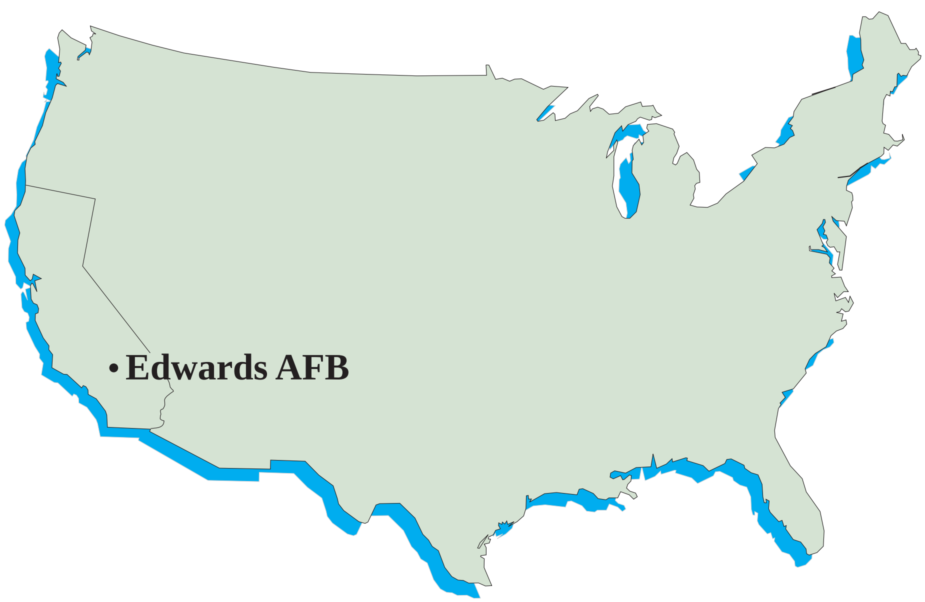
95th Air Base Wing
Air Force Flight Test Center
Edwards Air Force Base, California

ENVIRONMENTAL ASSESSMENT FOR THE INTEGRATION AND DEVELOPMENTAL TESTING OF HIGH POWER MICROWAVE SYSTEMS AT EDWARDS AIR FORCE BASE



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13. SUPPLEMENTARY NOTES

14. ABSTRACT
In compliance with the National Environmental Policy Act of 1969, and implementing regulations, the 95th Air Base Wing and U.S. Air Force Flight Test Center (AFFTC) have prepared a Draft EA. The Proposed Action, is to conduct open-air integration and developmental testing of high power microwave (HPM) systems at Edwards AFB while operating within restricted area R-2515 against ground-to-ground, ground-to-air, air-to-ground, and air-to-air targets. All targets will be physically located on or above Edwards AFB, inside restricted area R-2515. Up to 100 acres could be designated for target areas; however each target area would be limited to 5 acres. Up to 128 flight tests, 48 aircraft related ground tests, and 600 hours of non-aircraft related ground test would be conducted annually from 2006 to 2012. This proposed action is in support of future Air Force research and development programs. Edwards AFB has historically been selected as a primary testing site for new aircraft and new systems because of its remote location and suitable conditions that support reliable flight. Developmental systems would be investigated as part of the proposed program to establish baseline information on beam characteristics and hardware properties. The open terrain, low population densities, and minimal potential for impacts on the environment make this area ideally suited for this type of test and evaluation activity: testing of HPM systems.

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Directed Energy Systems, High Power Microwave, HPM, Edwards AFB, AFFTC

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FINDING OF NO SIGNIFICANT IMPACT FOR INTEGRATION AND DEVELOPMENTAL TESTING OF HIGH POWER MICROWAVE SYSTEMS AT EDWARDS AIR FORCE BASE

1.0 INTRODUCTION

The U.S. Air Force proposes to conduct integration and developmental testing of high power microwave (HPM) systems at Edwards Air Force Base (AFB), California, and within restricted area R-2515. High power microwave is a directed energy system. All targets will be physically located on or above Edwards AFB, inside restricted area R-2515. Up to 100 acres could be designated for target areas or for firing points; however, each target area would be limited to 5 acres. The Proposed Action is being developed to support the Air Force goal of meeting future requirements that are considered necessary for the defense of territorial United States.

The Proposed Action will support the integration and developmental testing of HPM systems on aircraft and other delivery platforms, which is considered one of the primary functions of the Air Force Flight Test Center (AFFTC), Edwards AFB, California.

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES CONSIDERED

The Proposed Action would authorize the AFFTC to conduct up to 100 ground test hours in 2006, 600 ground test hours in 2007, and 672 flight and ground test hours (180 flights [including chase aircraft] and 48 ground tests) each year from 2008 through 2012 for HPM systems. Alternative B would limit the test to using surrogate high power microwave systems (very low power), and under Alternative C, the No-Action Alternative, no open air integration and testing of HPM systems would occur at Edwards AFB.

3.0 ENVIRONMENTAL CONSEQUENCES

The Region of Influence (ROI) of the proposed project consists primarily of Edwards AFB and restricted area R-2515. The ROI for each alternative is discussed in terms of two distinct regions: (1) Edwards AFB and (2) the land under restricted area R-2515 (airspace). Impacts were reviewed for effects occurring on the areas surrounding and occurring on Edwards AFB.

Resources within the ROI have been identified and evaluated under the following categories: air quality, airspace, cultural resources, environmental justice, geology and soils, hazardous waste/hazardous materials, infrastructure, land use, natural resources, noise, public/emergency services, safety, socioeconomics, and water resources. With inclusion of the proposed mitigation measures, no potentially significant impacts were identified to any of these areas under the alternatives considered. This finding was based primarily on the following facts:

• The limited number of flights would be less than 2 percent of the current activity.

• The HPM target areas would be evaluated by the 95 ABW/CEV and other organizations to ensure mitigation measures were in place prior to testing events. The *Biological Opinion for Continued Use of the Precision Impact Range Area (PIRA)* allows for removal of desert tortoise critical habitat on the PIRA in support of construction and training activities as long as the removal does not exceed 5 acres per site or a cumulative total of 100 acres.

• Hazard zones would be established to prevent nonparticipating receptors from entering the target areas.

Decisions regarding the significance of impacts, as defined under National Environmental Policy Act of 1969 (NEPA), are based on a consensus of the interpretation of environmental laws, rules, and regulations by cognizant federal, state, and local agencies; previously certified environmental documentation for similar projects; and trained and experienced professionals in each environmental field.

Cumulative Impacts

Alternatives A, B, or C would have no cumulative impacts to airspace, land use, noise, or to any other issue area analyzed in this Environmental Assessment (EA).

Short-Term Versus Long-Term Productivity of the Environment

No new construction or other development would be required under the Integration and Developmental Testing of HPM Systems Program, and current Air Force or contractor personnel from other bases would be used for the program. Neither Alternative A, B, nor C would involve any short- or long-term changes in population or productivity of the environment.

Irreversible and Irretrievable Commitments of Resources

This EA only addresses the integration and developmental testing of HPM systems at selected target areas. Designating these sites for integration testing would not require an irreversible or irretrievable commitment of resources. Irreversible or irretrievable commitment of resources that would occur during other phases of the program (e.g., microwave system fabrication and transportation to the site) would be addressed in separate environmental documentation. Implementation of Alternative C (No-Action Alternative) would also not require an irreversible or irretrievable commitment of resources.

4.0 CONCLUSION

On the basis of the findings of the EA, no significant impact to human environment would be expected from implementation of the Proposed Action. No additional mitigation measures are recommended. Therefore, issuance of a Finding of No Significant Impact (FONSI) is warranted, and preparation of an Environmental Impact Statement, pursuant to the NEPA (Public Law 91-190) is not required.

Background information that supports the research and development of this FONSI and the EA are on file at Edwards AFB and may be obtained by contacting the following:

95 ABW/PAE
Environmental Management Division
Attn: Mr. Gary Hatch
5 E. Popson Avenue, Building 2650A
Edwards AFB, California 93524-8060
(661) 277-1454

James E. Judkins

JAMES E. JUDKINS, NH-IV
Base Civil Engineer

23 Oct 06

Date

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EXECUTIVE SUMMARY

1.0 INTRODUCTION

This Environmental Assessment (EA) evaluates the potential environmental impacts associated with the proposed integration and developmental test and evaluation of high power microwave (HPM) systems against targets on Edwards Air Force Base (AFB) and target in the airspace above Edwards AFB. High power microwave is a directed energy (DE) system. Other DE systems include low power microwave, lasers, and charged or neutral particle beam systems.

This EA was prepared in accordance with all applicable federal, state, and local laws and regulations including the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code 4321 *et seq*.); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal regulations [CFR] 1500–1508); U.S. Air Force Instruction 32-7061, *The Environmental Impact Analysis Process (EIAP)*; and Title 32 CFR Part 989, which implements these regulations in the EIAP and other federal and local regulations. The 95th Air Base Wing is representing the Department of Defense as the lead agency.

