perform traditional cultural practices and rituals (i.e., Traditional Cultural Properties). Cultural resources that can be demonstrated to be significant under certain criteria and that are largely intact are considered to be eligible for listing in the NRHP. Cultural resources that are either listed in, or considered eligible for listing, the NRHP are referred to as historic properties.

The NHPA of 1966, as amended, is federal legislation that is concerned with the protection of cultural resources. Compliance with Section 106 of the NHPA is generally integrated into the overall NEPA process. Section 106 of the NHPA requires consideration of the potential effects of any federal action (aka, an

Undertaking) on historic properties. Federal undertakings are actions by the federal government that require federal permitting or funding. Section 106 of the NHPA is codified in 36CFR800, which outlines the process for compliance with the Act. Compliance with Section 106 of the NHPA is a four-step process that is completed by the lead federal agency in consultation with the State Historic Preservation Office (SHPO), the public, and any other identified interested parties to include Native American groups. The four steps are: 1) Determine if the proposed action is an undertaking, 2) Define the area of potential Effect (APE) of the undertaking, 3) Identify any historic properties within the APE, and 4) Assess the effects of the undertaking on any identified historic property.

The current proposed action has been determined to be an undertaking by HAFB. The APE is the geographical area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties (36 CFR 800.16[d]). For the current undertaking, the HAFB has determined that the APE will be the entire 1,591-acre study area as depicted in **Figure 2**.

5.8.2 Existing Conditions

5.8.2.1 Cultural Resources Background

The archaeological record of human occupation in the general area of the study area extends back approximately 12,000 years to 10000 B.C. (**Table 6**). Cultural materials associated with the Paleoindian period (10000-6000 B.C.) are rare but known from the area. Three sites associated with this period are known from nearby HAFB (HAFB, 2015). The Archaic period is divided into the early, middle, and late phases. Chihuahuan Tradition groups are theorized to have traversed the Tularosa Basin during the Archaic period (6000 B.C. – A.D. 200) in search of plant and animal resources. Remains from this period consist of small campsites. Excavations at the Keystone Dam site near El Paso, Texas suggest that winter base camps with pit structures were being established near reliable sources of water by 2000 B.C. Agriculture was being practiced by the end of the period with evidence for the cultivation of corn and squash (HAFB, 2015).

Table 6. Regional Cultural History Chronology (from HAFB, 2015)

Period/Phase	Date
Paleoindian	Ca. 10000-6000 B.C.
Archaic	6000 B.C.- A.D. 200
Early	6000-4300 B.C.
Middle	4300-900 B.C.
Late	900 B.C.- A.D. 200
Formative	A.D. 200- 1450
Mesilla	A.D. 200-1100
Doña Ana	A.D. 1100-1200
El Paso	A.D. 1200-1450
Protohistoric	A.D. 1450-1659

Historic	A.D. 1659-Present

The Jornada Mogollon tradition is the principal cultural tradition in southwestern New Mexico during the Formative period. It is characterized by the presence of pit houses, pueblos, and black-on-white pottery. A majority of the Jornada Mogollon sites recorded in southwestern New Mexico consist of ceramic sherd and lithic scatters suggesting a highly mobile population (Cordell, 1984). The Formative period is divided into three phases. The Mesilla Phase (A.D. 200-1100) is characterized by the use of pit houses, growing reliance on agriculture, and social and economic ties with the Mimbres Valley, as evidenced by the occurrence of Mimbres style ceramics (Cordell, 1984). In addition, small pit house villages from this phase are known from along the Rio Grande and on the alluvial fans along the mountain fronts (HAFB, 2015). During the succeeding Doña Ana Phase (A.D. 1100-1200), both pit houses and aboveground structures are known. During the El Paso Phase (A.D. 1200-1450), aboveground adobe pueblos are known the from the area, some of which are large enough to have been occupied by multiple family groups (HAFB, 2015).

The El Paso Phase pueblos were abandoned by A.D. 1450 and the area was occupied by the Mansos and Apache Indians. The Spanish arrived in the area around A.D. 1540, but were forced to abandon New Mexico following the Pueblo Revolt in 1680. The Spanish reconquered New Mexico in 1692 by forces that had been amassed in El Paso and the local Mansos Indians were missionized after 1700 by Christian missionaries. The Apache tribes had abandoned the Rio Grande valley and occupied the mountains surrounding it. Apache predations, however, continued after the reconquest and kept Hispanic settlers from gaining a permanent foothold in the Tularosa Basin until the 1800s (HAFB, 2015).

Following the conclusion of the Mexican-American War in 1848, the area was ceded to the United States and a military presence was established to protect settlers from bandits and Indian attacks. Fort Fillmore was established in La Mesilla in 1851 and Fort Bliss was established in El Paso in 1854. Fort Stanton was established in Capitan in 1855 and Fort Seldon was established in 1865 near Las Cruces (HAFB, 2015).

Small settlements continued to spring up along Rio Grande. Doña Ana was established in 1839, Las Cruces was established in 1849, and Mesilla was established in 1850. The village of La Luz was established in 1854 by Hispanic farmers from the Rio Grande valley near Socorro after a devastating flood. Tularosa was settled in 1855 and Alamogordo was founded as a railroad town in 1898. The historic Old La Luz Road connected the settlements of Tularosa and La Luz on the east side of the Tularosa Basin to Doña Ana and La Mesilla on the west side (HAFB, 2015).

The territorial period was tumultuous with the violent altercations between competing business concerns in the Lincoln County War (1878) and between the U.S. Cavalry and the Apaches during the long-running Apache Wars (1847-1890s). By 1900, the Apaches had been confined to reservations by the U.S. Cavalry. Settlers attempted to establish homesteads and ranches in the Tularosa Basin during the 1920s and 1930s, but only those near reliable sources of water survived. Passage of the Taylor Grazing Act in 1934 further restricted the pursuit of agriculture in the Tularosa Basin (HAFB, 2015).

The sparsely populated Tularosa Basin became a training ground for air crews and for the development and testing of weaponry with the outbreak of World War II in 1942. The Alamogordo Army Airfield and the Alamogordo Bombing and Gunnery Range were established by 1943. The first atomic bomb was detonated in 1945 at the Trinity Site at the north end of the Alamogordo Bombing and Gunnery Range. The White Sands Proving Grounds were established in 1945. The Alamogordo Army Airfield closed briefly in 1946 and the then re-opened in 1947 to test missiles and rockets and was renamed Holloman Air Force Base. Testing and missile development activities were moved to Vandenburg Air Force Base in 1962 and HAFB has been primarily used as a fighter base since 1970 (HAFB, 2015).

5.8.2.2 Cultural Resources Records Search

A records search of the APE was conducted through the New Mexico Cultural Records Information System (NMCRIS) on October 30, 2019. The entire 1,591-acre APE has been inventoried during the course of three large survey projects that occurred in 1993-1994 (NMCRIS Activity #s 44668 and 46375) and 1996 (NMCRIS #47962). Nine projects (NMCRIS #s 43143, 470635, 47757, 50185, 60426, 70635, 88839, 101379, and 111970) inventoried smaller areas, monitored construction, or performed evaluative test excavations at selected sites.

A total of 29 archaeological sites have been documented within the APE (**Table 7**). Eighteen of the sites are prehistoric, three are historic, and eight have both prehistoric and historic occupations. Twenty-two of the sites have no features associated with them and seven have associated features. Prehistoric periods represented include Paleoindian, Archaic, and Formative, with the Formative period the primary period represented. Paleoindian period sites (n=2) are associated with the Folsom/Midland technocomplex. Archaic sites (n=7) are primarily associated with the Late Archaic phase. The majority of the Formative period sites (n=17) are affiliated with the Jornada Mogollon tradition. Historic period sites (n=11) primarily date to the first half of the 20th century (1906-1950). Six of the sites have been informally determined to be eligible for the NRHP by the New Mexico State Historic Preservation Office (SHPO) and one historic site has been informally determined to be not eligible. The remaining 22 sites have not been evaluated for NRHP eligibility. Three of the previously recorded sites (LA104267, LA108110, LA108111) are located within the planned development area for the Preferred Alternative and five (LA100170, LA104265, LA104272, LA104273, and LA144440) are located within the development area for Alternative 2. Only LA100170 has been evaluated for the NRHP. It is informally determined to be eligible for the NRHP by the New Mexico SHPO.

Table 7. Recorded Archeological Sites within the Area of Potential Effect

Site LA #	Site Name	Site Type	Temporal Affiliation	NRHP Evaluation	Associated Alternative
100168		Prehistoric with features	Archaic (3000 B.C.-A.D.200); Formative (A.D. 750-1400)	Unevaluated	None
100170	James McKillip Farm	Prehistoric/Historic with features	Archaic (1800 B.C.-A.D. 200); Formative A.D. 1200-1400; Historic 1908-1950	Eligible	Alternative #2
103412	Boles Farm; Walthall Farm	Prehistoric/Historic with features	Formative (A.D. 1200-1400); Historic (1908-1959)	Eligible	None

103413	Well D	Prehistoric/Historic with features	Unspecified Prehistoric; Historic (1947-1953)	Not Eligible	None
103414	Grooms Place	Prehistoric/Historic with features	Formative (A.D. 1050-1400); Historic (1908-1913)	Eligible	None
103415	Reynolds Dairy	Prehistoric/Historic with features	Archaic (1800 B.C.-A.D. 400); Historic (1908-1929)	Eligible	None
103416	Arthur Blair Homestead	Historic with features	Historic (1906-1910)	Eligible	None
103417		Prehistoric artifact scatter	Formative (A.D. 200-1400)	Eligible	None
104259		Prehistoric artifact scatter	Formative (A.D. 200-1400)	Unevaluated	None
104260		Prehistoric artifact scatter	Archaic (5500-1800 B.C.); Formative (A.D. 200-1400)	Unevaluated	None
104261		Prehistoric artifact scatter	Archaic (1800 B.C.-A.D. 200); Formative (A.D. 1100-1400)	Unevaluated	None
104262		Prehistoric artifact scatter	Formative (A.D. 1150-1400)	Unevaluated	None
104263		Historic artifact scatter	Historic (1880-1920)	Unevaluated	None
104264		Historic with features	Historic (1946-1959)	Unevaluated	None
104265		Prehistoric with features	Formative (A.D. 200-1400)	Unevaluated	Alternative #2
104267		Prehistoric artifact scatter	Paleo Indian (9000-8000 B.C.); Unspecified Prehistoric	Unevaluated	Preferred Alternative
104268		Prehistoric artifact scatter	Formative (A.D. 200-1400)	Unevaluated	None
104269		Prehistoric artifact scatter	Unspecified Prehistoric	Unevaluated	None
104270		Prehistoric artifact scatter	Formative (A.D. 200-1400)	Unevaluated	None
104271		Prehistoric artifact scatter	Formative (A.D. 750-1100)	Unevaluated	None

104272	Prehistoric artifact scatter	Formative (A.D. 200-1400)	Unevaluated	Alternative #2
104273	Prehistoric artifact scatter	Formative (A.D. 750-1100)	Unevaluated	Alternative #2
108110	Prehistoric/Historic artifact scatter	Unspecified Prehistoric/Unspecified Historic	Unevaluated	Preferred Alternative
108111	Prehistoric artifact scatter	Paleo Indian (9000-6000 B.C.); Archaic (900 B.C.-A.D.200); Formative (A.D. 1100-1450)	Unevaluated	Preferred Alternative
108112	Prehistoric/Historic artifact scatter	Unspecified Prehistoric/Unspecified Historic	Unevaluated	None
108113	Prehistoric/Historic artifact scatter	Unspecified Prehistoric/Unspecified Historic	Unevaluated	None
108114	Prehistoric artifact scatter	Archaic (900 B.C.-A.D. 200); Formative (A.D. 200-1400)	Unevaluated	None
130324	Prehistoric artifact scatter	Unknown	Unevaluated	None
144440	Prehistoric artifact scatter	Unknown	Unevaluated	Alternative #2

5.9 Land Use

5.9.1 Definition of Resource

Land use applies to how humans manage territory for housing, recreation, conservation, economic, and governmental purposes. Land may be manged in a natural or modified state causing changes in the local environment.

