U. S. AIR FORCE

INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

Altus Air Force Base

2021

(See INRMP signature pages for plan approval date)

ABOUT THIS PLAN

This installation-specific Environmental Management Plan (EMP) is based on the U.S. Air Force's (AF) standardized Integrated Natural Resources Management Plan (INRMP) template. This INRMP has been developed in cooperation with applicable stakeholders, which may include Sikes Act cooperating agencies and/or local equivalents, to document how natural resources will be managed. Non-U.S. territories will comply with applicable Final Governing Standards (FGS). Where applicable, external resources, including Air Force Instructions (AFIs); AF Playbooks; federal, state, local, FGS, biological opinion and permit requirements, are referenced.

Certain sections of this INRMP begin with standardized, AF-wide "common text" language that address AF and Department of Defense (DoD) policy and federal requirements. This common text language is restricted from editing to ensure that it remains standard throughout all plans. Immediately following the AF-wide common text sections are installation sections. The installation sections contain installation-specific content to address local and/or installation-specific requirements. Installation sections are unrestricted and are maintained and updated by the Altus Air Force Base Environmental Element (97 CES/CEIE).

NOTE: The term '97 CES/CEIE' is used throughout this document to refer to the installation organization responsible for the natural resources program.

TABLE OF CONTENTS

DOCUMENT CONTROL

Record of Review – The INRMP is updated annually, or more frequently as changes to natural resource management and conservation practices occur, including those driven by changes in applicable regulations. In accordance with (IAW) the Sikes Act and AFMAN 32-7003, *Environmental Conservation*, the INRMP is required to be reviewed for operation and effect every five years at the least. The base Natural Resources Manager (NRM) and 97 CES/CEIE accomplish annual reviews and updates. The installation shall establish and maintain regular communications with the appropriate federal and state agencies. At a minimum, the installation NRM (with assistance as appropriate from the Installation Support Team Natural Resources Media Manager) conducts an annual review of the INRMP in coordination with internal stakeholders and local representatives of the United States Fish and Wildlife Service (USFWS), state fish and wildlife agency, and National Oceanic and Atmospheric Administration (NOAA) Fisheries, where applicable, and accomplishes pertinent updates. Installations will document the findings of the annual review in an Annual INRMP Review Summary. By signature to the Annual INRMP Review Summary, the collaborating agency representative asserts concurrence with the findings. Any agreed updates are then made to the document, at a minimum updating the work plans.

INRMP APPROVAL/SIGNATURE PAGES

The United States Fish and Wildlife Service (USFWS), Oklahoma Department of Wildlife (ODWC), and the 97th Air Mobility Wing (97 AMW) by signature of their agency representative, hereby enter into a cooperative agreement for the conservation, protection, and management of natural resources present on Altus AFB. This agreement may be modified and amended by mutual agreement of the authorized representatives of the three agencies. This agreement becomes effective upon the date of the last signatory and shall cover 5 years or until terminated by written notice, in whole or in part, by any of the parties signing this agreement.

By their signatures below, or an enclosed letter of concurrence, all parties grant their concurrence with and acceptance of the following document.

Approving Official: Date

Matthew A. Leard, Colonel, USAF
Commander, 97th Air Mobility Wing

11 DEC 20

Amy Lueders
Southwest Regional Director, U.S. Fish and Wildlife Service

December 23, 2020

J.D. Strong
Director, Oklahoma Department of Wildlife Conservation

10·15·2020

EXECUTIVE SUMMARY

The U.S. Department of Defense (DoD) is responsible under the Sikes Act [Title 16 United States Code (U.S.C.), Section (§) 670a-670f, as amended in 1997] for implementing management strategies to conserve and protect biological resources on its lands. The Sikes Act was enacted into law in 1960 to manage DoD lands for the conservation and wise use of natural resources. The Sikes Act was amended in 1997 to mandate the development of an Integrated Natural Resources Management Plan (INRMP) at DoD installations.

Requirements of the Sikes Act that are implemented by this INRMP include Department of Defense Instruction (DODI) 4715.03, *Natural Resources Conservation Program* (18 March 2011), Air Force Policy Directive (AFPD) 32-70, *Environmental Considerations in Air Force Programs and Activities* (30 July 2018), and Air Force Manual (AFMAN) 32-7003, *Environmental Conservation* (20 April 2020).

The Headquarters Air Force's Directorate of Civil Engineers (AF/A4C), the USFWS, and ODWC have designated Altus AFB as a Category I installation that contains significant natural resources requiring conservation and management. AFMAN 32-7003 requires Category 1 installations to establish and maintain an INRMP. Category 1 criteria at Altus AFB include conducting on-the-ground military missions that have the potential to impact natural resources, containing wetland habitat, allowing natural resources- based outdoor recreation, operating an agricultural outgrant, and experiencing significant bird/wildlife aircraft strike hazards on the airfield.

This INRMP guides the implementation of the natural resources program at Altus AFB for years 2020 through 2025. The INRMP is an integrated plan based on ecosystem management. The plan shows the interrelationships of individual components of natural resources management (e.g., fish and wildlife, land management, outdoor recreation) to military mission requirements and other land use activities affecting natural resources at Altus AFB.

The purpose of this plan is to provide a framework for the conservation and restoration of natural resources in a manner that ensures operational capability of the land to support the AF military mission. The plan details the goals, objectives and methods for managing the lands, waters, and wildlife that comprise the ecosystems within Altus AFB. Implementation of the natural resources program helps maintain quality training lands and ensures that the environment will remain healthy and stable for continuous military use.

The primary natural resources management goals at Altus AFB are to support military mission sustainability through ecological stewardship, conserve native biodiversity by restoring and maintaining wildlife populations and ecological processes, and provide for the sustainable multi-purpose use of natural resources through outdoor recreational opportunities. Substantial revisions to the plan have been made since the last annual review in 2019. Implementation of the goals and objectives of this plan will be a significant change in management direction for natural resources on the installation.

1.0 OVERVIEW AND SCOPE

This INRMP was developed to provide effective management and protection of natural resources. It summarizes the natural resources present on the installation and outlines strategies to adequately manage those resources. Natural resources are valuable assets of the United States Air Force. They provide the natural infrastructure needed for testing weapons and technology, as well as for training military personnel for deployment. Sound management of natural resources increases the effectiveness of Air Force adaptability in all environments. The Air Force has stewardship responsibility over the physical lands on which installations are located to ensure all natural resources are properly conserved, protected, and used in sustainable ways. The primary objective of the Air Force natural resources program is to sustain, restore and modernize natural infrastructure to ensure operational capability and no net loss in the capability of AF lands to support the military mission of the installation. The plan outlines and assigns responsibilities for the management of natural resources, discusses related concerns, and provides program management elements that will help to maintain or improve the natural resources within the context of the installation's mission. The INRMP is intended for use by all installation personnel. The Sikes Act is the legal driver for the INRMP.

1.1 Purpose and Scope

The purpose of this INRMP is to provide a framework for the sustainable management of natural resources on Altus AFB lands. The INRMP strives to improve and maintain the health of the environment within the context of the military mission. Altus AFB manages its natural resources to facilitate testing and training, mission readiness, and range sustainability in a long-term, comprehensive, coordinated, and cost-effective manner as detailed by DODI 4715.03 *Natural Resources Conservation Program.*

The natural resources program is integrated with mission activities and installation planning and programming. Natural resources, to include land, water, soil, plants, fish, and wildlife, are managed for multiple human uses at Altus AFB including sustainable yields, scientific research, education, and outdoor recreation. Coordination with other facilities and management plans is necessary to enable these activities to take place. Multiple use of natural resources is balanced with conservation to ensure long-term sustainability of those resources.

This INRMP ensures that natural resources conservation measures and mission activities are integrated and consistent with federal stewardship requirements. The plan is prepared in cooperation with the United States Fish and Wildlife Service (USFWS) and the Oklahoma Department of Wildlife Conservation (ODWC) to ensure that natural resources management activities are in compliance with federal and state environmental laws and regulations.

1.2 Management Philosophy

This INRMP follows a unified management philosophy that integrates natural resources management with the diverse needs, interests, and visions of the Altus AFB community. The plan was developed in an interdisciplinary and cooperative manner, incorporating input from various internal organizations, AF installations, and state and federal agencies. A cross-agency, cross-discipline approach is also used for the INRMP annual review process. Natural resources planning and decision making is integrated with other installation plans to ensure compatibility with the mission.

This plan strives to maintain the long-term ecological integrity of the environment and the ecosystem services it provides in order to ensure sustained use of land, air, and water resources for military training and testing. The plan also strives to improve the morale and overall well-being of the people who live

and work on the installation.

This INRMP follows the AF principles for ecosystem management and incorporates biodiversity conservation, exotic and invasive species control, and climate change considerations in accordance with DODI 4715.03 and AFMAN 32-7003. Native ecosystems will be restored or enhanced and viable populations of native species will be maintained when practical and consistent with the military mission. Exotic, feral, and invasive species will continue to be removed from the installation. Assessments of climate change risks are incorporated into each applicable natural resources section. Routine monitoring of vegetation and wildlife will allow for adaptive management in response to changing ecosystem dynamics. The latest scientific information is incorporated into decision-making and adaptive management techniques to enhance the resiliency of the ecosystem.

The AF principles for ecosystem management are outlined as follows:

- Maintain or restore native ecosystem types across their natural range where practical and consistent with the military mission.
- Maintain or restore ecological processes such as fire and other disturbance regimes where practical and consistent with the military mission.
- Maintain or restore the hydrological processes in streams, floodplains, and wetlands when feasible and practical and consistent with military mission.
- Use regional approaches to implement ecosystem management on an installation by collaboration with other DoD components as well as other federal, state and local agencies, and adjoining property owners.
- Provide for outdoor recreation, agricultural production, harvesting of forest products, and other practical utilization of the land and its resources, provided that such use does not inflict long-term ecosystem damage or negatively impact the AF mission.

1.3 Authority

The Sikes Act requires the development and implementation of an INRMP for all DoD installations that contain significant natural resources. This act provides for cooperation by the DoD and the Department of Interior (DoI) with state agencies in planning, developing, and maintaining natural resources on military installations. The INRMP for Altus AFB is implemented in collaboration with the USFWS and ODWC.

DODI 4715.03, *Natural Resources Conservation Program,* establishes policy and assigns responsibilities for compliance with applicable federal laws and regulations for the integrated management of natural resources. AFPD 32-70, *Environmental Considerations in Air Force Programs and Activities* establishes policy to address environmental considerations in all AF programs and activities using a framework for environmental management. AFMAN 32-7003, *Environmental Conservation,* provides direction and instructions for INRMP preparation and implementation.

A summary of key legislation and guidance used to create and implement this INRMP can be found in Appendix A, which includes all applicable federal laws, executive orders, United States Code (U.S.C.), DoD policy, instructions, and directives, and AF instructions and directives.

The National Environmental Policy Act (NEPA) requires federal agencies to evaluate potential environmental impacts of proposed federal actions and consider alternatives prior to action approval. NEPA requires Environmental Assessments (EAs) and Environmental Impact Statements (EISs). The Council on

Environmental Quality (CEQ) oversees federal adherence to NEPA requirements. 40 CFR 1500-1508, *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* codifies the process for implementing NEPA.

The table below summarizes installation-specific policies, including state and local laws and regulations.

Table 1. Installation-Specific Policies (including State and/or Local Laws and Regulations)	
Oklahoma Administrative Code (OAC) Title 800:25-26 and OK Statute Title 29 §29-4-118	● Requires a license for handling special concern species and collecting wildlife/nests/eggs for scientific purposes.
Altus AFB Access Policy	● Installation access is limited to DoD employees, guests, family members, and retirees.
OAC 800:25 and Oklahoma Statute Title 29	● All hunting and fishing must be conducted IAW OK Statute Title 29, as adopted by the ODWC. Base policies take precedence when more restrictive than Title 29.
Base Fishing Pond Rules	● Catch and release for bass and sunfish. Daily limit of 2 over 12 inches for catfish. No more than 2 rods per person. No swimming or wading in pond.
OAC Title 35 OK Statute Title 2	● Provides provisions for agriculture that installation outgrant operators must comply with.

1.4 Integration with Other Plans

The INRMP is reviewed annually by representatives of various organizations throughout the installation. The Altus AFB Environmental Element, (97 CES/CEIE) coordinates INRMP projects with all affected installation organizations. The 97 CES/CEIE ensures that the INRMP and any plans that may affect natural resources at Altus AFB are mutually supportive and not in conflict. This includes the following plans:

- Installation General Plan (IGP)
- Installation Development Plan (IDP)
- Installation Contingency Plan (ICP)
- Storm Water Pollution Prevention Plan (SWPPP)
- Integrated Cultural Resources Management Plan (ICRMP)
- Integrated Pest Management Plan (IPMP)
- Bird/Wildlife Aircraft Strike Hazard (BASH) Plan
- Wildland Fire Management Plan (WFMP) (not yet created)
- Grounds Maintenance Performance Work Statement (PWS)
- Golf Environmental Management (GEM) Plan
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) cleanup plans

1.5 Approvals and Revisions

The INRMP is considered compliant with the Sikes Act if it has been approved by signature on the INRMP signature page, or in writing in a signed letter, by the appropriate representative from each cooperating

agency within the last 5 years. The 97 CES/CEIE updates the INRMP as needed and the NRM reviews the plan annually in collaboration with ODWC and the USFWS.

INRMP revisions are reviewed by internal stakeholders and approved by the installation commander or delegated signatory, the ODWC Director, and the USFWS Regional Supervisor.

2.0 INSTALLATION PROFILE

Office of Primary Responsibility	97 CES/CEIE has overall responsibility for implementing the natural resources management program and is the lead organization for monitoring compliance with applicable federal, state and local regulations.
Natural Resources Manager/POC	Kelly Niland 580-481-7606 kelly.niland.1@us.af.mil
State and/or local regulatory POCs (For US-bases, include agency name for Sikes Act cooperating agencies)	Amy Lueders, Southwest Regional Director USFWS Albuquerque, NM Laurence Levesque, Supervisory Fish & Wildlife Biologist USFWS Tulsa, OK JD Strong, Director ODWC Oklahoma City, OK
Total acreage managed by installation	8,016 acres
Total acreage of wetlands	35
Total acreage of forested land	4.64
Does installation have any Biological Opinions? (If yes, list title and date, and identify where they are maintained)	No
NR Program Applicability (Place a checkmark next to each program that must be implemented at the installation. Document applicability and current management practices in Section 7.0)	☒ Invasive species ☒ Wetlands Protection Program ☒ Grounds Maintenance Contract/SOW ☐ Forest Management Program ☐ Wildland Fire Management Program ☒ Agricultural Outleasing Program ☒ Integrated Pest Management Program ☒ Bird/Wildlife Aircraft Strike Hazard (BASH) Program ☐ Coastal Zones/Marine Resources Management Program ☐ Cultural Resources Management Program

2.1 Installation Overview

2.1.1 Location and Area

Altus AFB, home to the 97th Air Mobility Wing (97 AMW), is located within the City of Altus, at the heart of Jackson County in southwestern Oklahoma (Figure 1). Altus lies about 140 miles southwest of Oklahoma City and 14 miles north of the Oklahoma/Texas border. The city is intersected from the north and south by U.S. Highway 283 and from the east and west by U.S. 62.

Altus AFB consists of approximately 7,057 acres within the northeast portion of Altus, as shown in Figure 2 (USAF, 2018a). The installation owns a geographically separate unit called the Sooner Drop Zone (SDZ) in Harmon County, approximately 23 miles southwest of Altus. The SDZ is a 959-acre site utilized by aircrews to practice aerial pallet drops of simulated cargo loads. Both Altus AFB and the SDZ contain significant natural resources requiring management that will be addressed in this plan (Table 2).

Altus AFB contains 754 facilities including 166 buildings and 530 privatized housing units. The airfield, shown in Figure 3, includes two north-south runways, an assault strip, and aircraft operations and maintenance areas. The primary runway, 17R/35L, is 13,440 feet by 150 feet. The parallel runway, 17L/35R, is 9,000 feet by 150 feet, and the assault strip, 174/354, is 3,500 feet by 95 feet.

The base also uses the Clinton-Sherman Industrial Air Park in Burns Flat, located 45 miles to the north, as an alternative runway for aircraft touch and go practice.

Figure 1. Regional map of Altus AFB

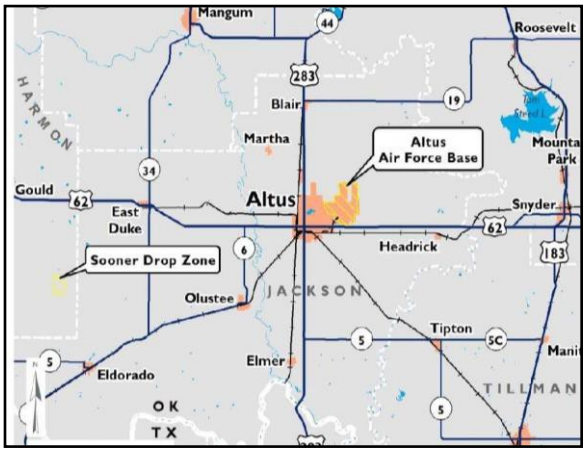


Figure 2. Vicinity map of Altus AFB

Figure 3. Aerial view of Altus AFB

Table 2. Installation/GSU Location and Area Descriptions

Base/GSU Name	Main Use/Mission	Acreage	Addressed in INRMP?	Describe NR Implications
Altus AFB	Training AF airlift and air refueling crews	7,057	INRMP Category I coverage	Management of recreational areas, pests, floodplains, wetlands, wildlife, and airfield landscape
Sooner Drop Zone	AF C-17 airdrop training	959	INRMP Category I coverage	Management of landscape for continued use for Air Force training

2.1.2 Installation History

Activated in 1943 as Altus Army Airfield, the installation began as a training base for airmen to learn to operate multi-engine aircraft during World War II (Guinan, 2014). The flat landscape and sunny skies of southwest Oklahoma made an ideal location for flight training. Airmen learned to fly AT-9, AT-17, and UC-78 aircraft. At the end of the war in 1945, Altus Army Air Field was inactivated.

In 1948, the War Assets Administration Office deeded the installation to the City of Altus for $1.00, and it became the Altus Municipal Airport. Five years later, during the Korean War, it was reactivated as Altus Air Force Base (AFB) under control of the AF Tactical Air Command (TAC). The host unit, 63d Troop Carrier Wing, operated C-47 and C-45 aircraft.

In 1954, Strategic Air Command (SAC) assumed control of Altus AFB and activated the 96th Bombardment Wing (96 BW) to fly strategic bomber aircraft to support Cold War operations. The 96 BW flew B-47 all jet-engine bombers, as well as KC-97 strategic cargo and air refueling aircraft.

The 96 BW was replaced by the 11th Bombardment Wing (11 BW) in 1957. The B-47s and KC-97s were replaced by B-52 bombers and KC-135 aerial refueling aircraft. The 11 BW gained the 577th Strategic Missile Squadron (577 SMS) in 1961 and activated twelve Atlas F missile sites in the area. However, the Atlas missile was phased out of military use in 1965, and the 577 SMS was inactivated.

The loss of the 577 SMS prompted a local businessman to travel to Washington, D.C. to ask the president for economic aid for the Altus community. In response, President Lyndon B. Johnson ordered a military unit traveling west to be temporarily diverted to Altus. The 4th Mobile Communications Group (4 MCG) arrived at Altus AFB in 1966 to replace the 11 BW after it phased out the B-52, and the 11 BW was transferred to Bolling AFB, Washington, D.C. The 4 MCG operated tactical air traffic control and landing systems for combat and emergency mission support in the Pacific theater.

In 1968, the Military Airlift Command (MAC) assumed control of Altus AFB and transferred the 443d Military Airlift Wing (443 MAW), from Tinker AFB in Oklahoma City to Altus. The 443 MAW trained aircrews on C-141 cargo aircraft and C-5 transport aircraft. B-52s were phased out of use and the 11 BW was inactivated. KC-135s continued to be flown under tenant units.

In 1984, SAC activated the 340th Air Refueling Wing (340 ARW) to operate the KC-135s as a tenant unit on the base. In 1992, the AF replaced the SAC, TAC, and MAC commands with the Air Mobility Command (AMC), Air Combat Command (ACC), and the Air Education and Training Command (AETC). Altus AFB was now under AMC, and the 443 MAW and 340 ARW were replaced by the new 97th Air Mobility Wing (97 AMW). Command of the 97 AMW was then transferred from AMC to AETC, and the 97 AMW became

home to the KC-135 Combat Training School and the C-141 and C-5 Training Schoolhouse, dubbed the University of Military Airlift Command.

In 1994, Altus AFB was selected as the training school for the new C-17 cargo aircraft. The base acquired a 640-acre tract of land near Eldorado, Oklahoma for airdrop training, called the Sooner Drop Zone. The first C-17 arrived at the base in 1996.

In 2002, the 97 AMW reorganized as a combat wing to conduct strategic airlift, aerial delivery, and aerial refueling training. Altus AFB became an aerial port of embarkation for U.S. Army Fort Sill, Oklahoma. The following year, the base purchased nearly 1,100 acres of easements within the clear zones and accident potential zones of the airfield. In 2005, the Sooner Drop Zone was expanded to allow airmen to practice C-17 dual-row airdrop delivery, which doubles the amount of cargo that can be delivered into combat. C-5 aircraft were transferred out of Altus AFB in 2007.

In 2016, the base reactivated the 56th Air Refueling Squadron (56 ARS) as the formal training unit for the KC-46A *Pegasus* air refueling and cargo aircraft. The base began receiving KC-46 aircraft in 2019.

Despite the primary mission of training airlift and air refueling crews, the 97 AMW has deployed its airmen to support worldwide military efforts including Operations Northern Watch, Desert Storm, Desert Fox, Allied Force, Joint Guard, Enduring Freedom, Noble Eagle, Iraqi Freedom, and New Dawn. The wing also served as the aerial port of debarkation for the 31st Air Defense Artillery Brigade at Fort Sill, Oklahoma, supporting the deployment of two Patriot missile batteries to fortify Turkey during the Syrian civil war.

The 97 AMW transported medical crews and provided fighter aircraft support after the 9/11 terrorist attacks in 2001. The wing flew humanitarian missions following hurricanes Katrina, Rita, and Wilma in 2005 and Gustav and Ike in 2008. The wing also supported Haiti during the aftermath of an earthquake in 2010 and Puerto Rico following Hurricane Maria in 2017. Altus AFB continues to provide support for global contingencies and humanitarian emergencies as needed.

2.1.3 Military Missions

Altus AFB is home to the 97th Air Mobility Wing (97 AMW) under the Air Education and Training Command of the Nineteenth Air Force. The installation is the C-17, KC-135, and KC-46 strategic airlift and air refueling training school of the USAF. The wing provides initial and advanced training programs for flight and aircraft maintenance crews.

As expressed in the mission statement, “We Train Exceptional Mobility Airmen” the mission of the 97 AMW is to train airmen to be combat-ready to ensure global reach for America. Aircrews are trained, equipped, and ready to deploy for combat in support of the Global War on Terrorism. Approximately 550 mobility positions are maintained to be available for immediate worldwide deployment. Since 2001, the wing has sustained an average of 150 personnel a year deployed at any one time.

The 97 AMW consists of the following major units:

97th Operations Group (97 OG)
The 97 OG executes C-17, KC-135, and KC-46 formal training programs for up to 3,300 students annually. This group sustains airland, airdrop, and air refueling mobility forces providing global reach for combat and contingency operations. It also provides air traffic control and weather forecasting for flight operations. Airmen are trained to operate KC-135s for AF active duty, Air National Guard, Air Force Reserve Command, and international customers. Six units make up the 97 OG:

- 97th Operations Support Squadron

- 97th Training Squadron
- 54th Air Refueling Squadron
- 56th Air Refueling Squadron
- 58th Airlift Squadron
- 730th Air Mobility Training Squadron (Reserve unit)

97th Mission Support Group (97 MSG)
The 97 MSG provides mission support for aircraft operations and base infrastructure to include communications, civil engineering, law enforcement, force/fire protection, contracting, disaster response, environmental, lodging, transportation, recreation, supply, education, mobility, food service, and family and personnel support. Six units make up the 97 MSG:

- 97th Civil Engineer Squadron
- 97th Communications Squadron
- 97th Force Support Squadron
- 97th Logistics Readiness Squadron
- 97th Security Forces Squadron
- 97th Contracting Flight

97th Maintenance Group (97 MXG)
The 97 MXG provides sortie generation, aircraft and equipment maintenance, and transient alert, enabling the 97 AMW to perform its aircrew training mission. Two units and two direct report sections make up the 97 MXG:

- 97th Maintenance Squadron
- 97th Aircraft Maintenance Squadron
- 97th Maintenance Operations Section
- 97th Maintenance Group Quality Assurance Section

97th Medical Group (97 MDG)
The 97 MDG ensures combat readiness and capability by promoting the health, safety, and morale of active duty personnel. The unit trains, mobilizes, and provides medical services to support contingency operations worldwide. The unit developed and operates a healthcare system for over 9,500 beneficiaries, increasing wellness in the local community. Two units make up the 97 MDG:

- 97th Operational Medical Readiness Squadron
- 97th Healthcare Operation Squadron

Table 3. Organizations and Natural Resources Management Responsibilities at Altus AFB

Group	Squadron	Flight/Staff	Responsibilities
Wing Staff		Wing Commander	-Chair, Environment, Safety, and Occupational Health Council (ESOHC)
		Judge Advocate	-Regulatory interpretation -Provide legal advice
		Safety	-Executive Secretary, Environment, Safety, and Occupational Health Committee -BASH program implementation
Operations Group	Operations Support	Airfield Management	-Airfield grounds management -Runway clear zone management

Mission Support Group	Civil Engineering	Environmental	-Spill response -Stormwater pollution prevention -Natural resources program management -Installation restoration program implementation -Hazardous materials and waste management -Recycling and solid waste management
		Engineering	-Stormwater/erosion control design -Construction project design -Community planning
		Operations	-Grounds maintenance/landscaping -Infrastructure construction/repair -Pest management
		Fire Department	-Wildland Fire Management Plan oversight -Spill response
Medical Group	Operational Medical Readiness	Bioenvironmental/ Public Health	-Environmental health risk assessments -Zoonotic disease monitoring

2.1.4 Surrounding Communities

The City of Altus is located in Jackson County, Oklahoma, which comprises the Altus Micropolitan Statistical Area (MSA). According to the most recent U.S. Census Bureau estimate, Altus has a population of approximately 18,709, which makes up 75% of the total population of Jackson County (USCB, 2018). Nearly 18% of Altus residents are below the poverty level, and the median household income for the city is $42,035.

Roughly 2,583 military personnel and their dependents and 1,012 military retirees reside at Altus AFB and the surrounding community. The installation is the largest non-farm employer in Jackson County, employing approximately 1,484 active duty military, 25 Guard/Reserve, 1,740 Cadets/students, and 1,811 civilian personnel (USAF, 2018b). An estimated 1,443 jobs are supported by base operations, and the estimated annual economic impact on the local community is over $361 million.

Agriculture plays a significant role in the local economy. The majority of land in Jackson County is farmland, with 634 farms comprising 510,761 acres of land. According to the USDA Census of Agriculture (2017), crops account for 85% of all agriculture sales in Jackson County, while livestock, poultry, and animal products account for 15% of agriculture sales. Cotton lint and cottonseed account for 85% of the income from crop sales, while grain sales (mainly wheat) account for the rest. Cattle account for 98% of animal/animal product sales, followed by equine, hog, sheep and goat, and poultry sales.

2.1.5 Local and Regional Natural Areas

Altus AFB and the Sooner Drop Zone are predominantly surrounded by farmland and undeveloped open space. Developed areas of the city of Altus are in close proximity to the western side of the base. There are no federal wildlife refuges, state wildlife management areas, or nature preserves within five miles of Altus AFB. The closest natural area is Gist Wildlife Management Area (WMA), located about 19 miles southeast of the installation. Gist WMA is an area of bottomland vegetated by sand plum thickets, cottonwoods, and tall grasses. The next closest natural area is a state park named Quartz Mountain Nature Park, located about 24 miles north of the base. Quartz Mountain is one of the westernmost peaks of the Wichita Mountains and overlooks Lake Altus-Lugert.

2.2 Physical Environment

2.2.1 Climate

Jackson County experiences a humid subtropical climate bordering a semi-arid climate zone (Köppen, 1936). The region sees hot, dry summers and warm to cool, dry winters. High amounts of direct solar radiation and outgoing radiation create extreme variations between day and night temperatures. Altus AFB experiences around 300 days of clear skies per year, making it very compatible with flying operations.

Spring produces the most rainfall, with intense thunderstorms that produce strong winds and occasional hail. Altus AFB sees an average of 28.9 inches of precipitation per year, and 1.3 days that exceed 2 inches of precipitation (CSU, 2019). On rare occasions, a tornado will touch down in the area. The most recent tornado to cause major damages in Jackson County occurred in 2015.

Summers are extremely hot and dry with occasional heavy rainfall due to remains of hurricanes from the Gulf of Mexico. July and August are the warmest months with average daily temperatures greater than 80°F (Figure 4). Altus sees an annual average of 93.9 days that exceed 90°F, and many days exceed 100°F. The highest recorded temperature of 120°F occurred in 1936.

The autumn season in Altus is brief and warm. The area experiences another peak in precipitation in September and October from thunderstorms. The long growing season for the region averages 224 days.

Winter is generally cool and dry, but temperatures can be extremely variable. Warm Chinook winds from the Pacific Northwest may bring in hot temperatures and dry out vegetation, producing wildfires. At other times, a block may form over the Gulf of Alaska and create cold fronts below 0°F. An average of 78.5 mornings fall to or below freezing each winter. January is the coldest month with an average temperature of 39.3°F. Snowfall occurrence in Altus is rare and minimal.

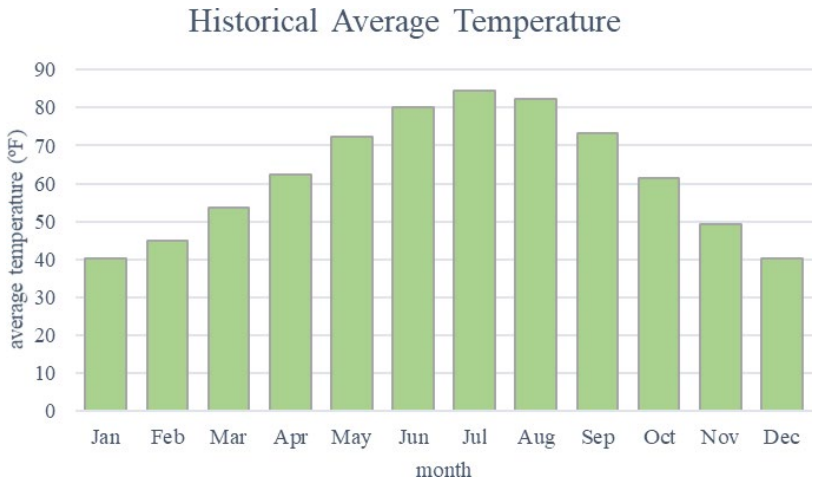


Figure 4. Historical monthly average temperatures at Altus AFB

2.2.1.1 Climate Change Projections

Climate projections for Altus AFB, created by Colorado State University (2019), are presented in Table 4 and graphically shown in Appendix C. The results suggest minimum and maximum temperatures will increase over time under two emission scenarios – a moderate carbon emission scenario (Representative

Concentration Pathway [RCP] 4.5) and a high emission scenario (RCP 8.5). The potential impact of these two climate change scenarios on the site's natural resources was analyzed using extracted climate data from 2026 to 2035 to represent the decadal average for 2030, and extracted data from 2046 to 2055 for the decadal average for 2050.

For the decade centered around 2030, both scenarios project an increase in average annual temperature of between 2.7 °F (1.5 °C) for RCP 4.5 and 3.9 °F (2.1 °C) for RCP 8.5 over the historic average. The two emission scenario projections show higher warming by 2050, with RCP 4.5 expressing a warming of 3.6 °F (2.0 °C). RCP 8.5 expresses a slightly greater warming of 5.5 °F (3.1 °C) for this period.

Average annual precipitation (PRECIP) varies between emission scenarios and over time due to larger interconnected ocean-atmosphere dynamics associated with the NCAR CCSM model. For 2030, RCP 4.5 scenario projects an increase in PRECIP of 14% while RCP 8.5 shows a small increase of 2%. For 2050, RCP 4.5 projects an increase in PRECIP of 13%, while RCP 8.5 shows a smaller increase of 10% from the historic average.

Table 4. Historical and projected climate data for Altus AFB

Variable	Historical	RCP 4.5		RCP 8.5	
		2030	2050	2030	2050
PRECIP (inches)	28.9	33.0	32.7	29.6	31.7
TMIN (°F)	49.2	51.9	52.5	53.1	54.4
TMAX (°F)	75.1	77.9	79.2	79.1	80.9
TAVE (°F)	62.2	64.9	65.8	66.1	67.7
GDD (°F)	5729	6362	6511	6578	6872
HOTDAYS	93.9	118.9	123.1	127.7	137.1
WETDAYS	1.3	0.3	1.0	0.5	0.8

Notes: TAVE ºF = annual average temperature; TMAX ºF = annual average maximum temperature; TMIN ºF = annual average minimum temperatures; PRECIP (inches) = average annual precipitation; GDD ºF = Average annual accumulated growing degree days with a base temperature of 50 ºF; HOTDAYS (average # of days per year) = average number of hot days exceeding 90 ºF; WETDAYS (average # of days per year) = annual number of days with precipitation exceeding 2 inches in a day.

Understanding changes in daily intensity and total precipitation for multi-day precipitation events is helpful to evaluate precipitation patterns in addition to assessment of annual averages. Three-day storm events (design storms) were generated from projected precipitation data based on RCP 4.5 and 8.5 emission scenarios for the 2030 and 2050 timeframes (Table 5). Historical precipitation data were used to calculate a baseline storm event for the year 2000 for comparison.

Table 5. Design storm precipitation for Altus AFB.

Design Storm		Baseline	RCP 4.5		RCP 8.5	
		2000	2030	2050	2030	2050
Precipitation (inches)	Day 1	1.1	1.6	1.7	1.2	1.5
	Day 2	2.2	2.1	2.5	2.2	2.4
	Day 3	1.9	1.1	1.9	0.9	1.4
	Total	5.2	4.8	6.1	4.3	5.3
Percent change from baseline			-8%	17%	-17%	2%

2.2.2 Landforms/Physiography

Altus AFB lies within the Central Redbed Plains area of the Central Lowlands physiographic region of the United States (Fenneman and Johnson, 1946). This landscape is characterized by mostly level to rolling hills and moderately dissected, rolling plains with numerous stream terraces. Topography at the base is nearly level to gently sloping, and local relief is the result of stream erosion or human activities. Surface elevation ranges from approximately 1,330 feet above mean sea level (MSL) in the drainage at the south end of the base to 1,390 feet above MSL at the northernmost point (USAF, 2020). Overall, surface topography gently slopes to the south-southeast, from a high elevation near the northwest corner.

A small stream called Stinking Creek passes through the airfield from the northwest to the southeast. An unnamed tributary to Stinking Creek runs along the southwestern boundary of the installation. These streams flow southeast to the North Fork of the Red River. The North Fork flows south about 13 miles east of the base and the Salt Fork flows south about 5 miles west of the base. The Red River flows east about 14 miles south of the base on the border between Oklahoma and Texas.

2.2.3 Geology and Soils

Altus AFB is located within the Wichita Uplift geological province. This area is underlain by the Hennessey Group, a reddish-brown to gray soft shale underlain by sandstone, shale, and siltstone, and interlaced with beds of gypsum and salt (Stanley and Miller, 2004). The stream channel and flood plain of the unnamed tributary to Stinking Creek along the southwestern border of the installation contain alluvium deposits of unconsolidated sand, silt, clay, and gravel (Figure 5).