2.0 PURPOSE AND NEED

The purpose of the Proposed Action is to conduct integration and developmental testing of the HPM systems with aircraft and ground-based weapons systems of the future at the Air Force Flight Test Center (AFFTC). The AFFTC mission is to conduct and support research, development, test and evaluation of aerospace systems from concept to combat. The mission of AFFTC has developed from a high performance aircraft flight test facility in the 1950s and 1960s to that of a high technology integration and developmental testing and evaluation center for complete aircraft, avionics systems, and integrated airframe weapons support. Thus, HPM testing would continue the evolution of the primary mission of AFFTC and would be fully in accord with that mission as it has evolved since the 1940s.

The Proposed Action is needed to support the Air Force goals for meeting future requirements that are considered necessary for defending the territorial United States. The *Air Force Transformational Flight Plan*, *Directed Energy Master Plan, AFFTC Roadmap,* and *Electronic Warfare Flight Plan* provide guidance for conducting test and evaluation of developmental HPM systems needed to demonstrate critical technologies in a realistic environment (Montoya 2005). This EA serves as an assessment of the environmental effects and any mitigation that may be required to test and evaluate a variety of HPM technologies at Edwards AFB and selected targets in restricted area R-2515.

The United States has recognized that technologies applicable to the development and production of HPM systems can be critical to the war fighting capability of U.S. Forces on the land, sea, and air. The use of HPM systems can allow the United States maintain the edge over our adversaries for the foreseeable future, with applications throughout the joint battlefield and entire spectrum of war. They represent a technology that will have tremendous impact on the joint service and Air Force operational concepts and our ability to win decisively in the future.

The *Air Force Transformational Flight Plan* (Flight Plan), published in November 2003, emphasizes the importance of developing strategies and concepts of operation appropriate for this new era. The Flight Plan gives guidance and recommends that we rethink our doctrinal approaches to organizing, training, and equipping. In addition, the Flight Plan identifies key Air Force programs, advanced concept technology demonstrations, and future system concepts that the Air Force believes will likely be the key enablers of the transformational capabilities required for success. The Air Force recently completed the *Directed Energy Master Plan*, which articulates its strategy to develop and transition DE applications such as precision engagements, information superiority, and ballistic missile defense. It also identifies six DE science and technology programs that would offer near-term transformational capabilities to the Air Force if funding were accelerated: Advanced Tactical Laser, High Powered Microwave Airborne Electronic Attack (Mid-Term, 2010–15), Airborne Active Denial System (Long-Term, past 2015), the Evolutionary Air and Space Global Laser Engagements, and 100 Kilowatt Solid State Laser (U.S. Air Force 2003). While these are the currently projected programs, technical achievements may result in advances of other unnamed programs that may replace these before they develop to the test and evaluation stage.

The *AFFTC Roadmap* (2004)—along with the *Electronic Warfare Flight Plan* (2004)—lays out a capabilities-based acquisition strategy to invest in capabilities to support developmental test and evaluation of DE platforms for the Air Force. This flight plans' scope captures this capability out to the year 2020.

3.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

Alternative A, the Proposed Action, is to conduct open-air integration and developmental testing of HPM systems against targets at Edwards AFB and within restricted area R-2515 in the ground-to-ground (G/G), ground-to-air (G/A), air-to-ground (A/G), and air-to-air (A/A) modes. Alternative B is similar to Alternative A, except open-air integration and developmental testing would be limited to using representative surrogate HPM systems with low power against targets at Edwards AFB and within restricted area R-2515 in the G/G, G/A, A/G, and A/A modes. Under Alternative C, the No-Action Alternative, open-air HPM integration and developmental testing would not occur.

Target areas and firing points located on Edwards AFB would be limited to 5 acres per site; there would be a maximum total of 100 acres of disturbed area for designated sites and future undesignated sites.

Edwards AFB has historically been selected as a primary testing site for new aircraft and new systems because of its remote location and pristine conditions that support reliable flight. Developmental systems would be investigated as part of the proposed program to establish baseline information on beam characteristics and hardware properties. The open terrain, low population densities, and minimal potential for impacts on the environmental make this area ideally suited for A/G and G/G testing of HPM systems.

3.1 ALTERNATIVES CONSIDERED AND DISMISSED FROM FURTHER CONSIDERATION

The CEQ regulations require that NEPA documents evaluate all reasonable alternatives, briefly discuss those alternatives eliminated from detailed analysis, and provide the reasons for elimination of any alternatives (40 CFR 1502.14[a]). "Reasonable is defined as practical or feasible from a common sense, technical, and economic standpoint" (51 *Federal Register* 15618, April 25, 1986).

Several alternatives were considered, but were dismissed because reasons for selecting them as potential alternatives were not considered to be practical, feasible, or economically sound. They are described below.

- The testing of HPM systems throughout the R-2508 Complex was considered but eliminated from consideration because of the potential constraints and impacts to populated areas between firing positions and target sites.

- Testing HPM systems where HPM equipped aircraft remained over Edwards AFB for all phases of A/A, A/G, and G/A modes. Normal flight operations from Edwards AFB would not impose such a restriction on other types of tests due to the required turning radius for test and target aircraft.

- Testing HPM systems in the air-to-space, space to air, and space-to-ground modes was considered; however, because an extremely large antenna would be required to radiate sufficient radio frequency (RF) energy for the intended effect, this potential alternative was eliminated.

- Testing HPM systems only at indoor facilities would not allow full system integration and testing inherent in the AFFTC mission. Environmental factors and impacts associated with open air tests could not be ascertained in a closed indoor environment; therefore this alternative was eliminated.

- Testing against humans at Edwards AFB and in restricted area R-2515.

3.2 NO-ACTION ALTERNATIVE

Alternative C (No-Action Alternative) is the status quo; the open-air HPM system integration and developmental testing would not occur against targets on Edwards AFB or within restricted area R-2515.

4.0 SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION MEASURES

The analysis indicates that none of the impacts individually or collectively would be significant. Measures to protect the various resource areas have been incorporated into the description of each action alternative, and mitigation measures have been included to further address any potential effects on the environment. Notable mitigation measures include the following.

- Airspace. Since there would be no significant impacts on airspace from implementing Alternative A, B, or C, no mitigation measures would be required.

- Cultural Resources. Any new proposed target areas will be investigated by 95th Air Base Wing Civil Engineer Flight (95 ABW/CEV) to verify that cultural artifacts are not present prior to designating the areas as approved targets. Test plans involving ground targets at Edwards AFB will be designed so that target impacts occur at one of the designated target sites on the Precision Impact Range Area (PIRA) or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Recovery of the target from designated target sites will be done in a way that minimizes ground disturbance and potential impacts on undiscovered cultural artifacts or sites on-base. Range personnel will use existing roads, whenever possible, to recover and transport targets for analysis. To ensure there is no impact to cultural resources in the R-2515 area, flight tests will be developed to ensure HPM RF energy avoids areas of critical environmental concern as shown in Figure 3-5.

- Geology and Soils. Since there would be no significant impacts on geology and soils from implementing Alternatives A, B, or C, no mitigation measures would be required.

- Infrastructure. To minimize potential HPM RF hazards, multiple controls will be used to reduce the potential for impacts on unsuspecting receptors. These controls will include shielding, distance, barriers and backdrops, and administrative controls as described in Section 4.7.4 of this EA. The use of test frequencies will be coordinated with the Frequency Spectrum Manager at Edwards AFB.

  Prior to each HPM system test event the 412th Test Wing Range Safety Office (412 TW/ENROR) will be required to complete a Directed RF Energy Assessment Model.

- Natural Resources. Impacts to natural resources would include blading of roads and target areas, any improvements involving ground clearing for the reuse of existing target sites, and direct or indirect impacts from the HPM testing. The effects of HPM testing are expected to primarily affect birds; however, the size and duration of HPM activity is expected to be so small/brief as to mathematically have almost no effect. As the intensity of the HPM beam increases, there may be other effects on natural resources from reflection. The low probability of direct effects on wildlife includes both A/A and A/G tests. The blading and maintenance of the target sites would affect all plants and animals within bladed areas and would indirectly affect organisms adjacent to the target site and access roads.

Two of the targets are located in Zone 3, desert tortoise critical habitat. Two sites are also located within the Edwards AFB Desert Tortoise Management Area. The site at Mt. Grinnel has been constructed, and the other site at Mt. Mesa has not. These two sites would reduce the best desert tortoise habitat by approximately 10 acres. Damage would also occur from fragmentation and degradation of the habitat. The *Biological Opinion for the Precision Impact Range Area* allows for disturbance of up to 5 acres per site with a maximum cumulative disturbance of 100 acres within Zone 3 desert tortoise critical habitat and the PIRA. The greatest and most direct effect of this project on desert tortoises would be caused by crews traveling on unpaved roads to the sites. Crews hauling portable target boards to the sites may encounter desert tortoises on the roads. They may either wait for the tortoise to leave the road or move the tortoise out of harm's way.