5.9.2 Existing Conditions

The study area primarily consists of undeveloped land that is part of the Boles Well Field, which is used to provide potable water to HAFB. There are multiple primitive roads used to access the individual wells and associated transmission lines located within the study area. Each of the primitive roads in connected to a main gravel road that bisects the area running east to west. The proposed project area is directly adjacent to the town of Boles Acres, which is a small community recognized as a Census Designated Place (CDP) by the U.S. Census Bureau with a population of approximately 1,638 according to the 2010 census (USCB, 2017).

5.10 Socioeconomics and Environmental Justice

5.10.1 Definition of Resource

Under EO 12898, federal agencies must assess environmental justice for a proposed action as part of its mission. Air Force guidance for implementation of the EO is provided in the "Interim Guide for Environmental Justice Analysis" within the EIAP (USAF, 1997).The objective of the EO is to identify and address the potential for disproportionately high and adverse health or environmental effects on minority and low-income communities due to the proposed action.

5.10.2 Existing Conditions

As previously described, the study area primarily consists of undeveloped land that is part of the Boles Well Field, which is used to provide potable water to HAFB.

5.10.2.1 Socioeconomics

Based on review of the U.S. Census Bureau (USCB) data for New Mexico, the 2013 to 2017 population estimates for Alamogordo (30,963) remained consistent with the official 2010 Census population of 30,403 USCB, 2010; 2017). This estimate represents a slight increase of approximately 1.8 percent in the total population and is considered a negligible population change in the region. In comparison, the total population for the State of New Mexico increased approximately 1.3 percent over the same timeframe, from 2,059,179 in the 2010 to approximately 2,084,828 (USCB, 2017).

Table 8 provides a comparison of the demographic and socioeconomic data associated with the national population, the State of New Mexico, and Alamogordo, which is the nearest major town to the study area (**Figure 1**).

Table 8. Demographic and Socioeconomic Comparison of Alamogordo, New Mexico; the State of New Mexico; and the United States

Characteristic	Alamogordo, New Mexico	State of New Mexico	United States
Racial Characteristics			
Total Population	30,963	2,084,828	321,004,407
White	79.1%	74.2%	73.0%
Black or African American	4.5%	2.0%	12.7%
American Indian and Alaska Native	1.7%	9.5%	0.8%
Asian	1.9%	1.4%	5.4%
Native Hawaiian and Other Pacific Islander	0.2%	0.1%	0.2%
Hispanic or Latino	34.4%	48.2%	17.6%
Other Race	7.8%	9.5%	4.8%

Characteristic	Alamogordo, New Mexico	State of New Mexico	United States
Social Characteristics			
Speak a language other than English at home (population 5 years and over)	21.8%	35.0%	21.3%
Economic Characteristics			
Families below poverty level	13.0%	15.6%	10.5%
Individuals below poverty level	17.3%	20.6%	14.6%
Median household income in 2017 inflation-adjusted dollars	$45,531	$46,718	$57,652

Source: USCB, 2017

5.10.2.2 Environmental Justice

A 15-mile buffer around the study area was assessed using the EPA online Environmental Justice Screen and Mapping Tool, Version 2018 (EJSCREEN; EPA 2018; **Figure 9**). The EJSCREEN Report for the area assessed is included in **Appendix D.**

The Study Area is part of the Boles Well System Annex and is owned by the Bureau of Land Management (BLM) according to the Otero County Tax Assessor's office (Otero, 2019). Properties zoned for residential use, both currently developed as residential properties and those owned by a residential company, are located adjacent to the study area (Otero 2019). However, the general population density is relatively low (**Figure 10**). A section of the undeveloped property to the east is owned by Otero Sunsets Estates, LLC with the remaining majority also owned by the BLM (Otero 2019).

The majority of the population within 15 miles of the study area are 40 percent minority (EPA 2018; **Figure 11**). The percent of the surrounding population that is considered to be of low-income ranges from less than 50 percent to the 95-100th percentile (EPA 2018; **Figure 12**). However, the overall low-income population is 41 percent, which is two percent less than the State of New Mexico's average (EPA 2018).