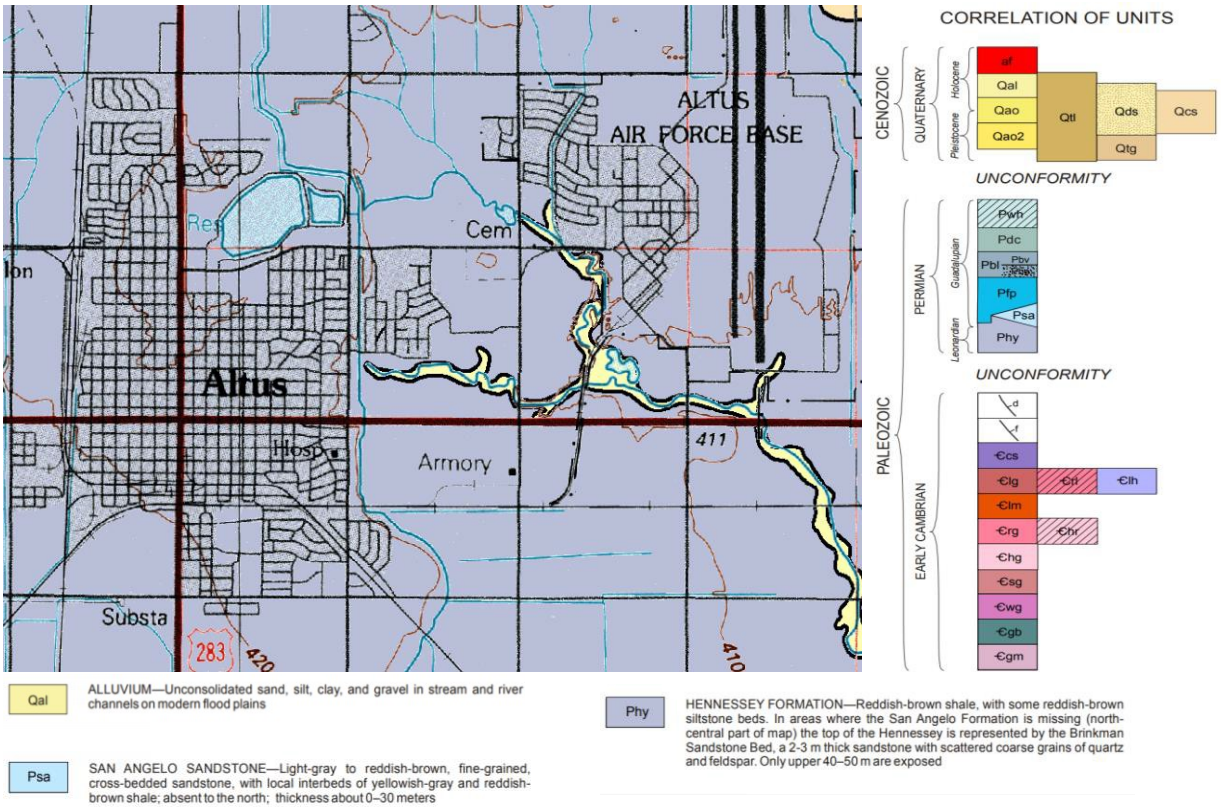


Figure 5. Geological map of the City of Altus and Altus AFB.

A 1983 USDA soil survey of Jackson County identified four major soil series on Altus AFB as Miles, Tillman, Hollister (intermingled with Tillman), and Altus Series. There are also several small areas of Nobscot, Abilene, Port, Spur, and Mansic soils. The Sooner Drop Zone (SDZ) contains Spur, Vernon, Knoco-Badland, Acme, Beckman, Tilvern, and Westill soil types. Locations of all known soil types on the installation and SDZ are depicted in Figure 6. NRCS (2014) describes each soil type as follows:

Tillman Clay Loam, 1 to 3% Slopes (TaB): This deep soil occurs in uplands along natural drains. TaB is hard when dry and firm when moist. This soil has weak granular structure and is susceptible to water erosion. The surface layer is a reddish-brown, granular clay loam that is noncalcareous (lacking lime) with a pH of 7.5. This layer is 5 to 8 inches thick, or less in eroded areas. The subsoil is reddish, more clayey, and 8 to 12 inches thick. The subsoil is calcareous in most places.

Tillman and Hollister Clay Loams, 0 to 1% Slopes (TcA): TcA soils are deep, lean clays that occur in uplands and grade to slowly permeable clays. These soils are composed of about 60% Tillman soil and 40% Hollister soil, in an intermingled pattern. The surface layer is a granular clay loam, 8 to 10 inches thick. This layer is reddish-brown in the Tillman soils and a darker grayish-brown in the Hollister soils. The subsoil is 18 to 27 inches of clay. TcA soils are non-calcareous (pH 7.5 to 8) to a depth of 20-24 inches.

TcA soils are hard when dry and firm when moist. They have a moderate to high shrink-swell potential with changes in water content. Lack of moisture that plants can use is the main problem with these soils. Erosion is not particularly a hazard. During prolonged dry periods, however, fine particles of clay and silt are detached from the soil mass and blown about. This occurs mainly on poorly managed, cultivated fields.

Miles Fine Sandy Loam, 0 to 1% Slopes (MeA): This soil is deep and well-drained but can store large amounts of moisture that plants can use. MeA contains 10 inches of brown fine sandy loam surface soil. The 44-inch subsoil is moderately permeable to air and water. Both layers are friable, noncalcareous (lacking lime), and neutral to mildly alkaline in reaction. Some areas below the subsoil are calcareous and contain a clayey layer at depths of about 60 inches.

Miles Fine Sandy Loam, 1 to 3% Slopes (MeB): This soil lies along natural drains and on gently sloping hills or ridges. The surface layer is 6 to 10 inches thick and the rest of the profile is the same as above.

Miles Loamy Fine Sand, 0 to 3% Slopes (MfB): MfB soil has a profile similar to that of MeA, but it contains less plant nutrients so it is not as productive, and it is somewhat sandy throughout. In some places the 10 to 18-inch surface layer has been lost through wind erosion, exposing the subsoil. Some areas are subirrigated by the water table near the surface. Groundwater saturation creates a somewhat mottled subsoil. Subirrigated areas are in low parts of the landscape or along drainage ways.

Altus Fine Sandy Loam, 0 to 1% slopes (AtA): The surface soil of AtA is about 8 inches of dark gray-brown, fine sandy loam that is friable and easy to work. The 34-inch subsoil is sandy clay loam in the upper half and heavy sandy clay loam in the lower part. The subsoil is moderately tight but readily penetrated by plant roots. The depth to red beds is usually between 4 and 10 feet. In places, the soil is subirrigated during wet seasons; the soil is more clayey throughout and its lower part is mottled. Some areas contain slick spots that diminish during dry periods. During wet years, the water table is generally within 5 feet of the surface.

Abilene Clay Loam 0-3% slopes (AbA): This very deep, well-drained and moderately permeable soil is dark brown throughout. The surface layer, about 8 inches in depth, is granular, friable, and not calcareous. From this layer down to 54+ inches, the soil becomes more clayey and increases in calcium carbonate.

Wet Spur Clay Loam 0-2% slopes (Sc): This soil is very deep, well-drained, and moderately permeable. The soil is found in floodplains of stream tributaries, drainage ways, and irrigated areas.

Port Soil (Po): This clay loam is very deep, fertile, moderately permeable, and well drained. Po soil occurs on bottomlands that are seldom flooded. However, it forms on sediments deposited from floodwaters of adjacent streams. This soil has a good water-holding capacity, and are well suited to irrigation.

Nobscot Fine Sand, 0 to 5% slopes (NoC): This light-colored soil forms in deep sands on choppy-surfaced uplands. NoC is very deep, well-drained, and moderately rapidly permeable. The soil is very susceptible to wind erosion. The texture of the surface soil is fine sand in most areas, with some areas of loamy fine sand. The upper 4 inches of the 15 to 25-inch thick surface layer contains a loose grayish-brown fine sand, underlain by loose fine soil. The subsoil, about 25 to 40 inches in depth, is fine sandy loam that is hard when dry, but friable when moist.

Westill Clay Loam 0-3% slopes (WtlA, WtlB): These deep, well-drained upland soils are very slowly permeable. They have a reddish brown color and are alkaline throughout. The first 15 inches of soil are friable, followed by dense, compact soil throughout 80+ inches. Iron-manganese is common in fine accumulations after a few feet of depth.

Mansic Clay Loam 1-3% slopes (MaB): Mansic soils are very deep, well-drained, and moderately permeable. The surface layer is dark brown and the soil becomes lighter with depth. MaB soils are firm, friable, and moderately alkaline throughout. The first 9 inches may be slightly granular, giving way to very fine soil. Calcium carbonate is irregular near the surface, but becomes more common with depth.

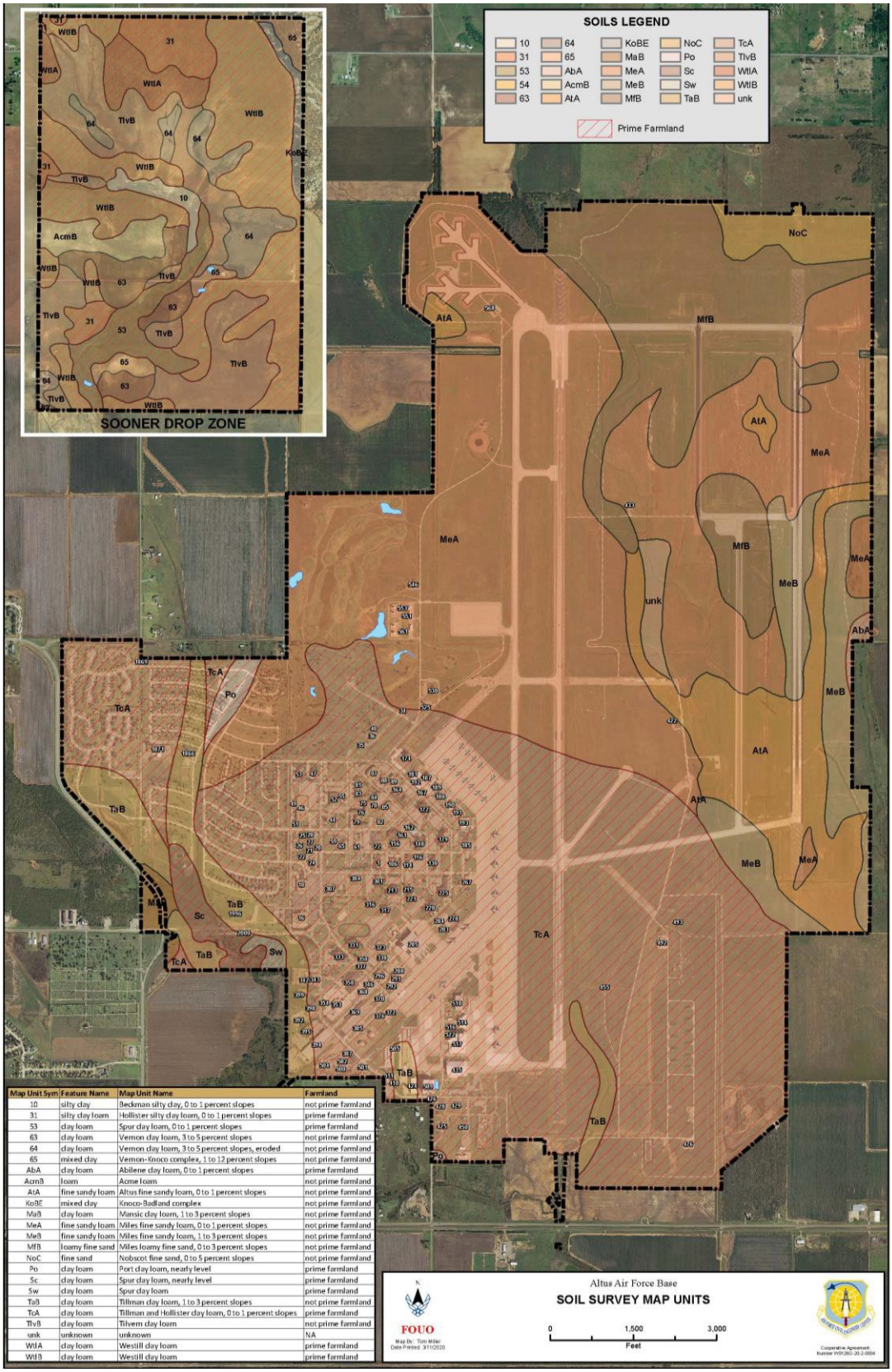
Knoco-Badland Complex (KoBE): This shallow, well-drained, dense clay is very slowly permeable and has a deep reddish color. Calcium carbonate may be found in small amounts, and moderate alkalinity is common. Clay bedrock may be found as shallow as 28 inches.

Acme Loam 0-1% slopes (AcmB): This soil is very deep, well-drained, and moderately permeable. AcmB soil is a greyish brown color. Upper portions are very fine and friable, while more coarse material may be found in depths of 65+ inches. Calcium carbonate and gypsum are found at about 12 inches of depth, and increase in concentration at greater depths.

Vernon Clay loam 3% + slopes (63, 64): These shallow, reddish-brown soils form over claystone bedrock on uplands. They are well-drained and very slowly permeable. The 6-inch surface layer is compact, calcareous, clay loam/clay soil. The subsoil down to 15 inches is mostly red compacted clay.

Beckman Silty Clay 0-1% slopes (10): These very deep, compact soils are found on level alluvial flood plains and are dark reddish in color. They are moderately well-drained and very slowly permeable. While typically non-saline in the first few inches, salinity increases with depth. Gypsum and salt crystals appear within the first few feet, increasing with depth. Iron becomes prevalent at 2-3 feet of depth.

Tilvern Clay Loam 1-3% slopes (TlvB): These deep, well-drained, and very permeable soils have a surface color of dark brown and increasing redness with depth. These soils reach depths of over 80 inches and are firm and blocky throughout. Calcium carbonate begins to be found sporadically at 5 inches deep and increases in concentration in depth. Gypsum, iron, and alkalinity also increase with depth.



Map Unit Sym	Feature Name	Map Unit Name	Farmland
10	silty clay	Beckman silty clay, 0 to 1 percent slopes	not prime farmland
31	silty clay loam	Hollister silty clay loam, 0 to 1 percent slopes	prime farmland
53	clay loam	Spur clay loam, 0 to 1 percent slopes	prime farmland
63	clay loam	Vernon clay loam, 3 to 5 percent slopes	not prime farmland
64	clay loam	Vernon clay loam, 3 to 5 percent slopes, eroded	not prime farmland
65	mixed clay	Vernon-Knoco complex, 1 to 12 percent slopes	not prime farmland
AbA	clay loam	Abilene clay loam, 0 to 1 percent slopes	prime farmland
AcmB	loam	Acme loam	not prime farmland
AtA	fine sandy loam	Altus fine sandy loam, 0 to 1 percent slopes	not prime farmland
KoBE	mixed clay	Knoco-Badland complex	not prime farmland
MaB	clay loam	Mansic clay loam, 1 to 3 percent slopes	not prime farmland
MeA	fine sandy loam	Miles fine sandy loam, 0 to 1 percent slopes	not prime farmland
MeB	fine sandy loam	Miles fine sandy loam, 1 to 3 percent slopes	not prime farmland
MfB	loamy fine sand	Miles loamy fine sand, 0 to 3 percent slopes	not prime farmland
NoC	fine sand	Nobscot fine sand, 0 to 5 percent slopes	not prime farmland
Po	clay loam	Port clay loam, nearly level	prime farmland
Sc	clay loam	Spur clay loam, nearly level	prime farmland
Sw	clay loam	Spur clay loam	prime farmland
TaB	clay loam	Tillman clay loam, 1 to 3 percent slopes	not prime farmland
TcA	clay loam	Tillman and Hollister clay loam, 0 to 1 percent slopes	prime farmland
TlvB	clay loam	Tilvern clay loam	not prime farmland
unk	unknown	unknown	NA
WtlA	clay loam	Westill clay loam	prime farmland
WtlB	clay loam	Westill clay loam	prime farmland

Figure 6. Soil survey map of Altus AFB and Sooner Drop Zone.

2.2.4 Hydrology

2.2.4.1 Groundwater

The Blaine and Seymour aquifers are the major aquifers closest to Altus AFB. Minor aquifers in the area are unconsolidated alluvial deposits associated with the Salt and North Forks of the Red River (USAF, 2004). The primary hydrologic unit underlying Altus AFB is the Hennessey Shale, which is exposed at the surface and only contains small amounts of groundwater (USAF, 2001a). The groundwater in the Hennessey Shale is typically shallow and unconfined. Precipitation is the primary source of recharge to the water-bearing zone. Groundwater storage can fluctuate significantly between seasons and periods of heavy rainfall.

The groundwater at Altus AFB moves toward the southeast, generally following surface topography. Shallow groundwater is present at depths of less than 5 feet in some areas (USAF, 2002). The groundwater has a high content of gypsum and suspended solids, and is classified as a Class 3 aquifer that is adequate for livestock, manufacturing, and industrial use (USAF, 1997).

2.2.4.2 Surface Water

Surface water on Altus AFB is drained by two watersheds, Stinking Creek and an unnamed tributary to Stinking Creek, flowing from the northwest to the southeast. Stinking Creek passes through the northern half of the airfield and the unnamed tributary runs along the southwestern boundary of the installation.

Stinking Creek drains the eastern portion of the base and is a tributary to the North Fork of the Red River approximately 13 miles downstream from Altus AFB. Stinking Creek is a perennial stream with a flow generally less than 20 cubic feet per second, except during rainfall. The unnamed tributary is an intermittent stream draining the housing area and the western portions of Altus AFB. This tributary usually does not flow during the later summer months. South of the housing area, the stream receives stormwater flow from the City of Altus reservoir. The tributary joins Stinking Creek about 5 miles downstream of Altus AFB.

An agricultural irrigation canal, the Ozark Canal, crosses the northernmost end of the base horizontally. In addition to the Ozark Canal, an unnamed irrigation canal passes under the main runway, flowing southeast for several hundred yards before turning south to eventually exit the base at the southern end. These canals do not receive surface runoff from the base and the base has no access to its waters. The canal is used for agricultural irrigation and may be dry or ponded during the off-season.

Altus AFB contains five small impoundments that are all located on the golf course. Some of them are used for golf course irrigation. These are not potable water sources and are not permanent.

2.2.4.3 Stream Channel Modeling for Climate Change

Modeling of stream channel overflow (or flood modeling) was conducted for Altus AFB to examine the extent of flooding along Stinking Creek and an unnamed tributary of Stinking Creek associated with climate projections (CSU, 2019). Flood modeling did not consider flooding of independent surface bodies, stormwater systems, or surface ponding. Flood modeling was conducted using local watershed characteristics and the design storms generated from climate projection data (Table 5). The projected design storms do not represent extreme weather events (e.g., hurricanes, extraordinary storm fronts).

2.3 Ecosystems and the Biotic Environment

2.3.1 Ecosystem Classification

Altus AFB lies within the Dry Domain, Subtropical Steppe Division, Great Plains Steppe and Shrub Province, Redbed Plains Section of the Southern Plains Ecoregion of the United States (Bailey, 2014). This region is characterized by gently sloping to rolling plains. Natural vegetation on about 90% of the land in this area has been converted to agricultural crops or pasture.

The primary natural ecosystems within the installation are grassland prairie, floodplain or wetland, and woodland. As shown in Figure 7, floodplain, wetland, and woodland comprise less than 1% of the landscape, while prairie comprises nearly 19% of the land. About 46% of the landscape is open space and 34% is developed.

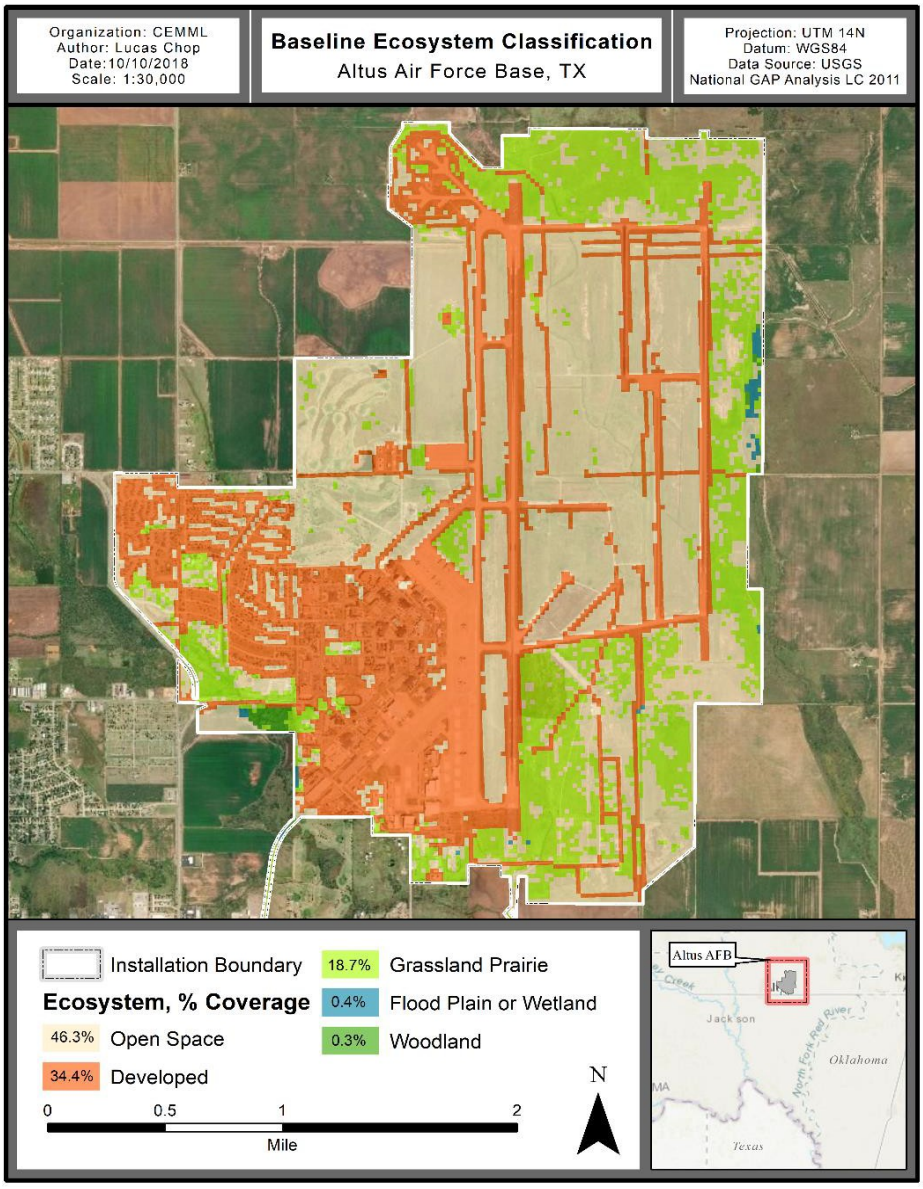


Figure 7. Baseline ecosystem coverage of Altus AFB.

2.3.2 Vegetation

Altus AFB is located within the Kansan biotic province, originally a region of mixed prairie grassland. Historically dominant grass species were bluestem, buffalo, grama, and needle grasses (USAF, 2002). Other grasses included vine mesquite, switchgrass, tobosa grass, and Arizona cottontop, intermingled by scattered shrubs such as yucca and sagebrush. Native trees in the area included mesquite and hackberry. Trees mainly occurred in riparian zones along streams and in floodplains.

Most of the vegetated areas on the installation are actively landscaped or maintained by mowing, but current vegetative cover in unimproved areas is similar to historical species composition (USAF, 2009). Table 6 lists the current native vegetative cover at Altus AFB by the soil type in which the plant species are found. Sandy and loamy soils on the alluvial plains and along streams of Altus AFB are dominated by big bluestem and little bluestem. These areas also support silver bluestem, switchgrass, sideoats grama, blue grama, drop seeds, buffalograss, and vine mesquite. Bottom land areas of Tillman clay loam and Hollister soil series are dominated by blue grama and sideoats grama. These areas also support little bluestem, silver bluestem, switchgrass, Indiangrass, sedges, Texas wintergrass, and vine mesquite. A complete list of vegetation surveyed and documented at Altus AFB can be found in Appendix F.

Table 6. Current native vegetative cover on Altus AFB by soil series

Altus fine sandy loam (AtA), 0 to 1% slopes		**Miles fine sandy loam (MeA) 0 to 1% slope**	
Common plant name	**Percent composition**	**Common plant name**	**Percent composition**
Big bluestem	20	Sand bluestem	20
Little bluestem	25	Little bluestem	25
Indian grass	5	Indian grass	5
Sand love grass	5	Sand love grass	5
Switchgrass	5	Switchgrass	5
Sideoats grama	10	Sideoats grama	10
Blue grama	5	Blue grama	5
Other perennial grasses	15	Lead plant	5
Other perennial forbs	7	Heath aster	5
Other shrubs	3	Other perennial grasses	5
		Other perennial forbs	5
		Other shrubs	5
Tillman clay loam 0 to 3% slope		**Hollister**	
Common plant name	**Percent composition**	**Common plant name**	**Percent composition**
Sand bluestem	5	Sand bluestem	5
Little bluestem	5	Little bluestem	5
Silver bluestem	5	Silver bluestem	5
Buffalo grass	10	Buffalo grass	10
Western wheatgrass	5	Western wheatgrass	5
Sideoats grama	25	Blue grama	20
Blue grama	20	Sideoats grama	25
Vine-mesquite	5	Vine-mesquite	5
White tridens	5	White tridens	5
Other perennial grasses	10	Other perennial grasses	10
Other perennial forbs	5	Other perennial forbs	5

The major grass species that occur on improved and semi-improved grounds on the installation are listed in Table 7. Turf and landscaped areas are dominated by common bermudagrass. Semi-improved lands are dominated by sideoats grama, blue grama, switchgrass, buffalograss, and little bluestem.

Table 7. Current native vegetative cover on Altus AFB on improved and semi-improved grounds

Common Name	Scientific Name
Improved grounds	
Common Bermuda grass	*Cynodon dactylon*
Semi-improved grounds	
Sideoats grama	*Bouteloua curtipendula*
Blue grama	*Bouteloua gracilis*
Switchgrass (Blackwell variety)	*Panicum virgatum*
Buffalo grass (south one-half of base)	*Buchloe dactyloides*
Little bluestem	*Andropogon scoparius*

Native trees on the upland are mesquite and honey locust, while the draws and stream channels contain elm and cottonwood along with some encroaching saltcedar. Much of the historically mixed prairie land surrounding the installation has been converted to short-grass pasture for livestock grazing (USAF, 1998).

2.3.2.1 Climate Change Implications for Vegetation

The dominant ecosystem present at the installation is grassland/prairie. According to CSU (2019), light changes in temperature and precipitation can substantially alter the composition, distribution, and abundance of species in these ecosystems, and the products and services they provide. The extent of these changes will also depend on changes in precipitation and fire. Increased drought frequency could also cause major changes in vegetation cover. Loss of vegetative cover coupled with increases in precipitation intensity and climate-induced reductions in soil aggregate stability will dramatically increase potential erosion rates.

As warmer temperatures increase evaporation and water use by plants, soils are likely to continue to become drier. Average rainfall is likely to increase during winter, spring, and summer. Climate change impacts to grasslands and pasture bioregions include increased seasonal, annual, minimum, and maximum temperature and changing precipitation patterns. Because these ecosystems are relatively dry with a strong seasonal climate, they are sensitive to climatic changes and vulnerable to shifts in climatic regime. Rising temperatures under various climate change scenarios will likely enhance soil decomposition. Together with reductions in rainfall, this may also reduce plant productivity over large areas.

A qualitative analysis of vegetation cover type maps in MC2 Dynamic Global Vegetation Model was done to assess potential changes to land cover and uses under the projected climate change scenarios. Historically, vegetation type at Altus AFB has been Subtropical Shrubland C4. Under RCP 8.5, vegetation cover at Altus AFB could be converted to temperate warm mixed woodland (Kim, Kerns, Drapek, Pitts, & Halofsky, 2018). This means a projected loss of grassland/shrubs and prairie ecosystems at the installation in the future.

2.3.3 Fish and Wildlife

A full list wildlife species known to occur at Altus AFB can be found in Appendix G. The following paragraphs outline the higher taxonomic classifications present.

A variety of mammalian orders are represented at Altus AFB. Rodentia is one of the most abundant groups and is represented by several species of mice, rats, and squirrels. Lagomorphs are also abundant, although limited in representation to two species, the eastern cottontail (*Sylvilagus floridanus)* and the black-tailed jackrabbit (*Lepus californicus*). An outbreak of tularemia over the past few years has decreased the populations of these two groups; however population swings regularly occur due to predator-prey cycles. Seasonal abundances of Chiroptera (bats) can be significant, with an acoustic survey by the University of Montana and Tetra Tech, Inc. in 2017 identifying 11 species at Altus AFB. The eastern red bat (*Lasiurus borealis*), Brazilian free-tailed bat (*Tadarida brasiliensis*), and silver-haired bat (*Lasionycteris noctivagans*) dominate activity levels on the installation. Order Carnivora is also well represented, with several Mustelids and Canids, and single species from families Felidae and Procyonidae. The nine-banded armadillo (*Dasypus novemcinctus*) is the sole representative of the order Cingulata. Artiodactyla also has a lone representative, the white-tailed deer (*Odocoileus virginianus*), although its presence on Altus AFB is only intermittent due to successful exclusion efforts.

The order Amphibia has multiple representatives from both the Anura and Caudata classes. Most of their presence is restricted to the immediate areas surrounding permanent water bodies (i.e., creeks and ponds) or vernal pools. Toads are the exception to this, occupying a larger range of habitats. Amphibian species on base are abundant where found.

The installation is home to Reptilia members from three classes, Testudinata, Squamata, and Aves. From Testudinata there are several species of turtles present. Squamata has a large representation, as both snakes and lizards have multiple species present. Aves is likely the most abundant class of vertebrates on the installation. A significant number of families are represented; however, Icterids and Columbids have the highest presence.

2.3.3.1 Climate Change Implications for Fish and Wildlife

Fish and wildlife communities at Altus AFB are not expected to experience significant changes due to climate change. A substantial proportion of Altus AFB is developed and as a result, the majority of wildlife species found on post are widespread generalists capable of tolerating a wide range of environmental conditions.

Changing climate has the potential to alter vegetation communities. This will likely have a negative impact on specialist wildlife species that have historically depended on specific native plant communities for their survival (Dukes & Mooney, 1999). Changing environmental conditions may also create open niches for non-native invasive species to expand onto Altus AFB. Newly arriving invasive species often have the ability to outcompete native species which are already experiencing reduced fitness due to environmental conditions shifting away from historic standards (Hellmann, Byers, Bierwagen, & Dukes, 2008). Rising temperatures could also result in the increased potential for foodborne diseases and incidences of infectious disease of animals that are transmittable to humans, particularly those carried by foxes, rodents and arthropods such as rabies and West Nile virus (Süss, Klaus, Gerstengarbe, & Werner, 2008).

Precipitation is projected to increase slightly but will possibly be offset by higher evapotranspiration rates due to increasing temperatures. Increasing temperature could have a negative impact on water quality,

particularly in lentic systems. As water temperatures rise in lentic systems, dissolved oxygen content decreases, impairing water quality particularly for larval amphibians and aquatic macroinvertebrates. Increasing water temperature will also increase the chances of algal blooms occurring, further depleting dissolved oxygen content and degrading habitat quality (Paerl, Hall, & Calandrino, 2011).

2.3.4 Threatened and Endangered Species and Species of Concern

The Endangered Species Act (ESA) of 1973 (16 US Code [USC] §1531 *et seq*.) serves to protect and recover species nearing extinction and the ecosystems upon which they depend. The ESA is administered by the USFWS, which designates federally threatened and endangered terrestrial and freshwater species. ODWC designates and maintains a list of species that are threatened or endangered in Oklahoma.

According to an endangered species survey conducted by the Oklahoma Biological Survey in 1998, no known federally or state listed threatened or endangered plant or wildlife species are known to occur on Altus AFB or Sooner Drop Zone (SDZ) (Schnell et al. 1998). Furthermore, no habitat listed as critical for any such species has been designated.

Southwestern Oklahoma does not contain any recorded federally threatened or endangered plant species. Federally endangered wildlife species known to occur in southwestern Oklahoma that have not been documented on Altus AFB include the whooping crane (*Grus americana*), the interior least tern (*Sterna antillarum*), and the piping plover (*Charadrius melodus*) The least tern is known to occur in Jackson and Harmon counties in the summer (Tyler 1979, Wood and Schnell 1984). The piping plover is known to occur in southwest Oklahoma, but has not been recorded in Jackson County. The whooping crane has been recorded in Jackson County, and could potentially fly over the installation. However, Altus AFB and the SDZ do not contain habitats likely to attract any of these species.

ODWC also designates rare and declining wildlife species in Oklahoma as state-listed Species of Greatest Conservation Need. Mammalian species of concern that have been documented at Altus AFB include the Brazilian (Mexican) free-tailed bat (*Tadarida brasiliensis*), tricolored bat (*Perimyotis subflavus*), and western big-eared bat (*Corynorhinus townsendii*). Reptilian species of concern include the spiny softshell turtle (*Apalone spiniferus*) and the Texas horned lizard (*Phrynosoma cornutum*). Avian species of concern include the loggerhead shrike (*Lanius ludovicianus*), burrowing owl (*Athene cunicularia*), little blue heron (*Egretta caerulea*), Swainson's hawk (*Buteo swainsoni*), prairie falcon (*Falco mexicanus*), northern bobwhite (*Colinus virginianus*), and the upland sandpiper (*Bartramia longicauda*).

Several species listed under the USFWS Birds of Conservation Concern list occur regionally. Their presence on the base can vary annually, and ranges from full year, seasonal, and migratory to absent. These species of concern include Bell's vireo, Cassin's sparrow, chestnut-collared longspur, buff-breasted sandpiper, Harris's sparrow, Hudsonian godwit, lark bunting, little blue heron, loggerhead shrike, marbled godwit, McCown's longspur, Mississippi kite, red-headed woodpecker, scissor-tailed flycatcher, short-billed dowitcher, Smith's longspur, snowy plover, solitary sandpiper, Sprague's pipit, Swainson's hawk, and upland sandpiper.

2.3.5 Wetlands and Floodplains

Wetlands are defined 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" (COE, 1987). The National Wetlands Inventory identifies roughly 35 acres of wetlands on Altus AFB, as shown in Figure 8 (USFWS, 1983). This does not include creeks, irrigation canals, and drainage swales.

Figure 8. Wetland areas at Altus AFB.

A wetlands delineation completed in 1994 identified wetlands at Altus AFB using three designations for aquatic systems (Webb and Aurelius):

System 1 areas are riverine, intermittent streambed systems with seasonal or temporary hydrology. These are natural drainages with a defined bed and bank, and occur in channelized portions of Stinking Creek as well as unnamed tributaries and natural drainages that connect to Stinking Creek. Many of these drainages are routinely mowed and maintained. Small, intermittent oxbow-like, isolated patches of wetland within these beds are considered jurisdictional wetlands, subject to the regulations of Section 404 of the CWA. Plant species commonly observed within these isolated wetlands are threesquare bulrush *(Scirpus pungens)* and Small's spikerush *(Eleocharis smalllii).*

System 2 areas are palustrine, emergent, persistent systems that may have temporary or seasonal hydrology, or seasonally saturated soils. Altus AFB contains four System 2 areas, which are larger, more easily distinguishable sites that may be subject to Section 404 regulatory review as special aquatic sites.

System 3 areas are riverine, intermittent streambed systems with seasonal, permanent, or temporary hydrology. These are constructed drainages and swales that provide drainage for base facilities. Altus AFB contains eight System 3 areas of maintained canals that often connect to natural drainages across the base. Two of these areas have permanent hydrology, four areas have seasonal hydrology, and two areas have temporary hydrology. These systems are usually not regulated under Section 404 of the CWA.

Six excavated areas on Altus AFB are classified as palustrine, unconsolidated bottom aquatic sites that may have semi-permanent hydrology. These are percolation ponds for facility treatment systems or ponds used for irrigation for the base golf course. Artificial ponds are not regulated under the CWA.

Floodplains are defined by the Federal Emergency Management Agency (FEMA) as “any land area susceptible to being inundated by floodwaters from any source” (FEMA, 2019). Floodplains provide space to accommodate flood waters from the overflow of streams after heavy rain events. Floodplains on Altus AFB surround Stinking Creek and unnamed tributaries to Stinking Creek. The majority of the floodplains are in unimproved, semi-improved, and airfield grounds.

The 100-year and 500-year FEMA flood maps for the installation were created in 2012 and are considered outdated according to FEMA guidelines. Additionally, portions of the FEMA flood maps show no changes or updates since July 2005. A recent floodplain analysis conducted by Colorado State University (CSU) provided updated 100-year and 500-year floodplain mapping information for Altus AFB using high quality spatial data and 2D hydraulic modeling (CSU, 2020). Figure 9 overlays the outdated floodplain map with the new floodplain data for the installation. .