This project may affect sensitive plant species if the new target sites are located within population boundaries. Field surveys and searches of data in geographic information systems and literature will verify if the project will directly affect sensitive plant species. Prior to conducting any test and evaluation associated with the Proposed Action or Alternatives, surveys will be conducted at the target area(s) chosen for the test to determine if sensitive, threatened, or endangered species are in the immediate areas. Desert tortoises found within the project area will be removed from the target area(s) and firing points and placed in outdoor desert tortoise pens located in a natural environment for up to 7 consecutive days. If tortoise fences are installed around the target area(s) and firing points, then this tortoise removal will be permanent. This removal action constitutes a short-term effect to the tortoises and will be reported to the U.S. Fish and Wildlife Service. Relocating the tortoises out of harm's way will reduce the potential for disruption of their natural routine but may have long-term negative effects on local populations.

Base personnel and contractors will adhere to the standard basewide mitigation measures as described in the Integrated Natural Resources Management Plan (Edwards AFB 2004) and as noted in Section 4.9.4. Prior to initiating a HPM test on targets within one of the selected sites or other areas on the PIRA, the monitoring procedures outlined in Appendix E will be implemented.

High power microwave targeting activities would be performed at firing points and target areas approved by 95th Air Base Wing Commander (95 ABW/CC), 412th Test Wing Commander (412 TW/CC), or the Operations Group Commander (OG/CC).

- Noise. Hearing protection would be required for personnel in the immediate vicinity of the aerospace ground equipment, ground support equipment, ground power units, and other noise sources as noted above. The types of hearing protection would be prescribed by test plans, standard operating procedures, and maintenance manuals for the equipment used during the ground test activities. Edwards AFB regularly monitors noise complaints (which are often just inquiries); these average less than 30 per year. Although noise complaints associated with HPM test and evaluation are expected to be negligible, Edwards AFB would continue to monitor noise complaints as a normal part of community relations.

- Public/Emergency Services. The RF energy levels would be predetermined, and test plans would be developed to prevent the RF energy from exceeding specific absorption rate levels and the immunity levels for equipment at the public/emergency services locations as discussed in Section 3.11. The distances from the HPM system to the public/emergency services would be calculated and targeting solutions would be established to prevent impacts on these services or the unsuspecting personnel associated with these activities.

- Safety and Occupational Health. To minimize potential HPM RF hazards, multiple controls will be used to reduce the potential for impacts on unsuspecting receptors. These controls would include shielding, barriers and backdrops, distance, and time as described in Section 4.7.4.

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APPENDICES

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1.0 PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

This Environmental Assessment (EA) evaluates the potential environmental impacts associated with the integration and developmental test and evaluation of high power microwave (HPM) systems against targets on Edwards Air Force Base (AFB) and within restricted area R-2515. High power microwave is a directed energy (DE) system. Other DE systems include low power microwave, lasers, and charged or neutral particle beam systems.

This EA was prepared in accordance with all applicable federal, state, and local laws and regulations including the National Environmental Policy Act (NEPA) of 1969, as amended (42 United States Code [U.S.C.] 4321 *et seq*.); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 Code of Federal regulations [CFR] 1500–1508); U.S. Air Force Instruction 32-7061, *The Environmental Impact Analysis Process (EIAP)*; and Title 32 CFR Part 989, which implements these regulations in the EIAP and other federal and local regulations. The 95th Air Base Wing is representing the Department of Defense (DoD) as the lead agency.

1.2 LOCATION OF PROPOSED ACTION

The Proposed Action would occur primarily at selected locations on Edwards AFB and within restricted area R-2515 above Edwards AFB. Edwards AFB is located in the Antelope Valley region of the western Mojave Desert in Southern California, about 60 miles northeast of Los Angeles, California. Portions of the Base lie within Kern, Los Angeles, and San Bernardino counties. The Base occupies an area of approximately 301,000 acres or 470 square miles. Except for approximately 20 square miles on the Base's western border, the airspace above Edwards AFB lies totally within restricted area R-2515. Restricted area R-2515 occupies an area of approximately 2,000 square miles, extending from 45 miles north of Los Angeles, California, to 5 miles east of Mojave, California, and northeast to the south range at China Lake (restricted area R-2524). The eastern boundary of restricted area R-2515 approaches Ft. Irwin (restricted area R-2502N), and Barstow is to the southeast of the operating area (Figure 1-1).

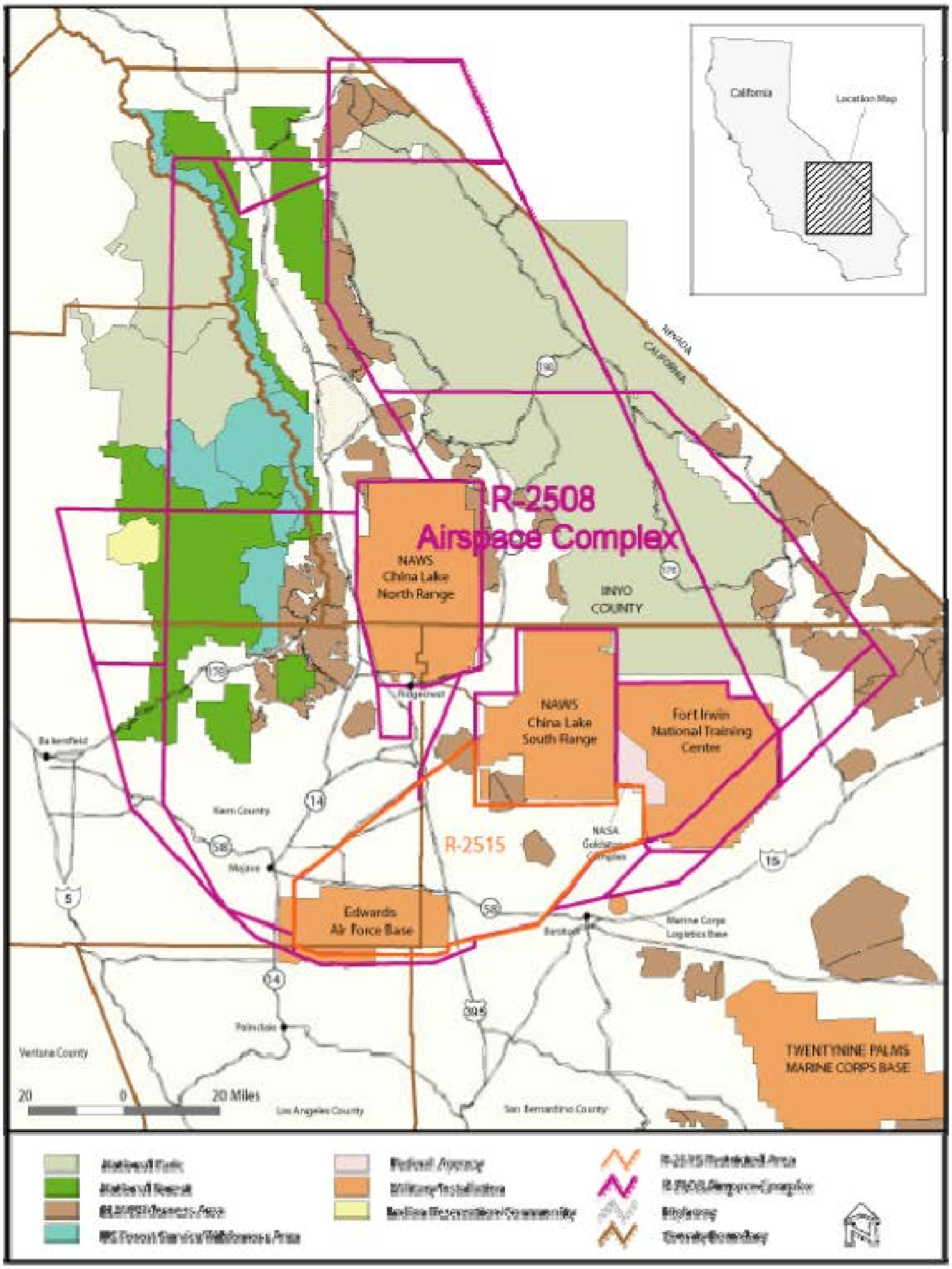


Figure 1-1 Edwards AFB and Vicinity Map

1.3 DEVELOPMENTAL TEST AND EVALUATION

Developmental testing of HPM systems to establish baseline measurements is necessary to understand characteristics of system hardware in relation to the aircraft or ground-based assets that would use the systems. Demonstrating the potential use and functioning of these systems under field conditions is another part of the decision-making process that is required before undertaking full scale production.

1.3.1 Test and Evaluation Process

An aircraft weapons system today is a tightly integrated system of airframe, engine, avionics (sensors and communications systems), and weapons. When current weapons become integrated with the avionics and sensor suite of the aircraft, it becomes impractical to test any part of the system (aircraft, avionics, or weapon) individually. As HPM systems, which are DE systems, continue to mature, they will also become an integral part of the complete aircraft system. As the primary Air Force test center for new aircraft and modifications of existing aircraft, it will be necessary for Edwards AFB to test the HPM components on aircraft of the future along with all the other components of the aircraft system. It is impractical to conduct a thorough test of the airframe, the engine, or any of the avionics suites without being able to operate the HPM system or test the HPM weapons as well. These systems and weapons could be similar in design to the Active Denial System (ADS) or Airborne Electronic Attack (AEA) HPM weapon. The outdoor test and evaluation of HPM systems and weapons could utilize facilities at Edwards AFB including, but not limited to, the Precision Impact Range Area (PIRA), portions of Rogers Dry Lakebed, and other base facilities and selected airborne targets in restricted area R-2515.