Figure 9. EPA Online Environmental Justice Screen and Mapping Tool, Version 2018

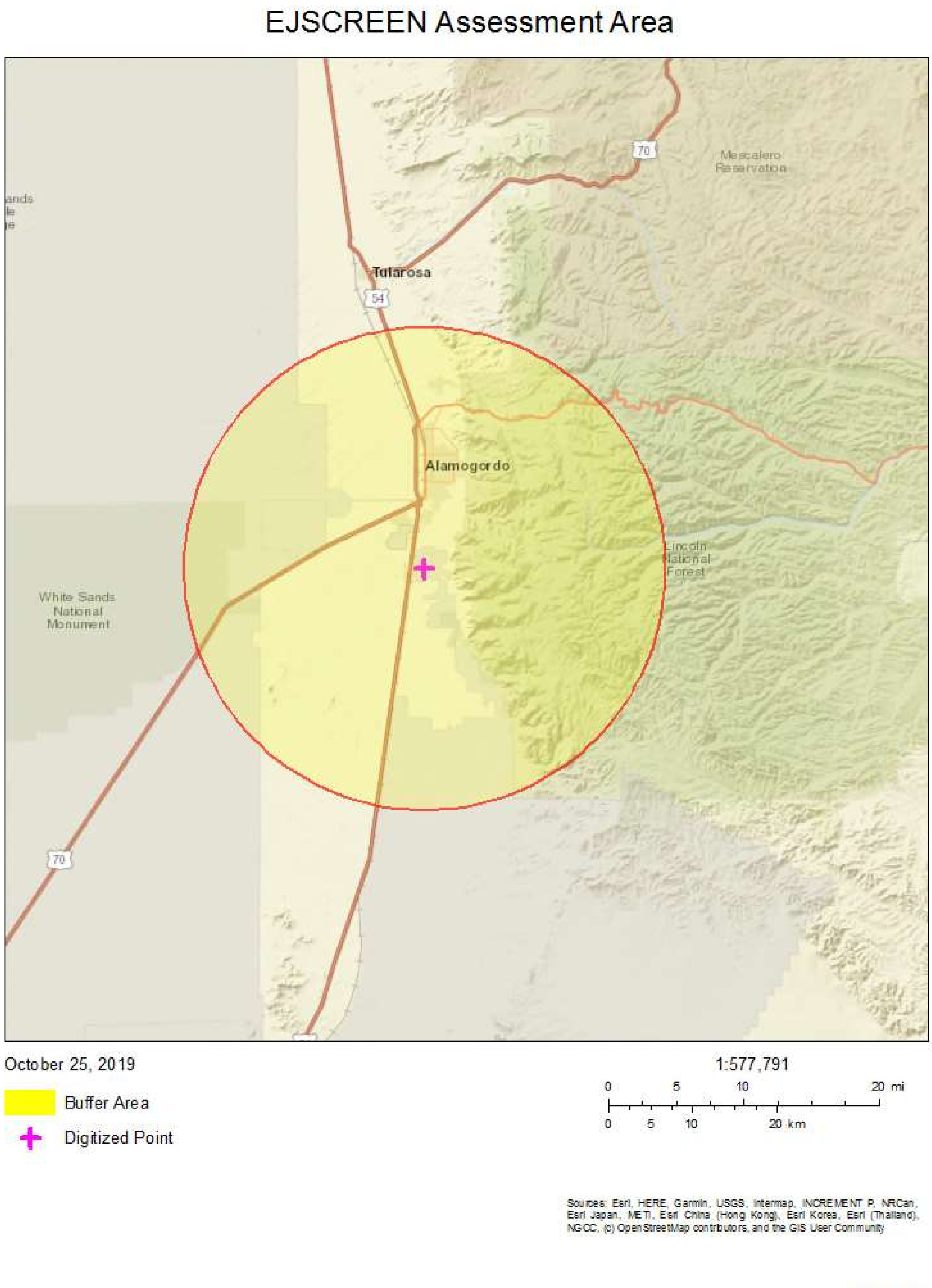


Figure 10. Population Density within a 15-mile Buffer of the Study Area

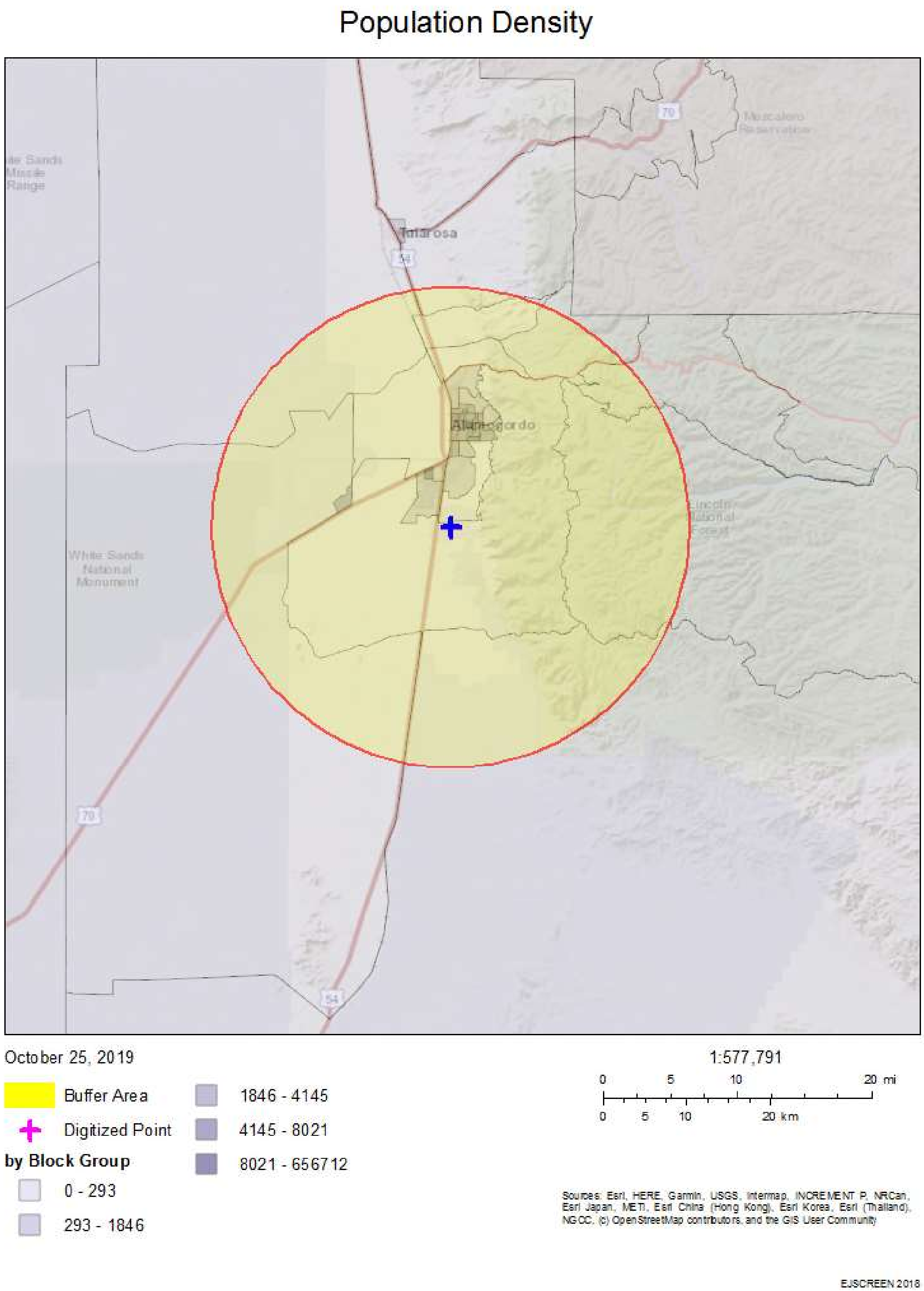


Figure 11. Minority Populations within a 15-mile Buffer of the Study Area

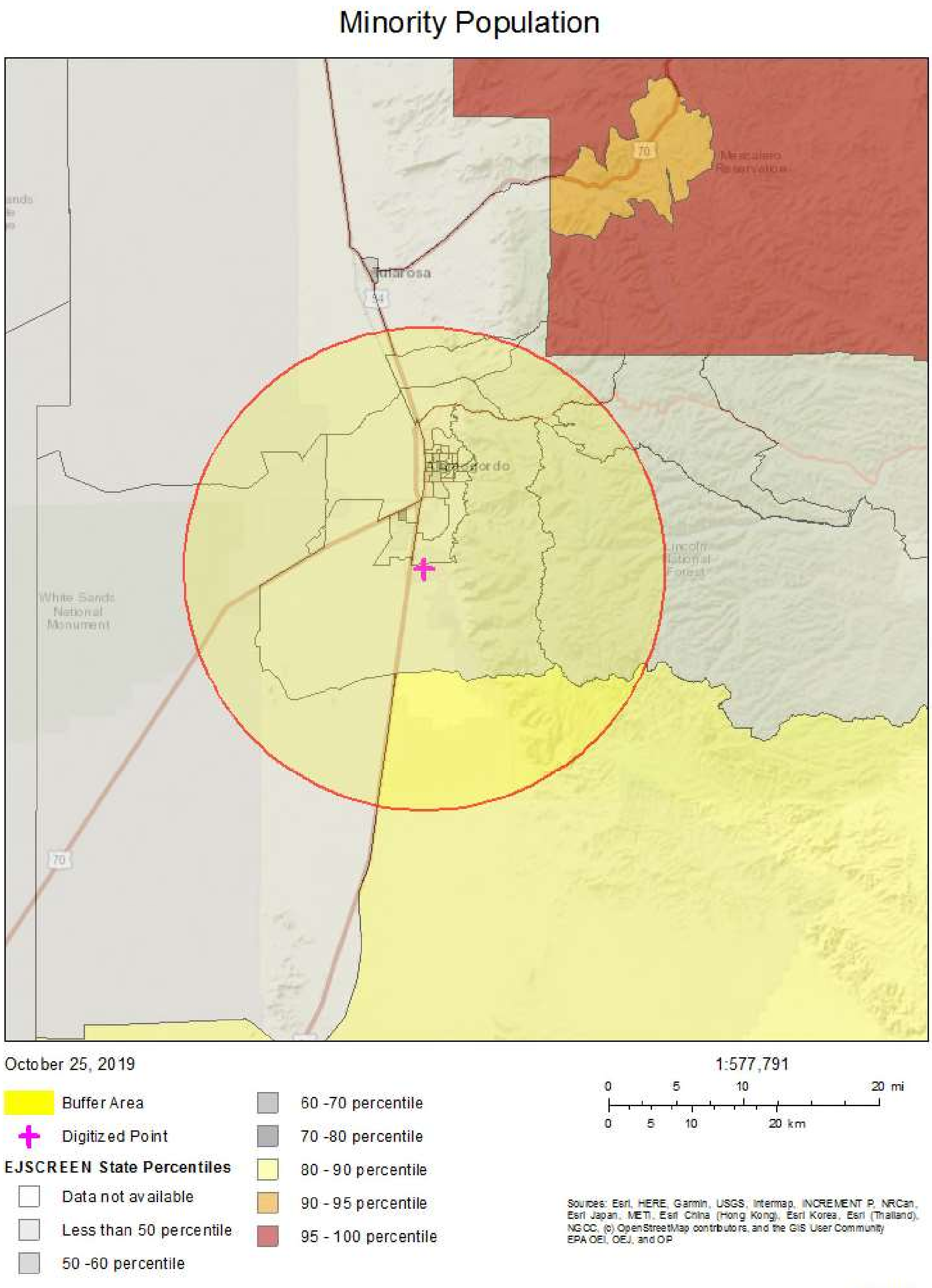
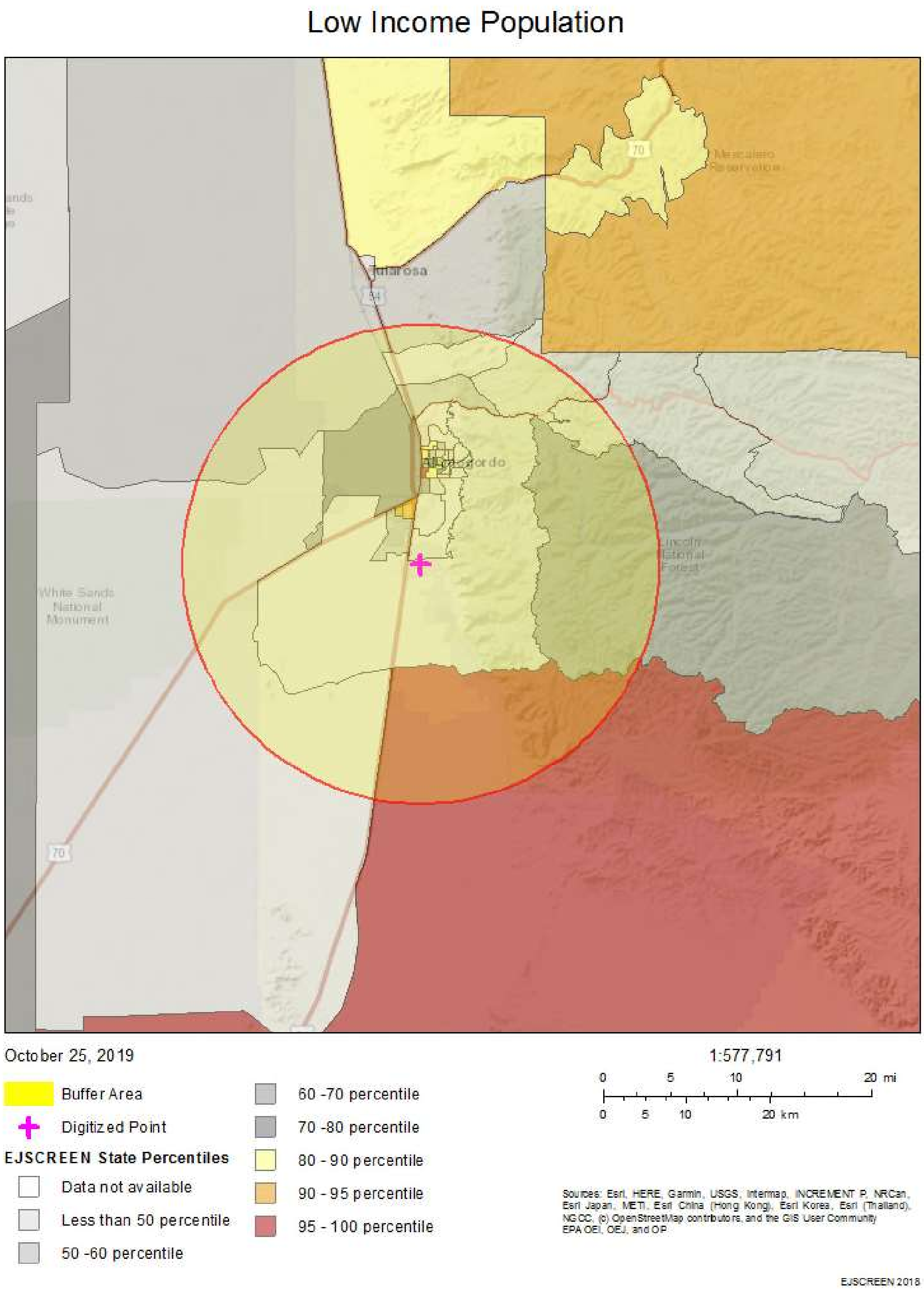