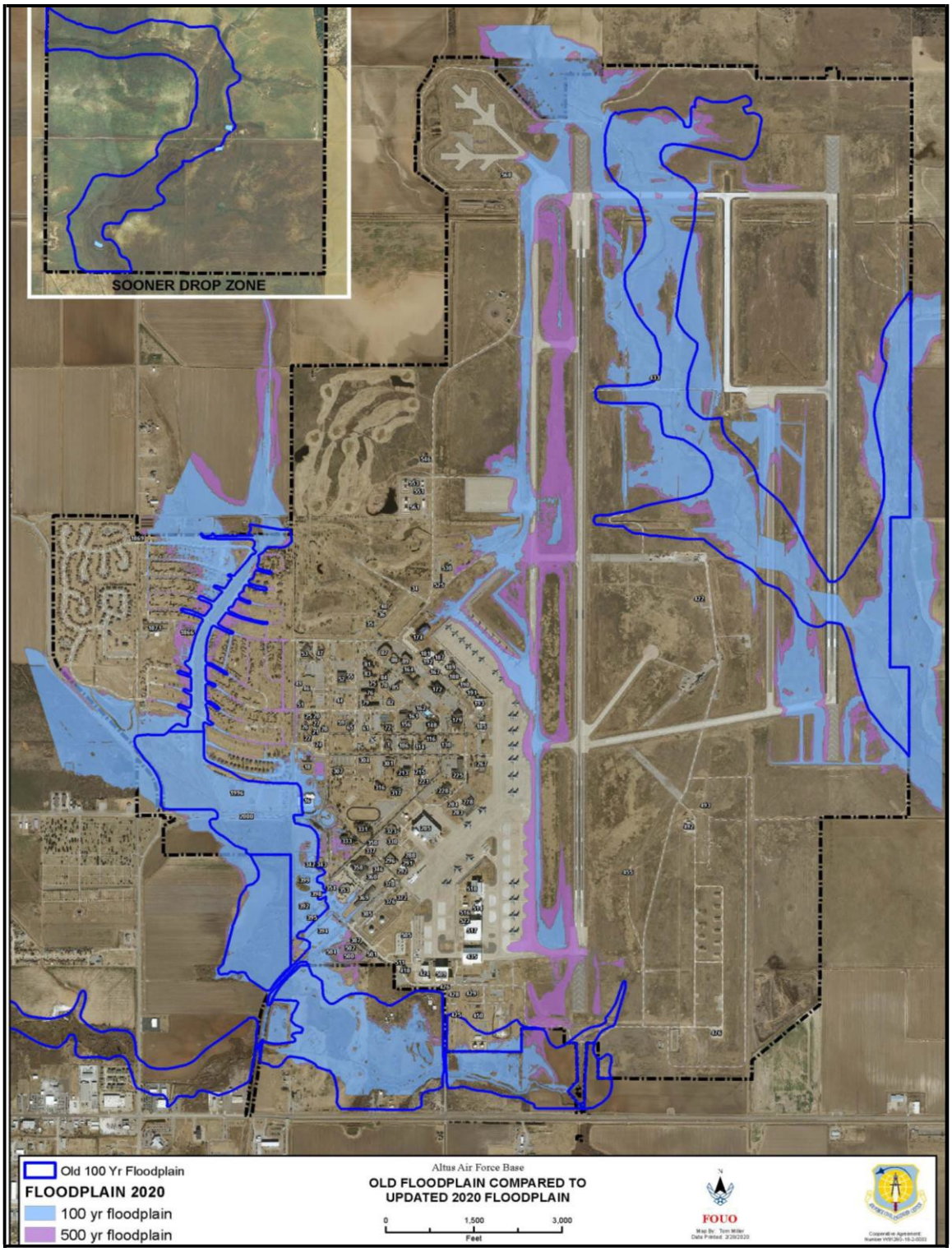


Figure 9. Outdated FEMA floodplain areas and updated CSU floodplain areas at Altus AFB.

2.3.5.1 Climate Change Implications for Wetlands

Wetland ecosystems will face increases in air and surface water temperatures, alterations in the magnitude and seasonality of precipitation and run-off, and shifts in reproductive phenology and distribution of plants and animals (Parmesan and Yohe, 2003). These ecosystems are naturally resilient, provide linear habitat connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife all characteristics that can contribute to ecological adaptation to climate change. Because wetland systems and the projected impacts of climate change are highly variable geographically, there is a pressing need to develop a place-based understanding of climate change threats to riparian ecosystems.

2.4 Mission and Natural Resources

2.4.1 Natural Resources Needed to Support the Military Mission

Existing ecosystem components of the installation such as wetlands, floodplains, vegetation, and fish and wildlife are all necessary aspects of a healthy landscape capable of supporting the mission.

Wetlands and floodplains provide free ecosystem services such as erosion and flood control by storing floodwaters from local streams after heavy rainfall, which minimizes loss of property in developed areas. These areas help control stormwater runoff and improve water quality by removing pollutants and excess sediment and nutrients. They contribute to groundwater recharge by promoting infiltration, and contain higher plant diversity that helps maintain biodiversity and ecosystem integrity.

Adequate undeveloped open space is necessary for airfield buffering and contingency training. Vegetation provides water filtration and soil stabilization that prevents erosion. Vegetation also provides privacy and increases the aesthetic value of the landscape.

Natural areas and fish and wildlife provide for enjoyable outdoor recreation experiences that increase the morale of airmen, their families, and guests on the installation. A healthy natural environment and proactive natural resources management program at Altus AFB will continue to improve the quality of life for airmen and increase the resiliency of the landscape to support the AF mission.

2.4.2 Natural Resource Constraints to Mission and Mission Planning

Altus AFB does not contain any major constraints to the mission and mission planning that would prohibit development and operations in affected areas. The installation does contain minor constraints in which development is permitted in affected areas with consideration and/or mitigation. Minor natural resources constraints on the installation include bird/wildlife aircraft strike (BASH) hazards, wetlands, and floodplains (USAF, 2014).

2.4.2.1 BASH Constraints

Wildlife strikes are a serious flight safety concern and can also cause significant monetary loss from damages to aircraft. Altus AFB is located in the middle of the Central Flyway and experiences significant BASH risks due to a high presence of migratory birds. The impact of bird strikes on the mission is mitigated through the BASH program, which utilizes a full-time USDA wildlife biologist to deter and remove hazardous wildlife from the airfield environment and surrounding areas.

2.4.2.2 Wetlands and Floodplains Constraints

Wetland and floodplain areas may present a constraint to installation development. Proposed actions in jurisdictional wetland areas require permits and wetland mitigation measures pursuant with the CWA.

Proposed actions within a floodplain, or actions that could affect floodplains, must be assessed to identify the effect on flood risk and must go through the AF Environmental Impact Analysis Process (EIAP). This may impact the military mission by increasing costs and timelines for construction projects.

Multiple areas and buildings lie within floodplains, and several have been damaged by flooding in recent years. Flooding is caused by several factors, including intensity and frequency of rainfall, flat terrain, and the soil's low capacity for absorption (USAF, 1997). Off base land development and modification along tributaries to the north have caused increased runoff through base property, and some drainage ways outside of the base are narrow and constricted. Excess runoff along with the limited carrying capacities of nearby tributaries cause flood waters to back up onto base property.

Current areas affected include buildings in the southwestern portion of the base, as well as areas of the airfield pictured. Flooding is a problem in the southwest portion of the base including the main gate, the family camping (FAM Camp) area, and the outdoor recreation areas (Figure 10). Flooding also occurs in the northeast portion of the base, affecting operations on the parallel runway and assault strip.

The 2020 CSU analysis of the FEMA database resulted in the creation of an updated flood map for Altus AFB. This updated flood map will benefit planning and mission readiness at Altus AFB.

According to the CSU analysis of data from the Air Force Geospatial Information Management System (AFGIMS), the following assets on Altus AFB are located within the 100-year floodplain (Figure 10):

- 60 real property buildings
- 8 hazardous materials sites
- 4 hazardous waste sites
- 2 storage tanks
- 16.9% of the airfield

The following assets on Altus AFB are located within the 500-year floodplain (Figure 9):

- 107 real property buildings
- 10 hazardous materials sites
- 6 hazardous waste sites
- 3 storage tanks
- 35.7% of the airfield

CSU projected the 95th percentile maximum flood depth, flood velocity, and shear stress on the local terrain due to flooding for Altus AFB:

- Maximum flood depth is projected to be 1.8 feet for the 100-year storm and 1.9 feet for the 500-year storm.
- Maximum flood velocity is projected to be 1.4 feet/second for the 500-year storm and 1.3 feet/second for the 100-year storm.
- Maximum shear stress on the local terrain due to flooding is projected to be 0.1 lb/ft^2 for the 500-year storm and 0.2 lb/ft^2 for the 100-year storm.

Figure 10. Floodplain area and exposed infrastructure at Altus AFB.

2.4.3 Climate Change Impacts to the Mission

The undeveloped land and airspace that are needed to fulfill Altus AFB's mission of training aircrews do not require specific habitat or vegetation types that may be an integral part of mission readiness at other installations. Climate change will have negligible to no effect on the amount of air and land space available. The climate at Altus AFB is expected to get hotter, which could have secondary effects on the mission such as vegetation shifts and species migrations leading to an increased regulatory environment.

Additional floodplain inundation due to climate change is not a major concern, but as development continues on Altus AFB, and if forecasted climate changes eventuate, the quantity and intensity of flooding events may increase; floodplains may not have the capacity to hold increased flood waters. If the installation expands into flood zones, unmitigated, it would exacerbate flooding impacts on downstream off-base communities such as the City of Altus. Therefore, proper floodplain management is essential. Execution of this INRMP strives to manage the landscape to reduce the effects of future flood events on the mission.

Future impacts to the mission at Altus AFB linked to climate change could include:

- increases in temperature and wind velocity leading to unsafe environmental conditions for the launch of current and planned weapons and equipment, resulting in increased maintenance requirements, requirements for new equipment, or decreased launch capacity (DoD, 2014);
- increased dust generation affecting equipment and visibility (DoD, 2014);
- increased wind velocities damaging vital mission infrastructure (Sydeman et al., 2014);
- increased drought potential (Glick, Stein, & Edelson, 2011);
- potential loss of future training areas that may be needed in light of a changing geopolitical landscape and base realignment.

In addition to these direct effects, climate change has the potential to disrupt the acquisition and transportation of materials required for the maintenance, construction, and storage of the equipment required for these systems (DoD, 2014).

Inundation projections were influenced by four variable inputs: (1) variation in total precipitation between design storms, (2) variation between the daily distribution of precipitation over the three-day period, (3) land cover change over the watershed area used in hydrologic modeling, and (4) land cover change in the area within the installation used in hydraulic modeling.

Projected inundation associated with each climate scenario and the relative change from baseline conditions are summarized in Table 8. The spatial extent of projected flooding is depicted in a series of maps included in Appendix C. Projected changes in stream channel overflow can be used to assess potential vulnerabilities to species, habitat, mission, and built and natural infrastructure.

Total design storm precipitation is projected to decrease in 2030 and increase in 2050 (Table 4). Stream channel overflow is projected to increase by between 5% (RCP 8.5 in 2050) and 17% (RCP 4.5 in 2050) (Table 9). Flooding is projected to decrease by 24% under the RCP 4.5 emission scenario in 2030, despite total design storm precipitation decreasing by 8%. Projected land cover over the modeled watersheds was unique for this scenario having primarily grassland cover, compared to shrubland and forested vegetation, which were dominant in the other scenarios.

Table 9. Area inundated by stream channel overflow.

	Baseline	RCP 4.5		RCP 8.5	
	2000	2030	2050	2030	2050
Projected inundation (acres)	169	128.8	197.4	186.5	176.8
Change in inundation area from baseline (acres)		-40.2	28.4	17.5	7.7
Percent change from baseline		-24%	17%	10%	5%

2.4.4 Land Use

The Major Land Resource Area (MLRA) that Altus lies within is 78C, the Central Rolling Red Plains, Eastern Part (Figure 11). This MLRA is part of Land Resource Region H, the Central Great Plains Winter Wheat and Range Region (NRCS, 2006). Land use consists of 38% private cropland, 56% private grassland, 3% private urban development, 1% federal grassland, 1% private water, and 1% private other.

Farms and ranches that produce grain crops and livestock make up most of this MLRA. Most of the area is used as rangeland. The more gently sloping lands are used for pasture or for dry-farmed crops. Cotton also compromises a significant percentage of agricultural land use.

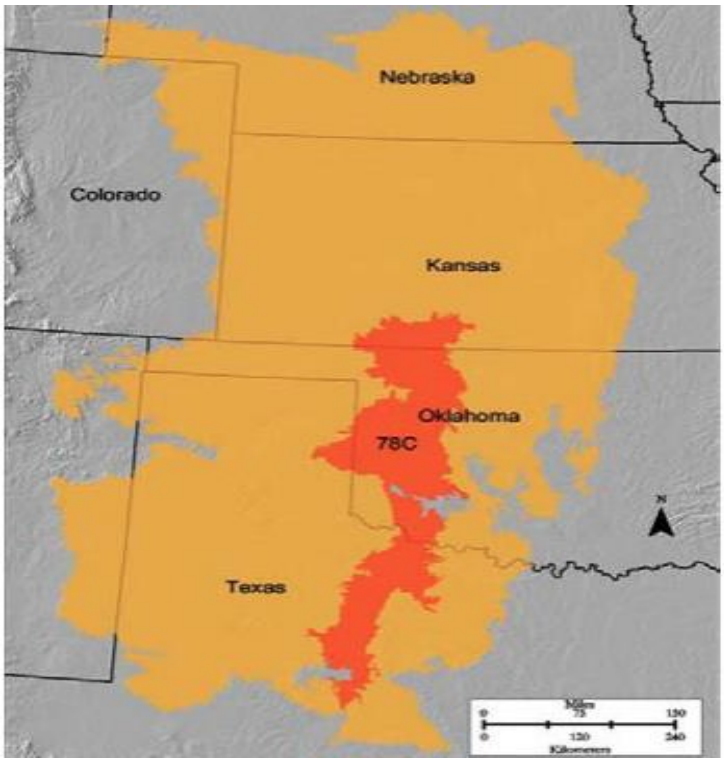


Figure 11: Location of MLRA 78C within Land Resource Region H.

Development at Altus AFB incorporates the grouping of compatible land uses. Industrial facilities are consolidated at the southern edge of the installation, and operations and maintenance areas are located along the flight line. Commercial and service community land uses are centrally located. Privatized military family housing is located in the northwest portion of the base. Open space occurs predominantly along the northeastern border of the base and also at the southern edge of the family housing area north of the main gate.

Land use on the installation includes areas for aircraft operations and maintenance, military training, outdoor recreation, and areas of medical, administrative, and industrial facilities, housing, community services, airfield, and open space. (Figure 12).

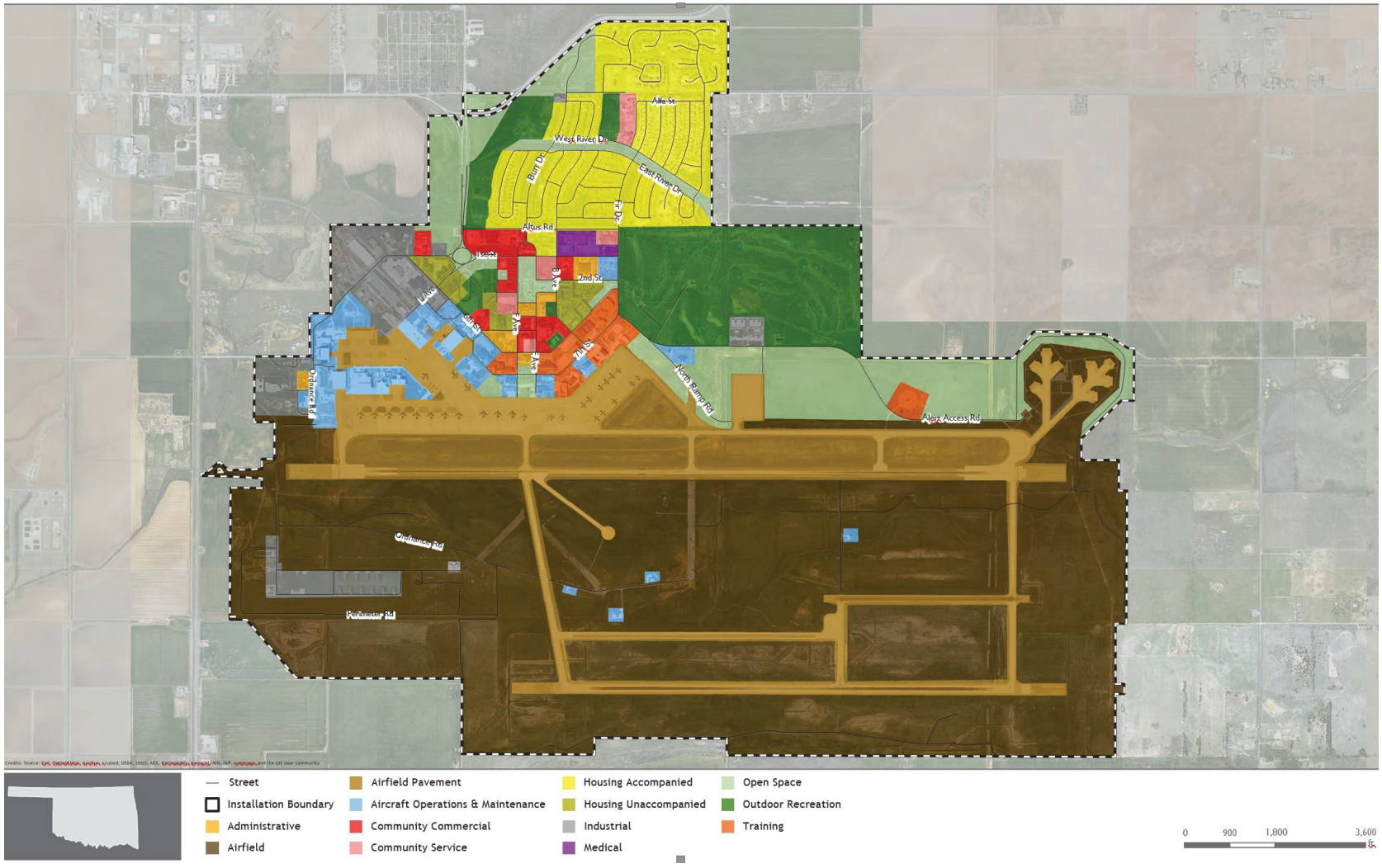


Figure 12. Existing Land Use at Altus AFB

2.4.5 Current Major Mission Impacts on Natural Resources

2.4.5.1 Aircraft Operations

Airmen at Altus AFB fly three types of aircraft; C-17s, KC-135s, and KC-46s. Aspects of aircraft operations that impact natural resources include noise, fuel spills, wildlife aircraft strikes, and ecological management conducted to support aircraft operations. Aircraft strike risks are managed through the BASH program and the grounds maintenance contract.

2.4.5.2 Hazardous Materials

Base operations generate several types of hazardous wastes that require special handling for proper disposal. These include oils and fuels, cleaning compounds, paints and solvents, batteries, and mercury and lead foil. Hazardous wastes are collected in containers up to 55-gallons at Initial Accumulation Points (IAPs) that are located throughout the base. Full containers are collected by the 97 CES Environmental Element (CEIE) and delivered to building 52, the base Central Accumulation Point (CAP). The CAP allows hazardous waste storage for up to 90 days until the waste is transferred to the Defense Reutilization and Marketing Office. The installation also contains 67 active aboveground oil storage tanks regulated by the Clean Water Act (CWA). The installation does not contain any active RCRA-regulated underground storage tanks.

Hazardous material spills can negatively impact fish and wildlife, streams and other aquatic habitats, outdoor recreational areas, and sensitive areas such as wetlands (USAF, 2017). Oil spills present a particularly high risk to wetlands, which contain significant biological diversity and provide critical habitat for many types of plants and animals. Hazardous material spills and leaks are contained and cleaned up immediately to prevent or minimize groundwater or surface water contamination. The Altus AFB Integrated Contingency Plan details practices and procedures for preventing and responding to releases of petroleum products and hazardous substances. Successful implementation of this plan has the largest direct influence on minimizing the potential exposure of contaminants to stormwater.

Industrial materials at Altus AFB contain contaminants also have the potential to enter the storm sewer system and cause environmental harm. Areas where industrial materials are exposed to stormwater include the flight line, maintenance shops, bulk fuel storage, motor pools, and scrap metal and waste recycling facilities. The flight line aprons and taxiways are the primary areas where contaminants come in contact with stormwater from spills and leaks, aircraft fueling, emergency maintenance, and aircraft and runway deicing. The primary pollutant sources include fuel and other petroleum, oil, and lubricant (POL) leaks and spills, aqueous film forming foam (AFFF), and deicing fluids.

The base maintains a permit for stormwater discharges from industrial activity from the Oklahoma Department of Environmental Quality (ODEQ). The 97 CES/CEIE implements a Storm Water Pollution Prevention Plan (SWPPP) to minimize the potential for the discharge of pollutants into the storm sewer system. Stormwater Best Management Practices (BMPs) used to prevent stormwater pollution include sediment and erosion controls, oil/water separators, weirs, check dams, grass swales, infiltration galleries, SOPs, good housekeeping practices, and employee trainings. Routine inspections of stormwater discharges are conducted to check for pollution and ensure permit compliance with effluent limits. Industrial facilities, stormwater conveyance systems, and stormwater BMPs are also routinely inspected to ensure proper function for pollution prevention.

2.4.5.3 Solid Waste

All refuse generated on Altus AFB is collected weekly by a local contractor and disposed in the City of Altus landfill. The base collects recyclable materials and processes them at its recycling center, Building

400.

Waste that is improperly contained or littered contributes to environmental degradation. Waste often accumulates in drainage swales and may be transported by stormwater runoff off base into local streams. In conjunction with the Hazardous Waste Management Plan, the Pollution Prevention Program strives to reduce the overall amount of waste generated at Altus AFB. Reduction of hazardous material and waste volumes will lower the potential for accidental spills and releases.

2.4.5.4 Installation Restoration Program Sites

Altus AFB has identified 29 areas on the installation with histories of hazardous waste spills or disposal from past activities. These sites contain contaminants that may pose environmental health risks. The USAF Installation Restoration Program (IRP) identifies, investigates, cleans up, and ultimately closes out such sites in an effort to protect the environment and human health. Currently, 15 sites have completed clean up, while 14 sites are still undergoing corrective action activities. Some sites must complete a long-term groundwater monitoring program to be considered for closure. Monitoring wells are located around the sites where contamination possibly occurred.

2.4.5.5 Air Emissions Sources

Air emissions can reduce air quality and negatively affect the health of humans and the environment. Industrial activities at Altus AFB generate air emissions that release pollutants. ODEQ monitors air emission quality. All emission activities and equipment are permitted with ODEQ. Emission sources on the installation include mobile sources such as aircraft, automobiles, and grounds maintenance equipment, and stationary sources such as power generation, fire training exercises, fueling operations, painting operations, welding operations, and woodworking facilities.

2.4.5.6 Construction Activities

Construction activities cause land disturbance to soil and vegetation and constitute the primary avenue of potential erosion and sedimentation damage at Altus AFB. Exposed soils are subject to wind and rain erosion, which can create sediment buildup in waterways. All construction projects one acre or larger must hold an OKR10 construction stormwater permit from ODEQ and maintain a SWPPP that is reviewed by the stormwater program manager. The stormwater program manager conducts routine site inspections to monitor compliance. The NRM and environmental engineer review construction project proposals to ensure compliance with this INRMP and applicable environmental laws and regulations.

2.4.6 Potential Future Mission Impacts on Natural Resources

Future development on and surrounding Altus AFB may negatively impact native floral and faunal communities if not properly planned and reviewed. Habitat loss and fragmentation will decrease biodiversity in the area. A strong mitigation program will lessen the impacts of development on natural resources. The Altus AFB Installation Development Plan contains information on future development patterns within and surrounding the base.

3.0 ENVIRONMENTAL MANAGEMENT SYSTEM

The AF environmental program adheres to the Environmental Management System (EMS) framework and it's Plan, Do, Check, Act cycle for ensuring mission success. Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade*, U.S. Department of Defense Instruction (DoDI) 4715.17, *Environmental Management Systems*, AFI 32-7001, *Environmental Management*, and international standard, ISO 14001:2004, provide guidance on how environmental programs should be established,

implemented, and maintained to operate under the EMS framework.

The natural resources program employs EMS-based processes to achieve compliance with all legal obligations and current policy drivers, effectively managing associated risks, and instilling a culture of continuous improvement. The INRMP serves as an administrative operational control that defines compliance-related activities and processes.

4.0 GENERAL ROLES AND RESPONSIBILITIES

General roles and responsibilities that are necessary to implement and support the natural resources program are listed in the table below. Specific natural resources management-related roles and responsibilities are described in appropriate sections of this plan.

Table 10. Roles and responsibilities for implementing the Altus AFB natural resources program.

Office/Organization/Job Title (Listing is not in order of hierarchical responsibility)	**Installation Role/Responsibility Description**
Installation Commander	● Approves the INRMP ● Certifies the annual review of the INRMP as valid and current; or delegates the certification of the annual INRMP review to the appropriate designee. ● Provides appropriate funding and staffing to ensure implementation of the INRMP. ● Controls access to and use of installation natural resources.
AFCEC Natural Resources Media Manager/Subject Matter Expert (SME)/ Subject Matter Specialist (SMS)	● AFCEC Natural Resources Media Manager (TAFB)—Christopher White (provides base-level support to ensure natural resources program execution in accordance with the Sikes Act and other regulatory requirements). ● AF Subject Matter Expert—Kevin Porteck ● AF Subject Matter Specialist—Paul Jurena
Installation Natural Resources Manager/POC	● Natural Resources Manager—Kelly Niland (provides program oversight to ensure no net loss in capability of AF lands to support the military mission while sustaining the long-term ecological integrity of natural resources and the ecosystem services they provide)
Installation Security Forces	● Enforces fish and wildlife laws and regulations and supports other conservation requirement
Installation Unit Environmental Coordinators (UECs); see AFI 32-7001 for role description	● Serve as conduit between natural resources function and their unit ● Ensure units comply with natural resources policies, regulations, laws, and other conservation requirements
Installation Wildland Fire Program Manager	● Not applicable

Pest Manager	● Oversees all aspects of the installation Integrated Pest Management Plan to include in-house, contracted, and out-leased natural resources operations
Range Operating Agency	● Not applicable
Conservation Law Enforcement Officer (CLEO)	● Not applicable
NEPA/Environmental Impact Analysis Process (EIAP) Manager	● Ensures proposed federal actions are analyzed to determine, document, and disclose impacts to the environment (to include natural resource
National Oceanic and Atmospheric Administration (NOAA)/ National Marine Fisheries Service (NMFS)	● Not applicable
US Forest Service	● Not applicable
US Fish and Wildlife Service	● Serves as the primary federal party of the Sikes Act mandated tripartite core group for cooperative INRMP development, review, signature, and implementation to meet Sikes Act goals.
Oklahoma Department of Wildlife Conservation	● Serves as the primary state party of the Sikes Act mandated tripartite core group for cooperative INRMP development, review, signature, and implementation to meet Sikes Act goals.

5.0 TRAINING

AF installation NRMs/POCs and other natural resources support personnel require specific education, training and work experience to adequately perform their jobs. Section 107 of the Sikes Act requires that professionally trained personnel perform the tasks necessary to update and carry out certain actions required within this INRMP. Specific training and certification may be necessary to maintain a level of competence in relevant areas as installation needs change, or to fulfill a permitting requirement.

Installation Supplement – Training

Natural resources management training is provided to ensure that base personnel, contractors, and visitors are aware of their role in the program and the importance of their participation to its success. As appropriate, training records are maintained IAW the Recordkeeping and Reporting section of this plan. Below are key NR management-related training requirements and programs:

- Altus AFB is a Category I installation which requires NRMs to take the course, DoD Natural Resources Compliance, endorsed by the DoD Interservice Environmental Education Review Board and offered for all DoD Components by the Naval School, Civil Engineer Corps Officers School (CECOS).
- Natural resource management personnel at Altus AFB routinely attend appropriate national, regional, state, and local conferences, seminars, and training courses.
- Pest management personnel receive training in pest and nuisance wildlife control techniques, and are licensed in pesticide application.
- USDA Wildlife Services and the Pest Management Shop support the BASH program. Both are trained and licensed to drive on the flight line. USDA staff have degrees in wildlife biology and are trained in bird identification. USDA receives initial airport wildlife control training; advanced training in

mitigating wildlife hazards at airports; Immobilization and Euthanasia training; and annual component training for firearms. Others, such as Base Operations, who are authorized to haze wildlife are periodically trained in pyrotechnic use.

6.0 RECORDKEEPING AND REPORTING

6.1 Recordkeeping

The installation maintains required records IAW Air Force Manual 33-363, *Management of Records*, and disposes of records IAW the Air Force Records Management System (AFRIMS) records disposition schedule (RDS). Numerous types of records must be maintained to support implementation of the natural resources program. Specific records are identified in applicable sections of this plan, in the Natural Resources Playbook and in referenced documents.

Installation Supplement – Recordkeeping

Natural resources records are maintained on the Electronic Records Management System (ERMS), on natural resources staff computers through the base network, and on some hard copy documents.

6.2 Reporting

The installation NRM is responsible for responding to natural resources-related data calls and reporting requirements. The NRM and supporting AFCEC Media Manager and Subject Matter Specialists should refer to the Environmental Reporting Playbook for guidance on execution of data gathering, quality control/quality assurance, and report development.

Installation Supplement –Reporting

Natural resources-related reporting consists of the following:

- Annual report and renewal of the Migratory Bird Treaty Act (MBTA) depredation permit (NRM to USFWS)
- Annual review of MBTA depredation permit WS Form 37 (USDA-Wildlife Services Biologist to NRM)
- Annual Depredation Report Form 3-202-9 (USDA-Wildlife Services Biologist to NRM)
- Annual Scientific Collectors Permit renewal and collection report (NRM to ODWC)
- Annual Natural Resources Program Report (NRM to USFWS and ODWC)

7.0 NATURAL RESOURCES PROGRAM MANAGEMENT

This section describes the current status of the installation's natural resources management program and program areas of interest. Current management practices, including common day-to-day management practices and ongoing special initiatives, are described for each applicable program area used to manage existing resources. Program elements in this outline that do not exist on the installation are identified as not applicable and include a justification, as necessary.

Installation Supplement –Natural Resources Program Management

No Installation Supplement

7.1 Fish and Wildlife Management

Applicability Statement

This section applies to all AF installations that maintain an INRMP. The installation is required to implement this element.

Program Overview/Current Management Practices

This plan reflects the mutual agreement of internal stakeholders, the USFWS, and ODWC for the conservation, protection, and management of fish and wildlife on Altus AFB lands. Fish and wildlife management is overseen by the 97th Environmental Element (97 CES/CEIE) and guided by AFMAN 32-7003. Management activities are conducted in a manner that is consistent with the military mission and compliant with applicable environmental laws and regulations. The overall management goal is to maintain a healthy native ecosystem to ensure the resiliency of the land for sustained AF use.

Fish and wildlife populations at Altus AFB need to be surveyed and monitored so that informed management decisions can be made. Amphibian, reptile, bird, fish, and mammal surveys will be conducted to estimate species abundance and diversity in the varying habitat types on base, and will serve as baseline comparisons for future surveys in order to monitor population changes over time. Benthic macro-invertebrate surveys will also be conducted and used to assess and monitor stream health on base.

Fish and wildlife management activities at Altus AFB will focus on restoring and maintaining natural habitat to benefit native fauna. Management activities will also aim to provide outdoor recreation opportunities for base residents and employees. Current fish and wildlife management includes a hunting and fishing program, BASH program, and a pest management program (see Sections 7.11 and 7.12 for details). Future management activities will include habitat creation and habitat enhancements, and routine wildlife population surveys will be conducted.

The natural resources manager (NRM) at Altus AFB will implement the following strategies for fish and wildlife management:

- Collaborate with USDA-Wildlife Services to minimize BASH risks by deterring hazardous birds and other wildlife from the airfield. Apply for and maintain USFWS depredation permits for the installation.
- Maintain viable wildlife populations by minimizing negative impacts and by restoring, enhancing, and maintaining native habitats.
- Conduct wildlife surveys to monitor populations and assess wildlife management effects.
- Review the BASH plan and IPMP to make sure they align with INRMP objectives for wildlife management.
- Collaborate with ODWC, USFWS, USDA WS, and the Natural Resources Conservation Service (NRCS) during project planning.

7.1.1 Hunting and Fishing as a Management Tool

Hunting that occurs at Altus AFB may help to temporarily reduce BASH threats but it is not useful for the purpose of wildlife population management due to its very limited nature. A one-day annual dove hunt on the airfield is implemented to boost morale among airmen, while targeting species that have a high presence on the airfield (see section 7.2.1 for details). The target species are mourning doves (*Zenaida macroura*), white-winged doves (*Zenaida asiatica*), Eurasian collared doves (*Streptopelia decaocto*), and

rock doves/common pigeons (*Columba livia*). Eurasian collared doves and rock pigeons are invasive species that are not legally protected, while the mourning dove and white-winged dove have a state-designated hunting season.

A small pond on the base was stocked for the first time in June of 2020 to support recreational fishing (see section 7.2.1 for details). This pond will be managed to maintain suitable habitat for the survival and reproduction of bluegill, longear sunfish, largemouth bass, and channel catfish. State regulations and stricter installation fishing rules are enforced to ensure fish populations are not depleted. The pond will be routinely surveyed and assessed, and management activities will be implemented as needed.

7.1.2 Fish and Wildlife Habitat Enhancement

Habitat enhancements are implemented to increase and/or maintain native wildlife populations. 97 CEIE plans to create patches of habitat to support pollinators and restore areas of prairie and riparian habitat on the installation.

The creation of pollinator habitat is supported by the Pollinator Partnership Action Plan (PPAP) of the Pollinator Health Task Force that was established by the 2014 Presidential Memorandum, "Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators". According to this memorandum, "The Department of Defense shall, consistent with law and the availability of appropriations, support habitat restoration projects for pollinators, and shall direct military service installations to use, when possible, pollinator-friendly native landscaping and minimize use of pesticides harmful to pollinators through integrated vegetation and pest management practices."

Restoring patches of native mixed-grass prairie on the installation will support pollinators and other native wildlife as well as provide natural beauty and landscape diversity. The extent of native mixed-grass prairie in the region has been reduced by over 50% due to agriculture (ODWC, 2016). As prairies have been converted to crop fields, remaining fragmented patches of prairie have declined in quality. Habitat fragmentation disproportionately affects species that require large tracts of habitat for their home ranges or that have limited dispersal and movement capabilities (e.g. Texas horned lizard). According to the Oklahoma Comprehensive Wildlife Conservation Strategy, other Species of Greatest Conservation Need that inhabit mixed-grass prairies include burrowing owls, Cassin's sparrows, loggerhead shrikes, and northern bobwhites. Current distribution of patches of mixed-grass prairie and populations of species of greatest conservation on the installation must be assessed in order to identify areas of greatest conservation value. Wildlife population surveys or studies on species of concern may identify additional habitat needs. Development of fire regimes, removal of invasive grasses, and updating Best Management Practices (BMPs) for erosion control and herbicide application may also benefit prairie wildlife.

Restoring riparian zones on the base will enhance stream habitat for native aquatic wildlife and improve water quality. Riparian areas are often destroyed and degraded due to heavy cattle grazing, conversion to pasture and crop fields, fertilizer and pesticide use, stream channelization, and dam construction. Due to the aridity of the surrounding area, the limited riparian zones are of high importance to riparian-specific species and other wildlife utilizing the water resource. Species of Greatest Conservation Need in these areas include plains minnows, the American bumblebee, and smooth and spiny softshell turtles. Riparian areas also provide ecosystem services such as preventing erosion, filtering runoff, and mitigating flooding issues.

7.1.3 Migratory Bird Management

The Migratory Bird Treaty Act (MBTA) prohibits the acts (or attempted acts) of pursuing, hunting, taking, capturing, killing, or possessing of any migratory bird included in the Migratory Bird Treaty, including any parts, nests, or eggs, unless authorized by a federal permit (16 USC § 703).

The majority of bird species at Altus AFB are protected under the MBTA. The 97 CES/CEIE maintains a federal depredation permit to address significant bird/wildlife aircraft strike hazards on the airfield. The installation works under a cooperative agreement with USDA-Wildlife Services to decrease the potential for these hazards. An integrated wildlife damage management program is implemented according to the 97 AMW/SEF BASH plan. The BASH plan focuses on wildlife damage control techniques prioritizing habitat modification and nonlethal control, with lethal control implemented when necessary.

The relatively small size of the installation and the significant risk migratory birds present to aircraft make migratory bird conservation projects inadvisable. Avian population surveys for a wildlife hazard assessment are currently conducted by USDA-WS. An overall baseline avian survey for Altus AFB and the SDZ will be conducted by an ornithologist in cooperation with the USFWS in fiscal year 2022. Routine surveys will be conducted to monitor population trends and species presence. If potential conservation projects are identified for ESA-listed species, 97 CES/CEIE will coordinate planning and implementation with the USDA and 97 AMW/SEF.

7.1.4 Incorporating Climate Change into Fish and Wildlife Management

Fish and wildlife management on Altus AFB is not likely to change greatly with regards to projected climate change. Current fish and wildlife management issues are likely to persist in the future, such as presence of invasive/pest species, BASH concerns, and habitat management. Fish and wildlife surveys should continue to be conducted on a regular basis. Native species need to continue to be monitored to document changes. Changing climatic conditions also present opportunities for invasive species to flourish and push out native species. Monitoring of invasive species will continue to be important and management plans should be flexible enough to adapt to changing fish and wildlife concerns (Hellmann et al., 2008).