Thus, to continue providing the Air Force with a highly capable aircraft and aircraft weapon system test and evaluation capability it is essential that the Air Force Flight Test Center (AFFTC) conduct test and evaluation of HPM systems.

1.3.2 Test and Evaluation Objectives

The objectives of conducting integration and developmental test and evaluation of HPM systems and weapons include, but are not limited to, determining hardware characteristics, beam radiating characteristics, and system and mission performance. The following describes these objectives.

Determine Hardware Characteristics

Factors that must be considered to determine hardware characteristics include

- Selecting the appropriate packaging for the HPM systems (a function of size and weight constraints and platform with which the system is associated);
- Developing adaptable focusing arrays;
- Developing HPM systems with continuous wavelength capability;
- Identifying temperature and pressure constraints;
- Determine how to treat and dispose of residual energy buildup;
- System utility in all weather conditions;
- Developing failsafe software during beam projection to meet real-time conditions; and
- Adaptable hardware configuration for field military use.

Determine Beam Radiating Characteristics

Factors that must be considered to determine beam radiating characteristics include

- Identifying target acquisition and image enhancement necessary to support all weather conditions;
- Evaluating beam properties to determine the affect of reflection off target surfaces;
- Characterizing frequencies adaptable to all-weather conditions; and
- Improving beam properties to support long-range targeting.

Evaluate System and Mission Performance

Factors that must be considered to evaluate the HPM system and mission performance include

- Testing acquisition, tracking, and pointing subsystems;

- Investigating system and platform integration issues;
- Evaluating hardening requirements for friendly forces;
- Evaluating target effects; and
- Performing thermal, power, radio frequency interference system budget analysis and characterization.

1.4 BACKGROUND

The Air Force and other military services are investigating HPM systems to determine their application as weaponry on airborne platforms, ground-based stations, and mobile land-based sources. High-power microwave systems that have reached the developmental phase require extensive testing and evaluation before production can proceed. Examples of operational and developmental HPM systems include the ADS, Airborne ADS, and HPM Airborne Narrowband Munitions programs.

As part of its mission, the AFFTC conducts integration, test, and evaluation for the Air Force in addition to supporting other test and evaluation customers including the U.S. Army and U.S. Navy. The majority of the workload consists of testing integrated weapons systems, including all major subsystems, as part of the Air Force Materiel Command systems development and support. Each subsystem is evaluated to determine whether it will perform to the Air Force specifications, whether it will perform in conjunction with other subsystems in a mission environment, and the effects on the total system performance.

High power microwave energy is a form of DE. Directed energy is an umbrella term covering technologies that relate to the production of a beam of electromagnetic energy or atomic or subatomic particles (DoD 2003). Directed energy is propagated from selected regions of the electromagnetic spectrum emitting radiation energies that have distinct wavelengths and frequencies. Research into DE and microwave energy has been in progress for decades. Understanding the mechanisms that propagate these energies, understanding the systems that produce them, and characterizing their effects are the focus of current research and development by private industry and the military.

The world is entering an era where microwave technology is a part of everyday life. Microwave energy is pervasive in the civilian and commercial worlds. We are surrounded by DE systems from microwave ovens in our kitchens to the laser surgery used to correct our vision and remove or repair damaged tissue inside our bodies, allowing us to recover from surgery within hours instead of weeks or months.

The Air Force has committed to a vigorous program of developing, testing, and evaluating new operational concepts and developmental HPM systems. The application of HPM technology is opening opportunities to rapid changes in military strategies and operations. Because HPM systems take less time than conventional weapons to reach a target and can reduce the collateral damage to personnel and infrastructure, they offer broad applications at virtually every level of military operations and conflict from peacekeeping to intercontinental warfare.

High power microwave weapons offer military commanders the option of:

- Covert operations;
- Area coverage of multiple targets with minimal prior information on threat characteristics;
- Denying, degrading, disabling, or destroying selected levels of combat;
- Minimal collateral damage in politically sensitive environments; and
- Attacking sophisticated targets at low cost.

Speed and tunability (the ability to change the wavelength) are all, to a greater or lesser extent, characteristics of HPM systems that make them desirable for military applications. Figure 1-2 shows the evolution of HPM systems beginning with radio (simple radio frequency [RF] energy) in the 1920s, to sophisticated solid state devices in the 1970s, to the development of magnetrons, klystrons, and multi-wave generators that can produce high power RF energy.

Technical challenges for HPM weapons include developing and demonstrating high-peak power sources, high average power HPM sources, ultrawideband (UWB) antennas, high power pulse power drives, high power intermediate storage devices, prime power sources, predictive models for HPM effects and lethality, low-impact hardening of systems against hostile and self-induced electromagnetic interference, and system integration meeting military platform requirements. Testing HPM systems on targets at Edwards AFB and within restricted area R-2515 will enable the Air Force to answer many of the questions relating to the successful future deployment of these systems.

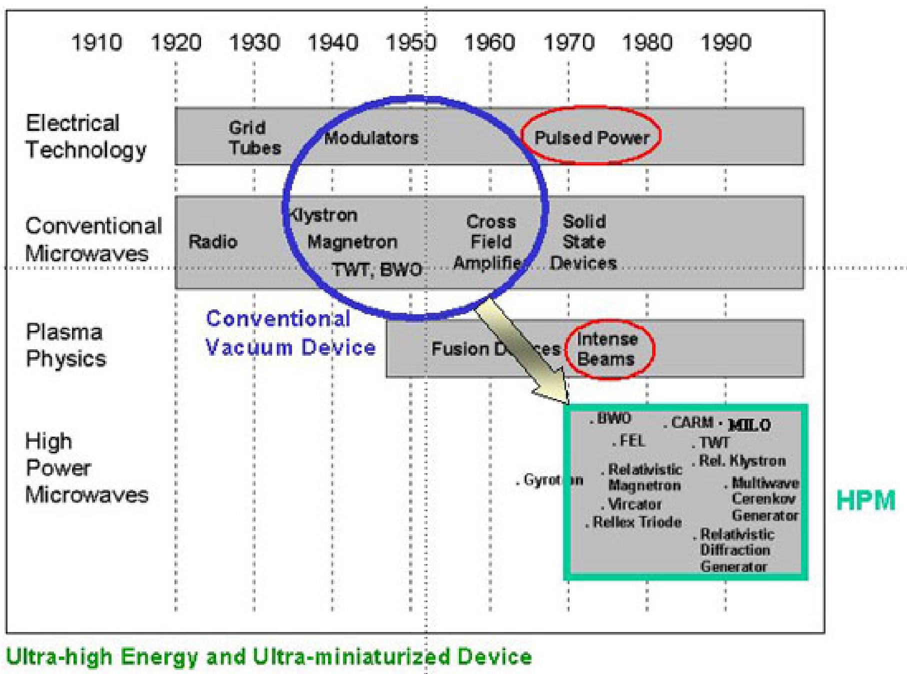


Figure 1-2 Historical Developments of High Power Microwave Systems

1.5 PURPOSE OF THE PROPOSED ACTION

The purpose of the Proposed Action is to conduct integration and developmental testing of the HPM systems with aircraft and ground-based weapons systems of the future at the AFFTC. The AFFTC mission is to "conduct and support research, development, test and evaluation of aerospace systems from concept to combat" (Bedke 2005). The mission of AFFTC has developed from a high performance aircraft flight test facility in the 1950s and 1960s to that of high technology integration and developmental testing and evaluation center for complete aircraft and avionics systems of today. Thus, HPM testing would continue the evolution of the primary mission of AFFTC and would be fully in accord with that mission as it has evolved since the 1940s.

1.6 NEED FOR THE PROPOSED ACTION

The Proposed Action is needed to support the Air Force goals for meeting future requirements that are considered necessary for the defense of the territorial United States. The *Air Force Transformational Flight Plan, Directed Energy Master Plan, AFFTC Roadmap,* and *Electronic Warfare Flight Plan* provide guidance for conducting test and evaluation of developmental systems such as HPM in a realistic environment. This EA serves as an assessment of the environmental effects and any mitigation measures that may be required to test and evaluate a variety of HPM technologies at Edwards AFB and against selected airborne targets in restricted area R-2515.

The United States has recognized that technologies applicable to the development and production of HPM systems can be critical to the war fighting capability of U.S. Forces on the land, sea, and air. The use of HPM systems can allow the United States to maintain the edge over our adversaries for the foreseeable future, with applications throughout the joint battlefield and entire spectrum of war. They represent a technology that will have tremendous impact on the joint service and Air Force operational concepts and our ability to win decisively in the future.