Figure 12. Low Income Populations within a 15-mile Buffer of the Study Area

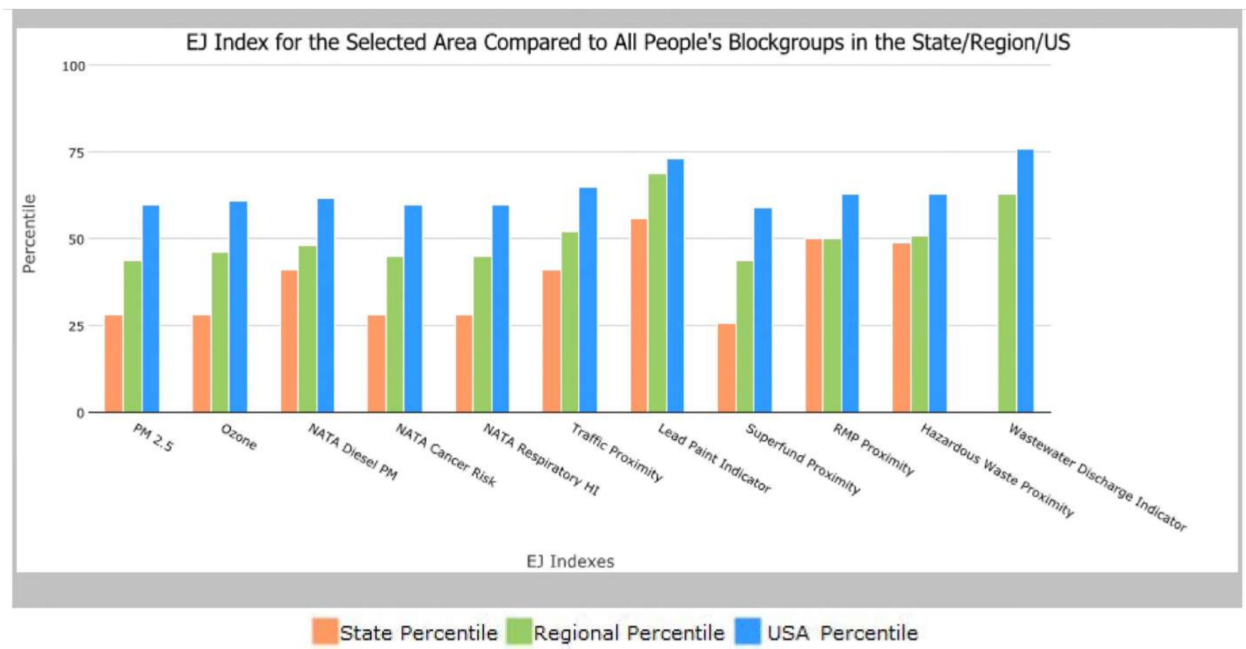


Additional environmental justice indices assessed include:

- environmental hazards such as particulate matter (PM 2.5) levels,
- ozone level in air,
- diesel PM in air (National-scale Air Toxics Assessment [NATA]),
- air toxics cancer risk (NATA cancer risk),
- air toxics respiratory hazard index (NATA respiratory HI),
- traffic proximity,
- lead paint indicator (percent of pre-1960 housing),
- proximity to a superfund site,
- proximity to a risk management plan (RMP) facility,
- proximity to a hazardous waste, and
- wastewater discharge indicator.

Figure 13 compares the state, regional, and national percentiles for these indexes within the 15-mile buffer area around the study area. This information is also included in the EJSCREEN Report provided in **Appendix D**. The State of New Mexico's percentages for all indices is lower than the EPA Region 6 or national percentages with exception to the RMP Proximity index.

Figure 13. Environmental Justice Indexes Comparison Within a 15-mile Buffer of the Study Area



5.11 Health and Safety

5.11.1 Definition of Resource

Health and safety resources are herein defined as potential impacts to overall the well-being of the local human military and civilian population including aircraft crew. Health and safety resources may relate to short or long-term harm impacts associated with physical/chemical/behavioral risks.

5.11.2 Existing Conditions

The Boles Well Field is a currently an open and relatively undeveloped tract of land and does not have operations that would normally be considered a health or safety hazard for the local population or aircraft flight operations. The wells within the field are used to provide potable water to HAFB. There are multiple primitive roads used to access the individual wells and associated transmission lines located within the proposed project area. Electrical transmission lines are known to emit electromagnetic radiation; however, electromagnetic emissions produced by electrical lines are not known to affect human health or interfere with aircraft flying over. The existing access road system poses minimal health and safety risk assuming safe driving practices and observed.

5.12 Solid Waste, Hazardous Materials and Wastes, Toxic Materials

5.12.1 Definition of Resource

The definition of uncontaminated terrain is land that does not present any hazardous waste, solid waste, or toxic material concerns. The terms of potential concerning activities, operations, or materials are defined using the Resource Conservation and Recovery Act of 1976 (42 USC 82), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 USC 103) as amended by the Superfund Amendments and Reauthorization Act of 1986, the Small Business Liability Relief and Brownfields Revitalization Act of 2002, and the Toxic Substances Control Act of 1976 (15 USC 53).

5.12.2 Existing Conditions

The Boles Well Field is a relatively undeveloped tract of land with operational activities confined the groundwater wells. The site does not contain waste systems, hazardous material operations systems, or toxic material operations. There are no solid or hazardous wastes or materials in the study area and impacts to the study area are unanticipated.

6.0 ENVIRONMENTAL CONSEQUENCES

6.1 Geology and Seismicity

6.1.1 Alternative 1 – Preferred Alternative

Construction of a PV array in the proposed location is not expected to create significant disturbance to the geology and seismicity of the area. It is expected that techniques and actions such as surface clearing, cable trenching, and shallow excavations for foundations would be used. The probability of seismic events is low in the area and construction would not be expected to cause any changes in the geologic structures that affect seismicity. Considering these factors, there are no expected impacts to geology or seismicity.

6.1.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, impacts to local geology and seismicity would be comparable to the Preferred Alternative.

6.1.3 Alternative 3 – Wind Energy

Under this alternative, the construction of wind energy turbines would have similar impacts to geology during the installation process, but would have a smaller impact in the long term due to a reduced need for extensive land clearing. Wind turbine structures would need to be installed into the existing ground surface on heavy foundations, along with the necessary access roads and staging areas for construction. The existing geology would be disturbed and impacted during construction, potentially to a greater depth due to the structural requirements of the wind turbine foundations. The structures would not affect or induce seismic events in the region but may be susceptible to future naturally occurring seismic events. Overall, this alternative would have similar impacts to geology and seismicity to those associated with the Preferred Alternative.

6.1.4 Alternative 4 – Geothermal Energy

Geothermal power plants and associated wells would have a relatively small footprint. A power production facility would need to be constructed, including the primary electrical generating plant, production and injection wells, and ancillary facilities. Pipelines would be required to transport geothermal fluid from production wells to the primary facility, and from the facility to injection wells. Similar to the existing water wells, drilling the geothermal wells would not adversely impact the underlying geology, nor would it create seismologic events. Overall, this alternative would have similar impacts to geology and seismicity to those associated with the Preferred Alternative.

6.1.5 No Action Alternative

Under the No Action Alternative, there would be no changes to the existing geology and seismicity.

6.2 Soils

6.2.1 Alternative 1 – Preferred Alternative

Construction of a PV array in the proposed location is expected to create some disturbance to the soils of the area, which will depend on the final PV array design and site layout. It is also likely that some BSC would be destroyed during construction, installation, and maintenance activities. Up to approximately 382 acres of land may be cleared and graded under this alternative, although the final PV array would likely require far less area. **Figures 7** and **8** provide an estimated vegetative ground cover for the study area, which is based on observations made during the March 10, 2020 site visit and subsequent aerial photo interpretation and GIS analysis. Based on these field observations, BSC were more frequently located within the interstitial space between more vegetated areas, likely because these areas experienced less surface runoff and erosion. Though not quantified through field survey, the estimated highest vegetative ground cover may provide an indication of BSC coverage within the study area. According to **Figures 7** and **8**, approximately 104 acres (approximately 27 percent) of existing BSC may potentially be impacted if the entire Preferred Alternative project area were developed. Disturbance caused by construction and installation activities may contribute to negative long-term, or even permanent, soil impacts (HAFB, 1999; 2011; Rosentreter et al 2007). It is likely that a higher percentage of wind-carried particles, also called fugitive dust, may arise due to disturbance and BSC removal or destruction. The impact of disturbing vegetation and soil crusts is reasonably expected to diminish over time with reseeding and regrowth from seeds and BSC spores remaining in the soil.

As previously described, regional soil types are known to be vulnerable to wind and water erosion and regional landowners have had challenges controlling the surface flow of water and managing the associated displacement of soil in the Tularosa Valley (Otero Soil and Water Conservation District, 2016). Tome soil types are susceptible to rapid erosion in response to exposure to wind when not held in place with vegetation or cryptobiotic crusts. Cryptobiotic crusts and roots are then pedestalled, exposed, and eventually eroded away through a combination of water and wind erosion activity. Because the study area is located at the base of the adjacent mountains, high volume rapid rainfall runoff enters the study area from the east/northeast and flows across the central portion of the study area to the southwest. This historical challenge led to the creation of diversionary channels throughout much of the region in order to alleviate flooding in the residential Boles Acres neighborhood. Ongoing erosion control measures will be an important project consideration and the creation of new surface water control channels/structures, or improvement of existing structures, will be a critical component of future project planning.

It is expected that some roads would need to be constructed and paved or gravelled. These actions have the potential to impact trafficked areas, both in short-term and long-term time frames, but neither of these actions are expected to create significant levels of disturbance. It is expected that a small percentage of the study area would be covered by impervious surfaces which would have the potential to reduce the amount of soil surface available to water infiltration and increase surface runoff. However, the project design will include measures to minimize erosion and the local terrain is gentle, so runoff is unlikely to impact the project's effectiveness or the ecology of the surrounding area.

In accordance with EPA requirements, construction activities would conform to a National Pollutant Discharge Elimination System (NPDES) permit, including preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP). Implementation of an appropriate design, as well as construction and post-construction Best Management Practices (BMP) would reduce the overall potential for soil erosion. Impacts on soils are reasonably expected to not be significant (HAFB, 2015).

6.2.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, impacts to soils would be comparable to the Preferred Alternative. According to **Figures 7** and **8**, approximately 18 acres of existing BSC may potentially be impacted if the entire Alternative 2 project area were developed.

6.2.3 Alternative 3 – Wind Energy

Under this alternative, the construction of wind energy turbines would have similar impacts to soil during the installation process but would have a smaller impact in the long term due to a reduced need for extensive land clearing. Wind turbine structures would need to be installed into the existing ground surface on heavy foundations, along with the necessary access roads and staging areas for construction. The existing soils would be disturbed and impacted during construction, potentially to a greater depth due to the structural requirements of the wind turbine foundations. Overall, this alternative would have similar impacts to soils to those associated with the Preferred Alternative.

6.2.4 Alternative 4 – Geothermal Energy

Geothermal power plants have relatively small surface footprints, which is in the range 18-74km^2/TW h, with major elements located underground (Bertani 2005). Ganon et al. reported a total footprint of 72 km^2/TW h for wind power, without allocating any share of this to agriculture (2002). Lackner and Sachs find a land occupation of 28-68 km^2/TW h for PV power with no dual-purpose allocation (2005). Overall, the impact to surface soils would be less compared to the Preferred Alternative, but the subsurface impacts would increase.

6.2.5 No Action Alternative

Under the No Action Alternative, there would be no changes to the soils.

6.3 Air Quality

6.3.1 Alternative 1 – Preferred Alternative

It is expected that temporary impairment of air quality would occur from the construction of the PV facility. These expected impairments would include emissions from construction vehicles and fugitive dust released during construction, site visits, and maintenance. Fugitive dust can be a health and safety issue, as well as a general nuisance. It is expected that as biological soil crust is removed during construction and installation, fugitive dust may increase temporarily. Construction BMPs to address fugitive dust suppression, such as wetting temporary gravel roads and mulching, can be implemented to minimize impact until more permanent methods of dust suppression, such as BSC and vegetation re-growth, can be implemented. Disturbance of natural ground cover while constructing and maintaining a PV array would be considered extensive, but it would not be permanent. Vegetation that will need to be removed during the construction process would be expected to grow back within a reasonable timeframe. In the interim, fugitive dust releases would be expected to increase; however, it would not be expected to extensively impact HAFB or the town of Alamogordo.