Increasing temperatures could have a negative impact on amphibians, aquatic macroinvertebrates and fish species if water temperatures in lentic systems increase. As water temperatures increase in lentic systems, dissolved oxygen decreases, resulting in diminished habitat quality, particularly for larval amphibians and aquatic macroinvertebrates. Increasing water temperatures can also increase the chances of algal blooms occurring, further depleting dissolved oxygen content and habitat suitability (Paerl et al., 2011). Efforts to remove invasive aquatic plants and algae from ponds should be continued (Poff, Brinson, & Day, 2002).

Increasing temperatures and precipitation favor vectors for diseases such as mosquitoes and ticks (Süss et al., 2008). Minimization of stagnant water in and around the cantonment area will help to reduce mosquito related infections. Tick populations in urban settings can be minimized by keeping lawns mowed and by preventing overabundances of hosts such as deer and rodents.

7.2 Outdoor Recreation and Public Access to Natural Resources

Applicability Statement

This section applies to all AF installations that maintain an INRMP. Altus AFB is required to implement this element.

Program Overview/Current Management Practices

Altus AFB strives to support the military mission by providing outdoor recreational opportunities to improve morale and enhance the quality of life for people who live and work on the installation. The Altus

AFB Outdoor Recreation center offers a variety of outdoor trips and activities including hikes, bike rides, rock climbs, fishing trips, and paintball and archery tournaments. The organization also provides rental items for activities such as camping, hunting, fishing, gardening, biking, and paintball tournaments.

Outdoor recreation areas are classified based on recreation potential and ecosystem sustainability as Class I (developed), Class II (dispersed), or Class III (special interest areas). Class I recreation areas are designed to accommodate intensive activities such as sports, RV camping, picnicking, and utilizing paved trails. Developed recreation areas at Altus AFB include a running track, sports fields/courts (volleyball, baseball, softball, football, soccer), playgrounds, an 18-hole golf course, miniature golf course, archery range, and two outdoor saltwater swimming pools. Class I areas also include a one-acre camping area, a one-acre picnic area, and a paved trail that passes through the housing area and golf course. These areas are managed by the 97th Force Support Squadron (FSS).

Class II dispersed recreation areas are suitable to support activities such as hunting, fishing, birdwatching, primitive camping, boating, hiking, and sightseeing. Altus AFB contains one pond used for fishing that is maintained by 97 CES. The base does not contain areas for mountain biking or off-road vehicle use. Available areas of open space will be considered for the creation of nature paths, fishing ponds, a community garden, and wildlife viewing areas.

Class III special interest recreation areas contain valuable archaeological, botanical, ecological, geological, historical, zoological, or scenic features that warrant special protection and access control. Altus AFB does not contain any Class III recreation areas.

All outdoor recreation areas at Altus AFB are classified by AFMAN 32-7003 as Category B restricted access areas that are open only to DoD employees, guests, family members, and retirees. Public groups may be allowed controlled access for special events such as Earth Day and Arbor Day. Outdoor recreation is not available to the general public due to installation security requirements.

The NRM will collaborate with the Community Planner and Outdoor Recreation when planning for new outdoor recreation opportunities at Altus AFB, and will ensure that all outdoor recreation activities are consistent with the INRMP and the AF mission.

7.2.1 Recreational Hunting and Fishing

Altus AFB has a limited hunting program due to a lack of unimproved areas that are suitable for this activity. An annual one-day dove hunt, limited to a small group of base personnel, is implemented on the airfield to boost morale among airmen while targeting game species that have a high presence. The Environmental office coordinates with the BASH biologist, Airfield Management, and Security Forces during the planning process. The Occupational Safety office may provide a risk assessment for the hunt.

The target species are mourning doves, white winged doves, Eurasian collared doves, and rock pigeons. Eurasian collared doves and rock pigeons are invasive species that are not legally protected, while the mourning dove and white winged dove have a state-designated hunting season. The hunt occurs during the state dove season on a weekend day when the airfield is not in operation. Participants of the hunt must abide by all federal and state hunting regulations, to include carrying a current state hunting license and Harvest Information Program (HIP) permit. Hunters must also attend a safety briefing, which may be provided by the Oklahoma Department of Wildlife Conservation (ODWC).

Altus AFB recently opened one small 1.88-acre pond for recreational fishing. Stocked species include hybrid sunfish（*Lepomis macrochirus X microlophus and X cyanellus*）, largemouth bass（*Micropterus salmoides*）, and channel catfish（*Ictalurus punctatus*）. Other species found in the pond include bluegill（*Lepomis macrochirus*）, longear sunfish（*Lepomis megalotis*）, and black bullhead catfish（*Ameiurus*

melas). Fishermen must have a state fishing license and abide by state fishing regulations and base-specific rules. State regulations can be found on the ODWC website (www.wildlifedepartment.com/law/fishing_guide). Base regulations are more restrictive than state regulations; the method of take is limited to rod and reel only, with a maximum of two rods per person. The daily creel limit is set at two and the size limit is 12 inches for channel catfish. The daily creel limit for sunfish species is 10. Largemouth bass are limited to catch and release only.

7.2.2 Camping

The installation contains a one-acre plot of land known as FAM Camp, which provides tent campsites as well as full-hookup recreational vehicle (RV) sites with water, electric, and sewer hookups. FAM Camp is located just north of the main gate.

Altus AFB also leases a 7.62-acre tract of land at Quartz Mountain Nature Park in Lone Wolf, Oklahoma that is available to all DoD ID cardholders for recreational use (Figure 13). This land contains sites for primitive (tent) camping.

Figure 13. Aerial view of Altus AFB's leased plot at Quartz Mountain.

Quartz Mountain sits on Lake Altus-Lugert which can be used for beach-going, swimming, boating, fishing, and watersports (Figure 14). The park contains areas for hiking, biking, off-road ATV use, rock climbing, and wildlife viewing, and also contains a waterslide, go carting facility, golf course, mini golf facility, and a nature center.

Altus AFB plans to make improvements to its leased site to include grills, fire pits, picnic tables, RV sites, and potentially a centralized gathering facility for family or squadron functions.

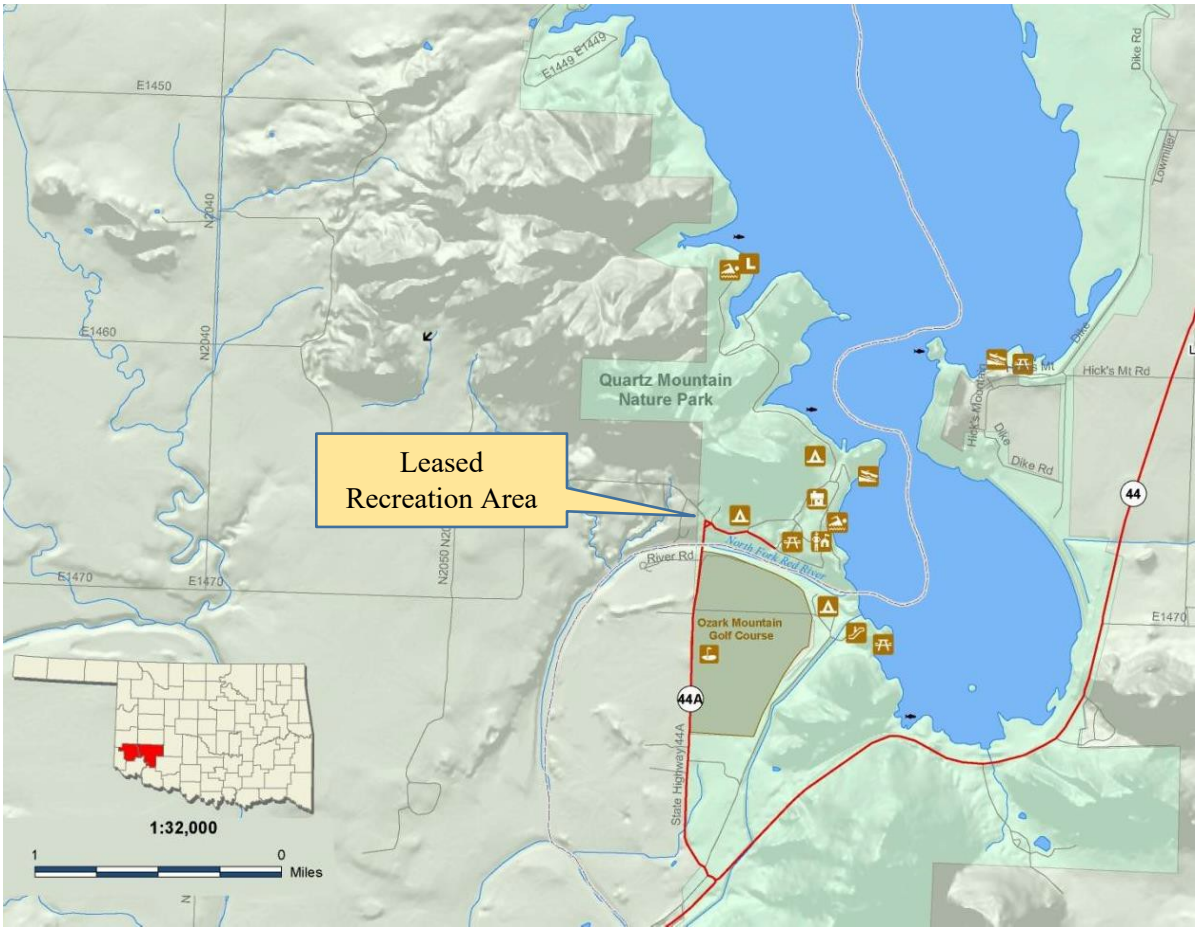


Figure 14. Map of Altus AFB's leased plot at Quartz Mountain.

7.2.3 Climate Change Implications for Outdoor Recreation

Outdoor recreation and public access to natural resources on Altus AFB will not likely be affected by climate change. Low impact activities and use of facilities such as parks, playgrounds, picnic sites, camping areas, swimming pools, the golf course and sports fields (baseball, softball, football and soccer) should continue without any change.

7.3 Conservation Law Enforcement

Applicability Statement

This section applies to all AF installations that maintain an INRMP. The installation is required to implement this element.

Program Overview/Current Management Practices

The installation does not have a conservation law enforcement program on site due to its small size, low abundance of fish and wildlife resources, and its limited fishing and hunting programs. However, the ODWC game warden of Jackson County has base access to patrol fishing and hunting areas and enforce compliance with state regulations. If 97 CES/CEIE personnel observe or are notified of illegal activities

involving natural resources on base, the game warden will be contacted by phone and able to promptly arrive. Base-specific hunting and fishing rules that are more restrictive than state regulations may be enforced by Security Forces (97 SFS).

7.4 Management of Threatened and Endangered Species, Species of Concern and Habitats

Applicability Statement

This section applies to AF installations that have threatened and endangered species on AF property. This section **IS NOT** applicable to Altus AFB. There are no known threatened and endangered species or critical habitats on Altus AFB or the Sooner Drop Zone.

Currently, no conservation measures are implemented for federally or state-listed threatened and endangered species because none are known to occur on Altus AFB or the SDZ. The whooping crane *(Grus americana*) and the interior least tern (*Sterna antillarum*) are federally endangered birds that have been recorded in Jackson County, but the installations do not contain habitats likely to attract these species. The whooping crane has the potential to fly over the installations; 97 CEIE plans to collaborate with the United States Geological Survey (USGS) and USFWS to conduct aerial telemetry surveys to confirm the presence or absence of this species in the airspace above the installations. If whooping crane presence is confirmed, Altus AFB will continue to monitor to obtain data on migration patterns and will consult with ODWC and USFWS to explore ways to reduce the potential for base operations to negatively impact this species.

Several state-listed Species of Greatest Conservation Need are known to occur at Altus AFB. One such species, the tricolored bat (*Perimyotis subflavus*), is currently under status review by the USFWS to determine if it warrants listing under the Endangered Species Act. Altus AFB plans to conduct routine acoustic bat surveys and analyses to monitor this species' presence on the installation.

The removal of birds listed on the USFWS Birds of Concern list for BASH program purposes is limited to 10 individuals per species. Species of concern do not legally require protection on installations, but it is beneficial to monitor their populations to ensure local populations are not in decline, and to conduct research to contribute data towards their conservation.

The Texas horned lizard (*Phrynosoma cornutum*) is a species of particular interest due to population declines throughout the state (Carpenter et al. 1993, Donaldson et al. 1994). The Oklahoma Department of Wildlife Conservation (2016) identifies the species as possibly threatened or vulnerable to extirpation, but insufficient evidence exists to substantiate concern regarding its long-term survival. Concern about the long-term status of this species has led to an increasing number of studies. For nearly 20 years, researchers from multiple universities and federal agencies have been tracking Texas horned lizard populations at Tinker AFB in Oklahoma City, Oklahoma. 97 CES/CEIE plans to work with the USFWS in consultation with ODWC to expand on this work by utilizing the same research designs to study the populations on Altus AFB. There are currently no biological data of the Texas horned lizard populations on Altus AFB properties. Research will seek to provide baseline survey information to help us to better understand the ecology of the species in a military environment surrounded by agriculture and urban development. The goals are to estimate abundance, home range, and survival rates.

7.5 Water Resource Protection

Applicability Statement

This section applies to AF installations that have water resources. This section **IS** applicable to Altus AFB.

Program Overview/Current Management Practices

Altus AFB implements various measures to protect water resources that may be affected by installation activities. Management practices focus on stormwater pollution prevention, water quality monitoring, and environmental reviews of proposed actions that may affect wetland areas.

7.5.1 Surface and Groundwater Protection

Stormwater runoff drains from south to east and is collected into a system of open ditches that carry the water to various discharge points from the base. These drainage ways and outfalls covey stormwater directly to tributaries of Stinking Creek. A detailed map of the stormwater drainage system can be found in the Storm Water Pollution Prevention Plan (SWPPP) maintained by 97 CES/CEIE. Altus AFB maintains a permit for stormwater discharges from industrial activity from the Oklahoma Department of Environmental Quality (ODEQ). The 97 CES/CEIE implements the SWPPP to minimize the potential for the discharge of pollutants into the storm sewer system in order to protect surface water and groundwater quality.

Stormwater Best Management Practices (BMPs) used to prevent stormwater pollution include sediment and erosion controls, oil/water separators, weirs, check dams, grass swales, infiltration galleries, standard operating procedures (SOPs), good housekeeping practices, and employee training. Routine inspections of stormwater discharges are conducted to check for signs of pollution, and stormwater samples are analyzed to ensure compliance with permitted effluent limits. Industrial facilities, stormwater conveyance systems, and stormwater BMPs are also routinely inspected to ensure proper function.

Construction activities constitute the primary avenue of potential erosion and sedimentation damage at Altus AFB. Exposed soils are subject to wind and rain erosion, which can create sediment buildup in waterways. All construction projects one acre or larger must hold an OKR10 construction stormwater permit from ODEQ and maintain a SWPPP that is reviewed by the stormwater program manager. The stormwater program manager conducts routine site inspections to monitor permit compliance. The NRM and environmental engineer review construction project proposals to ensure compliance with the INRMP and applicable environmental laws and regulations.

Investigation and remediation of groundwater contamination has been ongoing at Altus AFB for the past 22 years under the Air Force's Environmental Restoration Program. The primary remediation technology employed is bioremediation by injecting vegetable oil into contaminated groundwater and permeable reactive barriers to interrupt contaminated groundwater migration. Today, all operations and disposal activities are governed by ODEQ under a Resources Conservation and Recovery Act (RCRA) Corrective Action Permit.

7.5.2 Wetland Protection

Applicability Statement

This section applies to AF installations that have existing wetlands on AF property. This section **IS** applicable to Altus AFB.

Program Overview/Current Management Practices

Floodplains and wetlands have high water resource value for natural moderation of floods, water quality maintenance, and ground water recharge. They are also a culturally valuable resource for open space,

natural beauty, scientific study, outdoor recreation and education. In compliance with EO 11990, *Protection of Wetlands*, the AF must seek to preserve the natural values of wetlands while carrying out its mission. To the maximum extent practicable, the AF must avoid actions which would destroy or adversely modify wetlands. Proposals for actions that may affect wetlands at Altus AFB are reviewed by the 97 CES Environmental Element and undergo regulatory review in compliance with the Clean Water Act (CWA).

Activities that may impact waters and wetlands of the United States as defined in 40 CFR § 110.1, require full compliance with the Environmental Impact Analysis Process (EIAP), 32 CFR §§ 989 et seq; CWA Sections 401, 404 and 4041(b)(1); and EO 11990 prior to implementation. The term "waters of the United States", as defined by the Navigable Waters Protection Rule in 33 CFR 328.3 and 40 CFR 120, includes territorial seas and traditional navigable waters, perennial and intermittent tributaries that contribute surface water flow to such waters, certain lakes, ponds, and impoundments of jurisdictional waters, and wetlands adjacent to other jurisdictional waters.

Section 404 of the CWA mandates regulatory review and permitting for actions that may affect wetlands, to include dredging, filling, and displacing soils or other materials into a wetland. Section 401 of the CWA directs that any proponent of an action that requires a federal license or permit, such as a Section 404 or National Pollution Discharge Elimination System (NPDES) permit, must obtain a water quality certificate from the state water pollution control agency. The water quality certificate certifies that the action complies with state water quality criteria.

7.6 Grounds Maintenance

Applicability Statement

This section applies to AF installations that perform ground maintenance activities that could impact natural resources. This section **IS** applicable to Altus AFB.

Program Overview/Current Management Practices

The Altus AFB grounds maintenance program maintains all lands within the jurisdiction of the base. The primary goal is to maintain attractive, erosion-preventing vegetative cover to provide an aesthetically pleasing environment for people to live and work. The grounds maintenance plan is maintained by the 97 CES Quality Assurance office (97 CES/CEOES).

On Altus AFB, the grounds maintenance contractor maintains approximately 182 acres of unimproved grounds, 20 acres of prestige areas of vegetative and inert beds subject to soil tests, aeration, and fertilization, 3 acres of functional irrigation systems, 256 acres of semi-improved grounds, 223 acres of airfield, and 9 acres of perimeter fencing. Surface drainage ditches account for 7 acres. On the Sooner Drop Zone (SDZ), Grounds Maintenance maintains roughly 108 acres of unimproved grounds, 499 acres of semi-improved grounds, and 2 acres of surface drainage ditches. In total, 7,632 acres are maintained for weed control.

Contractor employees must complete Altus AFB Environmental Management System (EMS) awareness training and must comply with all applicable federal, state and local environmental laws and regulations. Hazardous materials are not brought onto the installation unless authorized for use by the Environmental Element (97 CES/CEIE). The contractor must have spill control kits on hand and must comply with waste minimization and pollution prevention practices and policies.

Grounds maintenance practices include organizing the productive utilization of land and various land and water treatment measures. Some of these measures include the use of chemical herbicides, pesticides and

fertilizers. The potential pollution impact from these applications is reduced by using only EPA-approved chemicals under the direction of certified applicators, using proper methods, strictly following label instructions, and avoiding applications in close proximity to surface waters.

Pollution problems associated with pesticides, fertilizers and stormwater runoff are mitigated by stormwater best management practices. Wind and water erosion are prevented by planting turf grasses, ground covers, trees and shrubs, or by mulching. Surface drainage ways are maintained to be free of debris and silt to prevent erosion and allow water flow. Vegetated drainage swales act as a filter for stormwater runoff; the grass within them must be maintained to ensure filtration capabilities and prevent soil erosion and sedimentation downstream. Solid wastes associated with grounds maintenance are collected weekly by a local contractor and disposed of in the City of Altus landfill.

Native trees, shrubs, and herbaceous species are given preferential choice for landscaping. Choosing native species that are adapted to the local environment promotes a healthy ecosystem and reduces water consumption. Tree removal work orders must be approved by the 97 CES Natural Resources Manager (NRM).

Weed control is limited to noxious or invasive species for improved, semi-improved (non-airfield) and perimeter fence areas. Semi-improved, unimproved, and airfield grounds are mowed to a height between 7 and 14 inches according to FAA guidelines in order to deter avian species that present a high risk for damaging aircraft strikes.

7.7 Forest Management

Applicability Statement

This section applies to AF installations that maintain forested land on AF property. This section **IS NOT** applicable to Altus AFB. There is no commercial forestry nor urban forestry associated with Altus AFB or the Sooner Drop Zone.

7.8 Wildland Fire Management

Applicability Statement

This section applies to AF installations with unimproved lands that present a wildfire hazard and/or installations that utilize prescribed burns as a land management tool. This section **IS NOT** applicable to Altus AFB.

Wildfires are an historical and essential ecological disturbance regime in southwestern Oklahoma. Many native plants have evolved fire tolerance and many native wildlife species benefit from burns. Routine controlled burning reduces the risk of catastrophic wildfires by decreasing fuel loads such as dead vegetation. Prescribed burning is also a time and cost-effective land management tool compared to various mechanical means of vegetative maintenance and habitat manipulation. Burns control the growth of invasive plants and maintain healthy wildlife habitat by improving soils and native plant habitat. These burns are often used for restoring native prairies.

The EPA promotes the use of prescribed fires, and Executive Order 13855, Promoting Active Management of America's Forests, Rangelands, and other Federal Lands to Improve Conditions and Reduce Wildfire Risk (2018), encourages federal agencies to collaborate with state and local governments to manage lands for fire.

Wildland Fire Management Plans (WFMPs) have been developed at various military installations by the Air Force Wildland Fire Center (AF WFC) to implement fire management practices and prescribed burn plans. A WFMP should be created for Altus AFB to implement future prescribed burning to maintain a healthy, resilient landscape capable of supporting the AF mission well into the future.

7.8.1 Climate Change Implications for Wildland Fire Management

Despite substantial projected temperature increases in all climate scenarios, fire frequency is likely to remain largely unchanged at Altus AFB. Fire at the installation is very rare. The mission of Altus AFB does not include activities that are highly fire prone, such as live-fire training. Though vegetation and climate may change in the future, presuming new ignition sources are not added, there is little likelihood for an increase in the number of annual fires.

Those few fires that do occur can be expected to spread more rapidly and produce more intense fire behavior as a result of higher temperatures mostly offsetting the minor increases in precipitation. Precipitation is expected to decrease during the summer months in almost all climate projections, which would lead to increased fire intensity. The increased temperatures throughout the year are likely to lead to reduced relative humidity, particularly during the hottest parts of the day. Additionally, the RCP 8.5 scenarios suggest drier weather from January through April, a time when vegetation tends to still be in its dormant, flammable state.

Estimated vegetation changes vary between projections, but there is a tendency toward a greater dominance of shrub fuels. The grass fuels are unlikely to be extirpated entirely, resulting in a grass and shrub fuel complex in which firefighting is more difficult due to both navigability and, potentially, greater fire intensity.

In aggregate, fires will remain infrequent. However, those few that do occur will have a greater potential to grow quickly and become severe.

7.9 Agricultural Outleasing

Applicability Statement

This section applies to AF installations that lease eligible AF land for agricultural purposes. This section **IS** applicable to Altus AFB.

Program Overview/Current Management Practices

Altus AFB leases approximately 14.58 acres of land for crop production. This land is located west of the installation and lies south of Falcon Road and east of Veterans Drive. The following describes environmental stipulations of the lease.

The lessee must take all feasible actions to protect the environment and natural resources of the property. Compliance with all applicable laws and regulations pertaining to their activities on the land is mandatory. Disposal of toxic or hazardous materials on the property is prohibited, as well as discharges of waste or effluents that may contaminate surface waters, groundwater, or air. Appropriate measures must be implemented to prevent or control soil erosion, and soil and water conservation structures must be properly maintained. Erosion control structures such as waterways and/or filter strips may not be cut for hay, disked, or otherwise disturbed.

EPA registered herbicides, insecticides, and other agricultural chemicals may be used, in accordance with EPA directions, if prior approval is obtained from the 97 AMW Commander or designated representative. Conservation tillage must be used to the maximum extent possible. Conservation tillage includes any method of crop production that minimizes cultivation and leaves 30% ground cover following harvesting. Fall tillage, when row crops are being grown, must be limited to light chiseling of the ground. Crops must be harvested in a manner that leaves the stubble as tall as practical, and stubble may not be harvested for feed or burned.

7.10 Integrated Pest Management Program

Applicability Statement

This section applies to AF installations that perform pest management activities in support of natural resources management, e.g. invasive species, forest pests, etc. This section **IS** applicable to Altus AFB.

Program Overview/Current Management Practices

The Altus AFB pest management shop maintains and implements the Integrated Pest Management Plan (IPMP) through a program of inspections and integrated pest management techniques. Integrated pest management (IPM) is defined as "a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health and environmental risks." IPM operations on Altus AFB use targeted sustainable methods to control pests, including the use of the least hazardous pesticides (USAF, 2016).

The program prioritizes control of pests that pose a higher risk to human health, such as bees, wasps, hornets, fleas, ticks, and mosquitoes. Other targeted pests include nuisance pests (ants, spiders, millipedes, centipedes, gnats, crickets, and mice, etc.), structural pests (termites), noxious or invasive animals (feral dogs and cats), undesirable vegetation (grasses and weeds), and vertebrates that present a risk to property or human health.

Common pest issues on the installation include weed control, birds roosting in hangars, and the presence of ants and mice in facilities. Invasive species that may be removed include feral cats, European starlings, house sparrows, Eurasian collared doves, and pigeons. The IPMP ensures that all pest management materials are handled, stored, used and disposed of in accordance with all local, state, and federal regulations, where applicable.

7.11 Bird/Wildlife Aircraft Strike Hazard (BASH)

Applicability Statement

This section applies to AF installations that maintain a BASH program to prevent and reduce wildlife-related hazards to aircraft operations. This section **IS** applicable to Altus AFB.

Program Overview/Current Management Practices

Altus AFB experiences significant bird/wildlife aircraft strike hazards on the airfield. The installation is located along the Mid-Continental Flyway and contains favorable habitat for feeding, loafing, breeding and roosting of both resident and migratory bird populations. Some of the avian species creating a hazard in the area include geese, ducks, egrets, hawks, kites, cranes, doves, and grackles. In addition, mammals such as rabbits, hares, skunks, and coyotes also pose a strike risk when they enter the airfield.

Altus AFB works under a cooperative agreement with USDA-Wildlife Services to decrease the potential for these hazards. An integrated wildlife damage management program is implemented in accordance with the 97 AMW/SEF BASH plan. A full-time USDA wildlife biologist is responsible for program oversight and implementation. The BASH plan focuses on wildlife damage control utilizing habitat modifications and removal of hazardous wildlife from the airfield and surrounding environment in accordance with a federal depredation permit.

The BASH Plan establishes implementation procedures and actions that can be taken to minimize the potential of aircraft bird strikes. Such measures include eliminating broad-leaf weeds, maintaining grass heights to between 7 and 14 inches, removing perch sites and brushy or forested areas, reducing or eliminating standing water, planting non-seeding grasses or mowing before seed heads develop, and scheduling aircraft flying hours to avoid peak bird flying times.

The BASH Plan also establishes the Bird Hazard Working Group (BHWG) composed of representatives of flight safety, civil engineering, airfield management/base operations, air traffic control, operations and other concerned organizations to address BASH concerns and coordinate efforts to reduce risks.

7.12 Coastal Zone and Marine Resources Management

Applicability Statement

This section applies to AF installations that are located along coasts and/or within coastal management zones. This section **IS NOT** applicable to Altus AFB.

7.13 Cultural Resources Protection

Applicability Statement

This section applies to AF installations that have cultural resources that may be impacted by natural resource management activities. This section **IS NOT** applicable to Altus AFB.

7.14 Public Outreach

Applicability Statement

This section applies to all AF installations that maintain an INRMP. Altus AFB is required to implement this element.

Program Overview/Current Management Practices

Altus AFB Environmental staff set up educational tables with laboratory activities at Science, Technology, Engineering and Math (STEM) events on and off of the base for students in order to provoke interest in natural resources. Environmental staff also provide outreach to classrooms and provide educational exhibits on base during leadership group tours and spouse orientations. 97 CES/CEIE plans to coordinate with base Public Affairs (97 AMW/PA) to include articles in the base newspaper to inform base personnel of current natural resources projects or issues.

7.15 Geographic Information Systems (GIS)

Applicability Statement

This section applies to all AF installations that maintain an INRMP, since all geospatial information must be maintained within the AF GeoBase system. Altus AFB is required to implement this element.

Program Overview/Current Management Practices

GIS is used as a management tool for creating, storing, analyzing, and managing spatial data and associated attributes. GIS allows managers to examine ecosystem components represented as layers in a spatial format. Altus AFB natural resources GIS data are developed and maintained by the AFCEC Installation Support System (ISS) Environmental GIS Support Analyst. The data are stored within ArcGIS and the Air Force Geospatial Information Management System (AFGIMS). ArcGIS software allows the 97 CES/CEIE to store and manipulate data for analysis and create digital maps.
Natural resources GIS layers available for Altus AFB include: agricultural tracts, floodplain areas, land cover, natural resources surveys, soil survey areas, vegetation, water bodies, watercourse lines, watersheds, and wetlands. GIS data for the installation is updated annually and data layers are added to the AF GeoBase system as needed.

8.0 MANAGEMENT GOALS AND OBJECTIVES

The installation establishes long term, expansive goals and supporting objectives to manage and protect natural resources while supporting the military mission. Goals express a vision for a desired condition for the installation's natural resources and are the primary focal points for INRMP implementation. Objectives indicate a management initiative or strategy for specific long or medium range outcomes and are supported by projects. Projects are specific actions that can be accomplished within a single year. Also, in cases where off-installation land uses may jeopardize AF missions, this section may list specific goals and objectives aimed at eliminating, reducing or mitigating the effects of encroachment on military missions. These natural resources management goals for the future have been formulated by the preparers of the INRMP from an assessment of the natural resources, current condition of those resources, mission requirements, and management issues previously identified. Below are the integrated goals for the entire natural resources program.

The installation goals and objectives are displayed in the 'Installation Supplement' section below in a format that facilitates an integrated approach to natural resource management. By using this approach, measurable objectives can be used to assess the attainment of goals. Individual work tasks support INRMP objectives. The projects are key elements of the annual work plans and are programmed into the conservation budget, as applicable.

Installation Supplement – Management Goals and Objectives

GOAL 1: Support military mission sustainability through ecological stewardship.

Objective 1.1: Provide a natural resources management program to support the 97 AMW mission through a proactive and responsive natural resource analysis and consultation process to ensure compliance with applicable federal and state laws and regulations and USAF policies.

> Project 1.1.1: Review installation project requests in order to provide natural resource recommendations, including CWA requirements; Section 404 and 401 permitting, National Pollutant Discharge Elimination System permits, ODEQ permits, the Storm Water Pollution Prevention Plan, and any other applicable requirements.
>
> Project 1.1.2: Annually review all installation plans that have the potential to affect natural resources on the base.

Project 1.1.3: Take all necessary actions to avoid adverse impacts to wetlands and floodplains, and create mitigation areas when wetland habitat loss occurs. Maximize their natural ability to moderate floods, maintain water quality, and recharge groundwater.

Objective 1.2: Coordinate with the USDA BASH biologist to provide technical expertise on continued development and implementation of the BASH plan to reduce wildlife risks to aircraft, and assist with population monitoring and habitat manipulation efforts.

Project 1.2.1: Obtain approval from the USDA biologist for all natural resources projects prior to implementation to ensure there are no conflicts with the BASH program.

Project 1.2.2: Assist the USDA biologist with raptor banding and relocation efforts as well as avian population studies on the installation.

Project 1.2.3: Assist the USDA biologist as needed with projects to reduce the attractiveness of the airfield and nearby areas to wildlife.

Objective 1.3: Enhance the long-term sustainability of the military mission and natural resources on the installation through implementation of an adaptive wildland fire program that minimizes risks, while meeting ecological and land management objectives.

Project 1.3.1: Coordinate with the AF Wildland Fire Center (WFC) to develop a Wildland Fire Management Plan for Altus AFB, including a prescribed burn plan to reduce risk of catastrophic wildfires and save money and time on vegetation maintenance.

Project 1.3.2: Through a responsive planning process, ensure minimal interference with military mission activity by conducting 100% of prescribed burns without interrupting mission operations.

GOAL 2: **Conserve native biodiversity by restoring and maintaining native habitat, wildlife populations, and ecological processes.**

Objective 2.1: Restore or maintain ecological processes to native communities damaged or otherwise impacted by human activities or invasive species.

Project 2.1.1: Restore areas of native grassland where practicable using prescribed burns and mechanical removal of non-native plants, and planting native seed mixes.

Project 2.1.2: Plant native grasses, shrubs, and forbs to create pollinator habitat

Project 2.1.3: Create a population monitoring program for the Monarch butterfly and/or other pollinator species such as honeybees and bumblebees.

Project 2.1.4: Complete an invasive species survey of Altus AFB.

Project 2.1.5: Remove invasive plant and animal species identified on the installation.

Objective 2.2: Monitor and develop management strategies for state and federally listed T&E species, species of special concern, and candidate species while ensuring no-net loss of military missions.

Project 2.2.1: Implement a monitoring and conservation program for the Texas horned lizard populations at Altus AFB and the Sooner Drop Zone in cooperation with ODWC and USFWS.

Project 2.2.2: Identify other plant and animal species of conservation interest on the installation for future research/monitoring projects.

Project 2.2.3: Conduct aerial whooping crane telemetry surveys to determine if the species utilizes air space over the installation.

Project 2.2.4: Conduct acoustic surveys and analyses to monitor the tricolored bat.

Objective 2.3: Inventory, monitor, and develop strategies to manage native plant and wildlife

populations.

Project 2.3.1: Conduct a baseline reptile and amphibian population survey.

Project 2.3.2: Conduct a baseline avian survey to determine species diversity.

Project 2.3.3: Conduct an initial baseline mammal survey and routine monitoring.

Project 2.3.4: Conduct a vegetation survey to determine plant species composition on the installation.

Project 2.3.5: Develop a centralized database for storing Altus AFB plant and wildlife monitoring data.

Project 2.3.6: Provide geospatial data of target species to update the installation GIS database.

Project 2.3.7: Complete an urban tree inventory and management plan for Altus AFB and SDZ.

Objective 2.4: Conduct monitoring and report findings to improve water quality, flow regimes and impaired waterways on the installation.

Project 2.4.1: Analyze water quality characteristics in Stinking Creek, a Section 303(d) impaired waterway, and the unnamed tributaries to Stinking Creek on Altus AFB.

Project 2.4.2: Complete habitat assessments and stream condition indices on Stinking Creek and its tributaries to determine a need for aquatic habitat improvement projects.

Project 2.4.3: Catalog macroinvertebrate species, conduct population surveys, and develop a study using population diversity to assess stream health on the installation.

Project 2.4.4: Conduct vegetative swale and riparian habitat restoration along waterways where feasible to improve drainage, help alleviate flooding issues, and improve water quality.

Project 2.4.5: Conduct a wetland delineation of Altus AFB and SDZ to update outdated wetland inventory.

Project 2.4.6: Conduct a soil survey of Altus AFB to assess drainage and erosion properties.

GOAL 3: Provide for the sustainable multi-purpose use of natural resources and dispersed outdoor recreational opportunities to improve morale and overall well-being of the base populace.

Objective 3.1**:** Enhance outdoor recreation areas and create opportunities for recreational activities to improve the morale of people who live and work on the installation.

Project 3.1.1: Plant native trees and shrubs along walking trails and around playgrounds to enhance outdoor aesthetics and provide children and recreationists with relief from the summer heat and protection from harmful UV rays.

Project 3.1.2: Create a community garden for base residents as a space for connectivity with fellow airmen and families that encourage healthy diet choices and food sustainability.

Project 3.1.3: Create a pollinator habitat educational outreach and wildlife viewing area.

Project 3.1.4: Convert open space along the walking trails south of base housing to native mixed-grass prairie where practicable.

Project 3.1.5: Stock existing pond on east side of golf course for recreational fishing.

Project 3.1.6: Create a pond in the open space south of base housing to mitigate wetland loss and to provide for recreational fishing on the installation.

Project 3.1.7: Fill in pond on east side of golf course near flight line to reduce BASK risks.

Project 3.1.8: Create native wildlife viewing areas along walking trails for educational outreach.

Objective 3.2**:** Increase awareness of and participation in outdoor recreational opportunities and natural resource activities for people who live and work on the installation.

Project 3.2.1: Promote the use of Altus AFB's leased campsite area at Quartz Mountain, as well as other outdoor recreational opportunities in the area.

Project 3.2.2: Enhance the installation's outdoor archery range and facilitate the creation of an archery league.

Project 3.2.3: Gauge base interest in, and pursue creation of other groups/clubs that utilize base natural resources (i.e. bird watching clubs and hiking groups).

Project 3.2.4: Create a tree care committee and host an Arbor Day event to attain Tree City USA certification from the Arbor Day Foundation.

9.0 INRMP IMPLEMENTATION, UPDATE, AND REVISION PROCESS

9.1 Natural Resources Management Staffing and Implementation

The entire installation, including tenant organizations, collaborate on the implementation of the INRMP to ensure mission readiness. The natural resources manager (NRM) and 97 CES Environmental Element (97 CES/CEIE) staff oversee implementation of the natural resources program. Natural resource management activities are planned in coordination with all affected installation organizations.