The *Air Force Transformational Flight Plan* (Flight Plan), published in November 2003, emphasizes the importance of developing strategies and concepts of operation appropriate for this new era. The Flight Plan provides guidance and recommends that we rethink our doctrinal approaches to organizing, training, and equipping Air Force units. In addition, the Flight Plan identifies key Air Force programs, advanced concept technology demonstrations, and future system concepts that the Air Force believes will likely be the key enablers of the transformational capabilities required for success. The Air Force recently completed a *Directed Energy Master Plan*, which articulates its strategy to develop and transition DE applications such as precision engagements, information superiority, and ballistic missile defense. It also identifies six DE science and technology programs that would offer near-term transformational capabilities to the Air Force if funding were accelerated: Advanced Tactical Laser, High Powered Microwave Airborne Electronic Attack (Mid-Term, 2010–15), Airborne Active Denial System (Long-Term, past 2015), the Evolutionary Air and Space Global Laser Engagements, and 100 Kilowatt Solid State Laser (U.S. Air Force 2003b). While these are the currently projected programs, technical achievements may result in advances of other unnamed programs that may take their place before they develop to the test and evaluation stage.

The *AFFTC Roadmap* (2004)—along with the *Electronic Warfare Flight Plan* (2004)—lays out a capabilities-based acquisition strategy to invest in developmental test and evaluation of DE platforms for the Air Force. This flight plans' scope captures this capability out to the year 2020.

1.7 ENVIRONMENTAL IMPACT ANALYSIS PROCESS

The NEPA established a national policy to protect the environment and ensure that federal agencies consider the environmental effects of their actions in their decision-making. The CEQ is authorized to oversee and recommend national policies to improve the quality of the environment. The CEQ published regulations that describe how NEPA should be implemented. These regulations encourage federal agencies to develop and implement procedures that address the NEPA process in order to avoid or minimize adverse effects on the environment. Title 32 CFR Part 989 addresses implementation of NEPA as part of the Air Force planning and decision-making process.

1.8 FUTURE USE OF THIS DOCUMENT

Future proposed projects would be reviewed and evaluated to determine if they fall within the scope of this EA. Program decision makers may use the analysis within this document if future proposed projects are determined to fall within the scope of this EA and no new environmental impacts would occur as a result of the future action. In some cases, a supplement to this EA may be required. If a supplemental EA were required, a new Finding of No Significant Impact would be necessary. Future actions that are found to result in a significant impact to the environment that could not be mitigated to a level of insignificance would need to be addressed in an Environmental Impact Statement.

1.9 STRUCTURE OF THIS EA

This EA analyzes and describes the potential environmental impacts that could result from the Proposed Action and Alternatives. As appropriate, the environmental consequences of the actions are presented in terms of regional and site-specific descriptions.

Section 2.0 of this EA describes the Proposed Action, Alternatives, and No-Action Alternative. In addition to providing project information, this section describes the general parameters associated with the Proposed Action.

Section 3.0 provides regional and site-specific information related to air quality, airspace, cultural resources, environmental justice, geology and soils, hazardous materials/waste, infrastructure, land use, natural resources, noise safety, socioeconomics, and water quality. The regional information included in this section provides the background for understanding the context of the site-specific information that could affect or be affected by the Proposed Action.

Section 4.0 addresses the potential effects of the Proposed Action on the resource areas analyzed. Possible impacts of project activities are analyzed, the significance of each impact is identified in each resource area, and mitigation measures, if required, are so stated.

Sections 5.0 through 8.0 identify, respectively, report references, persons and agencies contacted, preparers, and a list of acronyms and abbreviations used in this EA.

Appendix A is the Air Conformity Applicability Screening Analysis, Appendix B is the distribution list, Appendix C shows examples of the proposed target areas, Appendix D contains public and agency comments and the Air Force Response to Comments, and Appendix E contains wildlife survey and monitoring procedures for pre- and post-test analysis of the target areas.

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

This section describes the Proposed Action and Alternatives, including the No-Action Alternative. The potential environmental impacts of each alternative are summarized in table form at the end of this chapter. Alternative A, the Proposed Action, is to conduct open-air integration and developmental testing of HPM systems against targets at Edwards AFB and within restricted area R-2515 in the ground-to-ground (G/G), ground-to-air (G/A), air-to-ground (A/G), and air-to-air (A/A) modes. Alternative B is similar to Alternative A, except open-air integration and developmental testing would be limited to only using representative surrogate HPM systems with low power against targets at Edwards AFB and within restricted area R-2515 in the G/G, G/A, A/G, and A/A modes. Under Alternative C, the No-Action Alternative, open-air HPM integration and developmental testing would not occur.

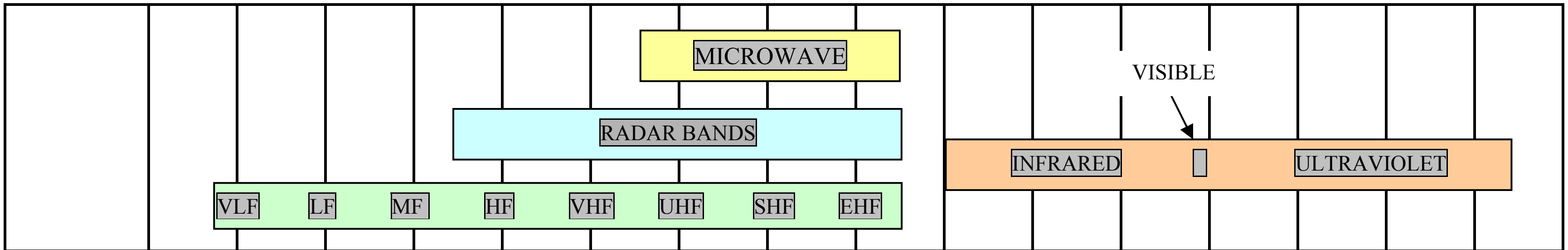
Target areas located only on Edwards AFB would be limited to 5 acres per site, with a maximum total of 100 acres for designated sites and undesignated future sites. Example photos of the proposed target areas are shown in Appendix C.

2.2 BACKGROUND

2.2.1 High Power Microwaves

Microwaves are electromagnetic waves with a wavelength longer than infrared light but shorter than radio waves. Conventional power sources or explosions are used to produce HPM energy at levels that can cause disruptions, degradation in performance, or destruction of electronic systems. Antennas are used to direct HPM energy in a specific direction. One form of high power microwaves has been used by electronic warfare radar jamming systems for many years by the U.S. military to degrade and deny the enemy's use of electronic surveillance and targeting radars.

High power microwave systems operate at a frequency range from 300 megahertz (MHz) to 300 gigahertz (GHz). Current HPM systems typically operate at frequencies up to 12 GHz. Figure 2-1 shows the frequencies of the microwave, radar, infrared, visible, and ultraviolet bands.



Frequency	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz	100 MHz	1 GHz	10 GHz	100 GHz	10^{12} Hz	10^{13} Hz	10^{14} Hz	10^{15} Hz	10^{16} Hz	10^{17} Hz	10^{18} Hz
Wavelength (λ)	300 km	30 km	3 km	300 m	30 m	3 m	300 mm	30 mm	3 mm	300 µm	30 µm	3 µm	300 nm	30 nm	3 nm	0.3 nm

Notes: VLF – very low frequency (3–30 kHz)
LF – low frequency (30–300 kHz)
MF – medium frequency (300–3 MHz)
HF – high frequency (3–30 MHz)
VHF – very high frequency (30–300 MHz)
UHF – ultra high frequency (300–3 GHz)
SHF – super high frequency (3–30 GHz)
EHF – extremely high frequency (30–300 GHz)

kHz – kilohertz (1,000 Hz)
MHz – megahertz (1,000,000 Hz)
GHz – gigahertz (1,000,000,000 Hz)
Hz – Hertz

km – kilometer (1,000 meters)
m – meter
mm – millimeter (1/1,000 meter)
µm – micrometer (1/1,000,000 meter)
nm – nanometer (1/1,000,000,000 meter)

Source: Directed Energy Professional Society 2004

Figure 2-1 Radio and Microwave Frequency Spectrum

Most households have microwave ovens that use RF energy of approximately 2.4 GHz to penetrate and cook food. Whereas a typical microwave oven generates less than 1,500 watts of power, the HPM system can generate higher levels of power that are intended to affect electronic systems. When microwave energy encounters modern microelectronics-based systems, the results can range from temporarily denying the use of the equipment to destroying the system's internal electronic components. The heavy reliance on electronic components in today's weaponry makes HPM systems attractive.

The application of HPM energy can be designed to deny, degrade, disable, or destroy electronics while having minimal direct effect on humans operating the equipment. The low physical damage aspect of the technology makes HPM weapons useful in a wide variety of missions where avoiding civilian casualties is a major concern.

High power microwave systems have potential application in command and control warfare, in suppressing enemy air defenses, and against tactical aircraft and unmanned aerial vehicles. These HPM systems can be designed for ground and air platforms or packaged in munitions that radiate energy after reaching the target area.

An example of a basic pulsed power HPM system is shown in Figure 2-2.