During construction, proper maintenance of vehicles and equipment can be followed to prevent unnecessary greenhouse gas emissions. Emissions released during the construction of the proposed action would not be expected to cause a significant increase in local air pollutant concentrations. The proposed action would also not be expected to result in nonattainment for NAAQS or air quality standards. Conversely, construction of a PV array would contribute to a reduced dependence upon fossil fuels, which in turn will reduce emission production over time.

6.3.2 Alternative 2 – Eastern Study Area PV Development

This alternative is similar to the Preferred Alternative, but involves construction of the PV system on the eastern side of the study area. It is likely that slightly increased levels of fugitive dust and emissions would be released under this alternative as construction equipment and maintenance staff would be required to drive approximately one mile further along dirt roads to access the construction site. The extra distance from the main road may also require the construction of additional facilities, such as roads or electrical infrastructure. The construction of additional infrastructure would require more grading, site preparation, and vehicle use, which would temporarily increase the expected emissions and fugitive dust. However, appropriate construction BMPs could be implemented to mitigate any increases. Under this alternative, the air quality impacts would be comparable to the Preferred Alternative.

6.3.3 Alternative 3 – Wind Energy

Wind turbines do not release emissions or require water for cooling during operation and the construction of a wind farm would likely cause a reduction in the amount of fossil fuels that are needed locally/regionally to provide electricity to HAFB. However, as in the above alternatives, construction equipment emissions, and the creation of fugitive dust, would both be expected during the installation and maintenance of wind energy turbines. Overall, this alternative would have similar impacts to air quality as those associated with the Preferred Alternative.

6.3.4 Alternative 4 – Geothermal Energy

The production of geothermal power would require a power production facility to be constructed, including the primary electrical generating plant, production and injection wells, and ancillary facilities. Pipelines would be required to transport geothermal fluid from production wells to the primary facility, and from the facility to injection wells. Construction and maintenance of these facilities would be expected to take longer than other alternative actions. Therefore, effects from emissions from construction equipment and vehicles, as well as fugitive dust from the disturbance to the soil, would be expected to last longer.

Geothermal energy systems also produce steam to rotate the turbine that activates the generator. This steam is released through a cooling tower or towers, often resulting in large, dense steam clouds that could pose a potential hazard to air traffic. Geothermal steam clouds often contain trace gases such as hydrogen sulfide and carbon dioxide, a greenhouse gas. However, binary cycle power plants emit virtually no gases because of their closed-loop system (DOE, 2019).

6.3.5 No Action Alternative

Under the No Action Alternative, there would be no expected changes to the existing air quality.

6.4 Aesthetic Resources

6.4.1 Alternative 1 – Preferred Alternative

Federal law does not specifically protect visual resources under normal circumstances, but both federal and state land management agencies may incorporate regulations regarding visual resources within their jurisdictions. Agencies may also create standards revolving around the value that comes from viewsheds. This standard is usually assessed by the degree to which an action would affect the existing view.

It is expected that the visual character of the study area would change due to the installation of a PV array. From a ground level view, the vegetation, power lines, and local roads would change to an array of vertical supports and large, flat panels. From the air, this area would change from a desert ecosystem to a large, flat, shiny surface. It is expected that this change would only be seen by overhead aircraft, local residential communities, and vehicular traffic on US-54. However, it is unlikely that the PV array and panels would be considered an adverse impact to the aesthetics of the area given other local and regional residential and commercial infrastructure.

6.4.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, impacts to aesthetic and noise resources would be comparable to the Preferred Alternative.

6.4.3 Alternative 3 – Wind Energy

The visual character of the preferred project area would change due to the installation of wind turbines. From ground level, the current view of native vegetation would remain largely intact, apart from the foundations for the wind turbines and associated roads and power lines. Since the wind turbines are vertical structures, obstruction of the Sacramento Mountains may be considered an adverse impact to the aesthetics of the area.

6.4.4 Alternative 4 – Geothermal Energy

The visual character of the study area would change under this alternative due to the placement of a geothermal power plant and associated infrastructure. A facility, similar to that of a small fossil fuel powerplant would be constructed and would include visible steam plumes, night lighting, and transmission lines, which may be considered an adverse impact to the aesthetics of the area.

6.4.5 No Action Alternative

Under the No Action Alternative, there would be no expected changes to the existing aesthetic resources.

6.5 Noise Resources

6.5.1 Alternative 1 – Preferred Alternative

Noise is characterized quantitatively, but noise impacts are also considered qualitatively. Noise impact is characterized based on sensitivity and relative change from the ambient noise (HAFB, 2015). PV arrays do not produce noise, but it is expected that as high winds pass over the array, some buffeting or vibration may be created. However, this noise is expected to be temporary and insignificant. The vast majority of noise associated with this action will be created during construction and installation of the PV system.

6.5.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, impacts to aesthetic and noise resources would be comparable to the Preferred Alternative.

6.5.3 Alternative 3 – Wind Energy

Wind turbines do produce low noise resulting from airflow passing over the turbine blades, which often creates low pressure zones and buffeting air pressure. Wind turbine noise has been purported as a primary reason for the objection to new wind farm projects by local communities. Some studies suggest that wind-related noise is often seen as an annoyance rather than a human health concern, but that annoyance is significant enough warrant noise-abatement interventions on their homes (Botelho et al., 2017).

Differentiating between wind turbine noise and annoyance is an important consideration during the project planning process, particularly when determining whether noise mitigating actions are needed.

Although the effects of wind turbine noise on human health are still being researched and discussed, in 2018 the World Health Organization (WHO) published the WHO Environmental Noise Guidelines for Europe, citing the potential human health effects of noise associated with wind turbines (WHO, 2018).

Generally speaking, most noise associated with this alternative would occur during the construction phase, and most operational phase noise would fall within OSHA's safety standards for noise exposure. Although operational noise may be intermittent depending on weather conditions, it would be sustained over the operational life of the wind farm.

6.5.4 Alternative 4 – Geothermal Energy

Geothermal energy facilities also produce low operational noise, but well within OSHA's safety standards for noise exposure. Most noise associated with the array would occur during the construction process and routine maintenance operations. Both would be considered short-term insignificant impacts.

6.5.5 No Action Alternative

Under the No Action Alternative, there would be no expected changes to the existing noise resources.

6.6 Water Resources

6.6.1 Alternative 1 – Preferred Alternative

When Waters of the U.S. are present, the EPA requires a NPDES permit for three potential sources of pollution, one of which is construction activities. Operators of these pollution sources would be required to obtain an NPDES permit before they can discharge stormwater. This permitting mechanism is designed to prevent stormwater runoff from washing harmful pollutants into local surface waters. Additionally, in these cases, a SWPPP is required for ground disturbing activities greater than one acre. However, because there are no recognized Waters of the U.S. in the Tularosa Basin, the preparation of a SWPPP and issuance of a NPDES permit from the EPA are not required. Regardless, proper construction design and surface water control BMPs should be utilized to minimize and reduce the potential for soil erosion and pollutant discharge into adjacent habitats.

Based on the review of aerial imagery, NWI map data, and USGS 7.5-minute topographic quadrangle maps, two streamlines are located within the proposed action project boundary. Both streams run adjacent to railroad tracks along the western side of the proposed action area, cross under the tracks at bridge locations, and continue until both streams dissipate into stock ponds or flat areas where water can percolate into the soil. These streams are designated as intermittent by the USFWS NWI data layer (USFWS, 2019a). No permanent surface waters are located within the proposed project area or its adjacent habitat. Precipitation is light and evaporates quickly in the area; however, severe precipitation does occur during the monsoon season. These intense precipitation events result in sheet-flow that flows to relatively level areas and percolates into the groundwater. No groundwater will be withdrawn during construction activities.

The northwest portion of the study area is located within the mapped FEMA 100-year floodplain (Zone A) (**Figure 5**). The remainder of the study area is not located within the 100-year or 500-year floodplain and is designated as Zone X. Depending on the final siting of the PV system, this action may have minor impacts in floodplains and may require FEMA floodplain permit coordination. It is expected that there will be no significant impacts to surface water, groundwater, or wetlands. It is expected that minimal impacts to floodplains will occur as a result of this project.

6.6.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, impacts to surface water, groundwater, and wetlands would be similar to the Proposed Action. However, this alternative is located outside of the 100-year floodplain and would not require FEMA floodplain permitting. Because there are no recognized Waters of the U.S. in the Tularosa Basin, the preparation of a SWPPP and issuance of a NPDES permit from the EPA are not required. Regardless, proper construction design and surface water control BMPs should be utilized to minimize and reduce the potential for soil erosion and pollutant discharge into adjacent habitats during project construction.

6.6.3 Alternative 3 – Wind Energy

Impacts to surface water, groundwater, wetlands, and floodplains from the installation of a wind farm would be similar to those of the Preferred Alternative. It is expected that these actions would not cause significant impacts to water resources in the proposed project area.

6.6.4 Alternative 4 – Geothermal Energy

Impacts to surface water, wetlands, and floodplains associated with the installation of a geothermal energy system would be similar to those of the Preferred Alternative. However, impacts to groundwater could occur due to the process of drilling geothermal energy wells. Temperature impacts can considerably alter the groundwater chemical composition and quality, the metabolism of organisms, and, consequently, biogeochemical processes and ecosystem functions (Griebler et al., 2016). Proper drilling safety measures and BMPs can be implemented to effectively prevent adverse impacts to groundwater resources.

6.6.5 No Action Alternative

Under the No Action Alternative, there would be no changes to water resources within the study area.

6.7 Biological Resources

6.7.1 Alternative 1 – Preferred Alternative

Vegetation

The final PV system configuration design will determine how significant the impact will be to vegetation and BSC within the study area. It is expected that up to 382 acres of vegetation could be directly impacted by the installation of a PV array, if the full extent of the Preferred Alternative project area were developed. However, the extent of development and impact would likely be closer 50 to 60 acres if the project were constructed to the scale of the similarly sized 42-acre PV system currently operating in the northeast portion of HAFB. Construction spaces that are temporarily disturbed will be allowed to revegetate naturally and/or reseeding following construction. Additionally, disturbed BSC is anticipated to regenerate naturally over time. (HAFB, 1999; 2011). The HAFB INRMP identified the biota of the Tularosa Valley as worthy of preservation, which would include the land within the study area due to similarity of vegetation cover types (HAFB, 2015).