Any actions that would substantially affect natural resources or require changes to this plan will be reviewed by the installation ESOHC. Such actions will proceed only when compatible with this plan or after the plan has been appropriately changed.

The NRM routinely reviews work requests and activity proposals and reviews installation plans that may affect natural resources to ensure their compatibility with the INRMP. Any construction plans or work requests for activities that may affect natural resources on the installation must be reviewed and approved by the 97 CES/CEIE. Proponents of such actions must coordinate with the 97 CES/CEIE throughout planning and implementation.

9.2 Monitoring INRMP Implementation

Monitoring, coordination with stakeholders and regulators, and recordkeeping are the primary responsibility of the 97 CES/CEIE office. 97 CES/CEIE is responsible for INRMP updates and implementation and natural resources management staffing. Yearly INRMP accomplishments are summarized in an annual review summary.

The Air Force Civil Engineer Center (AFCEC) Installation Support Section tracks INRMP Sikes Act compliance for Altus AFB and assists the 97 CES/CEIE with INRMP implementation.

9.3 Annual INRMP Review and Update Requirements

The INRMP requires annual review, in accordance with DoDI 4715.03, *Natural Resources Conservation Program* and AFMAN 32-7003, to ensure the achievement of mission goals, verify the implementation of projects, and establish any necessary new management requirements. The NRM and other 97 CES/CEIE personnel, internal base stakeholders, USFWS, and ODWC annually review the INRMP. Cooperating agencies should mutually agree that the INRMP presents a natural resources management program that is current as to operation and effect for those elements of the INRMP under the jurisdictional authority of each agency.

If the Altus AFB mission or any of its natural resources management issues change significantly after the creation of the original INRMP, a major revision to the INRMP is required. The INRMP is considered compliant with the Sikes Act if it has been approved by signature on the INRMP signature page, or in writing in a signed letter, by the appropriate representative from each cooperating agency. Approval of a revised INRMP must be documented by signature from the installation commander (or designee), the authorized signatory representative of the USFWS, and the authorized signatory representative of the ODWC within the past 5 years.

10.0 ANNUAL WORK PLANS

The INRMP Annual Work Plans are included in this section. These projects are listed by fiscal year, including the current year and four succeeding years. For each project and activity, a specific timeframe for implementation is provided (as applicable), as well as the office of primary responsibility (OPR), appropriate funding source, and priority for implementation. The work plans provide all the necessary information for building a budget within the AF framework. Priorities are defined as follows:

- High: The INRMP signatories assert that if the project is not funded the INRMP is not being implemented and the Air Force is non-compliant with the Sikes Act; or that it is specifically tied to an INRMP goal and objective and is part of a "Benefit of the Species" determination necessary for ESA Sec 4(a)(3)(B)(i) critical habitat exemption.
- Medium: Project supports a specific INRMP goal and objective, and is deemed by INRMP signatories to be important for preventing non-compliance with a specific requirement within a natural resources law or by EO 13112 on Invasive Species. However, the INRMP signatories would not contend that the INRMP is non-compliant if not accomplished within a programmed year due to other priorities.
- Low: Project supports a specific INRMP goal and objective, enhances conservation resources or the integrity of the installation mission, and/or supports long-term compliance with specific requirements within natural resources law; but is not directly tied to specific compliance within the proposed year of execution.

ANNUAL WORK PLANS (INCLUDE YEAR)	**OPR**	**Funding Source**	**Priority Level**
Project 3.1.5: Stock existing pond on east side of golf course for recreational fishing (FY2020)	97 CES/CEIE	In-house	Low
Project 2.2.1: Implement a Texas horned lizard population study at Altus AFB and SDZ (FY2021)	USFWS	AFCEC	Medium

Project 2.1.2: Plant native grasses, shrubs, and forbs to create pollinator habitat (FY2021)	97 CES/CEIE	AFCEC	Low
Project 1.3.1: Develop a Wildland Fire Management Plan and prescribed burn plan for Altus AFB (FY2021)	AF Wildland Fire Center	AFCEC	Low
Project 2.3.6: Complete an urban tree inventory and management plan for Altus AFB and SDZ (FY2021)	97 CES/CEIE	In-house	Low
Project 2.4.5: Conduct a wetland delineation of Altus AFB and SDZ (FY2021)	US Army Corps of Engineers (USACE)	In-house	Low
Project 2.4.6: Conduct a soil survey of Altus AFB (FY2021)	USDA NRCS	USDA NRCS	Low
Project 3.2.4: Create a tree committee and host an Arbor Day event to attain Tree City USA certification from the Arbor Day Foundation (FY2021)	97 CES/CEIE	In-house	Low
Project 3.2.2: Enhance the archery range and facilitate the creation of an archery league (FY2021)	97 CES/CEIE	In-house	Low
Project 3.2.3: Gauge interest in and pursue the creation of other outdoor recreation groups (i.e., bird watching clubs and hiking groups) (FY2021)	97 CES/CEIE	In-house	Low
Project 2.3.3: Conduct an initial baseline mammal survey (FY2021)	97 CES/CEIE	In-house	Low
Project 3.1.2: Create a community garden (FY2021)	97 CES/CEIE	In-house	Low
Project 2.3.5: Develop a centralized database for storing Altus AFB plant and wildlife monitoring data (FY2021)	97 CES/CEIE	In-house	Low
Project 2.4.2: Complete habitat assessments and stream condition indices for Stinking Creek and its tributaries (FY2021)	97 CES/CEIE	In-house	Low

Project 2.4.3: Conduct macroinvertebrate population surveys to assess stream health (FY2021)	97 CES/CEIE	In-house	Low
Project 3.1.1: Plant native trees and shrubs along walkways and around playgrounds (FY2022)	97 CES/CEIE	In-house	Low
Project 2.3.2: Conduct a baseline avian survey to determine species diversity (FY2022)	USFWS	AFCEC	Low
Project 2.2.3: Conduct aerial whooping crane telemetry surveys to determine presence at Altus AFB (FY2022)	USFWS	AFCEC	Medium
Project 2.2.2: Identify other plant and animal species of conservation interest on the installation for future research/monitoring (FY2022)	97 CES/CEIE	In-house	Medium
Project 2.3.1: Conduct a baseline reptile and amphibian population survey (FY2022)	DoD PARC	AFCEC	Low
Project 3.1.6: Create a pond to mitigate wetland loss and provide for recreational fishing (FY2022)	USFWS	AFCEC	Low
Project 3.1.3: Create a pollinator educational outreach/wildlife viewing area (FY2022)	97 CES/CEIE	AFCEC	Low
Project 3.1.7: Fill in pond on east side of golf course near flight line to reduce BASH risks (FY2022)	97 CES/CEIE	In-house	Low
Project 2.1.1: Restore degraded areas of native mixed-grass prairie at Altus AFB (FY2023)	AF Wildland Fire Center	AFCEC	Low
Project 2.1.4: Complete an invasive species survey of Altus AFB (FY2023)	USFWS	AFCEC	Medium

Project 3.1.4: Convert open space areas along walking trails to native mixed-grass prairie (FY2023)	97 CES/CEIE	AFCEC	Low
Project 3.1.8: Create wildlife viewing areas along walking trails (FY2023)	97 CES/CEIE	AFCEC	Low
Project 2.4.4: Conduct riparian habitat restoration to improve flood resilience drainage, and water quality (FY2023)	97 CES/CEIE	In-house	Low
Project 2.3.4: Conduct a vegetation survey to determine plant species composition on the installation (FY2023)	Oklahoma Biological Survey	AFCEC	Low
Project 2.2.4: Conduct acoustic surveys and analyses for the tricolored bat (FY2023-2027)	USFWS	AFCEC	Medium
Project 2.1.5: Remove invasive plant and animal species from the installation (FY2024)	97 AMW/CEOHE	In-house	Medium
Project 2.1.3: Survey pollinator populations at Altus AFB (FY2024)	97 CES/CEIE	AFCEC	Low

11.0 REFERENCES

11.1 Standard References *(Applicable to all AF installations)*

- AFMAN 32-7003, *Environmental Conservation*
- Sikes Act
- eDASH Natural Resources Program Page
- Natural Resources Playbook – an Internal AF reference available at https://cs1.eis.af.mil/sites/ceportal/CEPlaybooks/NRM2/Pages/

11.2 Installation References

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12.0 ACRONYMS

12.1 Standard Acronyms (Applicable to all AF installations)

- eDASH Acronym Library
- Natural Resources Playbook – Acronym Section

- U.S. EPA Terms & Acronyms

12.2 Installation Acronyms

13.0 DEFINITIONS

13.1 Standard Definitions (Applicable to all AF installations)

- Natural Resources Playbook – Definitions Section

13.2 Installation Definitions

- **Agricultural outleasing:** The use of DoD land under a lease to an agency, organization, or person for growing crops or grazing animals.
- **Biological diversity:** The variety of life forms, the ecological roles they perform, and the genetic variability they contain within any defined time and space.
- **Commercial forest land:** Land under management capable of producing at least 20 cubic feet of merchantable timber per acre per year. It must be accessible and programmed for silviculture prescriptions. The smallest area for this classification is five acres. Roadside, streamside, and shelterbelt strips of timber must have or be capable of producing a crown width of at least 120 cubic feet to be classified as commercial timber.
- **Consultation:** A process initiated by the installation commander in which the commander confers with the State Historic Preservation Office to reduce or avoid adverse effects on historic properties. The Advisory Council on Historic Preservation and certain interested persons may participate as consulting parties.
- **Cooperative agreement:** A written agreement between an Air Force installation and one or more outside agencies (federal, state, or local) that coordinates planning strategies. It is a vehicle for obtaining assistance in developing natural resource plans.
- **Critical habitat:** Any air, land, or water area (excluding existing synthetic structures or settlements that are not necessary to the survival and recovery of a species listed as endangered or threatened) and constituents thereof that the U. S. Fish and Wildlife Service (USFWS) has designated as essential to the survival and recovery of an endangered or threatened species or a distinct segment of its population.
- **Cropland:** Land primarily suitable for producing farm crops, including grain, hay, and truck crops.
- **Ecosystem management:** An approach to natural resources management that focuses on the interrelationships of ecological processes linking soils, plants, animals, minerals, climate, water and topography. Managers view such processes as a living system that affects and responds to human activity beyond traditional commodity and amenity uses. They also acknowledge the importance of ecosystem services such as water conservation, oxygen recharge and nutrient recycling.
- **Endangered species:** Any plant or animal listed or proposed for listing as threatened or endangered by the federal government or state governments.
- **Exotic species:** Any plant or animal not native to a region, state, or country (This definition excludes certain game species that have become established, such as pheasants).
- **Featured species:**
    - A fish or wildlife species whose habitat requires fish or wildlife management (including coordination, multiple-use planning, direct habitat improvements and cooperative programs) on a unit of land or water.

    - A tree species that the forest management plan cites as having value for wood fiber production. The plan usually specifies one or more featured tree species along with one or more associated species to meet multiple-use management objectives.
- **Fish:** Fresh and saltwater fin-fish, other than aquatic vertebrate organisms and crustaceans and mollusks.
- **Floodplains:** Lowland and flat areas adjoining inland coastal waters, including flood-prone areas on offshore islands, that have a one percent or greater chance of flooding in any given year.
- **Forest land:** Lands on which forest trees of various sizes constitute at least 10 percent of the area. This category includes open land that is capable of supporting trees and is planned for forest regeneration and management.
- **Forest management:** Developing, conserving and protecting forest resources to ensure that they provide sustained yield and multiple uses.
- **Forest products:** Plant materials in wooded areas that have commercial value, such as saw logs, veneer (peeler) logs, poles, pilings, pine needles, cordwood (for pulp, paper, or firewood), fence posts, mine timber, Christmas trees (from unsheared trees cut during intermediate harvests) and similar wood or chemical products.
- **Game:** Any species of fish or wildlife for which state or federal laws and regulations prescribe seasons and bag or creel limits.
- **Grazing land:** Land with vegetative cover that consists of grasses, herbs, and shrubs valuable as forage.
- **Grazing systems:** Specialized methods of grazing management (the manipulation of livestock grazing to accomplish a desired result) that defines systematically recurring periods of grazing and deferment for pastures or management units.
- **Habitat:** An area that provides the environmental elements of air, water, food, cover and space necessary for a given species to survive and reproduce.
- **Highly erodible soils:** Soils that, because of their physical properties or slope, the US Department of Agriculture (USDA), Natural Resources Conservation Service identifies as being highly susceptible to wind or water erosion.
- **Integrated natural resources management plan (INRMP):** A natural resources management plan based on ecosystem management that shows the interrelationships of the individual component plans as well as mission and land-use activities affecting the basic land management plans.
- **Improved grounds:** Grounds on which personnel annually plan and perform intensive maintenance activities. These are developed areas of an installation that have lawns and landscape plants that require intensive maintenance. They usually include the cantonment, parade grounds, drill fields, athletic areas, golf courses, (excluding roughs), cemeteries and housing areas.
- **Land management unit:** The smallest land management division that planners use in developing specific strategies to accomplish natural resources management goals. Land management units may correspond to grazing units on agricultural outleased lands, stands or compartments on commercial forest lands, various types of improved grounds (for example, athletic fields, parks, yards in family housing, or landscaped areas around administrative buildings), or identifiable semi-improved grounds (for example, airfield areas, utility rights-of-way, or roadside areas).
- **Land-use regulation:** A document that prescribes the specific technical or land use and restrictions with which lessees, permitees, or contractors must comply. It derives from the grazing or cropland management plan and forms a part of all outleases, land use permits, and other contracts.
- **Livestock:** Domestic animals kept or raised for food, by-products, work, transportation, or recreation.
- **Multiple use:** The integrated, coordinated and compatible use of various natural resources to derive the best benefit while perpetuating and protecting those resources.

- **Multiple use and sustained yield management:** The care and use of natural resources so as to best serve the present and future needs of the United States and its people without impairing the productivity of the land and water.
- **Natural resources management professional:** A person with a degree in the natural sciences who manages natural resources on a regular basis and receives periodic training to maintain proficiency in that job.
- **"No funds" service contract:** An agreement by which a party performs a land management service for a consideration other than funds. Such a contract exists, for example, when a party hired to establish, control, or remove vegetative cover or growth agrees to take payment for the service in the form of the growth that results.
- **Noncommercial forest land:** Land not capable of yielding forest products of at least 20 cubic feet per acre per year because of adverse site conditions. The classification also includes productive forest land on which mission requirements, accessibility, or incompatible uses preclude forest management activities.
- **Outdoor interpretation:** Observing or explaining the history, development and significance of our natural heritage and natural resources.
- **Outdoor recreation resources:** Land and water areas and associated natural resources that provide, or have the potential to provide, opportunities for outdoor recreation for present and future generations.
- **Prime farmland:** Land that has the best combination of chemical and physical characteristics for producing food, feed, forage, fiber and oil-seed crops and is also available or potentially available for these uses. It has the soil quality, growing season and moisture supply needed to economically produce sustained high yields of crops under modern farming methods. Existing pasture land, rangeland, forest land and other land not in an urban buildup condition is considered eligible for designation as prime farmland, providing it meets the other criteria.
- **Procurement contract:** An agreement by which the government agrees to pay a contractor to establish control, or remove vegetative cover or growth for land management purposes. This contract may not extend beyond the period for which funding for the service is available.
- **Rangeland:** Land on which the native vegetation is predominantly grasses, grass-like plants, herbs, or shrubs suitable for grazing or browsing use. It includes lands revegetated naturally or artificially to provide a forage cover that is managed like native vegetation. It also includes natural grasslands, savannas, shrubland, most deserts, tundra, alpine communities, coastal marshes and wet meadows.
- **Recreation carrying capacity:** The level of recreational use that an area can sustain without damage to the environment.
- **Reforestation:** The renewal or regeneration of a forest by natural or artificial means.
- **Rotation age:** The planned number of years between the regeneration of a forest stand and its final cutting at a specified stage of maturity.
- **"Sales" service contract:** An agreement by which the contractor pays the government for crops, crop residue, or grazing privilege incidental to control or removal of vegetative growth for land management purposes. Sales contracts cover a period of one to five years.
- **Semi-improved grounds:** Grounds where personnel perform periodic maintenance primarily for operational and aesthetic reasons (such as erosion and dust control, bird control, and visual clear zones). These usually include grounds adjacent to runways, taxiway and aprons; runway clear zones; (UFC 3-260-01); rifle and pistol ranges; picnic areas; ammunition storage areas; antenna facilities and golf course roughs.
- **Stewardship:** The management of a resources base with the goal of maintaining or increasing the resources' value indefinitely into the future.
- **Threatened species:** Those federally or state-listed species of plants or animals that are likely to become endangered within the foreseeable future throughout all or a significant portion of their

range and that have been designated for special protection and management pursuant to the Endangered Species Act.

- **Timber management:** The application of silviculture knowledge and prescriptions to forest lands within economic and environmental constraints to produce a sustained yield of forest products.
- **Timber stand improvement (TSI):** Silviculture treatment applied to existing stands to improve their quality, composition, condition, or rate of growth (such as pruning, thinning, releasing and prescribed burning).
- **Unimproved grounds:** Grounds not classified as improved or semi-improved and usually not mowed more than once a year. These include weapons ranges; forest lands; cropland and grazing lands; lakes, ponds and wetlands and areas in airfields beyond the safety zones (UFC 3-260-01).
- **Unique farmland:** Land, other than prime farmland, used for producing specific high- value food and fiber crops at the time of designation. It has the special combination of soil quality, location, growing season and moisture supply needed to produce sustained high-quality or high yields of a specific crop under modern farming conditions. Examples are citrus, tree nuts, olives and cranberries.
- **Urban forests:** Planted or remnant native tree species existing within urbanized areas such as parks, tree-lined residential streets, scattered tracts of undisturbed woodlands and cantonment areas.
- **Urban wildlife:** Wildlife that habitually live or periodically survive in an urban environment on improved or semi-improved grounds.
- **Watchable wildlife areas:** Areas identified under the Watchable Wildlife Program as suitable for passive recreational uses such as bird watching, nature study and other nonconsumptive uses of wildlife resources.
- **Wetlands:** Areas inundated or saturated by surface or ground water at a frequency and a duration to support and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions
- **Wildlife carrying capacity:** The maximum density of wildlife that a particular area or habitat can carry on a sustained basis without deterioration of the habitat.

14.0 APPENDICES

Appendix A. Annotated Summary of Key Legislation Related to INRMP Design and Implementation

Federal Public Laws and Executive Orders	
National Defense Authorization Act of 1989, Public Law (P.L.) 101-189; Volunteer Partnership Cost-Share Program	Amends two Acts and establishes volunteer and partnership programs for natural and cultural resources management on DoD lands.
Defense Appropriations Act of 1991, P.L. 101-511; Legacy Resource Management Program	Establishes the "Legacy Resource Management Program" for natural and cultural resources. Program emphasis is on inventory and stewardship responsibilities of biological, geophysical, cultural, and historic resources on DoD lands, including restoration of degraded or altered habitats.
EO 11514, Protection and Enhancement of Environmental Quality	Federal agencies shall initiate measures needed to direct their policies, plans, and programs to meet national environmental goals. They shall monitor, evaluate, and control agency activities to protect and enhance the quality of the environment.
EO 11593, Protection and Enhancement of the Cultural Environment	All Federal agencies are required to locate, identify, and record all cultural resources. Cultural resources include sites of archaeological, historical, or architectural significance.

EO 11987, Exotic Organisms	Agencies shall restrict the introduction of exotic species into the natural ecosystems on lands and waters which they administer.
EO 11988, Floodplain Management	Provides direction regarding actions of Federal agencies in floodplains, and requires permits from state, territory and Federal review agencies for any construction within a 100-year floodplain and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for acquiring, managing and disposing of Federal lands and facilities.
EO 11989, Off-Road vehicles on Public Lands	Installations permitting off-road vehicles to designate and mark specific areas/trails to minimize damage and conflicts, publish information including maps, and monitor the effects of their use. Installations may close areas if adverse effects on natural, cultural, or historic resources are observed.
EO 11990, Protection of Wetlands	Requires Federal agencies to avoid undertaking or providing assistance for new construction in wetlands unless there is no practicable alternative, and all practicable measures to minimize harm to wetlands have been implemented and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of Federal lands and facilities; and (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.
EO 12088, Federal Compliance With Pollution Control Standards	This EO delegates responsibility to the head of each executive agency for ensuring all necessary actions are taken for the prevention, control, and abatement of environmental pollution. This order gives the U.S. Environmental Protection Agency (US EPA) authority to conduct reviews and inspections to monitor Federal facility compliance with pollution control standards.
EO 12898, Environmental Justice	This EO requires certain federal agencies, including the DoD, to the greatest extent practicable permitted by law, to make environmental justice part of their missions by identifying and addressing disproportionately high and adverse health or environmental effects on minority and low-income populations.
EO 13112, Exotic and Invasive Species	To prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	The U.S. Fish and Wildlife Service (USFWS) has the responsibility to administer, oversee, and enforce the conservation provisions of the Migratory Bird Treaty Act, which includes responsibility for population management (e.g., monitoring), habitat protection (e.g., acquisition, enhancement, and modification), international coordination, and regulations development and enforcement.
United States Code	
Animal Damage Control Act (7 U.S.C. § 426-426b, 47 Stat. 1468)	Provides authority to the Secretary of Agriculture for investigation and control of mammalian predators, rodents, and birds. DoD installations may enter into cooperative agreements to conduct animal control projects.
Bald and Golden Eagle Protection Act of 1940, as amended; 16 U.S.C. 668-668c	This law provides for the protection of the bald eagle (the national emblem) and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession and commerce of such birds. The 1972 amendments increased penalties for violating provisions of the Act or regulations issued pursuant thereto and strengthened other enforcement measures. Rewards are provided for information leading to arrest and conviction for violation of the Act.

Clean Air Act, (42 U.S.C. § 7401– 7671q, July 14, 1955, as amended)	This Act, as amended, is known as the Clean Air Act of 1970. The amendments made in 1970 established the core of the clean air program. The primary objective is to establish Federal standards for air pollutants. It is designed to improve air quality in areas of the country which do not meet Federal standards and to prevent significant deterioration in areas where air quality exceeds those standards.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (Superfund) (26 U.S.C. § 4611–4682, P.L. 96-510, 94 Stat. 2797), as amended	Authorizes and administers a program to assess damage, respond to releases of hazardous substances, fund cleanup, establish clean-up standards, assign liability, and other efforts to address environmental contaminants. Installation Restoration Program guides cleanups at DoD installations.
Endangered Species Act (ESA) of 1973, as amended; P.L. 93-205, 16 U.S.C. § 1531 et seq.	Protects threatened, endangered, and candidate species of fish, wildlife, and plants and their designated critical habitats. Under this law, no Federal action is allowed to jeopardize the continued existence of an endangered or threatened species. The ESA requires consultation with the USFWS and the NOAA Fisheries (National Marine Fisheries Service) and the preparation of a biological evaluation or a biological assessment may be required when such species are present in an area affected by government activities.
Federal Aid in Wildlife Restoration Act of 1937 (16 U.S.C. § 669–669i; 50 Stat. 917) (Pittman-Robertson Act)	Provides Federal aid to states and territories for management and restoration of wildlife. Fund derives from sports tax on arms and ammunition. Projects include acquisition of wildlife habitat, wildlife research surveys, development of access facilities, and hunter education.
Federal Environmental Pesticide Control Act of 1972 (7 U.S.C. § 136, 86 Stat. 973)	Requires installations to ensure pesticides are used only in accordance with their label registrations and restricted-use pesticides are applied only by certified applicators.
Federal Land Use Policy and Management Act, 43 U.S.C. § 1701–1782	Requires management of public lands to protect the quality of scientific, scenic, historical, ecological, environmental, and archaeological resources and values; as well as to preserve and protect certain lands in their natural condition for fish and wildlife habitat. This Act also requires consideration of commodity production such as timbering.
Federal Noxious Weed Act of 1974, 7 U.S.C. § 2801–2814	The Act provides for the control and management of non-indigenous weeds that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health.
Federal Water Pollution Control Act (Clean Water Act [CWA]), 33 U.S.C. §1251–1387	The CWA is a comprehensive statute aimed at restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. Primary authority for the implementation and enforcement rests with the US EPA.
Fish and Wildlife Conservation Act (16 U.S.C. § 2901–2911; 94 Stat. 1322, PL 96-366)	Installations encouraged to use their authority to conserve and promote conservation of nongame fish and wildlife in their habitats.
Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.)	Directs installations to consult with the USFWS, or state or territorial agencies to ascertain means to protect fish and wildlife resources related to actions resulting in the control or structural modification of any natural stream or body of water. Includes provisions for mitigation and reporting.
Lacey Act of 1900 (16 U.S.C. § 3371-3378)	Prohibits the importation of wild animals or birds or parts thereof, taken, possessed, or exported in violation of the laws of the country or territory of origin. Provides enforcement and penalties for violation of wildlife related Acts or regulations.

Leases: Non-excess Property of Military Departments, 10 U.S.C. § 2667, as amended	Authorizes DoD to lease to commercial enterprises Federal land not currently needed for public use. Covers agricultural outleasing program.
Migratory Bird Treaty Act 16 U.S.C. § 703–712	The Act implements various treaties for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful without a valid permit.
National Environmental Policy Act of 1969 (NEPA), as amended; P.L. 91-190, 42 U.S.C. § 4321 et seq.	Requires Federal agencies to utilize a systematic approach when assessing environmental impacts of government activities. Establishes the use of environmental impact statements. NEPA proposes an interdisciplinary approach in a decision-making process designed to identify unacceptable or unnecessary impacts on the environment. The Council of Environmental Quality (CEQ) created Regulations for Implementing the National Environmental Policy Act [40 Code of Federal Regulations (CFR) Parts 1500– 1508], which provide regulations applicable to and binding on all Federal agencies for implementing the procedural provisions of NEPA, as amended.
National Historic Preservation Act, 16 U.S.C. § 470 et seq.	Requires Federal agencies to take account of the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP). Provides for the nomination, identification (through listing on the NRHP), and protection of historical and cultural properties of significance.
National Trails Systems Act (16 U.S.C. § 1241–1249)	Provides for the establishment of recreation and scenic trails.
National Wildlife Refuge Acts	Provides for establishment of National Wildlife Refuges through purchase, land transfer, donation, cooperative agreements, and other means.
National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. § 668dd–668ee)	Provides guidelines and instructions for the administration of Wildlife Refuges and other conservation areas.
Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001–13; 104 Stat. 3042), as amended	Established requirements for the treatment of Native American human remains and sacred or cultural objects found on Federal lands. Includes requirements on inventory, and notification.
Rivers and Harbors Act of 1899 (33 U.S.C. § 401 et seq.)	Makes it unlawful for the USAF to conduct any work or activity in navigable waters of the United States without a Federal Permit. Installations should coordinate with the U.S. Army Corps of Engineers (USACE) to obtain permits for the discharge of refuse affecting navigable waters under National Pollutant Discharge Elimination System (NPDES) and should coordinate with the USFWS to review effects on fish and wildlife of work and activities to be undertaken as permitted by the USACE.
Sale of certain interests in land, 10 U.S.C. § 2665	Authorizes sale of forest products and reimbursement of the costs of management of forest resources.
Soil and Water Conservation Act (16 U.S.C. § 2001, P.L. 95-193)	Installations shall coordinate with the Secretary of Agriculture to appraise, on a continual basis, soil/water-related resources. Installations will develop and update a program for furthering the conservation, protection, and enhancement of these resources consistent with other Federal and local programs.
Sikes Act (16 U.S.C. § 670a–670l, 74 Stat. 1052), as amended	Provides for the cooperation of DoD, the Departments of the Interior (USFWS), and the State Fish and Game Department in planning, developing, and maintaining fish and wildlife resources on a military installation. Requires development of an Integrated Natural Resources Management Plan

	and public access to natural resources, and allows collection of nominal hunting and fishing fees. NOTE: AFMAN 32-7003 sec 3.9. Staffing. As defined in DoDI 4715.03, use professionally trained natural resources management personnel with a degree in the natural sciences to develop and implement the installation INRMP. (T-0). 3.9.1. Outsourcing Natural Resources Management. As stipulated in the Sikes Act, 16 U.S.C. § 670 et. seq., the Office of Management and Budget Circular No. A-76, Performance of Commercial Activities, August 4, 1983 (Revised May 29, 2003) does not apply to the development, implementation and enforcement of INRMPs. Activities that require the exercise of discretion in making decisions regarding the management and disposition of government owned natural resources are inherently governmental. When it is not practicable to utilize DoD personnel to perform inherently governmental natural resources management duties, obtain these services from federal agencies having responsibilities for the conservation and management of natural resources.
DoD Policy, Directives, and Instructions	
DoD Instruction 4150.07 DoD Pest Management Program dated 29 May 2008	Implements policy, assigns responsibilities, and prescribes procedures for the DoD Integrated Pest Management Program.
DoD Instruction 4715.1, Environmental Security	Establishes policy for protecting, preserving, and (when required) restoring and enhancing the quality of the environment. This instruction also ensures environmental factors are integrated into DoD decision-making processes that could impact the environment, and are given appropriate consideration along with other relevant factors.
DoD Instruction (DODI) 4715.03, Natural Resources Conservation Program	Implements policy, assigns responsibility, and prescribes procedures under DoDI 4715.1 for the integrated management of natural and cultural resources on property under DoD control.
OSD Policy Memorandum – 17 May 2005 – Implementation of Sikes Act Improvement Amendments: Supplemental Guidance Concerning Leased Lands	Provides supplemental guidance for implementing the requirements of the Sikes Act in a consistent manner throughout DoD. The guidance covers lands occupied by tenants or lessees or being used by others pursuant to a permit, license, right of way, or any other form of permission. INRMPs must address the resource management on all lands for which the subject installation has real property accountability, including leased lands. Installation commanders may require tenants to accept responsibility for performing appropriate natural resource management actions as a condition of their occupancy or use, but this does not preclude the requirement to address the natural resource management needs of these lands in the installation INRMP.
OSD Policy Memorandum – 1 November 2004 – Implementation of Sikes Act Improvement Act Amendments: Supplemental Guidance Concerning INRMP Reviews	Emphasizes implementing and improving the overall INRMP coordination process. Provides policy on scope of INRMP review, and public comment on INRMP review.
OSD Policy Memorandum – 10 October 2002 – Implementation of Sikes Act Improvement Act: Updated Guidance	Provides guidance for implementing the requirements of the Sikes Act in a consistent manner throughout DoD and replaces the 21 September 1998 guidance Implementation of the Sikes Act Improvement Amendments. Emphasizes implementing and improving the overall INRMP coordination process and focuses on coordinating with stakeholders, reporting requirements and metrics, budgeting for INRMP projects, using the INRMP as a substitute for critical habitat designation, supporting military training and testing needs, and facilitating the INRMP review process.
USAF Instructions and Directives	

32 CFR Part 989, as amended, and AFI 32-1015, Integrated Installation Planning	Provides guidance and responsibilities in the EIAP for implementing INRMPs. Implementation of an INRMP constitutes a major federal action and therefore is subject to evaluation through an Environmental Assessment or an Environmental Impact Statement.
AFI 32-1015, Integrated Installation Planning	Provides guidance and responsibilities related to the USAF comprehensive planning process on all USAF-controlled lands.
AFMAN 32-7003, Environmental Conservation	Implements AFPD 32-70, Environmental Quality; DODI 4715.03, Natural Resources Conservation Program; and DODI 7310.5, Accounting for Sale of Forest Products. It explains how to manage natural resources on USAF property in compliance with Federal, state, territorial, and local standards.
AFMAN 32-7003, Environmental Conservation	This instruction implements AFPD 32-70 and DoDI 4710.1, Archaeological and Historic Resources Management. It explains how to manage cultural resources on USAF property in compliance with Federal, state, territorial, and local standards.
AFPD 32-70, Environmental Considerations in Air Force Programs and Activities	Outlines the USAF mission to achieve and maintain environmental quality on all USAF lands by cleaning up environmental damage resulting from past activities, meeting all environmental standards applicable to present operations, planning its future activities to minimize environmental impacts, managing responsibly the irreplaceable natural and cultural resources it holds in public trust and eliminating pollution from its activities wherever possible. AFPD 32-70 also establishes policies to carry out these objectives.
Policy Memo for Implementation of Sikes Act Improvement Amendments, HQ USAF Environmental Office (USAF/ILEV) on January 29, 1999	Outlines the USAF interpretation and explanation of the Sikes Act and Improvement Act of 1997.

Appendix B. Methods for Climate Change Projections

TABLE OF CONTENTS

TABLES

FIGURES

ACRONYMS

AFCEC	Air Force Civil Engineer Center
AFDD	Air Force Doctrine Documents
AOI	Area of Interest
ATP	Army Techniques Publication
CCSM	Community Climate System Model
CIP	Common Installation Picture
CMIP	Coupled Model Intercomparison Project

CN	Curve Number
CONUS	Contiguous United States
DEM	Digital elevation model
DoD	Department of Defense
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HCCVI	Habitat Climate Change Vulnerability Index
HEC	Hydrologic Engineering Center
HMS	Hydrologic Modeling System
HUC	Hydrologic Unit Code
ICEMAP	Installation Complex Encroachment Management Plans
INRMP	Integrated Natural Resources Management Plan
IPB	Intelligence Preparation of the Battlefield
IPCC	Intergovernmental Panel on Climate Change
ISI-MIP	Inter-Sectoral Impact Model Intercomparison Project
LOCA	Localized Constructed Analogs
MC2	Dynamic Global Vegetation Model
MCRP	Marine Corps Reference Publication
MHHW	Mean Higher High Water
MRLC	Multi-Resolution Land Characteristics
NCAR	National Center for Atmospheric Research
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NSSDA	National Standard for Spatial Data Accuracy
OCONUS	Outside the Contiguous United States
PRECIP	Average annual precipitation
RAS	River Analysis System
RCP	Representative Concentration Pathway
SCS	Soil Conservation Service
SLR	Sea Level Rise
SS	Storm Surge
TAVE	Annual average temperature
TMAX	Annual maximum temperature
TMIN	Annual average minimum temperature
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

This appendix provides a detailed overview of the data and methods used to assess installation-specific vulnerabilities and potential impacts associated with projected changes under four climate change scenarios. The scenarios represent two global carbon emissions levels for two different target years. The emissions scenarios are medium emissions (RCP 4.5) and high emissions (RCP 8.5). The two timeframes are decades around 2030 (2026-2035) and 2050 (2046-2055). Therefore, the climate change scenarios are:

RCP 4.5 2030

RCP 8.5 2030

RCP 4.5 2050

RCP 8.5 2050

Projected climate data were then used to assess potential impacts to Altus AFB's mission and natural resources.

A.1 Climate Projections

Climate projections are based on recent global climate model simulations developed for the Intergovernmental Panel on Climate Change (IPCC), Coupled Model Intercomparison Project Phase 5 (CMIP5) (Hibbard, Meehl, Cox, & Friedlingstein, 2007; Moss et al., 2008, 2010). Under the CMIP5 protocol, specified radiative forcing of the atmospheric warming were simulated using 32 global climate models to provide scenarios associated with emission levels at 4.5 W/m^2 and 8.5 W/m^2 (van Vuuren et al., 2011), denoted as RCP 4.5 and RCP 8.5, respectively (CMIP5 Data Search | CMIP5 | ESGF-CoG, n.d.).

A.1.1 Climate Methodology

For each US Air Force (USAF) installation assessed, historical daily temperature and precipitation data over a 30-year period were used to represent average historical conditions and generate climate projections. Future climate conditions under the RCP 4.5 and RCP 8.5 emission scenarios were projected to produce a decadal time series of daily climate values for the decades around 2030 (2026-2035) and 2050 (2046-2055).

Within the Contiguous United States (CONUS), DAYMET weather data (Thornton, Thornton, & Mayer, 2012) from 1980 to 2009 was used to represent the historical period. DAYMET provides gridded daily temperature and precipitation data at a 1-km spatial resolution. The historical climate data represent the 30-year historical reference point used by the IPCC to define climate change scenarios.

Climate projections were calculated using US National Center for Atmospheric Research (NCAR) Community Climate System Model (CCSM4) simulations prepared for the IPCC-AR5 (Gent & Danabasoglu, 2011; Hurrell et al., 2013; Moss et al., 2008, 2010). CCSM4 was chosen because it provides consistent and moderate climate representation across various climate regions. CONUS projections used Localized Constructed Analogs (LOCA) CCSM4 data with a 6-km spatial resolution (Pierce, Cayan, & Thrasher, 2014).

For installations Outside of the Contiguous United States (OCONUS), climate data for 1975-2004 from the ½ degree global degree dataset provided by the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) at the Max Planck Institute for Meteorology (Hempel, Frieler, Warszawski, Schewe, & Piontek, 2013) was used for the 30-year historical period. OCONUS climate projections used data from the HadGEM2-ES dataset, also provided by the ISI-MIP project with a spatial resolution of 50-km.