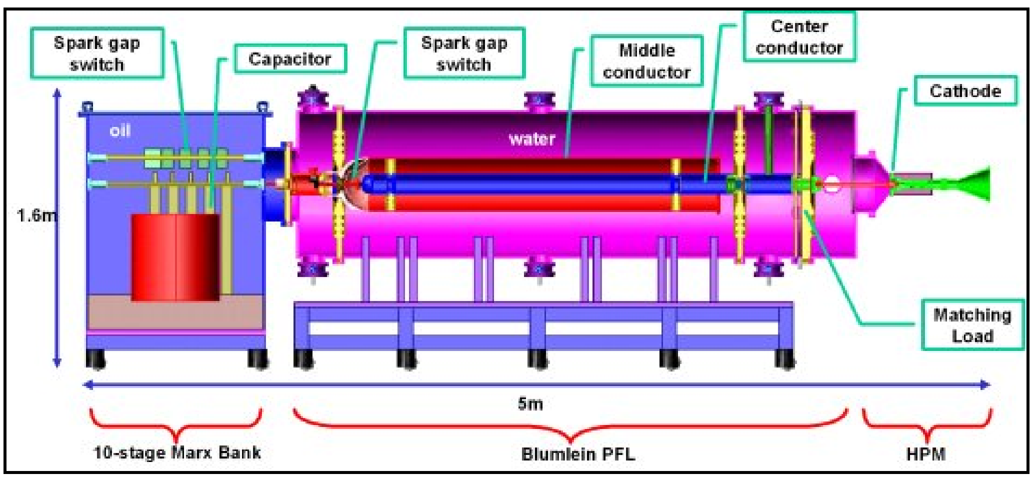


Figure 2-2 Basic High Power Microwave

2.2.2 Representative High Power Microwave Systems

The following representative developmental HPM systems and missions will be considered for the Proposed Action and Alternatives.

2.2.2.1 Active Denial Technology

Active denial technology (ADT) is an HPM system that enables a new class of weaponry using DE. This technology uses a beam of millimeter-wave RF energy to exploit the body's intolerance to temporary pain. Pain intolerance depends on the intensity and duration the RF energy. ADT is designed to cause pain on the surface of the body using a beam of energy to heat the tissue just below the skin surface and at the same depth as pain sensing nerves.

Ground-Based Active Denial Systems

A ground-based ADS consists of an electrical power source, a device producing millimeter-wave energy and an antenna directing the energy toward a target. Ground-based ADSs can be stationary or mounted on mobile platforms. Examples of ADS concepts are shown in Figures 2-3 and 2-4.

Figure 2-3 Example of a Ground-Based Active Denial System

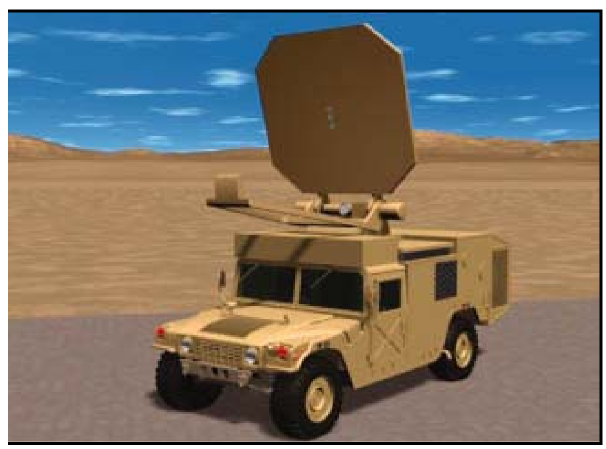


Figure 2-4 Artist's Rendition of a Mobile Active Denial System

Airborne Active Denial Systems

An airborne ADS is similar to the ground-based version. Examples of airborne ADS concept platforms are shown in Figure 2-5.

Figure 2-5 Examples of an Airborne Active Denial System

2.2.2.2 HPM Munitions Electronic Attack

The HPM narrowband and wideband weapons offer unique advantages when compared to conventional weapons. They can be designed to minimize injury to people. They can be used in an overt capacity to deny, degrade, disable, or destroy electronic resources over a broad geographic area. As such, their range of effects is considerably greater than that of conventional explosives. One weapon can be effective against many physically separated targets, making it possible to rapidly and persistently negate an adversary's electronics systems over wide areas. Artist’s renditions of HPM munitions attack by tactical aircraft are shown in Figures 2-6 and 2-7.

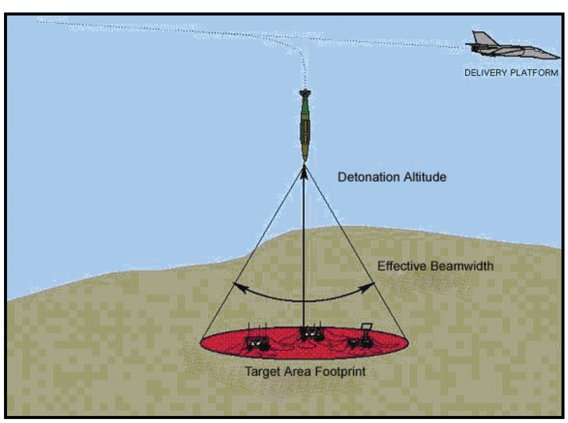


Figure 2-6 Artist Rendition of High Power Microwave Narrowband Munitions Attack

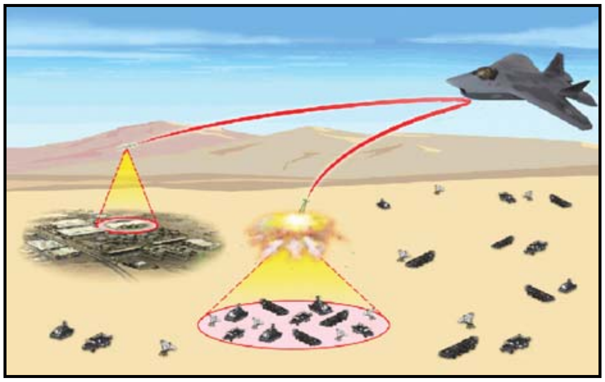


Figure 2-7 Example of HPM Munitions Electronic Attack

2.2.2.3 HPM Airborne Electronic Attack

An HPM AEA would be capable of selective and wide-area disruption and degradation of electronic systems used for command and control, weapons systems, and/or infrastructure, yet it would produce minimal physical damage. The Air Force has specific needs for an HPM system on a survivable aircraft that can neutralize targets in urban environments with low physical damage (Figure 2-8). HPM AEA could meet these requirements with large area coverage and would be effective in dynamic, ambiguous operational environments from wartime to peacetime crippling of high-priority electronic equipment.

Figure 2-8 AEA Used for Urban/Industrial Areas

2.2.3 Representative HPM Missions and Test Scenarios

2.2.3.1 Electronic Warfare (Airborne Electronic Attack) Mission

The HPM Munitions Electronic Attack program will create new types of HPM weapons to target an adversary's electronic subsystems within critical defense networks. These weapons will be incorporated into large diameter munitions and/or small sub-munitions and will be delivered by tactical aircraft or unmanned aerial vehicles (UAVs) away from our own assets. A key factor of the AEA mission is the ability of the HPM system to work against the enemy's system whether that system is on or off. There is a need to test the vulnerability and to perform battle damage assessments for the different effect levels (deny, degrade, disable, or destroy). Because these missions can occur in close proximity to our own forces in a covert or overt scenario, test scenarios must certify that the system can be used without affecting our own equipment. Figure 2-9 shows several possible scenarios for the AEA mission.

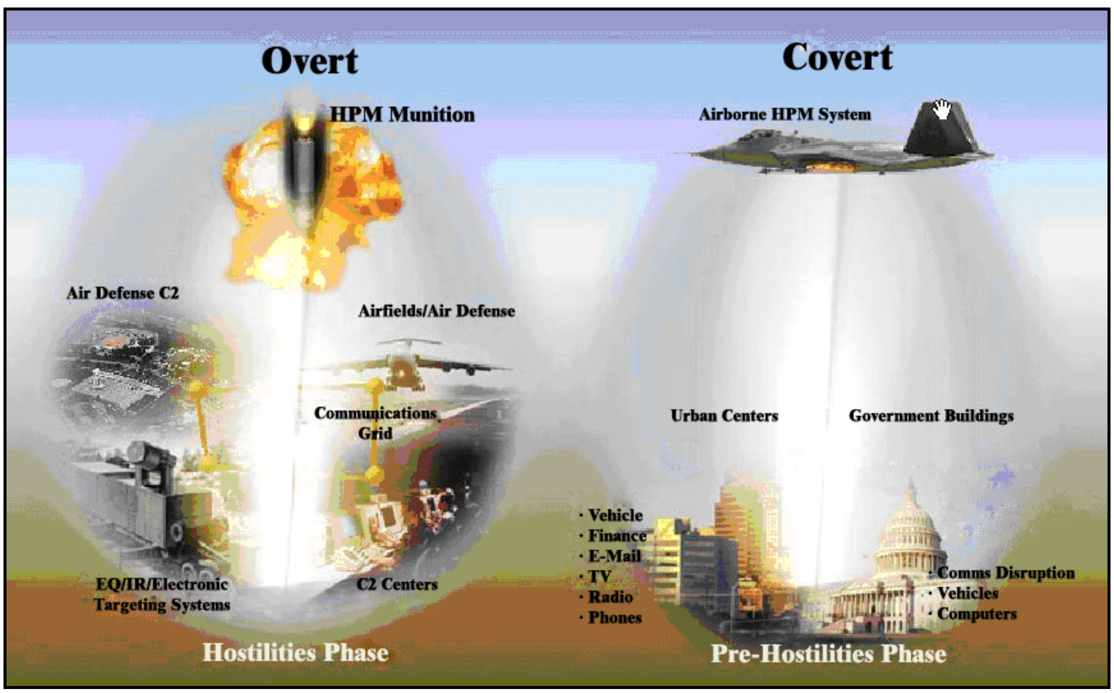


Figure 2-9 Overt and Covert AEA Missions

2.2.3.2 Strike Warfare Mission

A proposed scenario for a strike warfare mission using HPM munitions designed to disable equipment would be where the effect on equipment over broad area is desired rather than the physical effect. The Airborne ADS might be employed to flush out enemy troops from buildings and hiding places behind enemy lines. This system is ideal for disabling power distribution systems, communication links, and other electrical infrastructure.