As previously described, based on conditions observed during the March 10, 2020 site visit, and personal communication with HAFB planning staff, the study area was cleared for agricultural use and surface water collection in the 1950s. The clearing of vegetation likely exposed more soil surface to drought, rainfall, surface water runoff, and erosion over time. The continued erosional disturbance, paired with the arid climate and relatively slow growth rate of xeric desert species, appears to have reduced the study area's ability to regenerate native vegetation communities over time and stabilize local soils. The current vegetative community was sparse when compared to adjacent properties and exhibited low species diversity and extensive signs of soil scour and resultant plant hummocks. Dominant plant species within the study area included honey mesquite, creosotebush, and prickleypear and the more intact vegetative communities were observed in slightly elevated portions of the study area that are less susceptible to surface runoff and erosion, as depicted on **Figures 7** and **8**. These areas were largely located in the western and eastern portions of the study area, in the Preferred Alternative and Alternative 2 project areas.

Typically, development/construction projects would require site grading and vegetation removal, resulting in a net loss of native vegetative communities and biodiversity. However, due to the current erosional concerns and degraded vegetative communities with the study area, extensive surface water management and proactive site restoration would be a critical part of the post-construction planning process. Post-construction vegetative restoration would be a direct, positive impact on local vegetation, increase site diversity, and would provide needed site soil stabilization and long-term erosion control.

Noxious weed species, such as African rue, are reported by HAFB to occur within the region. Applicable BMPs and weed control measures (such as pressure washing equipment during construction activities) should be implemented during construction to decrease the probability of new infestations and the spread of new or existing colonies.

Wildlife

It is likely that local wildlife would experience temporary displacement during construction activities under the Preferred Alternative. Species with greater mobility, such as mammals, birds, reptiles, etc. are expected to avoid the site during construction, considering that extensive amounts of similar habitat exist within close proximity to the proposed project site. Construction should be planned around the migratory bird nesting season, as nests would be expected in this area. Any imperiled active nests should be marked and avoided until fledging occurred, at which point construction activities could begin (or resume).

Threatened, Endangered, and Sensitive Species

There are no known Federal or State listed plant species in the study area. Although the Kuenzler's hedgehog cactus and Sacramento prickly poppy are known to occur east of the study area, in the Sacramento Mountains, neither of these species have been observed within the proposed project area. No impact to threatened, endangered, or sensitive plants is expected.

There are no known Federal or State listed wildlife species in the proposed study area. However, the New Mexico burrowing owl, an SOC, and New Mexico loggerhead shrike (a sensitive species) have been known to occur near the study area. Furthermore, suitable habitat for Bell's vireo, loggerhead shrike, and burrowing owl exists within and adjacent to the proposed project area. However, the scarcity of surface water and suitable habitat makes it unlikely any additional listed species reside in the study area. There are no indications that the proposed project would adversely impact threatened, endangered, or sensitive wildlife (HAFB, 2015).

6.7.2 Alternative 2 – Eastern Study Area PV Development

The landform and biological community within the Alternative 2 project area are essentially the same as the Preferred Alternative. It is reasonably expected that the impacts of this alternative would be similar to that of the Preferred Alternative.

6.7.3 Alternative 3 – Wind Energy

Vegetation

Due to the vertical nature of wind turbine configuration, it is likely that less than the allocated 382 acres of vegetation within the Preferred Alternative project area would be impacted under this alternative. Depending upon the number of turbines, a portion of the impacts to vegetation and BSC would occur, but the vegetative communities outside of the turbine pads and associated infrastructure that are not impacted by construction or regular maintenance activities would remain intact. Further, the developer would be responsible for reseeding disturbed areas with a native plant seed mix, as required by base policy (HAFB, 1999; 2011).

The short-term loss and long-term partial restoration of the vegetative cover is not considered be a significant impact on the regional biota, and it is not thought to cause a significant decrease in available habitat in the study area (HAFB, 2015).The same precautions to prevent the spread of noxious weeds should be implemented as described under the Preferred Alternative.

Wildlife

Wildlife impacts would be similar to those included in the Preferred Alternative during the construction phase and the same precautions should be made to avoid impacts to migratory birds during the nesting season. However, operating wind farms are known to cause direct mortality to migratory birds and bats.

Threatened, Endangered, and Sensitive Species

No impact to threatened, endangered, or sensitive plants is expected under this alternative. There are no known Federal or State listed wildlife species in the proposed study area. However, the New Mexico burrowing owl, an SOC, and New Mexico loggerhead shrike (a sensitive species) have been known to occur near the study area. Furthermore, suitable habitat for Bell’s vireo, loggerhead shrike, and burrowing owl exists within and adjacent to the proposed project area. Because operation wind turbines have been documented to adversely affect avian and bat resources, further analysis would be needed to determine the potential for impact to these species.

6.7.4 Alternative 4 – Geothermal Energy

The landform and biological community within the Alternative 4 project area is essentially the same as the Preferred Alternative. It is reasonably expected that the impacts of this alternative would be similar to that of the Preferred Alternative.

6.7.5 No Action Alternative

Under the No Action Alternative, there would be no changes to biological resources within the study area.

6.8 Cultural Resources

6.8.1 Alternative 1 – Preferred Alternative

Previous inventories of the study area have documented three cultural sites (LA104267, LA108110, LA108111) within the Preferred Alternative project area that are potentially eligible for inclusion in the NRHP. All three sites would potentially be impacted by the implementation of this Preferred Alternative, but currently all three archaeological sites are unevaluated for the NRHP. Unevaluated sites are to be treated as eligible in keeping with the regulations at 36 CFR 800. An evaluation of effect to these resources would be necessary based their potential NRHP eligibility under 36 CFR 800. However, formal evaluations of NRHP eligibility, though recommended, are not required for NEPA compliance.

If the sites are determined to be eligible for the NRHP, the Preferred Alternative may adversely impact these resources depending on the PV system configuration design. As referenced in the NMCRIS Report No. 70635, adverse impacts to these cultural resources are likely to be minimal due the combined effects of previous surface water runoff and erosion. In addition, cultural features are extensively deflated from wind erosion. For example, fire-cracked rocks, lithic artifacts and ceramic artifacts are frequently seen out of their original context due to these erosional forces, thereby degrading the resource and reducing the potential for data recovery. Alternatively, the Preferred Alternative would have no adverse effect on these sites if they were determined to be ineligible for the NRHP. A determination of an adverse effect to the sites would necessitate formulation of a plan to avoid the impacts or implement mitigation measures that would reduce or eliminate the effects from the Preferred Alternative. Mitigation measures for archaeological sites typically take the form of data recovery of all or a portion of a site.

6.8.2 Alternative 2 – Eastern Study Area PV Development

Previous inventories of the study area have documented five cultural sites (LA100170, LA104265, LA104272, LA104273, and LA144440) within the Alternative 2 project area that are potentially eligible for inclusion in the NRHP. All three sites would potentially be impacted by the implementation of this alternative and unevaluated sites are to be treated as eligible in keeping with the regulations at 36 CFR 800. Currently, only one site (LA100170) has been evaluated for NRHP eligibility. Site LA100170 has been evaluated by the New Mexico State Historic Preservation Office as eligible for the NRHP. The other four archaeological sites (LA104265, LA104272, LA104273, and LA144440) are unevaluated for the NRHP.

As described under the Preferred Alternative, an evaluation of effect to these resources would be necessary based their NRHP eligibility under 36 CFR 800. However, formal evaluations of NRHP eligibility, though recommended, are not required for NEPA compliance. If the sites are determined to be eligible for the NRHP, this alternative may adversely impact these resources depending on the PV system configuration design. Conversely, this alternative would have no adverse effect on these sites if they were determined to be ineligible for the NRHP. A determination of an adverse effect to the sites would necessitate formulation of a plan to avoid the impacts or implement mitigation measures that would reduce or eliminate the effects from this alternative.

6.8.3 Alternative 3 – Wind Energy

Under this alternative, the cultural resources impacts would be comparable to the Preferred Alternative and dependent upon the the wind energy system configuration design.

6.8.4 Alternative 4 – Geothermal Energy

Under this alternative, the cultural resources impacts would be comparable to the Preferred Alternative and dependent upon the the geothermal energy system configuration design.

6.8.5 No Action Alternative

Under the No Action Alternative, there would be no changes to cultural resources within the study area.

6.9 Land Use

6.9.1 Alternative 1 – Preferred Alternative

The study area currently consists primarily of undeveloped land that is part of the Boles Well Field. Development and construction of a ground-mounted PV array would change the land use from undeveloped land to a solar powered electrical generating facility. Construction of the proposed PV array would limit any other land use in the developed portion of the project area for the life of the facility. The Preferred Alternative project area is approximately 382 acres. This change is expected to have no adverse impact on other local land use. The remaining 412 acres of the study area would continue to be used as the Boles Well Field and remain primarily undeveloped.

6.9.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, the land use impacts would be comparable to the Preferred Alternative.

6.9.3 Alternative 3 – Wind Energy

Because the study area is located in a region where wind speeds average less than 5.5 mps, and it is in a low wind-exposure area at the base of the Sacramento Mountains, it is likely that additional turbines would need to be constructed to meet required generating capacity. As a result, additional wind turbine, road construction, and transmission line construction may be required.

Construction of a wind turbine group would change the land use from undeveloped land to a wind energy generating facility. Turbines could potentially interfere with air traffic operation and training, and blade rotation can disrupt critical navigational radar signals and further adversely affect air traffic operations and airspace management (Lemmon et al., 2008). This potential impact limits potential future land use if airfield land development or flight operations are planned in the project area.

6.9.4 Alternative 4 – Geothermal Energy

The geothermal technology that would be used for electricity generation under this alternative has not yet been determined and is dependent upon exploration and identification of resource viability. However, geothermal power plants have a relatively small footprint, occupying less land per GWh than coal, wind, or solar PV (DOE, 2017b) so it is possible that the development footprint could be similar to or smaller than the above-mentioned alternatives. Construction of a geothermal power plant would change the land use from undeveloped land to a geothermal generating facility, which may limit future land use depending on the network or geothermal wells and pipelines.

6.9.5 No Action Alternative

Under the No Action Alternative, there would be no changes to land use within the study area.

6.10 Socioeconomics and Environmental Justice

6.10.1 Alternative 1 – Preferred Alternative

Construction and operation of the proposed PV system would not disrupt the existing community structure since all activities would occur within the Boles Well Field, which is located on Federal lands. The preferred alternative would not diminish properties available for residential or other community development due to the existing exempt status as the Boles Well Field. Placement of solar panels would have a positive temporary impact on the local socioeconomic environment by providing construction employment and material supplier opportunities to the local community. Therefore, the preferred alternative would not disproportionately impact low-income or minority individuals or families, nor would the action negatively impact other environmental justice considerations.

6.10.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, the socioeconomic environment and environmental justice impacts would be comparable to the Preferred Alternative.

6.10.3 Alternative 3 – Wind Energy

Under this alternative, the overall socioeconomic environment and environmental justice impacts would be comparable to the Preferred Alternative. There would be differences in the level of effort for initial project construction and long-term maintenance, but the operational requirements would likely occur on a similar scale with similar impacts. Construction of the wind energy infrastructure may have a greater positive temporary impact on the local socioeconomic environment than the Preferred Alternative or Alternative 2 by requiring a greater number of construction jobs and material supplier opportunities in the local community. Long-term monitoring and maintenance of wind energy infrastructure is also more technically complex than that of a PV system, which could provide more permanent long-term employment in the community. Therefore, this alternative would not disproportionately impact low-income or minority individuals or families, nor would the action negatively impact other environmental justice considerations.