For both CONUS and OCONUS installations, historical climate data were averaged over the 30-year historical period to establish a climatological baseline for each installation. This historical baseline was then used to develop a time series of daily data for the decades around 2030 and 2050. Historical climate data gathered for each installation included average daily temperature (°C), maximum daily temperature (°C), minimum daily temperature (°C), and daily precipitation (mm). Climate data were converted to °F and inches (i.e., English units) for analysis.

For each variable of interest, a daily anomaly was computed for each emission scenario (RCP 4.5 and RCP 8.5) for each day over both 10-year periods (2026-2035 and 2046-2055). Daily data were then averaged over the 10-year period for each variable and scenario to produce annual average temperature (TAVE), average annual maximum temperature (TMAX), average annual minimum temperature (TMIN), and average annual precipitation (PRECIP) estimated for 2030 and 2050.

Daily precipitation data were used to calculate baseline and design storms used in stream channel flood modeling, as applicable (Section A.2.1).

A.1.2 Generation of Climate Summaries

Two R packages were created and used to generate the climate summary. The DaymetLOCA package produced the site-bounded projected climate data. The ClimatePrimers package generated the climate summary document for each site. Figure A-1 below shows the general workflow.

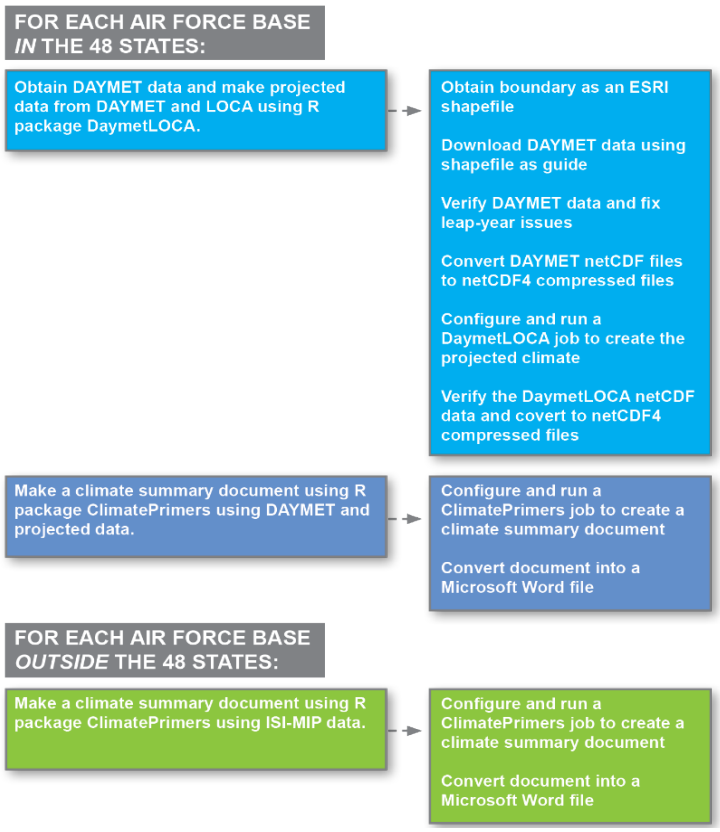

Figure A-1. Climate analysis workflow.

A.1.3 Walter & Lieth Climate Diagrams

The ClimatePrimers package in R also generated Walter & Lieth climate diagrams (Walter & Lieth, 1960), which display average monthly precipitation and temperature patterns throughout a year. The diagrams were developed by averaging temperature and precipitation data by month for each year of the 10-year period for each scenario. Resulting monthly values were then averaged across the 10-year period

to generate the Walter & Lieth climate diagrams. An annotated Walter & Leith diagram example is shown in Figure A-2.

The diagrams were developed using R functions derived from the "diagwl" function in the climatol R package (Climatol Climate Tools, n.d.). The original function was modified to display values in English units (°F and inches) for CONUS locations.

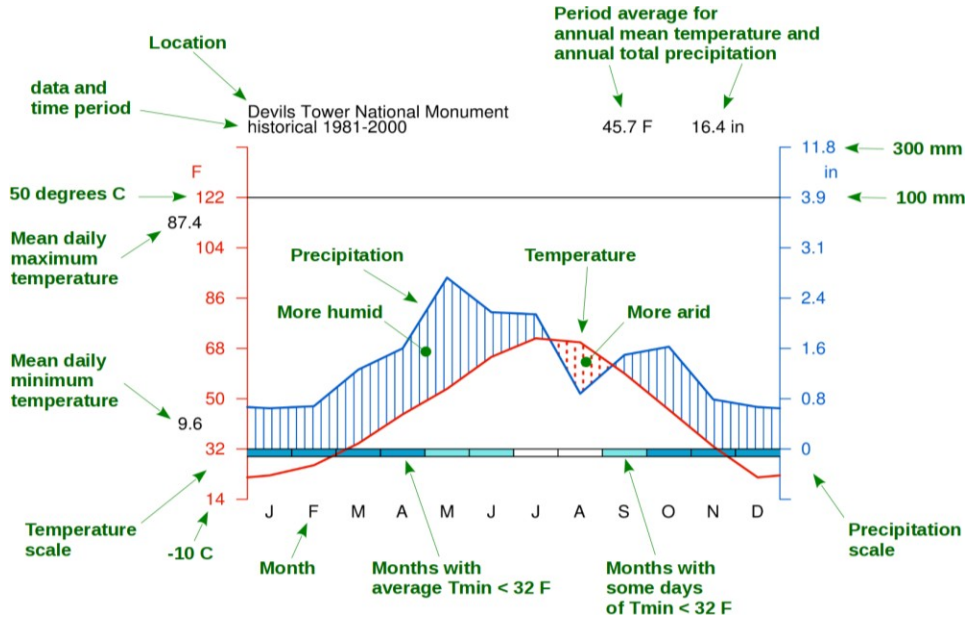

Figure A-2. Example Walter & Leith climate diagram.

A.2 Hydrology

Flooding associated with (1) precipitation induced stream channel overflow and (2) coastal sea level rise (SLR) and storm surges (SS) was assessed for USAF installations as applicable.

A.2.1 Stream Channel Modeling

Modeling of stream channel overflow (or flood modeling) was conducted using climate projection data for RCP 4.5 and RCP 8.5 emission scenarios in 2030 and 2050. The scope of flood modeling was limited to stream channel networks and did not consider flooding of independent surface bodies, stormwater systems, or surface ponding.

A.2.1.1 Design Storm Development

A design storm is a hypothetical storm used to design infrastructure, evaluate flood hazards, and/or inform land use planning and resource management. Daily precipitation data from 1996-2005 were used to estimate baseline design storms for the year 2000. Projected daily precipitation data from 2026-2035 and 2046-2055 were used to estimate design storms for emission scenarios in 2030 and 2050, respectively.

Projection methods did not allow for determination of design storm probability. Design storms were based ten years of data and therefore do not represent extreme weather events (e.g., hurricanes, extraordinary storm fronts) and are expected to be smaller than current 100-year storms.

Initially, each 10-year dataset was averaged, however it was determined that averaging daily precipitation data across a 10-year period resulted in decreased variance from day-to-day and, therefore, obscured potentially significant storm events. As a result, algorithms were developed to screen the raw data and identify the biggest three-day storm in each year (defined as the maximum annual precipitation over a three-day period where precipitation occurs each day). Daily totals were then averaged across the 10 selected storms (1 storm per year), omitting values below the 50th percentage. Three-day storm events were used as design storms for flood modeling because rainfall occurring over consecutive days can cause soil saturation, overland flow, and compounding runoff.

A design storm hyetograph was produced for each climate scenario representing simulated precipitation intensity over the 72-hour period. The National Oceanic and Atmospheric Administration (NOAA) Atlas 14 was used to develop the synthetic distribution for each design storm. The late-peaking storm distribution was selected for all installations.

A.2.1.2. Watershed Delineation

The watershed boundary was delineated for each drainage basin that was to be modeled. Most CONUS watersheds were delineated using the United States Geological Survey (USGS) online StreamStats application. If StreamStats watershed data were not available for CONUS locations, then Hydrologic Unit Code (HUC) shapefiles were accessed from the Natural Resources Conservation Service (NRCS) database. The watershed boundary was determined using the Digital Elevation Model (DEM), aerial imagery and/or a topographic map to establish the perimeter of area that would continuously contribute drainage to the installation.

For OCONUS locations, watersheds were delineated with the ArcHydro tools package in ArcGIS using available DEM. This tool uses a point shapefile (point of interest) and the DEM of the area to delineate the contributing runoff area upstream of the selected point. Alternatively, the Spatial Analyst toolbox called “Watershed” in ArcGIS could also be used to delineate the watershed using the DEM, point of interest, and flow direction raster.

A.2.1.3 Flood Modeling

U.S. Army Corps of Engineers’ (USACE) Hydrologic Engineering Center (HEC) Hydrologic Modeling System (HMS) software was used to simulate runoff and estimate discharge over the contributing watershed following design storms. HEC–River Analysis System (RAS) 2D software was used for hydraulic modeling to evaluate potential stream channel overflow at the installation. ESRI ArcGIS tools, such as ArcHydro, were used for preprocessing geospatial data used in hydrologic and hydraulic modeling. Figure A-3 shows the workflow for flood modeling.

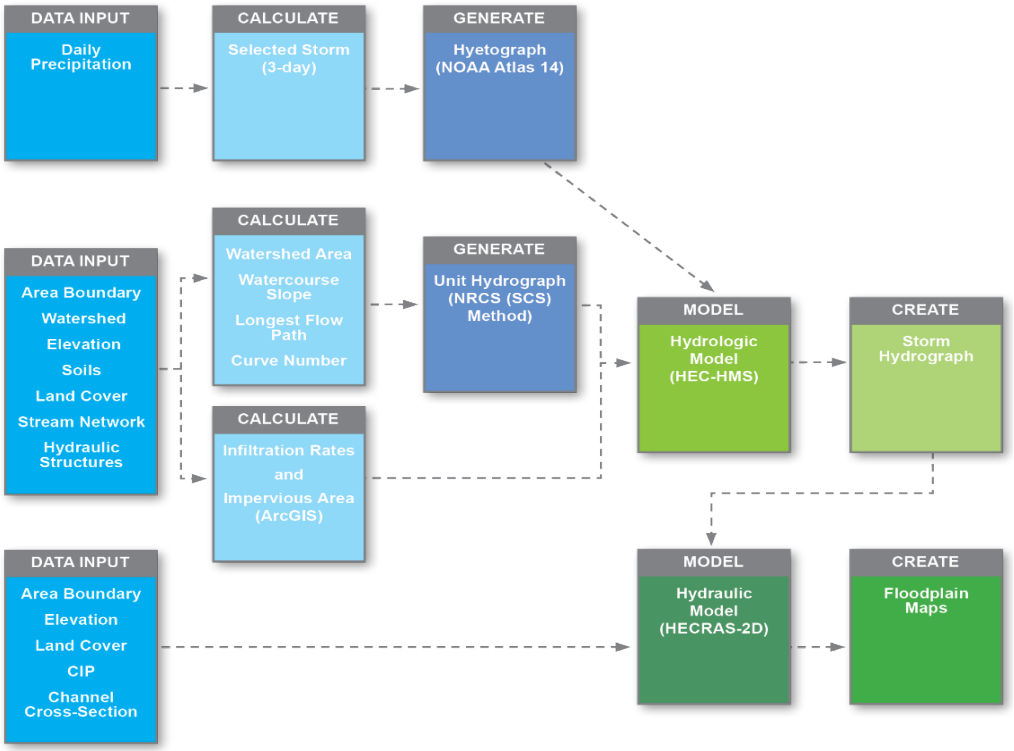

Figure A-3. Flood modeling workflow.

A.2.1.4 Hydrologic Modeling

A HEC-HMS hydrologic model was created for each watershed to represent how tributaries and sub-basins upstream of the installation are interconnected. Junctions were included where tributaries from sub-basins join a river or where two or more sub-basins drain. River routing was based on available data. Both the kinematic wave and lag routing methods were used to simulate flow.

The amount and timing of storm runoff also depends on physical characteristics of the watershed. A unit hydrograph characterizes how the watershed is expected to respond to a unit of rainfall. Unit hydrographs were developed according to the Soil Conservation Service (SCS), now the NRCS, method as described in the NRCS National Engineering Handbook (NRCS, 2009).

The SCS method requires the following parameters:

Watershed area (above the point where the hydrograph is to be developed)

Longest flow path using watershed and stream network data

Average watershed slope using elevation and watershed data

Curve Number (CN) determined from soils, land cover, and watershed data

Additional inputs into the model included land cover, soil type, depth to water table, and percent imperviousness. Infiltration losses were calculated using the initial and constant method. The NRCS National Engineering Handbook (NRCS, 2009) provides a range of infiltration rates for each type of soil

group according to water table depth. Soils data were used to determine infiltration rates for each portion of the land in the sub-basin. The constant infiltration rate was then calculated using a weighted area analysis. Impervious land area was calculated using land cover data. After identifying the imperviousness for each portion of the land in the sub-basin, the total percent imperviousness was calculated using a weighted area analysis.

When available, projected land cover data over the delineated watershed was used as a variable input for modeling future climate scenarios. MC2 data were available for most CONUS installations at a spatial resolution of 4-km. Other model parameters including soil type and impervious area were held constant in projection models. Land cover was held constant for OCONUS installations.

The HEC-HMS model generated a hydrograph for each design storm estimating discharge in cubic feet per second.

A.2.1.5 Hydraulic Modeling

A hydraulic model was used to simulate channelized flow and stream channel overflow at the installation. Inputs to the hydraulic model included hydrographs produced from hydrologic modeling, elevation data, land cover data, environmental data, and Common Installation Picture (CIP) data.

A 2D mesh digital representation of the channel and physical terrain adjacent to the channel. Elevation data was imported into the HEC-RAS 2D model to represent terrain and water surface elevations. If the channel bathymetry data was not captured within the elevation data, channel area was mapped and elevation within the channel was dropped to account for channel depth/capacity. Based on the spatial resolution, elevation data were further manipulated to account for hydraulic structures like culverts, bridges, and dams. Stream network data and road network data were imported into the model and assigned as breaklines. Breaklines stabilize the model by refining the cell sizes within the 2D mesh.

CIP data were imported into the model to assign buildings and structures as obstructions within the 2D mesh area. Land cover data were imported into the model and Manning's n roughness coefficients were assigned to each land cover classification (Table A-1). Roughness coefficients define the resistance for the terrain in the 2D flow area and have a large impact on the model results.

Once the 2D mesh was created, the boundary conditions were established at upstream (inflow) and downstream (outflow) ends of the channel. The inflow boundary condition was used to load the hydrologic information using the flow hydrograph. Since the flood modeling was conducted based on a projected three-day design storm, the inflow boundary conditions were set to unsteady flow data. The outflow boundary condition was used to define the outflow discharge information in the form of water surface elevation (typically set as 'normal' depth). The simulations were computed using full momentum equations for higher accuracy, compared to diffusion wave equations. A computational time interval of 6 seconds was used to generate stable results. Flood maps were created based on resulting inundation to display the spatial extent of projected inundation.

Table A-1. USACE recommended Manning's n roughness coefficients based on NLCD land cover type.

NLCD 'Code' 2011	NLCD 'Type' 2011	USACE 'n' 2016
11	Open Water	0.035
21	Developed, Open Space	0.040
22	Developed, Low Intensity	0.100
23	Developed, Medium Intensity	0.080
24	Developed, High Intensity	0.150
31	Barren Land Rock/Sand/Clay	0.040
41	Deciduous Forest	0.100
42	Evergreen Forest	0.120
43	Mixed Forest	0.080
52	Shrub/Scrub	0.080
71	Grassland/Herbaceous	0.045
81	Pasture/Hay	0.060
82	Cultivated Crops	0.060
90	Woody Wetlands	0.120
95	Emergent Herbaceous Wetlands	0.080

A.3 Ecosystems and the Biotic Environment

Literature review, available Geographic Information Systems (GIS) data and installation-provided descriptions, analysis and maps were used to assess baseline characteristics of ecosystems at the installation and create a baseline ecosystem feature map comprised of an ecosystem shapefile layer clipped to the installation's boundary.

Polygon layers containing land-cover, ecosystem, and wetlands data were drawn from the USAF AFCEC Environmental GIS Project. If the installation-specific data were provided to the USAF AFCEC Environmental GIS Project and/or uploaded into GeoBase, they were used. If installation-specific data was not available, public sources were used as an alternative. Online sources included the USGS GAP-Analysis Project, the Multi-Resolution Land Characteristics (MRLC) Consortium's NLCD, and the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory dataset.

A.3.1 Ecosystem Classification

The ecosystem classification follows the National Hierarchical Framework of Ecological Units or Bailey's Ecoregions (Bailey, 2014), which is a regionalization that links soils, physiography, and ecosystem types to stratify the landscape into progressively smaller areas. This classification is unlikely to be drastically modified under the climate change scenarios evaluated. Therefore, analysis focused on those ecosystems and vegetation types deemed vulnerable to the RCP 4.5 and RCP 8.5 climate change scenarios.

A.3.2 Vulnerability

Potential impacts of a moderate emission scenario (RCP 4.5) and a high emission scenario (RCP 8.5) on ecosystems under climate data from a decadal time series around 2030 (2026-2035) and 2050 (2046-2055), were evaluated using the framework developed by Comer et.al. (2012) for the Habitat Climate Change Vulnerability Index (HCCVI).

This index uses a two-dimension analysis of climate change sensitivity and ecological resilience for each ecosystem type distribution within a given ecoregion, using combined quantitative and qualitative approaches. Quantitative estimates for sensitivity to climate change included climate projections for the

decadal averages studied (climate induced stress), land cover condition (historic and projected) and flooding analysis, which were normalized to 0.0–1.0 scores.

Analysis of downscaled global climate forecasts for temperature and precipitation variables provided an indication of the relative intensity of climate-induced stress. Climate projection models were used to correlate and map current ecosystem distributions with a suite of key climate variables from a 1980 baseline. Then, the location of that same climate projection as predicted for 2030 and 2050, provided an indication of the directionality, magnitude, and overlap of geographic shift for species from the community and ecosystem. Finally, where available, models of hydrologic regime were used to forecast trends in the alteration or 'departure' from expected conditions for upland vs. riparian/aquatic communities, respectively.

Qualitative resilience categorizations used in this vulnerability assessment of the ecosystems at the installation were based on the following criteria:

Review of the ecological characteristics of each type of ecosystem/land or vegetation cover/ecosystem present at the installation;

Assessment of the adaptive capacity of each ecosystem/land or vegetation cover/ecosystem based on published scientific research.

The scores for sensitivity and resilience were combined to determine the categorical estimate of climate change vulnerability by the years 2030 and 2050 for each ecosystem type.

For the HCCVI, climate-change vulnerability was expressed in three categories: high, moderate, and low. Therefore, the index ratings are quite general, but this is because predictive uncertainty is often high, and the overall intent is a generalized indication of vulnerability. This is analogous to a scoring of "endangered" or "threatened" for a given species, but here focused specifically on climate change vulnerability, and applied to community and ecosystem types. A general framework of the concepts evaluated for each vulnerable ecosystem is shown in Figure A-4.

Once vulnerable ecosystems were identified, baseline and inundation maps, ecosystem maps and area tables were generated to reflect the current coverage of vulnerable ecosystems at the installation. Flooding (flood inundation) and/or SLR and SS projections based on the analysis provided by climate and hydrology models were also overlaid with ecosystem data to assess potential impacts.

Maps were created from the series of layered maps depicting the flood inundation shapefiles overlaid on the baseline ecosystem layer to show the extent of the projected inundation due to flooding. The maps provide a visual comparison of the projected inundation with the baseline inundation due to flooding. Four maps were created, one for each projected scenario. The baseline ecosystem is also presented to show possible affected ecosystems and the extent of the inundation relative to the different ecosystem classes.

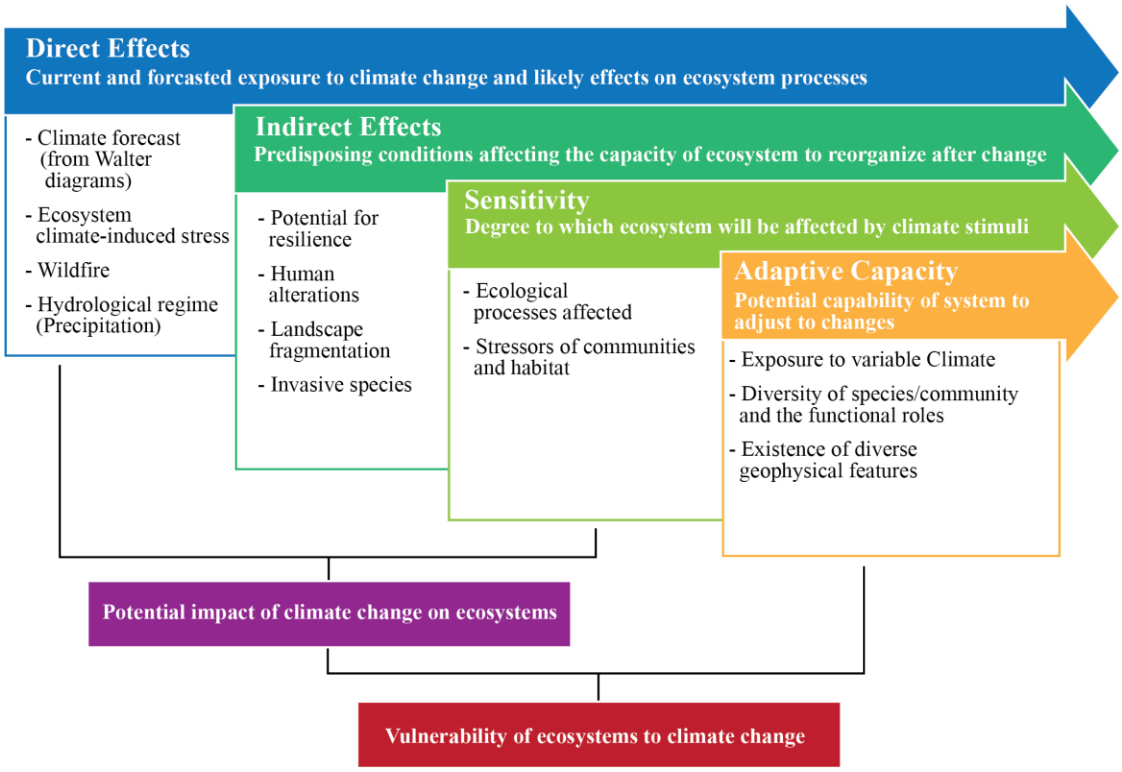

Figure A-4. Framework used to evaluate direct and indirect effects, sensitivity, and adaptive capacity of vulnerable ecosystems.

The SLR and SS inundation layers for each scenario were overlaid on the baseline ecosystem layer to visually depict potential areas of concern for each projected scenario. Each map features the inundation layers for the 4.5 RCP and 8.5 RCP scenarios, and they are organized by the projected model year. The area of inundation for flooding was also compared to the MC2 projected ecosystem scenarios (when available). If the inundation shapefiles covered an area where the MC2 ecosystem type changed from the baseline to one of the projected model years, the area and percent coverage were calculated. Finally, the flood and SLR and SS area tables compare the area of each inundation shapefile to the total area of the installation boundary. The percentage of coverage was calculated to quantify the extent of each inundation layer and to see what percentage of the installation was affected. The change in percentage from one inundation scenario to the next was also included to show whether the area of inundation was increasing or decreasing, compared to the baseline projection.

A.3.3 Fish and Wildlife

Fish and wildlife assessments use climate projections, as well as information related to climate and fish and wildlife species derived from the installation's INRMP. Important variables used in the analysis to determine impacts of climate change on fish and wildlife species include average monthly temperatures, monthly precipitation, and intensity/frequency of storm events, changes in vegetation, projected fire behavior and maps depicting habitat loss through inundation. With this information, qualitative analysis was done to address potential direct and indirect effects of vulnerable fish and wildlife populations. One example of a direct effect would be displacement of a terrestrial species due to habitat inundation. An example of an indirect effect would be increasing temperature causing algal blooms in benthic habitats leading to depletion of dissolved oxygen and displacement of aquatic organisms.

A.4 Mission Impacts on Natural Resources

A.4.1 Natural Resource Constraints to Mission and Mission Planning

The qualitative assessment of climate change impacts to the military mission closely follows the framework of Army Techniques Publication ATP 2-01/MCRP 2-3A, Intelligence Preparation of the Battlefield (IPB) (United States Army, 2014). The basics of this framework are general enough to be used to analyze mission requirements for any military branch and have been done so using Air Force documents related to the branch's specific mission requirements. IPB is a four-step process used by the U.S. Army (and Marine Corps) to provide a "systematic, continuous process of analyzing the threat and environment in a specific geographic area." (United States Army, 2014). Although this framework is designed for continual feedback over a long period, it was used here to assess impacts for multiple emission climate scenarios and time frames.

The four-step IPB process as applied to the mission impact analysis was tailored to Air Force mission types (primarily the 12 Air Force Core Functions), the biological and physical environment of each installation, and the potential primary and secondary effects of climate change on these operational environments and environmental features.

Describe the Operational Environment. This step collects all available data and information including but not limited to: geographical and climatic area of interest (AOI), mission types conducted within the AOI, habitat and vegetation types within the AOI, mission related infrastructure (including ranges, training areas, buildings, roads, and any other infrastructure relevant to the military mission), and the results of the climate and hydrologic analyses described in section 1.1. Sources include GIS layers, results of all other analyses used for the INRMP climate assessment, INRMPs, as well as Air Force mission related documents such as Installation Complex Encroachment Management Plans (ICEMAP), Air Force Doctrine Documents (AFDD) and Command Strategic Plans.

Describe Environmental Effects on Operations. Data and information from Step 1 were synthesized to define any spatiotemporal overlap between climate change effects on environmental exposures (e.g., wind, heat, sea level rise, flooding), military operations required to complete the mission, and environmental conditions required for these critical military operations.

Evaluate the Threat. A qualitative judgment was made as to the extent and severity of any of the overlaps identified in Step 2. Climate change related threats were deemed as low, moderate, or high risk depending on the predicted or inferred level of impact. This level of impact is contingent on factors such as importance to the mission, possibility of partial or full attainment of the mission with workarounds, and redundancy (such as multiple locations capable of fulfilling mission requirements or alternate routes available for personnel and equipment movement).

Determine Threat Courses of Action. This step was not conducted in the mission impacts assessment, although it is at least partially fulfilled by considering adaptation strategies within the INRMP climate change assessment

***A.5** Fish and Wildlife Management*

Fish and wildlife management is based on climate projections and vulnerabilities of fish and wildlife species. The framework for adaptation strategies is shown in Figure A-6 (Comer et al., 2012). Ideally, natural adaptation methods that provide multiple benefits to ecosystems would be implemented. In some cases, there are no feasible adaptation strategies available to combat effects of climate change, such as

loss of alpine tundra due to rising temperatures. Adaptation strategies to prevent loss of fish and wildlife species indicated as important or vulnerable in the installations INRMP are provided in a qualitative format.

A.6 Outdoor Recreation and Public Access to Natural Resources

Impacts of climate change on outdoor recreation and public access to natural areas are based on current recreational demands and opportunities listed in INRMPs and climate projections provided though this project. Qualitative analysis was done using data that included average monthly temperatures, monthly precipitation, and intensity/frequency of storm events, changes in vegetation, projected fire behavior and maps depicting habitat loss through inundation. In some cases, future climate should have little to no effect on recreational opportunities and no changes in management are deemed necessary. In other cases, recreational access will need to be limited in vulnerable habitat types to limit competition between habitat needs of fish and wildlife. Such cases often involve sandy shorelines at risk of complete deterioration through sea level rise and increasing storm intensity/frequency where requirements for restoration (beach nourishment and stabilization) are in conflict with intensive recreational use. Occasionally recreational use can be of benefit to natural resources management. For example, providing increased hunting is a cost-effective tool in managing invasive species, but will need to be balanced against constraints. Ideally qualitative analysis is conducted to determine land management practices which leave intact recreational opportunities highlighted in INRMP Section 7.2 Outdoor Recreation and Public Access to Natural Areas.

A.7 Management of Threatened and Endangered Species, Species of Concern and Habitats

Species-specific management actions directed at climate-related vulnerabilities are not recommended. Ecosystem-based, adaptive management approaches that are currently employed in the INRMP are a good foundation for building climate adaptation strategies to protect at-risk species. Climate change consideration should be included in all steps of the adaptive management process (Figure A-5).

Figure A-5. Adaptation process from America's Climate Choices (Bierbaum et al., 2013).

Adaptation management actions can be forward-looking (proactive/prospective) or reactive (retrospective). Appropriate actions are site-specific and based on the species' needs in the context of the Altus AFB mission. Figure A-6 depicts examples of each type of adaptation strategy (Comer et al., 2012).

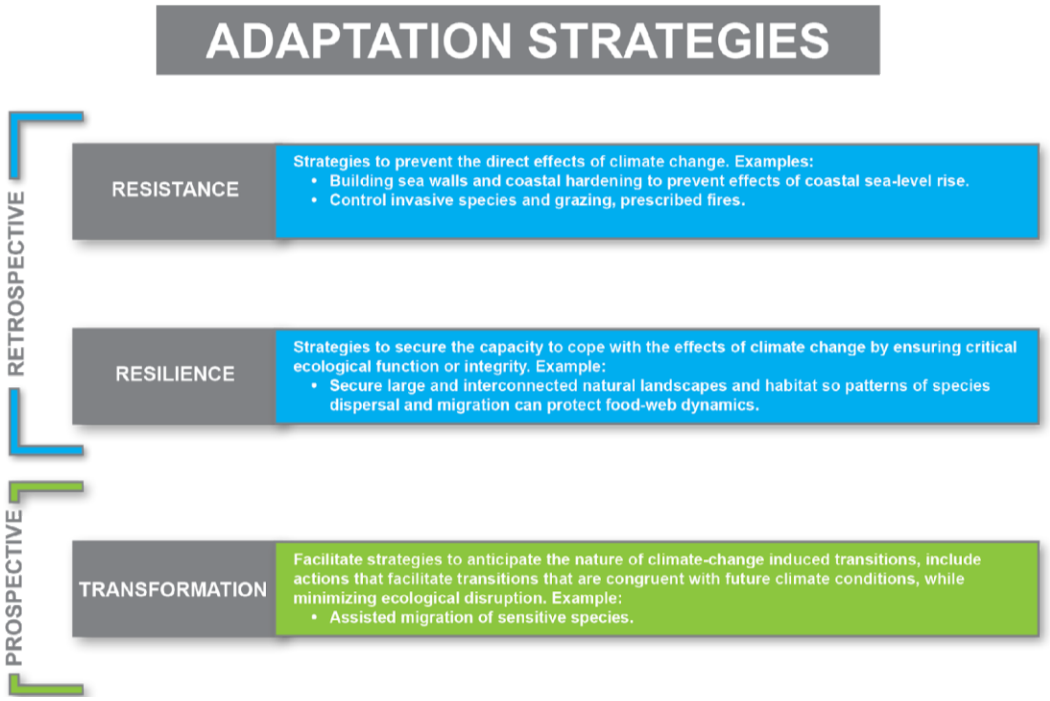

Figure A-6. Adaptation strategy framework.

A.8 Wildland Fire Management

The effect of future climate scenarios on wildland fire hazard was determined by considering each variable contributing to wildfire potential and evaluating its likelihood to worsen, improve, or remain unchanged and the magnitude of any change. Table A-2 shows the primary components of fire hazard, the metrics that comprise each, and the relevant indicators and measures from the projected climate scenarios evaluated. These factors were subjectively analyzed by subject matter experts. Sufficient data to produce a quantitative analysis is not currently available.

Many indicators of ignition and wildfire potential were not fully addressed because they are not available at the spatial or temporal resolution necessary for analysis, are beyond the scope of this study, cannot reasonably be estimated into the future, or are not expected to change. These variables are outlined in the table as well, but are assumed to remain equivalent to current day conditions.

Table A-2. Metrics of fire hazard, their indicators and measures, and whether they were considered in the analysis.

Fire Hazard Component	Metrics	Indicators and Measures	Considered in Analysis
Ignition Probability	Ignition Success	Temperature	Yes
		Precipitation Patterns	Yes

		Vegetation Communities	Yes
		Fuel Physical Characteristics	No
		Fuel Chemical Characteristics	No
		Shading	No
		Time of Day	No
		Aspect, Slope, Elevation	No
	Ignition Load	Human Activity (military and civilian)	No
		Lightning	No
Fire Behavior	Fuels	Temperature	Yes
		Fuel Load	Yes
		Vegetation Communities	Yes
		Fuelbed Physical Characteristics	No
		Fuel Chemical Characteristics	No
	Weather	Temperature	Yes
		Precipitation Patterns	Yes
		Wind	No
	Topography	Slope	No
		Aspect	No

A.9 Data Sources and Literature

A.9.1 Data Sources

A.9.1.1 LOCA Projected Date

LOCA projected data was downloaded from Lawrence Livermore National Laboratory FTP site.

ftp://gdo-dcp.ucllnl.org/pub/dcp/archive/cmip5/loca/LOCA_2016-04-02/CCSM4/16th/

Information on LOCA data can be found at: http://loca.ucsd.edu/

Coverage Area: CONUS data for CCSM4 for these years:

Historical=1950-2005

RCP4.5/8.5=2006-2100

Climate variables: TMIN, TMAX, PRECIP

Resolution: Temporal=Daily, Spatial=1/16th degree (~6km)

A.9.1.2 DAYMET Historical Data

Archived and distributed through the Oak Ridge National Laboratory, the DAYMET data set provides gridded estimates of daily weather parameters for North America.

Data was downloaded from: https://daymet.ornl.gov/

Coverage Area: CONUS plus parts of Canada and Mexico for these years: 1980 to Most Current Year (2016)

Climate variables: TMIN, TMAX, PRECIP

Resolution: Temporal=Daily, Spatial=1km

A.9.1.3 Hydrologic Data Information

Geospatial data used in flood modeling were acquired from the USAF AFCEC Environmental GIS Project and various national and international open source GIS data repositories including:

Elevation Data: USAF GeoBase, United States Department of Agriculture (USDA), USGS, NOAA, ArcOnline and other state/county/city data repositories

Land Cover Data: USAF AFCEC Environmental GIS Project; National Land Cover Database (NLCD); Dynamic Global Vegetation Model (MC2); and other state/county/city data repositories

Soils Data: USGS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) and other state/county/city data repositories

Watershed Boundaries: USGS HUC boundaries, USGS StreamStats and ArcHydro Tools

Stream Network: National Hydrography Dataset (NHD), USAF GeoBase

Common Installation Picture (CIP) Data: USAF GeoBase

Environmental Data: USAF AFCEC Environmental GIS Project

Data collected from open source databases generally required processing before it could be used in modeling. Varying spatial resolution, extent, quality of data and attributes as well as varying data formats were reconciled prior to use. ESRI's ArcGIS tools including ArcHydro were used for processing geo-spatial data.

Hyetographs NOAA Atlas 14 online tool: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

StreamStats: https://water.usgs.gov/osw/streamstats/

A.9.2 Literature

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Appendix C. Climate Analysis Results

TABLE OF CONTENTS

TABLES

FIGURES

ACRONYMS

AFB	Air Force Base
CCSM	Community Climate System Model
IPCC	Intergovernmental Panel on Climate Change
ISI-MIP	Inter-Sectoral Impact Model Intercomparison Project
NCAR	National Center for Atmospheric Research
PRECIP	Average annual precipitation
RCP	Representative Concentration Pathway
TAVE	Annual average temperature
TMAX	Annual average maximum temperature
TMIN	Annual average minimum temperature

B.1 CLIMATE ANALYSIS

The climate associated with Altus AFB is consistent with what is referred to as a humid subtropical climate bordering on a semi-arid climate (Köppen, 1884). It is characterized by extremely hot summers and generally cool, dryer winters. The average annual temperature is 62.2 ºF (16.8 °C) and annual precipitation of 28.9 inches (734mm) per year occurs in higher amounts in summer months.

The climate projections for Altus AFB represent a moderate emission scenario (RCP 4.5) and a high emission scenario (RCP 8.5) based on National Center for Atmospheric Research (NCAR) Community Climate System Model (CCSM) prepared for the IPCC-AR5 (Gent & Danabasoglu, 2011; Hurrell et al., 2013; Moss et al., 2008, 2010). Climate projections do not predict extreme weather events, which are short-term events that are significantly different from the usual weather pattern (hurricanes, flash floods, heat waves). Climate describes trends in temperature and precipitation over a long period of time (usually thirty years) for a given location.

Climate information for historical data are downscaled to approximately 1 km grid resolution and provide daily climate information from 1900 to 2009. Climate model simulations were downscaled to 6 km grid resolution and data from 2026 to 2035 were extracted to represent the decadal average for 2030 and extracted data from 2046 to 2055 represent the decadal average for 2050.