2.2.3.3 Force Protection Mission

In a force protection mission, HPM systems like the ground vehicle stopper (GVS), ADS, and Airborne ADS would be used in a self-defense role. This scenario would have increased importance in military operations other than war and humanitarian roles. These HPM systems can minimize injury to the targeted personnel and can be employed without affecting friendly forces. Examples of how the different HPM systems could be used to support the force protection mission are shown in Figure 2-10.

Notes: ADS – Active Denial System
GVS- Ground Vehicle Stopper
PEP- Mobile non-lethal weapon with biological effects such as temporary paralysis, pain, or distraction.
PING – Hummer vehicle (HMMWV) mounted wideband microwave based integration system, called PING, used to identify concealed weapons.

Figure 2-10 Examples of How HPM Systems Can be Used for Self-defense

2.2.3.4 Survivability

In addition to military mission test capabilities, these HPM systems need to be tested for friendly forces survivability. The test scenario for the survivability would focus on characterizing our own aircraft, communications equipment, and other electronic systems to ensure they are resistant to enemy HPM system attacks as well as HPM munitions employed by other friendly forces. Typical tests might include enemy ground-based and air-based HPM systems against United States aircraft and HPM detection systems.

2.2.3.5 Facilities Protection Mission

The facilities protection mission is similar to the force protection mission, except it would be implemented during a peacetime environment and would be used only as specified in rules of engagement. Types of HPM systems employed for the facilities protection mission could include ADS, GVS, PING (a vehicle-mounted, wideband microwave based integration system), and PEP (a mobile, non-lethal weapon with biological effects).

2.2.3.6 Homeland Security Mission

In a homeland security mission scenario, the HPM systems could provide facilities security and border security and aid law enforcement with crowd control. The ADS or GVS could be used for criminal interdiction to either stop criminal actions or prevent high speed car chases. Examples of HPM systems employed for homeland security are shown in Figure 2-11.

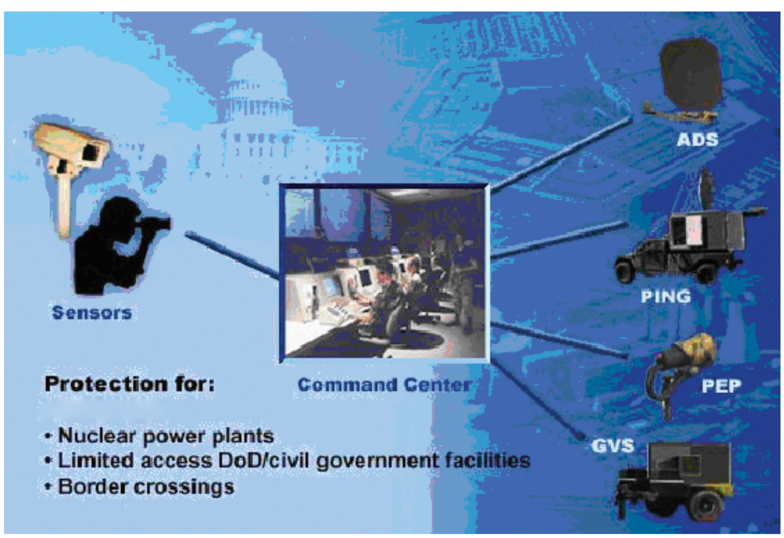


Figure 2-11 HPM Systems Used in a Homeland Security Role

2.3 ALTERNATIVES IDENTIFICATION PROCESS

The analysis of the Proposed Action and Alternatives is the cornerstone of the EA. It is intended to provide the decision maker and the public a clear understanding of the relevant issues and the basis of the choice among identified options. The alternatives must fulfill the need and purpose of the Proposed Action and be consistent with the goals, policies, management strategy, and mission requirements of the AFFTC.

The criteria identified here establish a minimum set of requirements that must be met in order for an alternative to be considered viable. Those not meeting one or more of the selection criteria have been eliminated from further discussion. The reason(s) why each was eliminated is/are documented in Section 2.4.5. Alternatives meeting all selection criteria are retained and each is fully analyzed in Chapter 4 (Environmental Consequences) of this EA.

The criteria used to select the alternatives discussed in this document are described below. They address the need to test complete weapon system performance at the AFFTC when the test requires the operation of an HPM system. A viable alternative would

- Present a broad range of airspace and ground test areas for operations of the test aircraft, its applicable subsystems, and the HPM system under test.
- Allow full functioning of the HPM system for complete system evaluation.
- Provide a full range of instrumentation and data reduction capability.
- Include a wide range of targets and target areas for evaluation of HPM system effectiveness.
- Support operation of all aircraft subsystems required to integrate with the HPM (i.e., electrical, hydraulic, avionics, engines, flight controls).
- Permit operation of both the aircraft and the HPM system without restrictions that would invalidate test results.
- Provide an acceptable safety environment including necessary containment of HPM energy.

2.4 DESCRIPTION OF THE ALTERNATIVES

High power microwave testing against targets on Edwards AFB and in restricted area R-2515 would be conducted in accordance with the requirements listed in the test plan, test schedule, operational regulations, and safety standards. The period of performance for this proposed action extends through 31 December 2012. The maximum number of aircraft flight and ground test hours conducted under this proposed action is listed in Table 2-1. This data shows representative aircraft types that could be used during testing. Other aircraft of similar characteristics (i.e., noise, emissions. etc.) could be used and would be expected to create effects similar to those shown in Chapters 3 and 4.

Table 2-1

Number of Aircraft Flight and Ground Test Hours for Proposed Action

	2006	2007	2008	2009	2010	2011	2012
Aircraft			Flight Test Hours[1]				
C-17	0	0	96	96	96	96	96
C-130	0	0	96	96	96	96	96
C-135	0	0	96	96	96	96	96
X-45/X-47	0	0	96	96	96	96	96
Total	0	0	384	384	384	384	384
			Ground Test Hours[2]				
C-17	0	0	72	72	72	72	72
C-130	0	0	72	72	72	72	72
C-135	0	0	72	72	72	72	72
X-45/X-47	0	0	72	72	72	72	72
Total	0	0	288	288	288	288	288

Notes: 1 – Assumes a 3-hour flight test, with an average of 2 or 3 tests per aircraft type per month from 2008 through 2012.
2 – Assumes one 6-hour ground test per month for each aircraft.

The maximum number of generator hours used for ground test of HPM devices other than aircraft is listed in Table 2-2. These data show representative generator types that could be used during testing. Other generators of similar characteristics (e.g., noise, emissions) could be used and would be expected to create effects similar to those shown in Chapters 3 and 4.

Table 2-2

Generator Hours for Non-Aircraft–Related HPM Ground Tests

	2006	2007	2008	2009	2010	2011	2012
Generator				Ground Test			
Cummins QSB5.9	50	300	300	300	300	300	300
A/M32A-60B	50	300	300	300	300	300	300

2.4.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

Alternative A, the Proposed Action Alternative, is to conduct open-air integration and developmental testing of HPM systems against targets on Edwards AFB and within restricted area R-2515 in the G/G, G/A, A/G, and A/A modes (Figure 2-12). All ground targets would be located on Edwards AFB, and each target would be limited to 5 acres; there would be with a maximum total disturbance of 100 acres on the base. No targets are planned for areas outside of Edwards AFB.

Developmental HPM systems are being tested and evaluated to determine their technical characteristics and performance. Developmental systems are those systems that have reached the developmental phase from the conceptual model and require a period of further testing and evaluation before production is justified.

Next generation developmental systems will require testing and evaluation of variants to current systems like the ADS technologies. If microwave emissions leave the controlled airspace of the test range, HPM testing events would require clearance from the U.S. Space Command and the regional Federal Aviation Administration (FAA) depending on the wavelength, power, beam width, and vector (e.g., above the horizon). The Frequency Spectrum Manager at Edwards AFB will coordinate the use of frequencies required for HPM test to ensure impacts on non-participating equipment are minimized. Developmental systems would be investigated to quantify baseline information on beam characteristics and hardware properties. Some of the properties that will be investigated and developed during the test and evaluation are presented in Table 2-3.