6.10.4 Alternative 4 – Geothermal Energy

Under this alternative, the overall socioeconomic environment and environmental justice impacts would be relatively comparable to the Preferred Alternative. As described above, there would be differences in the level of effort for initial project construction and long-term maintenance, as well as the operational requirements, but these differences would likely occur on a similar scale with similar overall impacts. Construction of the geothermal infrastructure may require a greater number of construction jobs and material supplier opportunities in the local community. The operational control of a geothermal system may also require additional staff and the long-term maintenance of the system would be more technically complex than that of a PV system. These differences may translate into more permanent long-term employment in the community. Therefore, this alternative would not disproportionately impact low-income or minority individuals or families, nor would the action negatively impact other environmental justice considerations.

6.10.5 No Action Alternative

The No Action Alternative would not disproportionately affect minority or low-income households or individuals since no construction would occur. However, the lack of construction activities would not provide employment opportunities and contribution to the local economy. The socioeconomics of the area would largely remain unchanged and would not be impacted under the No Action Alternative.

6.11 Health and Safety

6.11.1 Alternative 1 – Preferred Alternative

The Preferred Action is to install a ground-mounted solar PV system on the western side of the study area. Like all electrical generating equipment, the proposed PV system will produce electromagnetic emissions during operation. However, the emissions produced by the proposed solar array are not anticipated to be measurable at any distance away from the panels. The use of power inverters is required to convert direct current produced by the panels to alternating current to be transmitted through the power grid. Power inverters can potentially produce measurable electromagnetic emissions. The strength of electromagnetic emissions produced from PV systems does not typically reach levels considered harmful to human health established by the International Commission on Non-Ionizing Radiation Protection. The emissions that are produced rapidly diminish with distance and would be indistinguishable from background levels. Recent experience with PV development elsewhere on HAFB property alleviates concerns of electromagnetic emission impacting aircraft flight operations (HAFB, 2015).

Potential health and safety impacts to individuals developing, maintaining, and visiting the PV array are subject to internal health and safety standards and OSHA guidelines.

6.11.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, the health and safety impacts would be comparable to the Preferred Alternative.

6.11.3 Alternative 3 – Wind Energy

Due to the geophysical location of the study area, the construction of a wind energy generating facility is not considered an efficient or effective option for HAFB. However, health and safety impacts associated with the development of a wind energy generating facility include potential interference with air traffic operation and training, and blade rotation can potentially disrupt critical navigational radar signals and further adversely affect air traffic operations and airspace management (Lemmon et al., 2008). Their size and movement can create radar clutter, reduce detection sensitivity, obscure targets, and scatter target returns, which in turn impedes forecasts, interferes with target tracking, and inhibits detection (DOE, 2016). Additional impacts of wind turbines on aviation include physical penetration of airspace, and roto blade-induced turbulence (Mulinazzi and Zheng, 2014). It is also suspected that radar performance decreases exponentially as the amount of wind turbines increases linearly (Lemmon, et. al., 2008).

6.11.4 Alternative 4 – Geothermal Energy

The geothermal technology that would be used for electricity generation under this alternative has not yet been determined and is dependent upon exploration and identification of resource viability. If a geothermal energy generating facility is determined to be a plausible alternative, potential health and safety impacts would need to be further evaluated following the selection of a preferred technology. However, with the binary cycle system of the aforementioned geothermal generating technologies, steam is generated to rotate the turbine that activates the generator, central to electrical production. From this process, excess water vapor is released through a cooling tower or towers, often resulting in obscuring steam clouds that could pose a potential hazard to air traffic.

6.11.5 No Action Alternative

Under the No Action Alternative, there would be no changes to health and safety within the study area.

6.12 Solid Waste, Hazardous Materials and Wastes, Toxic Materials

6.12.1 Alternative 1 – Preferred Alternative

The EPA's National Priorities List and Superfund Alternative Approach Site map shows no active sites on HAFB, nor are there any active sites within 50 miles of Alamogordo (EPA, 2019). As the study area is historically undeveloped land, it is believed that no petroleum or hazardous waste storage or processing has occurred on the property. If hazardous material, waste, or toxic waste were to be found, remediation and compliance with all hazardous material regulations and criteria would be necessary. Photovoltaic cells may contain varying amounts of heavy metals such as silver, copper, lead, arsenic, cadmium, and selenium (CA DTSC, 2019). However, it would be expected that as the PV cells age, HAFB would follow all proper repair and recycling procedures to prevent adverse exposure to these metals.

No solid waste is currently known to be located in the study area. Solid waste, mostly consisting of solar panel packing and crating materials, would be generated during the construction phase of the project. Any solid waste would be recycled to the extent possible through the HAFB Recycling Program and nonrecyclable materials would be disposed of in state permitted landfills. The construction and operation of the project would likely entail small quantities of vehicle and equipment maintenance materials and wastes that would be managed in accordance with established HAFB procedures and would not constitute a significant concern. Any found munitions, including hazardous and toxic materials, would be dealt with through existing HAFB protocols. Thus, no significant impacts related to solid waste, hazardous materials, or toxic substances would result from the Proposed Action.

6.12.2 Alternative 2 – Eastern Study Area PV Development

Under this alternative, the solid waste, hazardous materials and waste, and toxic materials impacts would be comparable to the Preferred Alternative.

6.12.3 Alternative 3 – Wind Energy

Solid waste, mostly packing and crating materials, would be generated during the construction phase of the wind energy project. Any solid waste would be recycled to the extent possible through the HAFB Recycling Program and nonrecyclable materials would be disposed of in state permitted landfills. The construction and operation of the project would likely entail small quantities of vehicle and equipment maintenance materials and would not constitute a significant concern.

Over time, wind turbine blades degrade and must be replaced. This is expected to occur approximately every twenty years. As these blades are usually made of fiberglass and resin, they cannot be recycled or reused and will likely end up in a landfill as solid waste. However, even considering the eventual turbine blade waste, wind energy turbines create significantly less waste through their lifetimes than fossil fuel energy production methods. Under this alternative, the solid waste, hazardous materials and waste, and toxic materials impacts would be comparable to the Preferred Alternative.

6.12.4 Alternative 4 – Geothermal Energy

Construction of a geothermal energy system would be expected to produce de minimis amounts of waste, which would be reused when possible, recycled through the HAFB Recycling Program, or disposed of in a state permitted landfill. Binary cycle power plants emit virtually no gases because of their closed-loop system (DOE, 2019). However, if an alternative geothermal energy system is chosen, the steam may contain trace amounts of hydrogen sulfide, ammonia, methane, and carbon gases.

Geothermal energy production also uses geothermal fluid, which may contain sulfur, chlorides, silica compounds, vanadium, arsenic, mercury, nickel, and other toxic heavy metals (USFWS, 2018). It is important to note that these elements and compounds are not produced by the geothermal production plant itself or intentional additives to the fluid and steam used in geothermal processes, rather they are withdrawn from deep under the ground during production and released as trace amounts in steam clouds. Overall, under this alternative, the solid waste, hazardous materials and waste, and toxic materials impacts would be comparable to the Preferred Alternative.

6.12.5 No Action Alternative

Under the No Action Alternative, there would be no changes to solid waste, hazardous materials and waste, and toxic materials within the study area.

7.0 LITERATURE CITED

Blackwell, D., Richards, M., Frone, Z., Batir, J., Williams, M., Ruzo, A., Dingwall, R. 2011. SMU Geothermal Laboratory Heat Flow Map of the Conterminous United States 2011. Available online at http://www.smu.edu/-/media/Site/Dedman/Academics/Programs/Geothermal-

Lab/Graphics/SMUHeatFlowMap2011_CopyrightVA0001377160_jpg.ashx?la=en. Accessed September 6, 2017.

Botelho, A., Arezes, P., Bernardo, C., Dias, H., Costa Pinto, L. 2017. Effects of Wind Farm Noise on Local Residents' Decision to Adopt Mitigation Measures. International Journal of Environmental Research and Public Health, 14, 753.

Chronic, H. 1987. Roadside Geology of New Mexico. Mountain Press Publishing Company, Missoula.

Cordell, Linda S. 1984. *Prehistory of the Southwest.* Academic Press, Inc., New York.

Elliott, D., Holladay, C., Barchet, W., Foote, H., Sandusky, W. 1986. Wind Energy Resource Atlas of the United States. Prepared for the U.S. Department of Energy, Assistant Secretary, Conservation and Renewable Energy, Office of Solar Electric Technologies, Wind/Ocean Technologies Division. Pacific Northwest Laboratory, Richland, Washington.

Esteban M., Teri N., Yvonne C., and Amanda B. 2006. A Vegetation Survey and Map of Boles Wells Water System Annex, Southern Portion. Holloman Air Force Base, NM: Natural Heritage New Mexico. Available online at https://nhnm.unm.edu/sites/default/files/nonsensitive/publications/nhnm/U06MUL02NMUS.pdf

Federal Emergency Management Agency (FEMA). 2019. Federal Insurance Rate Map, Panel No. 35035C1180D and Panel No. 35035C1200D. Available online at https://msc.fema.gov/portal/home. Accessed October 28, 2019.

Ganon, L., Belanger, C., Uchiyama, Y. 2002. Life-cycle Assessment of Electricity Generation Options: The Status of Research in 2001. Energy Policy. 30:1267-78.

Griebler, C., Brielmann, H., Haberer, C., Kaschuba, S., Kellermann, C., Stumpp, C., Hegler, F., Kuntz, D., Walker-Hertkorn, S., Lueders, T. 2016. Potential impacts of geothermal energy use and storage of heat on groundwater quality, biodiversity, and ecosystem processes.

Holloman Air Force Base (HAFB). 1999. Integrated Natural Resource Management Plan. 49 CES/CEA Holloman Air Force Base, New Mexico. Available online at http://www.swdakotah.com/attachments/article/208/Atch_21_HAFB_Integrated_Natural_Resource_Mgmt_Plan.pdf.

Holloman Air Force Base (HAFB). 2011. Integrated Natural Resource Management Plan. 49 CES/CEA Holloman Air Force Base, New Mexico.

Holloman Air Force Base (HAFB). 2015. Environmental Assessment of a Photovoltaic Development for Holloman Air Force Base. FHOE-10-001-14-204.

Huff, G.F. 2005. Simulation of Ground-Water Flow in the Basin-Fill Aquifer of the Tularosa Basin, South-Central New Mexico, Predevelopment through 2040. Scientific Investigations Report 2004-5197.

Kenny, R., Law, C., Pearce, JM. 2010. Towards Real Energy Economics: Energy Policy Driven by Life-cycle Carbon Emission. 38:1969-78.

Kewen, L., Huiyuan, B., Changwei, L., Danfeng, Z., and Yanan, Y. 2014. Comparison of Geothermal with Solar and Wind Power Generations Systems. Elsevier – Renewable and Sustainable Energy Reviews: 42 (2015) 1464-1474.