Climate projections (Table B-1) indicate that minimum and maximum temperatures will increase over time under both emissions scenarios. For the decade centered around 2030, both scenarios project a similar degree of increase in average annual temperature (TAVE) of between 2.7 °F (1.5 °C) and 3.9 °F (2.1 °C) over the historic average. The two emission scenario projections show higher warming by 2050, with RCP 4.5 expressing a warming of 3.6 °F (2.0 °C). RCP 8.5 expresses a slightly greater warming of 5.5 °F (3.1 °C) for this period.

Average annual precipitation (PRECIP) varies between emission scenarios and over time due to larger interconnected ocean-atmosphere dynamics associated with the NCAR CCSM model. For 2030, RCP 4.5 projects a 14% increase in PRECIP while RCP 8.5 shows a small increase of 2%. For 2050, RCP 4.5 projects a 13% increase in PRECIP, while RCP 8.5 shows an increase of 10% from the historic average.

Table B-1. Summary climate data.

Variable	Historical	RCP 4.5		RCP 8.5	
		2030	2050	2030	2050
PRECIP (inches)	28.9	33.0	32.7	29.6	31.7
TMIN (°F)	49.2	51.9	52.5	53.1	54.4
TMAX (°F)	75.1	77.9	79.2	79.1	80.9
TAVE (°F)	62.2	64.9	65.8	66.1	67.7
GDD (°F)	5729	6362	6511	6578	6872
HOTDAYS	93.9	118.9	123.1	127.7	137.1
WETDAYS	1.3	0.3	1.0	0.5	0.8
Notes: TAVE °F = annual average temperature; TMAX °F = annual average maximum temperature; TMIN °F = annual average minimum temperatures; PRECIP (inches) = average annual precipitation; GDD °F = Average annual accumulated growing degree days with a base temperature of 50 °F; HOTDAYS (average # of days per year) = average number of hot days exceeding 90 °F; WETDAYS (average # of days per year) = annual number of days with precipitation exceeding 2 inches in a day.					

B.1.1 Temperature and Precipitation

Monthly climate analysis comparing historical averages with changes in each scenario is provided in Figure 0-7 through Figure 0-10. The historical time period represents a 30-year historical base period. The projected time periods represent decadal averages centered around 2030 (i.e., 2026-2035) and 2050 (i.e., 2046-2055).

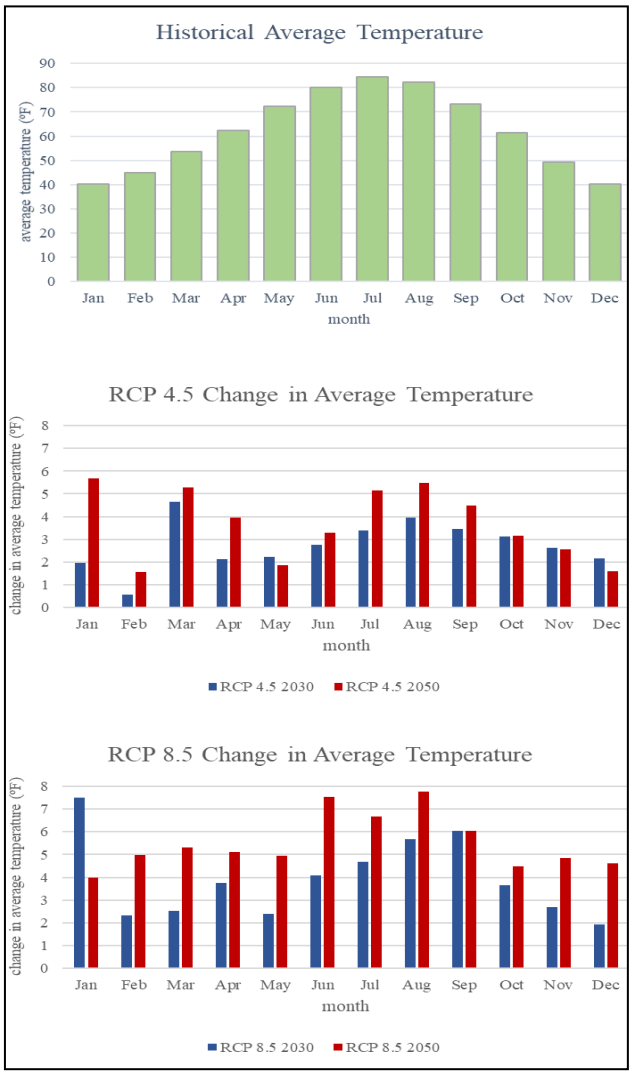

Figure B-1. Monthly average temperature.

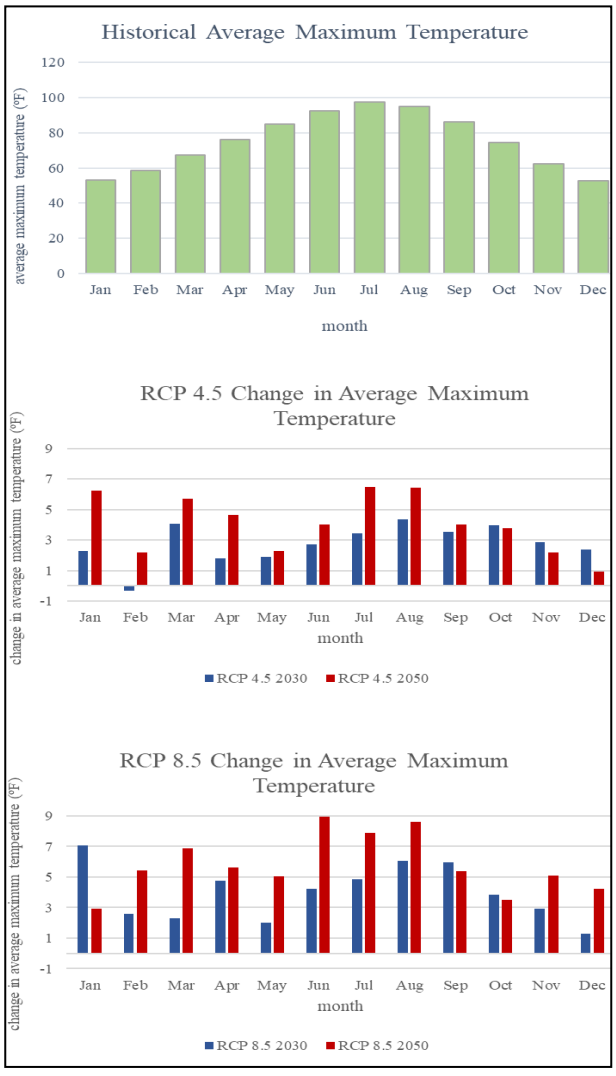

Figure B-2. Monthly average maximum temperatures.

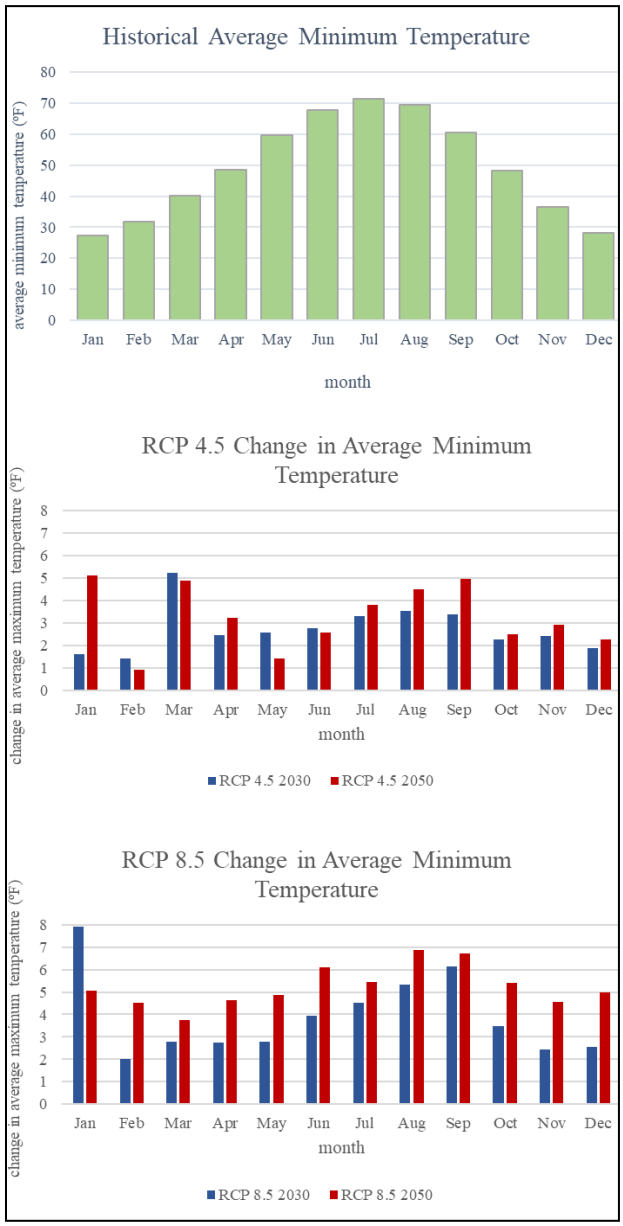

Figure B-3. Monthly average minimum temperatures.

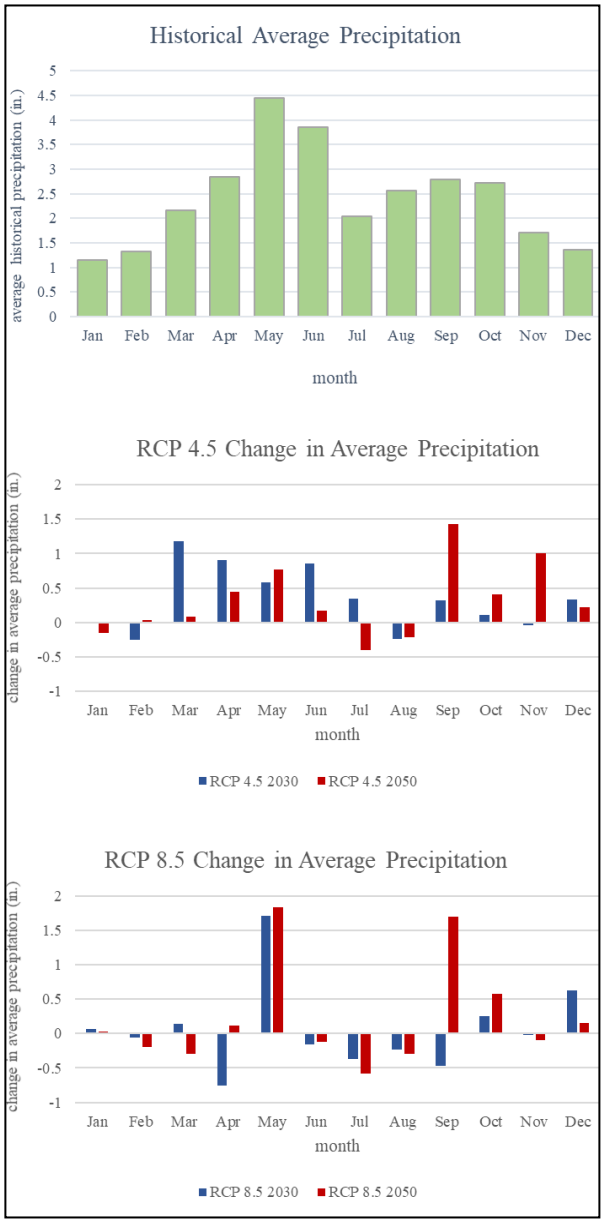

Figure B-4. Monthly average precipitation.

Walter and Lieth climate diagrams (Walter & Lieth, 1960) showing monthly temperatures overlaid with precipitation are shown for historical data and each projected scenario in Figures B-5 through B-8 and Lieth climate diagrams show precipitation and temperature interactions for the year modeled. The red line displays monthly temperature averages (degrees Fahrenheit) measured on the left axis. The blue line shows precipitation (inches) measured on the right axis. The bar along the x-axis defines predicted months with likely (dark blue) or possible (light blue) frost. Values at the top of the panel are mean annual temperature and mean total precipitation. Black numbers beside the axis are the mean maximum and mean minimum temperature of the warmest and coldest months, respectively. The diagrams show

seasonal changes in precipitation and temperature that may impact survival of flora and fauna on the installation.

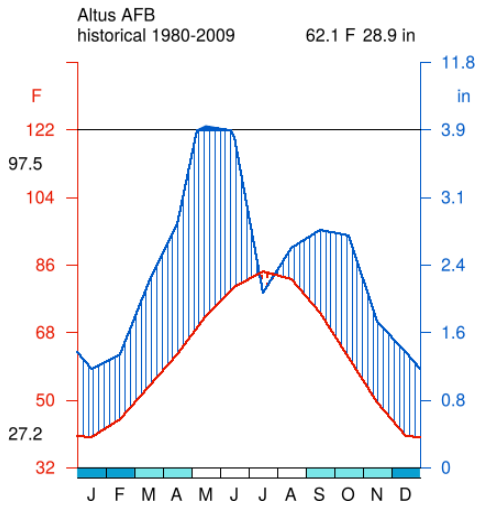

Figure B-5. Walter and Lieth climate diagram over the 30-year historical period.

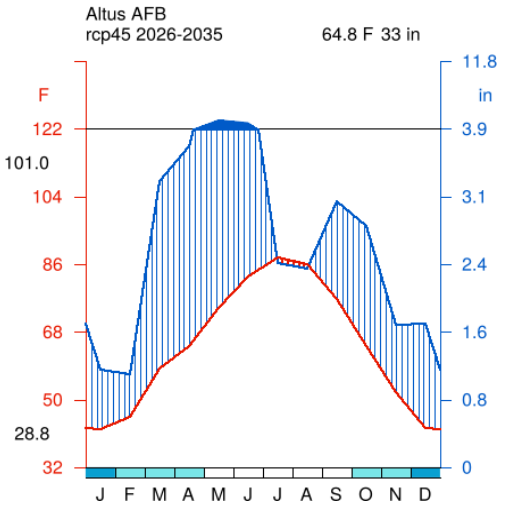

Figure B-6. Walter and Lieth climate diagram for the RCP 4.5 2030 scenario.

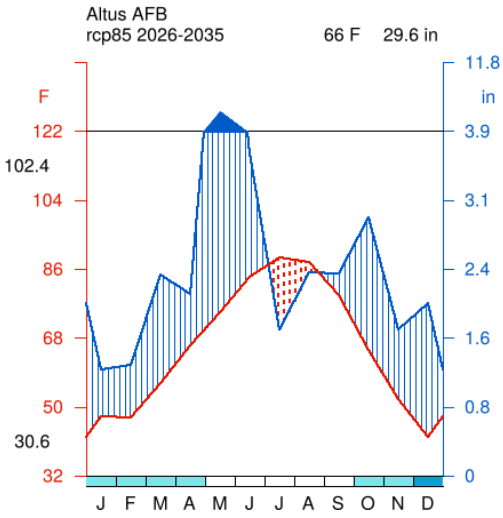

Figure B-7. Walter and Lieth climate diagram for the RCP 8.5 2030 scenario.

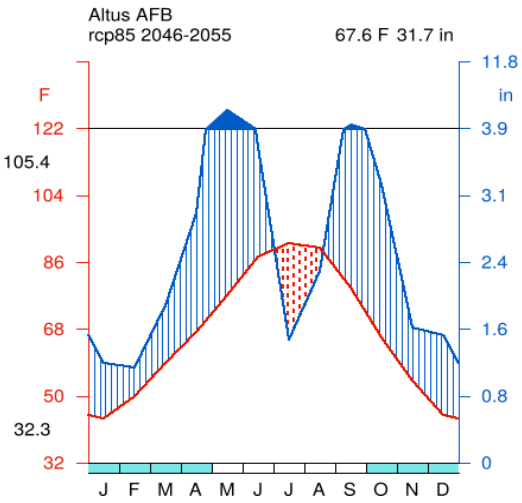

Figure B-8. Walter and Lieth climate diagram for the RCP 8.5 2050 scenario.

B.2. CLIMATE DISCUSSION

Temperature and precipitation changes under a single emissions scenario are not linear. In other words, the trends projected in the 2050 timeframe are not simple more extreme versions of the changes projected for 2030. The projections for RCP 4.5 are not simply a less intense pattern than RCP 8.5.

Although PRECIP increases in all scenarios, these increases are associated with decreasing Wetdays. This suggests more frequent, but slightly smaller rain events. Increase in precipitation will be attenuated by accompanying increases in temperature, which results in increase evapotranspiration. As a result of changing precipitation and temperature patterns, a summer arid season could become more severe.

Temperature increases do not happen uniformly throughout the year under either emissions scenario. While the increases are generally greater for the 2050 timeframe, temperature in May, November, and December under the RCP 4.5 2030 is greater than that projected for the RCP 4.5 2050 scenario. This is also the case in the RCP 8.5 scenarios, where January and September in the 2030 timeframe are projected to be warmer than the 2050 timeframe. The greatest temperature increases are expected to occur during the months of June through September, which have historically been hottest. The trend of increasing TAVE and PRECIP will ultimately result in less freeze thaw days, dry days and cold days, more growing degree days and hot days.

The humid subtropical climate that observes extremely hot summers and generally cool, dry winters will transition towards a semi-arid climate with warmer winters and hotter summers. The system-wide impacts of these changes is highly dependent on the ability of the flora and fauna to adapt to changing seasons, temperate extremes and more rapid temperature variation.

B.3.1. ABOUT THE CLIMATE DATA

The climate data sources as well as the North Central Climate Adaptation Science Center should be cited or acknowledged in any publications using these graphics.

B.3.1. ISI-MIP

Historical data used is the historical ½ degree global dataset provided by the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) at the Max Planck Institute for Meteorology (Hempel, Frieler, Warszawski, Schewe, & Piontek, 2013). Climate projections used data from HadGEM2-ES dataset, also provided by the ISI-MIP project. The temporal frequency of data records is daily. The time origin is 1860-1-1 00:00:00 UTC and the time increment is days. Dataset variables are maximum temperature = ‘TMAX’; minimum temperature = ‘TMIN’; average annual precipitation = ‘PRECIP’.

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Appendix D. Hydrology Results

TABLE OF CONTENTS

TABLES

FIGURES

ACRONYMS

AFB	Air Force Base
NOAA	National Oceanic and Atmospheric Administration
RCP	Representative Concentration Pathway

C.1. STREAM CHANNEL MODELING

Modeling of stream channel overflow (or flood modeling) was conducted for Altus Air Force Base (AFB) using climate projection data for Representative Concentration Pathway (RCP) 4.5 and RCP 8.5 emission scenarios in 2030 and 2050. The scope of flood modeling was limited to stream channel networks and did not consider flooding of independent surface bodies, stormwater systems, or surface ponding.

C.1.1. Design Storms

A design storm is a hypothetical storm used to design infrastructure, evaluate flood hazards, and/or inform land use planning and resource management. Climate projections were used to estimate design storms for the projected climate scenarios (Table C-1). Three-day storm events were used as design storms because rainfall occurring over consecutive days can cause soil saturation, overland flow, and compounding runoff, which may result in flooding. The National Oceanic and Atmospheric Administration (NOAA) Atlas 14 was used to develop a synthetic distribution (hyetograph) for each design storm to use in flood modeling (Figure C-). Design storms were based on annual events selected from ten years of data and therefore do not represent extreme weather events (e.g., hurricanes, extraordinary storm fronts) and are expected to be smaller than current 100-year storms.

Table C-1. Design storm precipitation.

Design Storm		Baseline	RCP 4.5		RCP 8.5	
		2000	2030	2050	2030	2050
Precipitation (inches)	Day 1	1.1	1.6	1.7	1.2	1.5
	Day 2	2.2	2.1	2.5	2.2	2.4
	Day 3	1.9	1.1	1.9	0.9	1.4
	Total	5.2	4.8	6.1	4.3	5.3
Percent change from baseline			-8%	17%	-17%	2%

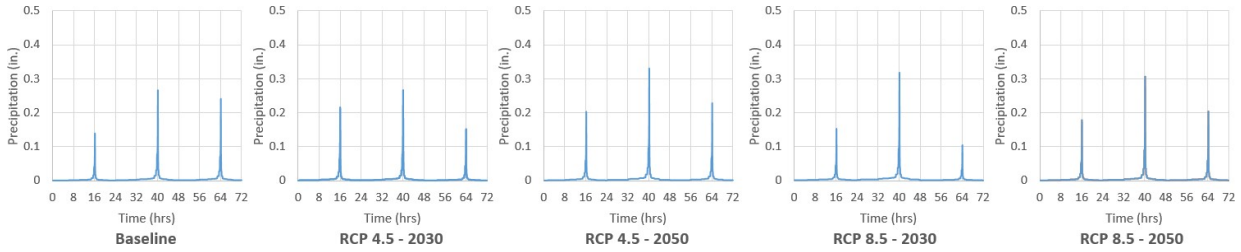

Figure C-1. Design storm hyetographs.

C.1.2. Flood Modeling

Design storms were used to model flooding along Stinking Creek (east) and an unnamed tributary of Stinking Creek (west). The amount and timing of storm runoff depends on physical characteristics of the watershed including soil type, water table depth, land cover, topography, and channel characteristics. These variables were incorporated into a hydrologic model to simulate discharge following the projected storm events for each watershed (Figure C-2 and Figure C-).

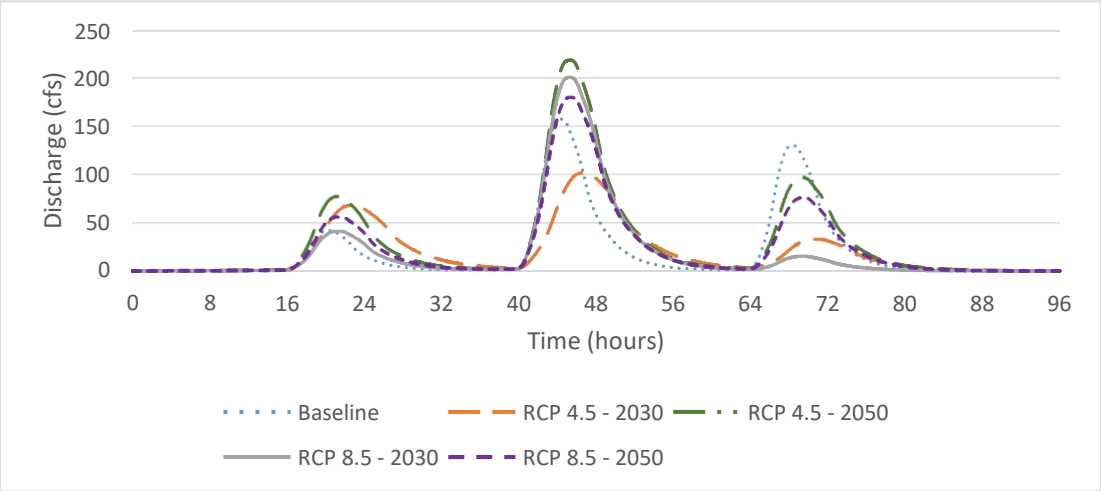

Figure C-2. Hydrographs for Stinking Creek (east).

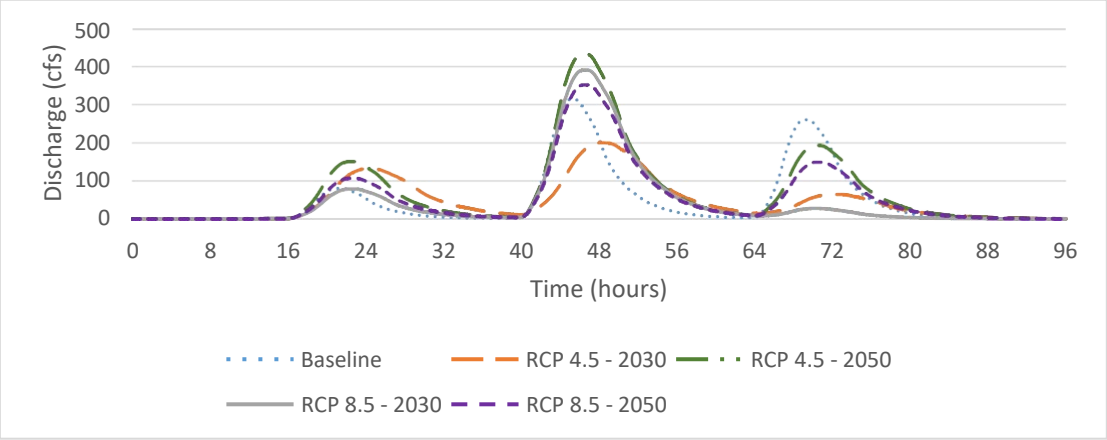

Figure C-3. Hydrographs for unnamed tributary of Stinking Creek (west).

Storm hydrographs (Figure C-2 and Figure C-3), land cover data, environmental data, and elevation data were input into a hydraulic model to estimate inundation from stream channel overflow. Table C-2 summarizes projected inundation by area and percent change from baseline.

Inundation projections were influenced by four variable inputs: (1) variation in total precipitation between design storms, (2) variation between the daily distribution of precipitation over the three-day period, (3)

land cover change over the watershed area used in hydrologic modeling, and (4) land cover change in the area within the installation used in hydraulic modeling.

Within the hydrologic model, projected land cover type (variable input) intersected with soils (constant between scenarios) and depth to water table (constant between scenarios) to estimate friction, infiltration rate, and runoff rate, thus contributing to variability in results between scenarios. The variability in the results is then compounded because projected change in land cover within the hydraulic model (installation area modeled) dictates the roughness coefficient (the path the water will take) which also has an effect on inundation.

Total design storm precipitation is projected to decrease in 2030 and increase in 2050 (Table C-1). Stream channel overflow is projected to increase by between 5% (RCP 8.5 in 2050) and 17% (RCP 4.5 in 2050) (Table C-2). Flooding is projected to decrease by 24% under the RCP 4.5 emission scenario in 2030, despite total design storm precipitation decreasing by 8% (Table C-2). Projected land cover over the modeled watersheds was unique for this scenario having primarily grassland cover, compared to shrubland and forested vegetation, which were dominant in the other scenarios. Figure C-4 through C-8 show the spatial extent of projected inundation for all climate scenarios.

Table C-2. Area inundated by stream channel overflow at Altus AFB.

	Baseline	RCP 4.5		RCP 8.5	
	2000	2030	2050	2030	2050
Projected inundation (acres)	169	128.8	197.4	186.5	176.8
Change in inundation area from baseline (acres)		-40.2	28.4	17.5	7.7
Percent change from baseline		-24%	17%	10%	5%

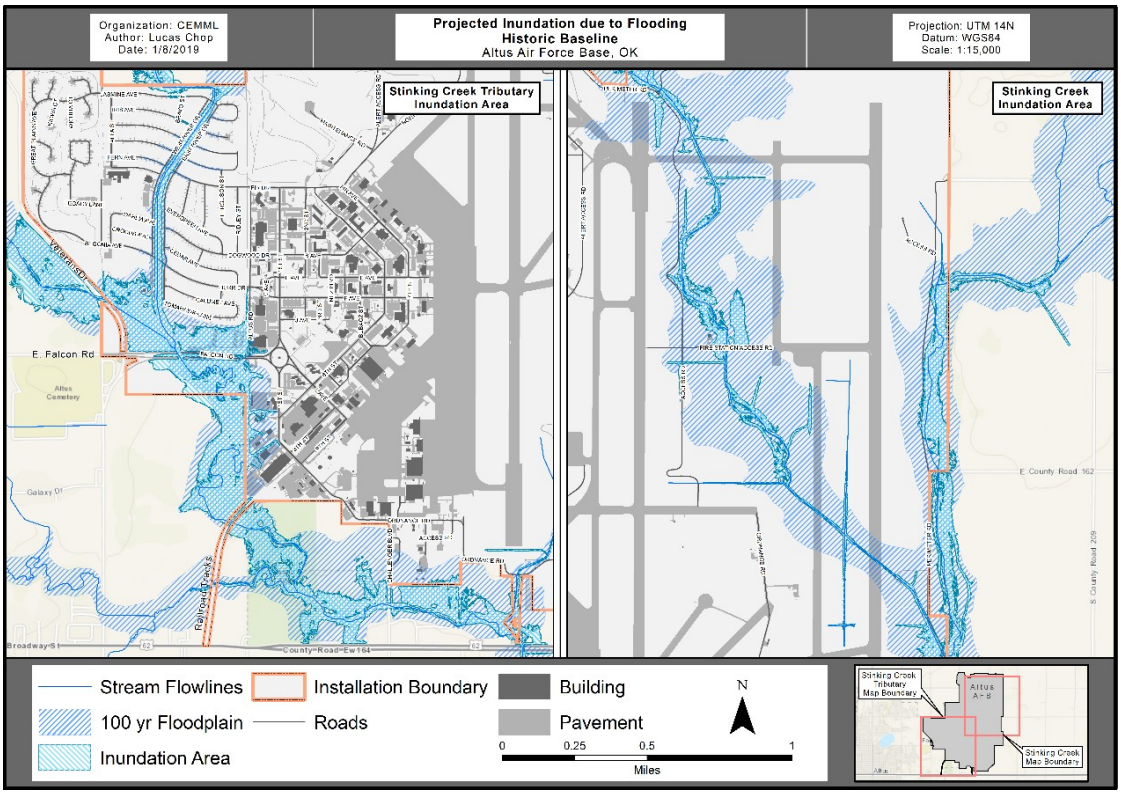

Figure C-4. Stream channel overflow for the baseline design storm.

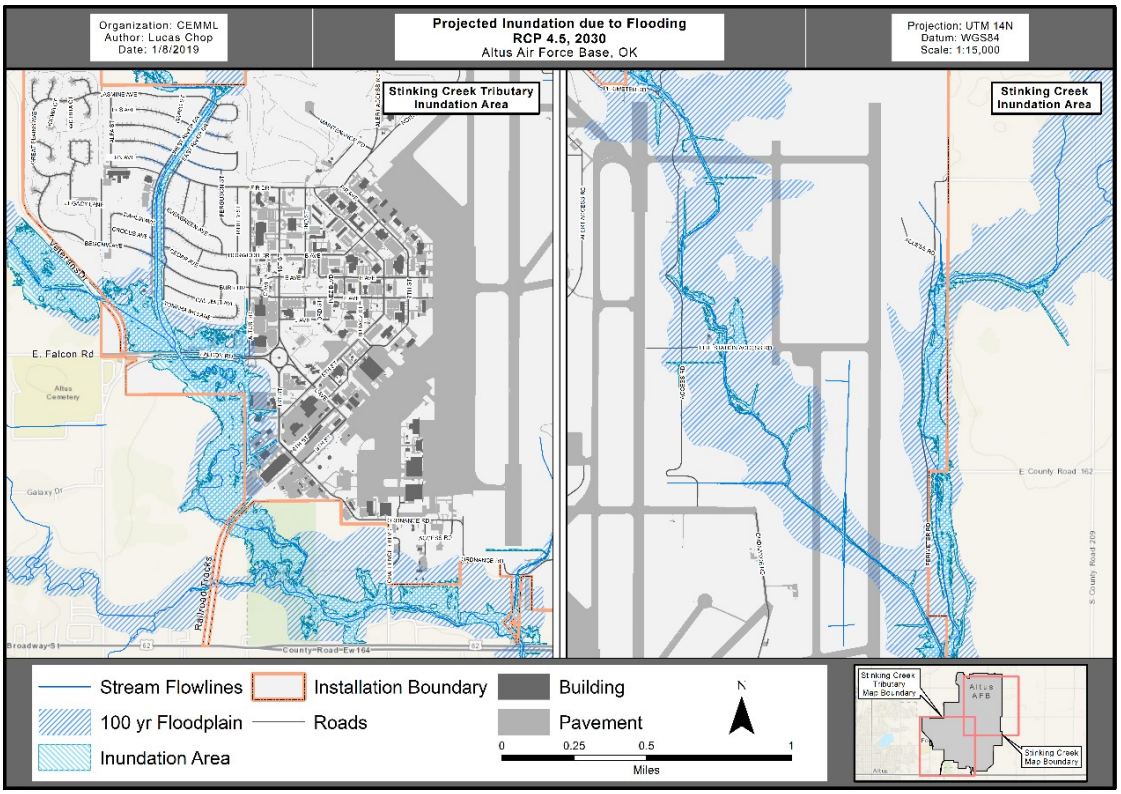

Figure C-5. Stream channel overflow for the RCP 4.5 emission scenario in 2030.

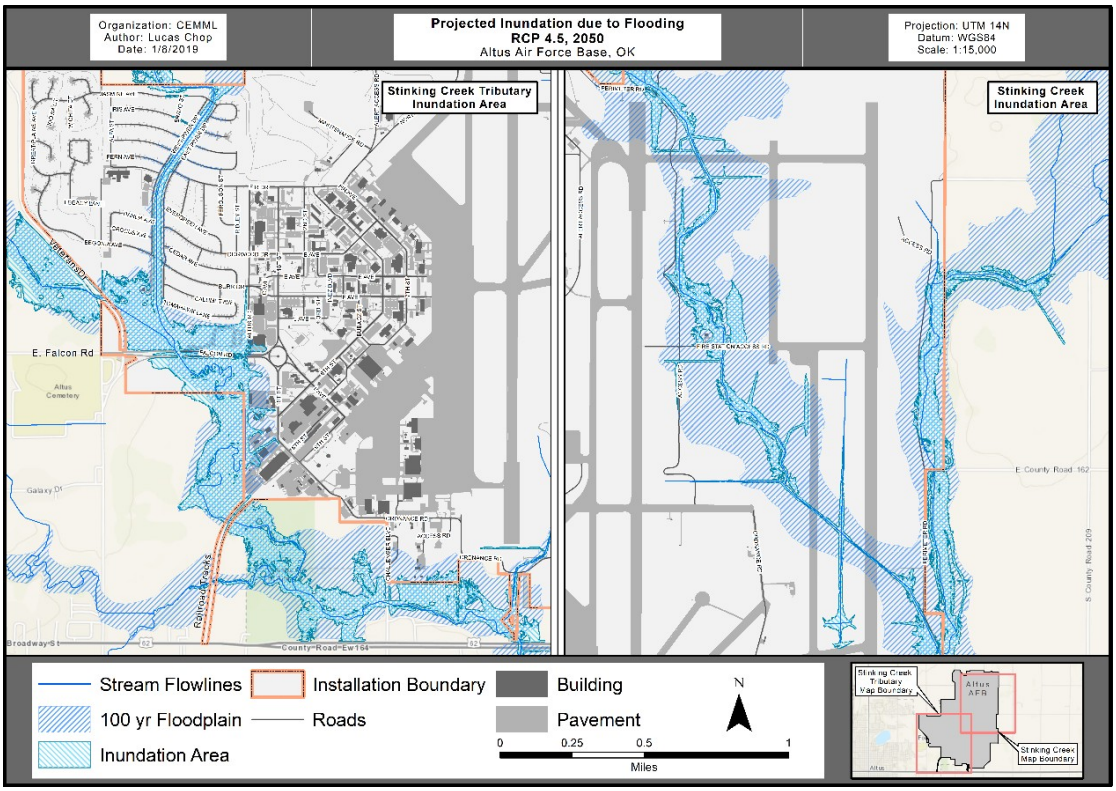

Figure C-6. Stream channel overflow for the RCP 4.5 emission scenario in 2050.

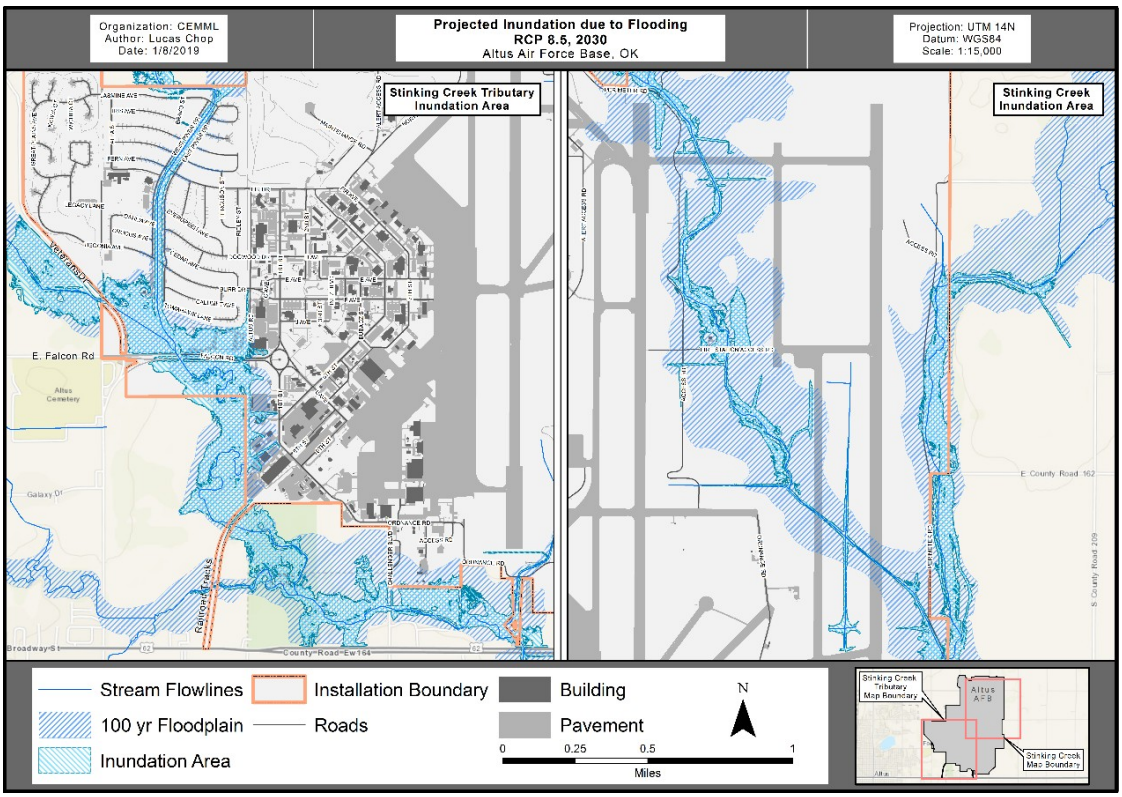

Figure C-7. Stream channel overflow for the RCP 8.5 emission scenario in 2030.