Kubota, H., Hondo, H., Hienuki, S., Kaieda, H. 2013. Determining barriers to developing geothermal power generation in Japan: societal acceptance by stakeholders involved in hot springs. Energy Policy. 61(0): 1079-87.

Lackner, KS., Sachs, JD. 2005. A Robust Strategy for Sustainable Energy. Brookings Paper Econ Act. 215-84.

Laney, P. and Brizzee, J. 2003. New Mexico Geothermal Resources, Publication No. - INEEL/MISC-2002-395 Rev. 1. Idaho National Engineering and Environmental Laboratory. Prepared for the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Geothermal Technologies Program.

Lemmon, J., Carroll, J., Sanders, F., & Turner, D. 2008. Assessment of the Effects of Wind Turbines on Air Traffic Control Radars. US Department of Commerce. National Telecommunications and Information Administration.

Meinzer, O.E., and Hare, R.F., 1915. *Geology and water resources of Tularosa Basin, New Mexico*: U.S. Geological SurveyWater Supply Paper 343, 317 p.

Mulinazzi, T., Zheng, Z. 2014. Wind farm turbulence impacts on general aviation airports in Kansas. University of Kansas. Accessed October 28, 2019.

National Oceanic and Atmospheric Administration (NOAA). 2017. Ranking of Cities Based on Percent Annual Possible Sunshine in Descending Order from Most to least Average Possible Sunshine. Source: http://www.ncdc.noaa.gov/oa/climate/online/ccd/pctpos.txt. Data through 2004.

National Renewable Energy Laboratory (NREL). 2009. United States Wind Resources Map. U.S. Department of Energy, National Renewable Energy Laboratory. Available online at https://www.nrel.gov/gis/images/US-50m-wind-power-map.jpg. Accessed September 5, 2017.

National Renewable Energy Laboratory (NREL). 2012a. United States – Annual Average Wind Speed at 30 Meters map. U.S. Department of Energy, National Renewable Energy Laboratory. Available online at https://www.nrel.gov/gis/images/30m_US_Wind.jpg. Accessed September 5, 2017.

National Renewable Energy Laboratory (NREL). 2012b. U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis. Technical Report NREL/TP-6A20-51946. Prepared under Task Nos. SA10.1012 and SA10.20A4.

National Renewable Energy Laboratory (NREL). 2013. United States – Land-Based and Offshore Annual Average Wind Speed at 100 Meters map. U.S. Department of Energy, National Renewable Energy Laboratory. Available online at https://www.nrel.gov/gis/images/100m_wind/awstwspd100onoff3-1.jpg. Accessed September 5, 2017.

National Renewable Energy Laboratory (NREL). 2014. Geothermal Exploration Policy Mechanisms: Lessons for the United States from International Applications. Technical Report NREL/TP-6A20-61477. Prepared under Task No. GTP2.9153.

National Renewable Energy Laboratory (NREL). 2015. Parabolic Trough Collector Cost Update for the System Advisor Model (SAM). Technical Report NREL/TP-6A20-65228. Prepared under Task No. CP13.3510. Available online at https://www.nrel.gov/docs/fy16osti/65228.pdf. Accessed September 6, 2017.

National Renewable Energy Laboratory (NREL). 2017a. Direct Normal Irradiance Maps: Concentrating Solar Resource of the Southwest United States. Available online at https://www.nrel.gov/csp/data-tools.html. Accessed September 5, 2017.

National Renewable Energy Laboratory (NREL). 2017b. National Wind Resource Assessment. Available online at https://www.nrel.gov/gis/wind.html. Accessed September 5, 2017.

National Renewable Energy Laboratory (NREL). 2017c. Geothermal Electrical Energy Production. Available online at https://www.nrel.gov/workingwithus/re-geo-elec-production.html. Accessed September 6, 2017.

Natural Resource Conservation Service (NRCS). 1999. Soil Taxonomy. A Basic System of Soil Classification for Making and Interpreting Soil Surveys. Available online at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051232.pdf. Accessed February 2020.

Natural Resource Conservation Service (NRCS). 2019. Web Soil Survey. Otero County Area, New Mexico. Available online at https://websoilsurvey.nrcs.usda.gov/app/. Accessed October 2019.

New Mexico Department of Game and Fish (NMDGF). 2019. Biota Information System of New Mexico (BISON-M). Available online at http://bison-m.org/.

Occupational Health and Safety Administration (OSHA). 1996. Preventing Occupational Hearing Loss – A Practical Guide. Available on online at https://www.cdc.gov/niosh/docs/96-110/pdfs/96-110.pdf?id=10.26616/NIOSHPUB96110. Accessed November 1, 2019.

Occupational Health and Safety Administration (OSHA). 2019. How Loud is Too Loud. Available on online at https://www.osha.gov/SLTC/noisehearingconservation/loud.html. Accessed November 1, 2019.

Otero County, New Mexico. 2019. Otero County, New Mexico Tax Assessor's Office. Property Records. Sourced from: https://oterocountynm-asrweb.tylerhost.net/assessor/web/. Accessed October 25, 2019.

Otero Soil and Water Conservation District. 2016. Land Use Plan. Available on online at http://www.oteroswcd.org/PDF/OteroSWCDLUP.pdf. Accessed March 7, 2020.

Rosentreter, R., Bowker, M., Belnap, J. 2007. A Field Guide to Biological Soil Crusts of Western U.S. Drylands. U.S. Government Printing Office. Denver, CO.

Salmon, J., Meurice, J., Wobus, N., Stern, F., and Duaime, M. 2011. Guidebook to Geothermal Power Finance. NREL/SR-6A20-49391. Golden, CO: National Renewable Energy Laboratory. Available online at http://www.nrel.gov/docs/fy11osti/49391.pdf. Accessed September 6, 2017.

Siemens, 2013. White Sands Missile Range – U.S. Army: The Army's Largest Renewable Energy Project Achieves Sustainability Objectives while Leaving Capital Funds Intact.

U.S. Air Force (USAF). 1997. Interim Guidance for Environmental Justice Analysis.

U.S. Census Bureau (USCB). 2010 Profile of General Population and Housing Characteristics for the City of Alamogordo, NM and the State of New Mexico. Accessed October 23, 2019.

U.S. Census Bureau (USCB). 2017. 2010 Profile of General Population and Housing Characteristics for the City of Alamogordo, NM and the State of New Mexico. Accessed October 23, 2019.

U.S. Department of Energy (DOE). 1998. Solar Trough Systems. DOE/GO-10097-395. Available online at https://www.nrel.gov/docs/legosti/fy98/22589.pdf. Accessed September 6, 2017.

U.S. Department of Energy (DOE). 2016. Office of Energy Efficiency and Renewable Energy. Federal Interagency Wind Turbine Radar Interference Mitigation Strategy. Accessed October 29, 2019.

U.S. Department of Energy (DOE). 2017a. Wind Exchange. Available online at https://windexchange.energy.gov/. Accessed September 5, 2017.

U.S. Department of Energy (DOE). 2017b. Geothermal Energy. Available online at https://energy.gov/eere/geothermal/geothermal-energy-us-department-energy. Accessed September 6, 2017.

U.S. Department of Energy (DOE). 2019. Office of Energy Efficiency and Renewable Energy. Geothermal Power Plants – Meeting Clean Air Standards. Sourced from: https://www.energy.gov/eere/geothermal/geothermal-power-plants-meeting-clean-air-standards

U.S. Department of the Interior (DOI). 2018. Guidance on the recent M-Opinion affecting the Migratory Bird Treaty Act (MBTA).

U.S. Environmental Protection Agency (EPA). 2018. EJSCREEN Report, Version 2018. 15-mile Ring Centered at 32.811883, -105.961349, New Mexico, EPA Region 6. Accessed October 25, 2019.

U.S. Geological Survey (USGS). 2018. Short-term Induced Seismicity Models. USGS Earthquake Hazards Program. Available online at https://earthquake.usgs.gov/hazards/induced/. Accessed October 2019.

U.S. Geological Survey (USGS). 2019a. USGS Online GIS Web-viewer of Regions of Known or Potential Geothermal Resources in New Mexico. Available online at https://my.usgs.gov/eerma/data/index/4f4e483ce4b07f02db4f1bb8?q=&facetType=Shapefile. Accessed October 25, 2019.

U.S. Geological Survey (USGS). 2019b. Interactive Quaternary Faults Database. USGS Geologic Hazards Science Center Golden, CO. Available online at https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf. Accessed October 2019.

U.S. Geological Survey (USGS). 2019c. Science in Your Watershed. Available online at https://water.usgs.gov/lookup/getwatershed?13050003/www/cgi-bin/lookup/getwatershed. Accessed October 21, 2019.

U.S. Fish and Wildlife Service (USFWS). 2018. Energy Technologies and Impacts – Geothermal Energy. Accessed October 28, 2019. Sourced from: https://www.fws.gov/ecological-services/energy-development/geothermal.html

U.S. Fish and Wildlife Service (USFWS). 2019a. National Wetlands Inventory Map, Wetlands Mapper. Available online at http://www.fws.gov/wetlands/Data/Mapper.html. Accessed August 1, 2019.

U.S. Fish and Wildlife Service (USFWS). 2019b. Endangered Species Overview. Available online at https://www.fws.gov/endangered/laws-policies/. Accessed November 1, 2019.

U.S. Fish and Wildlife Service (USFWS). 2019c. Information for Planning and Consultation (IPaC) Data Mapper for Otero County, New Mexico. Available online at https://ecos.fws.gov/ipac/. Accessed October 19, 2019.

Waltemeyer, S. D. 2001. Estimates of Mountain-Front Streamflow Available for Potential Recharge to the Tularosa Basin, New Mexico. U.S. Geological Survey, Water-Resources Investigations Report 01-4013.

Wilkins, D.W., 1986. Geohydrology of the Southwest Alluvial Basins Regional Aquifer- Systems Analysis, Parts of Colorado, New Mexico, and Texas, U.S. Geological Survey, Water-Resources Investigations Report 84-4224.

Williams, C., Reed, M., Mariner, R., DeAngelo, J., and Galanis, S. 2008. Assessment of Moderate- and High-temperature Geothermal Resources of the United States. U.S. Geological Survey Fact Sheet 2008-3082. Menlo Park: U.S. Geological Survey. Accessed July 26, 2012: http://pubs.usgs.gov/fs/2008/3082/.

World Health Organization (WHO). 2018. Environmental Noise Guidelines for the European Region. Copenhagen, Denmark.

APPENDIX A

SITE PHOTOGRAPHS

APPENDIX B

INTERAGENCY/INTERGOVERNMENTAL COORDINATION FOR ENVIORNMENTAL PLANNING – PUBLIC SCOPING LETTER

APPENDIX C

THREATENED, ENDANGERED, AND SENSITIVE SPECIES

APPENDIX D

U.S. ENVIRONMENTAL PROTECTION AGENCY – ONLINE ENVIRONMENTAL JUSTICE SCREEN AND MAPPING TOOL REPORT

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