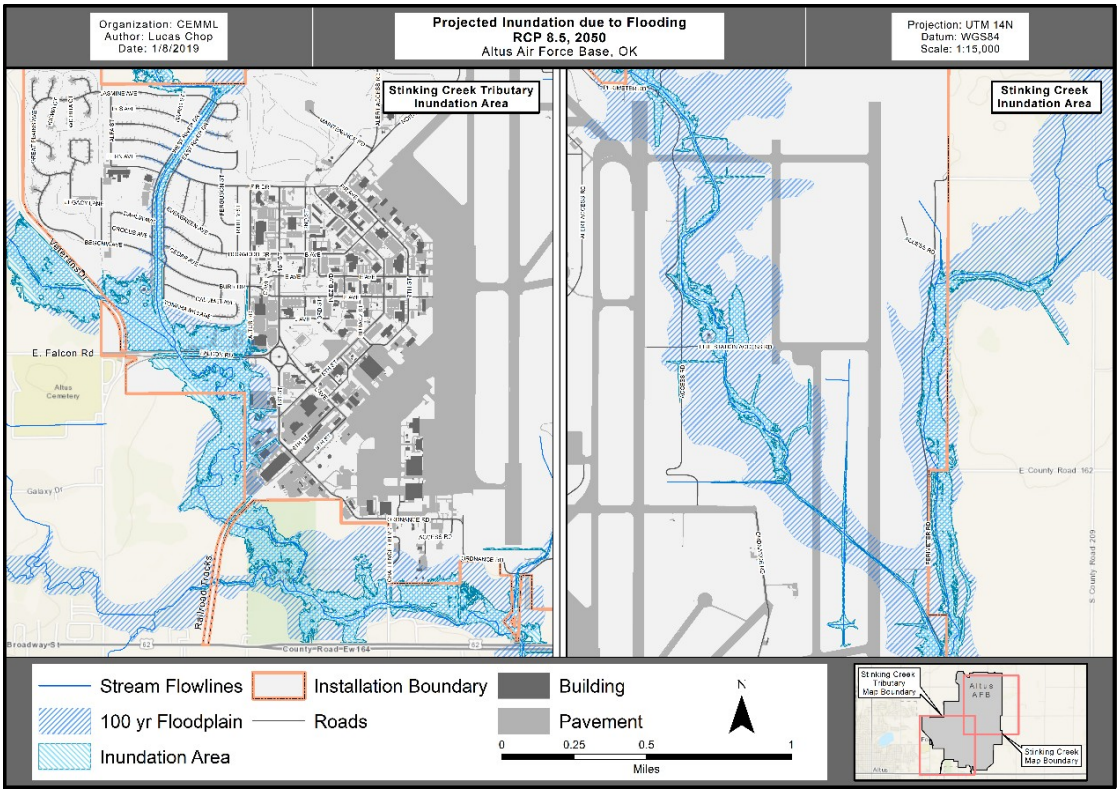

Figure C-8. Stream channel overflow for the RCP 8.5 emission scenario in 2050.

Appendix E: Ecosystem Classification and Vegetation

TABLE OF CONTENTS

TABLES

FIGURES

ACRONYMS

AFB	Air Force Base
GAP	Gap Analysis Project
HCCVI	Habitat Climate Change Vulnerability Index
MC2	Dynamic Global Vegetation Model
RCP	Representative Concentration Pathway
USGS	United States Geological Survey

D.1. ECOSYSTEM CLASSIFICATION

Three primary natural ecosystems at Altus AFB were identified for analysis: grassland prairie, flood plain or wetland, and woodland. This analysis used data derived from the United State Geological Survey (USGS) National Gap Analysis Project (GAP) Land Cover 2011 classification. Although open space and developed areas have limited value as habitat for priority species, there are significant areas of these lands at the installation, so they have also been included in the classification map presented in Figure D-1.

D.1.1. Grassland Prairie

Grasslands and other grass- and graminoid-dominated habitats occupy about 30–40 % of Earth's land surface. They cover more terrestrial area than any other single biome (Blair, Nippert, & Briggs, 2014). The calculated coverage area of this type of ecosystem is around 18.7% of total area in the installation.

D.1.2. Flood Plain or Wetland

These areas occur along watercourses and water bodies. Typical examples include flood plains and streambanks. They are distinctly different from surrounding lands because of unique soil and vegetation characteristics that are strongly influenced by the presence of water (Montgomery, 1996). The calculated coverage area of this type of ecosystem is around 0.4% of total area in the installation.

D.1.3. Woodland

Native trees on the upland are mesquite with elm and cottonwood in the draws or stream channels. The canopy cover in these areas depends on the maturity of the forest/woodland, with younger areas having somewhat open canopy (around 70%), and older mature forests having denser canopy coverage. These communities are part of a continuum of dry, acidic communities that contain a variety of oak and pine species (Ovaskainen et al., 2013). The calculated coverage area of this type of ecosystem is around 0.3% of total area in the installation.

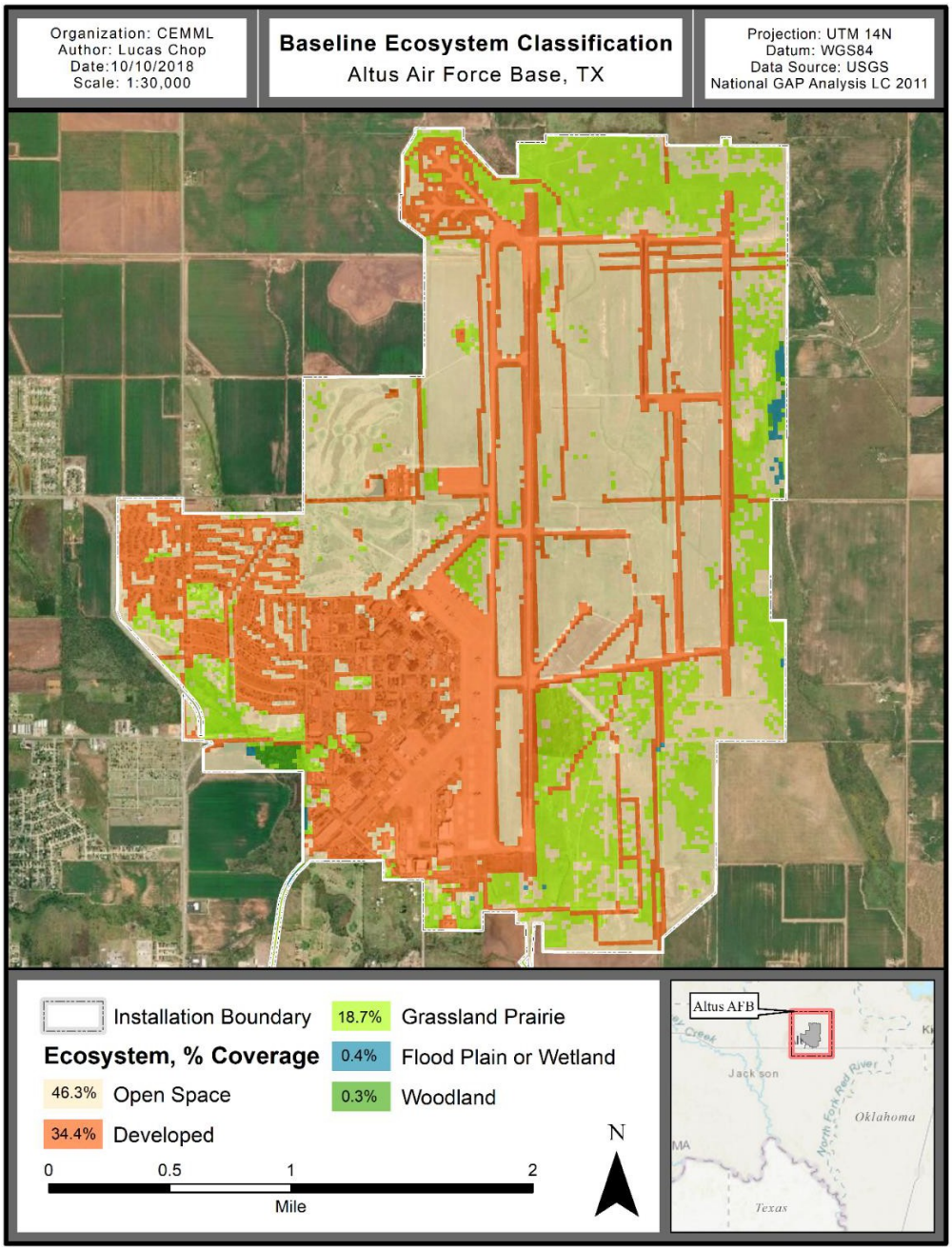

Figure D-1. Ecosystem classification.

D.2. VULNERABILITY ASSESSMENT

D.2.1. HCCVI Results Summary

Ecosystem vulnerability to climate change were assessed using the Habitat Climate Change Vulnerability Index (HCCVI) framework developed by Comer et.al. (2012). This index uses a two-dimension analysis of climate change sensitivity and ecological resilience for each ecosystem type distribution within a given ecoregion, using combined quantitative and qualitative approaches. The HCCVI assessment revealed that grassland and prairie ecosystems are classified as highly vulnerable under both studied scenarios. Woodland as well as flood plain or wetland ecosystems are classified as moderately to highly vulnerable (with low to medium confidence) under both climate scenarios (Table D-1 and 2).

Table D-1. Ecosystem vulnerability and level of confidence[1] for the 2030 timeframe.

Ecosystem	Low Vulnerability		Moderately Vulnerability		Highly Vulnerability	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Grassland Prairie					2	2
Flood Plain or Wetland				1	2	
Woodland				1	2	

[1] 3 = high level of confidence, 2 = moderate level of confidence, 1 = low level of confidence.

Table D-2. Ecosystem vulnerability and level of confidence[1] for the 2030 timeframe.

Ecosystem	Low Vulnerability		Moderately Vulnerability		Highly Vulnerability	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Grassland Prairie					3	3
Flood Plain or Wetland				2	2	
Woodland				2	2	

[1] 3 = high level of confidence, 2 = moderate level of confidence, 1 = low level of confidence.

D.3. ECOSYSTEM INUNDATION ANALYSIS

Projected inundation from flood modeling is shown with ecosystem coverage in Figure D-2. For the 2030 decadal average, there is a projected decrease in inundation across all natural ecosystems at Altus AFB of up to 34%. Projections for the 2050 decadal average indicate an increase in inundation for all natural ecosystems under low emission scenarios (RCP 4.5), and a slight decrease (5%) in inundation on woodland areas of the installation under high emission scenarios (RCP 8.5). Although projected inundation varies between the historic baseline, RCP 4.5 2050, RCP 8.5 2030, and RCP 8.5 2050 scenarios, the change in area is not visually distinguishable at the scale of the map (Figure D-2).

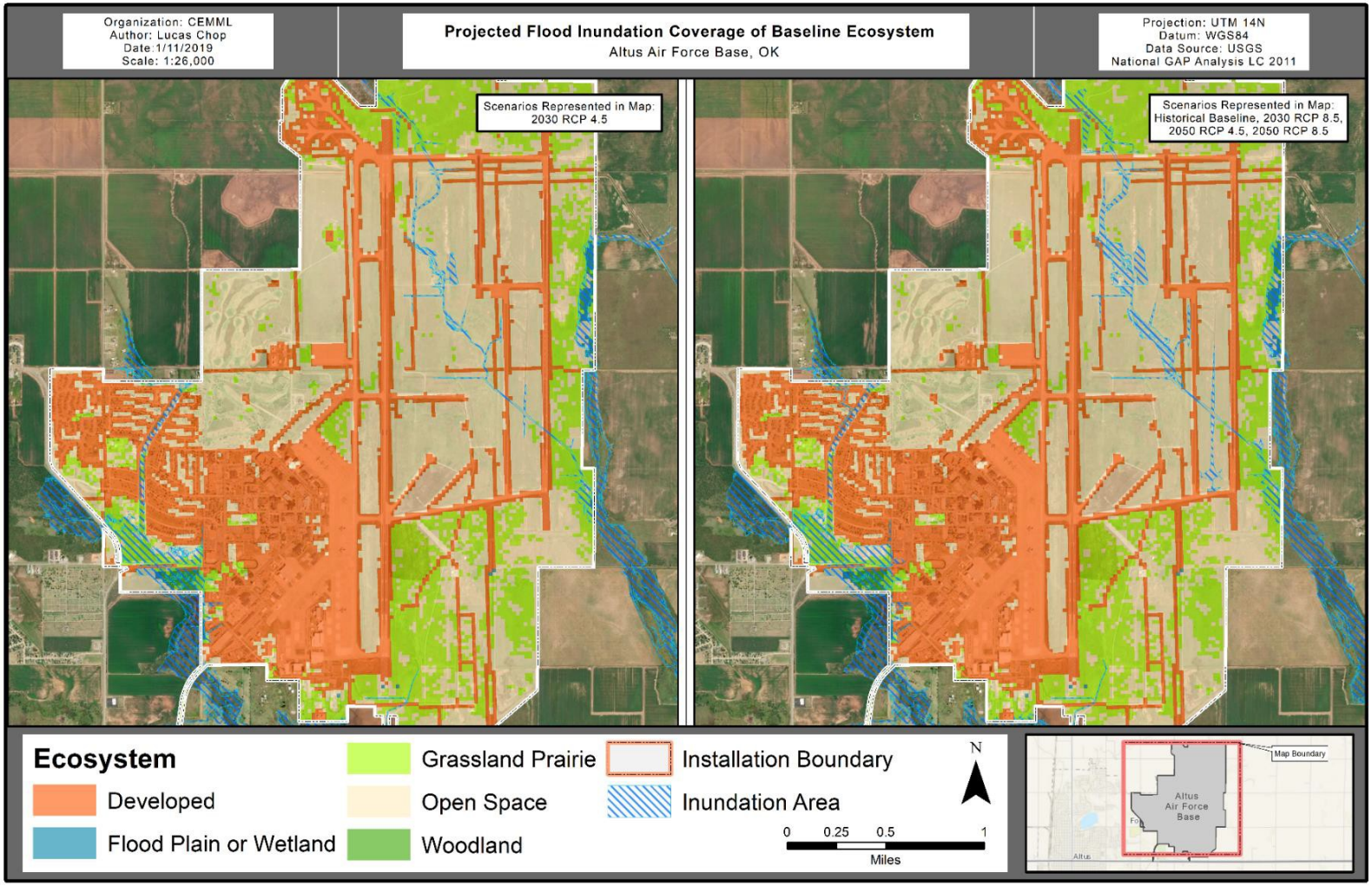

Figure D-2. Projected ecosystem inundation due to flooding.

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Appendix F. Plant Species at Altus AFB

List of common and scientific names of plants identified at Altus AFB (Marlow, 2001).
* Denotes extensively used food plants (Martin et al. 1961, Lefebvre and Mott 1987).

Common Name	Scientific Name
Arkansas yucca	*Yucca glauca*
Palmer's pigweed *	*Amaranthus palmeri*
Snake cotton	*Froelichia jloridana*
Slender snake-cotton	*Froelichia gracilis*
Plains sandparsley	*Ammoselinum popei*
Southwestern carrot	*Daucus pusillus*
Knotted hedgeparsely	*Torilis nodosa*
Spider antelopehorns	*Asclepias asperula*
Yarrow	*Achillea millefolium*
Western ragweed *	*Ambrosia psilostachya*
Giant ragweed *	*Ambrosia triflda*
Lazy daisy	*Aphanostephus. skirrhobasis*
Wreath aster	*Aster ericoides*
Shinners heirba del marrano	*Aster subulatus*
Groundsel-tree	*Baccharis salicina*
Roughhair golden aster	*Chrysopsis canescens*
Texas thistle	·*Cirsium texanum*
Wavyleaf thistle	*Cirsium undulatum*
Horseweed	*Conyza canadensis*
Dwarf fleabane	*Conyza ratnosissima*
Plains coreopsis	*Coreopsis tinctoria*
Yerba de tajo	*Eclipta prostrata*
Engelmann's daisy	*Engelmannia pinnatifida*
Plains fleabane	*Erigeron modestus*
Daisy fleabane	*Erigeron strigosus*
Rabbit tobacco	*Evax prolifera*
Indian blanket	*Gaillardia pulchella*
Rayless gaillardia	*Gaillardia suavis*
Rayjacksonia annua	*Haplopappus annuus*
Wax goldernweed	*Haplopappus ciliata*
Scratch-daisy	*Haplopappus validus*
Smallhead sneezeweed	*Helenium microcephalum*
Common sunflower *	*Helianthus annuus*
Ashy sunflower *	*Helianthus mollis*
Plains sunflower*	*Helianthus petiolaris*
Golden aster	*Heterotheca latifolia*
Annual false ragweed	*Iva annua*
Prickly lettuce	*Lactuca serriola*
Dotted gayfeather	*Liatrus punctata*

Common Name	Scientific Name
Lindheimet daisy	*Lindheimera texalia*
Purple camphorweed	*Pluchea odotata*
Geiser's false dandelion	*Pyrrhopllppus multicaulis*
Yellow prairie coneflower	*Ratibida columnifera*
Packera tampicana	*Senecio imparipinnatus*
Stiff prairie goldenrod	*Solidago rigida*
Spiny-leaved sowthistle	*Sonchus asper*
Common dandelion	*Taraxacum officinale*
Goat's beard	*Tragopogon dubius*
Cowpen daisy	*Verbesina encelioides*
Sleepy daisy	*Xanthisma texanum*
Cocklebur	*Xanthium strumartum*
Cigar-tree	*Catalpa speciosa*
Small cryptantha	*Cryptantha minima*
Salt heliotrope	*Heliotropium curassavicum*
Narrowleaf puccoon	*Lithospermum incisum*
Small-seeded false flax	*Camdina microcarpa*
Shepherd's purse	*Capsella bursa-pastoris*
Tansy mustard	*Descurainiapinnata*
Spectacle-pod	*Dimorphocarpapalmeri*
Western wallflower	*Erysimum asperum*
Bushy wallflower	*Erysimum repanclum*
Peppergrass	*Lepidium densiflorum*
Tumbling mustard	*Sisyrnbrium altissimum*
Bigroot prickly pear *	*Opuntia macrorhiza*
Honey locust	*Gleditsia triactmthos*
Pig nut	*Hojfrnanseggia glaiica*
Small venus’ looking-glass	*Triodanis biflora*
Eastern cleomella	*Cleomella angustifolia*
Thyme-leaved sandwort	*Arenaria serpyllifolia*
Common chickweed *	*Stellaria media*
Mexican tea *	*Chenopmlium ambrosioides*
Slimleaf goosefoot *	*Chenopodium leptophyllum*
Winged pigweed	*Cycloloma atriplicifolium*
Kochia	*Kochia scoparia*
Povertyweed	*Monolepis nuttalliana*
Sea blite	*Suaeda depressa*
Erect day-flower	*Commelina erecta*
Spiderwort	*Tradescantia bracteata*

Common Name	Scientific Name
Field bindweed	*Convolvutus arvensis*
Bush morning glory	*Ipomoea leptophylla*
Buffalo gourd	*Cucurbita foetidissima*
Common red cedar *	*Juniperus virginiana*
Love vine	*Cuscuta gronovii*
Taperleaf flatsedge	*Cypetus acuminatus*
Bearded flatsedge	*Cyperus aristatus*
Globe sedge	*Cyperus globulosus*
False nutgrass	*Cyperus strigosus*
One-flower flatsedge	*Cyperus uniflorus*
Spikerush, spikesedge *	*Eleocharis* sp.
Chainnaker's rush*	*Scirpus americanus*
Alkali bulrush *	*Scirpus maritimus*
Common threesquare	*Scirpus pungens*
Tropic croton *	*Croton glandulosus*
White margin euphorbia	*Euphorbia albomtrrginata*
Geyer's spurge	*Euphorbia geyeri*
Spreading euphorbia	*Euphorbia humistrata*
Prostrate spurge	*Euphorbia ptostrata*
Warty euphorbia	*Euphorbia spatkulata*
Drummond leaf-flower	*Phyllanthus abnormis*
Nettleleaf	*Tragia ramose*
Nuttall milkvetch	*Astragalus nuttallianus*
Ground plum	*Astragalus plattensis*
White wild indigo	*Baptisia lactea*
Nine anther dalea	*Dalea enneandra*
Silky prairie clover	*Dalea villosa*
Bush dover	*Lespedeza capitdta*
Alfalfa*	*Medicago sativa*
White sweet clover	*Melilotus alba*
Yellow sweet clover	*Melilotus officinalis*
Black locust	*Robinia pseudo-acacia*
Smoothseed wild bean	*Strophostyles leiosperma*
Small hop clover*	*Trifolittm dubium*
Filaree	*Erodtum cicutarium*
Carolina cranesbill	*Geranium carolinianum*
Prairie blue curls	*Phacelia strictiflora*
Blue-eyed grass	*Sisyrinchium angustifolium*
Pecan	*Carya illinoensis*

Common Name	Scientific Name
Grassleaf rush	*Juncus marginatus*
Henbit	*Lamium amplexicaule*
Horsemint	*Monarda punctata*
Azure blue sage	*Salvia azurea*
Valdivia duckweed	*Lemna valdiviana*
Plains onion	*Allium perdulce*
Crow poison	*Nothoscordum bivalve*
Meadow flax	*Linum pratense*
Bractless mentzelia	*Mentzelia nuda*
Juniperleaf	*Polypremum procumbens*
Toothcup	*Rotala ramosior*
Pink poppy mallow	*Callirhoe altaeoides*
Purple poppy mallow	*Callirhoe involucrata*
Red false mallow	*Sphaeralcea coccinea*
Hairy water clover	*Marsilea vestita*
Bundle flower	*Desmanthus illinoensis*
Mesquite*	*Prosopis glandulosa*
Sensitive briar	*Schrankia nuttallii*
Carpetweed	*Mollugo verticillata*
Osage orange	*Maclura pomifera*
White mulberry *	*Morus alba*
White four o'clock	*Mirabilis albida*
Velvety gaura	*Gaura parvijlora*
Showy evening primrose	*Oenothera grandis*
Cutleaf evening primrose	*Oenothera laciniata*
Fourpoint evening primrose	*Oenothera rhombipetala*
Broomrape	*Orobanche multiflora*
Yellow wood sorrel	*Oxalis corniculata*
Pricklepoppy	*Argemcme polyanthemos*
Common devil's claw	*Proboscidea louisitmica*
Buckhorn plantain	*Plantago lanceolata*
Wooly plantain (2 varieties)	*Plantago patagoriica*
Paleseed plantain	*Plantago virginica*
Western wheatgrass	*Agropyron smithiz*
Sand bluestem	*Andropogonhallii*
King Ranch bluestem	*Andropogon ischaemum*
Silver bluestem	*Andropogon saccharoides*
Little bluestem	*Andropogon scoparius*
Oldfield threeawn	*Aristida oligantha*

Common Name	Scientific Name
Purple threeawn	*Aristida purputea*
Sideoats grama *	*Bouteloua curtipendula*
Downy brome *	*Bromus tectorum*
Rescue grass *	*Bromus unioloides*
Sandbur	*Cenchrus incertus*
Windmill grass	*Chloris vetticillata*
Showy chloris	*Chloris virgata*
Bermuda grass	*Cynodon dactylon*
Hairy crabgrass *	*Digitaria sanguinalis*
Seashore saltgrass *	*Distichlis Spicata*
Barnyard grass *	*Echinochloa crusgalli*
Barnyard grass *	*Echinochola muricata*
Canada wild rye	*Elynms canaderisis*
Mediterranean lovegrass	*Eragrostis bartelieri*
Stinkgrass	*Eragrostis cilianensis*
Weeping lovegrass	*Eragrostis curvula*
Little.lovegtass	*Eragrostis minor*
Red lovegrass	*Eragrostis secundiflora*
Prairie cupgrass	*Eriochloa contracta*
Sixweeks fescue *	*Festuca octoflora*
Foxtail barley*	*Hordeum jubatum*
Little barley *	*Hordeum pusillum*
Bearded sprangletop	*Leptochloa fascicularis*
Alkali grass	*Muhlenbergia asperifolia*
Witchgrass *	*Panicum capillare*
Texas millet *	*Panicum texarium*
Switchgrass *	*Panicum vitgatum*
Florida paspalum	*Paspalum floridanum*
Thin paspalum	*Paspalum setaceum*
May grass	*Phalaris caroliniana*
Texas bluegrass*	*Poa arachnifera*
Plains. bluegrass *	*Poa arida*
Kentucky bluegrass *	*Poa pratensis*
Rabbitfoot grass	*Polypogon monspeliensis*
Green foxtail	*Setaria viridis*
Indiangrass	*Sorghastrum nutans*
Johnson grass	*Sorghum halepense*
Alkali sacaton *	*Sporobolus airoides*
Meadow dropseed *	*Sporobolus asper*

Common Name	Scientific Name
White tridens	*Tridens albescens*
Purple sandgrass	*Triplasis purpurea*
Wheat *	*Triticum aestivum*
Smartweed *	*Polygonum lapathifolium.*
Pennsylvania smartweed *	*Polygonum pensylvanicum*
Lady's thumb *	*Polygonum persicaria*
Bushy knotweed *	*Polygonuin ramosissimum*
Sour dock	*Rumex crispus*
Bitter dock	*Rumex obtusifolius*
Narrow-leaf dock	*Rumex stenophyllus*
Moss rose	*Portllaca mundula*
Wingpod purslane	*Portulaca umbraticola*
Water pimpernel	*Samolus parviflorus*
Tenpetal anemone	*Anemone berlandieri*
Blister buttercup	*Ranunculus scleratus*
Chickasaw plum *	*Prunus angustifolia*
Cottonwood	*Populus deltoides*
Black willow *	*Salix nigra*
Chittamwood	*Bumelia lanuginosa*
Prairie paintbrush	*Castilleja purpurea*
Oldfield toadflax	*Linaria canadensis*
Clasping false pimpernel	*Lindernia dubia*
Indian apple	*Datura innoxia*
Field ground d1erry	*Physalis viscosa*
Purple ground cherry	*Quincula lobata*
Silverleaf nightshade	*Solanum elaeagnifolium*
Black nightshade	*Solanum ptycanthum*
Buffalobur	*Solanum rostratum*
Saltcedar	*Tamarix chinensis*
Narrow-leaved cattail	*Typha angustifolia*
Sugarberry	*Celtis laevigata*
Chinese elm	*Ulmus parviflora*
Sweet-William	*Verbena bipinnatifida*
Possum grape	*Cissus incisa*
Horned pondweed *	*Zannicheilia paiustris*
Goathead	*Tribulus terrestris*

Appendix G: Wildlife Species at Altus AFB

These lists contain mammal, bird, reptile, and amphibian species confirmed present at Altus AFB, as well as fish species potentially present on the installation.

Species were identified in a 1998 endangered species survey (Schnell et al.), the 2001 Wildlife Hazard Management Plan for Altus AFB (Marlow), a 2017 acoustic bat survey (Hauer and Schwab), and a 2017 report on amphibian and reptile biodiversity on DoD installations (Petersen, et al.)

* Denotes a state-listed Species of Greatest Conservation Need.

Mammals Confirmed Present at Altus AFB

Common Name	Scientific Name
Raccoon	*Procyon lotor*
Badger	*Taxidea taxus*
Striped skunk	*Mephitis mephitis*
Coyote	*Canis latrans*
Red fox	*Vulpes fulva*
Plains pocket gopher	*Geomys bursarius*
Eastern cottontail	*Sylvilagus floridanus*
Whitetail deer	*Odocoileus virginianus*
Armadillo	*Dasypus novemgintus*
Fulvous harvest mouse	*Reithrodonomys fulvescens*
White-footed mouse	*Peromyscus leucopus*
Deer mouse	*Peromyscus maniculatus*
Hispid cotton rat	*Sigmodon hispidus*
Norway rat	*Rattus norvegicus*
House mouse	*Mus musculas*
Brazilian (Mexican) free-tailed bat *	*Tadarida brasiliensis*
Canyon bat	Parastrellus hesperus
Cave myotis	*Myotis velifer*
Eastern red bat	*Lasiurus borealis*
Evening bat	*Nycticeius humeralis*
Hoary bat	*Lasiurus cinereus*
Pallid bat	*Antrozous pallidus*
Silver-haired bat	*Lasionycteris noctivagans*
Western (Townsend's) big-eared bat *	*Corynorhinus townsendii*
Tricolored bat *	*Perimyotis subflavus*
Western small-footed myotis	*Myotis ciliolabrum*

Amphibians and Reptiles Confirmed Present at Altus AFB

Common Name	Scientific Name
Yellow-bellied slider	*Trachemys scripta scripta*
Pallid spiny softshell *	*Apalone spinifers*
Texas horned lizard *	*Phrynosoma cornutum*
Bullsnake	*Pituophis melanoleucus*
Western diamond-backed rattlesnake	*Crotalus atrox*
Woodhouse's toad	*Bufo woodhousii*
Blanchard's cricket frog	*Acris crepitans*
Plains leopard frog	*Rana blairi*

Birds Confirmed Present at Altus AFB

Common Name	***Scientific Name***
Northern mockingbird	*Mimus polyglottus*
Brown thrasher	*Toxostoma rufum*
Loggerhead shrike	*Lanius ludovicianus*
European starling	*Sturhus vulgaris*
Bell's vireo	*Vireo bellii*
Northern cardinal	*Cardinalis cardinalis*
Blue grosbeak	*Guiraca caerulea*
Indigo bunting	*Passerina cyanea*
Dickcissel	*Spiza americana*
Field sparrow	*Spizella pusilla*
Lark sparrow	*Chondestes grammacus*
Grasshopper sparrow	*Ammodramus savannarum*
Harris' sparrow	*Zonotrichia querula*
White-crowned sparrow	*Zonotrichia leucophrys*
White-throated sparrow	*Zonotrichia albicollis*
Vesper sparrow	*Pooecetes gramineus*
Lincoln's sparrow	*Melospiza lincolnii*
Fox sparrow	*Passerella iliaca*
Song sparrow	*Melospiza melodia*
Red-winged blackbird	*Agelaius phoeniceus*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Brewer's blackbird	*Euphagus cyanocephalus*
Eastern meadowlark	*Sturnella magna*
Western meadowlark	*Sturnella neglecta*
Horned lark	*Eremophila alpestris*
Great-tailed grackle	*Quiscalus mexicanus*
Common grackle	*Quiscalus quiscula*
Brown-headed cowbird	*Molothrus ater*
Northern oriole	*Icterus galbula*
American goldfinch	*Carduelis tristis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
House sparrow	*Passer domesticus*
Pine siskin	*Carduelis pinus*

Common Name	***Scientific Name***
Canada goose	*Brania canadensis*
Snow goose	*Chen caerulescens*
Great blue heron	*Areda herodias*
Great egret	*Casimerodius albus*
Little blue heron	*Egretta caerulea*
Cattle egret	*Bubulcus ibis*
Green-backed heron	*Butorides striatus*
Turkey vulture	*Cathartes aura*
Mississippi kite	*Ictinia mississippiensis*
Cooper's hawk	*Accipiter cooperii*
Northern harrier	*Circus cyaneus*
Rough-legged hawk	*Buteo lagopus*
Swainson's hawk	*Buteo swainsoni*
Red-tailed hawk	*Buteo jamaicensis*
American kestrel	*Falco sparverius*
Prairie falcon	*Falco mexicanus*
Wild turkey	*Meleagris gallopavo*
Northern bobwhite	*Colinus virginianus*
Killdeer	*Charadrius vociferus*
Upland sandpiper	*Bartraimia longicauda*
Rock dove	*Columba livia*
Mourning dove	*Zenaida macroura*
Yellow-billed cuckoo	*Coceyzus americarus*
Common poorwill	*Phalaenoptilus nuttalit*
Chimney swift	*Cheatura pelagica*
Belted kingfisher	*Ceryla aicyon*
Northern flicker	*Colaptes auratus*
Downy woodpecker	*Picoides pubescens*
Red-bellied woodpecker	*Melanerpes carolinus*
Great crested flycatcher	*Myiarchus crinitus*
Western kingbird	*Tyrannus verticalis*
Eastern kingbird	*Tyrannus tyrannus*
Scissor-tailed flycatcher	*Tyrannus forficatus*
Cliff swallow	*Hirundo pyrrhonota*
Barn swallow	*Hirundo rustica*
American crow	*Corvus brachyrynchos*
Tufted titmouse	*Parus bicolor*
Carolina wren	*Thryomanes ludovicianus*
American robin	*Turdus migratorius*
Northern Pintail	*Anas acuta*
Burrowing owl	*Athene cunicularia*
Common nighthawk	*Chordeiles minor*
Lapland longspur	*Calcarius lapponicus*
Lazuli bunting	*Passerina amoena*

Fish Species Potentially Present at Altus AFB, Oklahoma

(Robertson et al., 2002)

Family	Scientific Name	Common Name
Lepisosteidae	*Lepisosteus oculatus*	Spotted Gar
	Lepisosteus osseus	Longnose Gar
	Lepisosteus platostomus	Shortnose Gar
Clupeidae	*Dorosoma cepedianum*	Gizzard Shad
Cyprinidae	*Cyprinella lutrensis*	Red Shiner
	Cyprinella lutrensis × C. venusta	Red Shiner × Blacktail Shiner
	Cyprinella venusta	Blacktail Shiner
	Cyprinus carpio	Common Carp
	Hybognathus placitus	Plains Minnow
	Macrhybopsis australis	Prairie Chub
	Notropis atherinoides	Emerald Shiner
	Notropis bairdi	Red River Shiner
	Notropis boops	Bigeye Shiner
	Notropis buchanani	Ghost Shiner
	Notropis shumardi	Silverband Shiner
	Notropis stramineus	Sand Shiner
	Phenacobius mirabilis	Suckermouth Minnow
	Pimephales promelas	Fathead Minnow
	Pimephales vigilax	Bullhead Minnow
	Campostoma anomalum	Central Stoneroller
Catostomidae	*Carpiodes carpio*	River Carpsucker
	Ictiobus bubalus	Smallmouth Buffalo
Ictaluridae	*Ameiurus melas*	Black Bullhead
	Ameiurus natalis	Yellow Bullhead
	Ictalurus punctatus	Channel Catfish
	Pylodictis olivaris	Flathead Catfish
Fundulidae	*Fundulus zebrinus*	Plains Killifish
	Fundulus olivaceus	Blackspotted Topminnow
	Fundulus grandis	Gulf Killifish
Poeciliidae	*Gambusia affinis*	Western Mosquitofish
Cyprinodontidae	*Cyprinodon rubrofluviatilis*	Red River Pupfish
Centrarchidae	*Lepomis cyanellus*	Green Sunfish
	Lepomis humilis	Orangespotted Sunfish
	Lepomis cyanellus × L. humilis	Green Sunfish × Orangespotted Sunfish
	Lepomis gulosus	Warmouth
	Lepomis macrochirus	Bluegill
	Lepomis megalotis	Longear Sunfish
	Lepomis microlophus	Redear Sunfish
	Micropterus salmoides	Largemouth Bass
	Pomoxis nigromaculatus	Black Crappie
	Pomoxis annularis	White Crappie
Percidae	*Etheostoma radiosum*	Orangebelly Darter
	Percina caprodes	Logperch
	Percina sciera	Dusky Darter
	Etheostoma pulchellum	Plains Orangethroat Darter
Sciaenidae	*Aplodinotus grunniens*	Freshwater Drum

15.0 ASSOCIATED PLANS

Bird/Wildlife Aircraft Strike Hazard (BASH) Plan

Refer to plan OPR (Altus AFB Flight Safety office)

Integrated Cultural Resources Management Plan (ICRMP)

Refer to plan OPR (Altus AFB Civil Engineering office)

Integrated Pest Management Plan (IPMP)

Refer to plan OPR (Altus AFB Pest Management Coordinator)

Storm Water Pollution Prevention Plan (SWPPP)

Refer to plan OPR (Altus AFB Storm Water Program Manager)