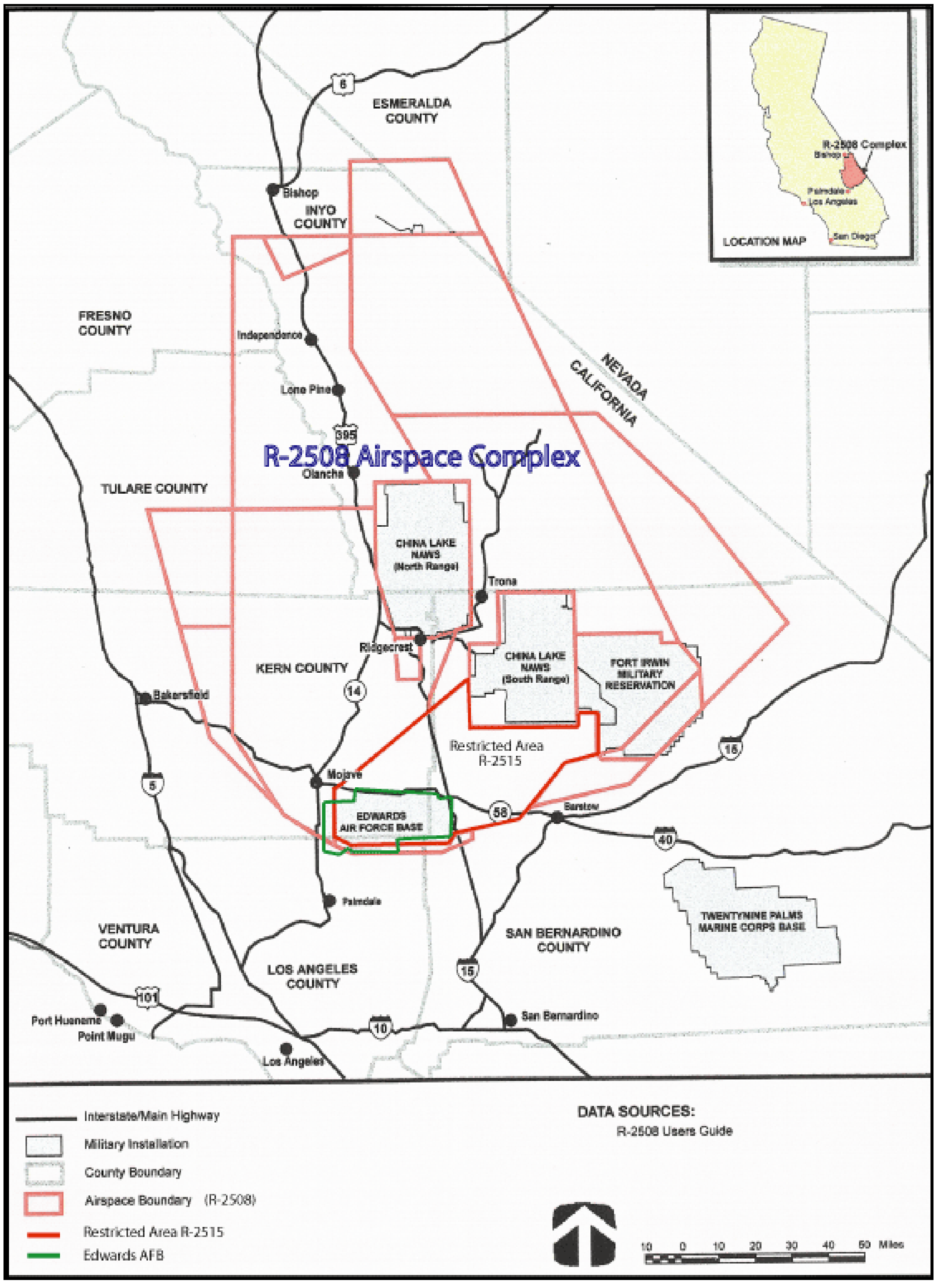


Figure 2-12 Edwards AFB and Restricted Area R-2515 for the Proposed Action

Table 2-3

Candidate HPM System Properties Requiring Test and Evaluation

Beam Properties	Hardware Systems
Refine target acquisition and targeting capability	Refine adaptable waveguide focusing for differing target requirements
Calibrate target distances with software systems	Refine HPM systems that are transportable and functional in the field
Refine target image enhancement capability	Refine software command and control systems with HPM operations
Refine transmission frequencies to deliver maximum power to target	Refine mechanisms for disposal of generated hazardous waste
Determine reflective potential of various target surfaces	Develop failsafe software during HPM activities, and calibration software package to meet real-time field conditions
Determine effects of weather on beam propagation	Refine electronic strike capability from ground or air capability
	Refine HPM countermeasure system against missiles

Adaptation of these HPM systems to a war-fighting capability would be further investigated to determine field applicability. Developmental systems that may be tested and evaluated in variant forms against targets at Edwards AFB and in restricted area R-2515 could include the following ground and flight test activities.

2.4.1.1 Ground Test Activities

Ground testing of developmental HPM systems would be conducted from ground stations and man-transportable and/or ground vehicles located in positions on Edwards AFB as determined by the test plan. HPM beams would be directed over open land to ground targets. Targets would be located in areas of topographic relief with significant size. Targets would be selected with natural terrain features appropriate for beam management. Individual target areas would be limited to 5 acres, with a cumulative total of 100 acres on the PIRA. Examples of target locations on Edwards AFB would include abandoned buildings and other targets like Grinnel, Mt. Mesa, Jackrabbit Hill, and Haystack Butte (Figure 2-13). Photos of several of these proposed target areas are shown in Appendix C.

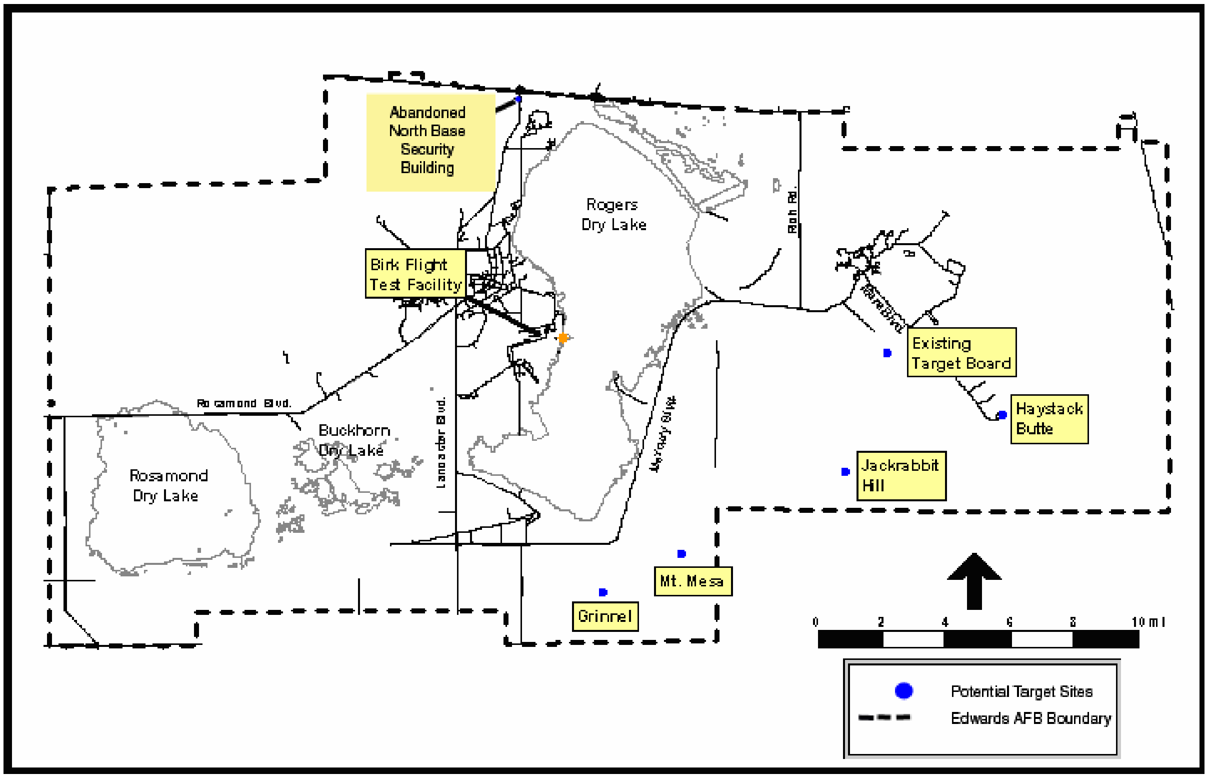


Figure 2-13 Examples of HPM Target Areas on Edwards AFB

The HPM systems would be directed at designated target areas with each firing position (FP) evaluated and authorized by the Range Safety Office and Range Control Office prior to the HPM event. Each of the FPs would have to meet specific requirements regarding radiation beam width angles for each target site. The antenna beam width angle is defined as the amount of beam spread relative to its maximum radiation level. The antenna beam width is a factor in determining the surface danger zone (SDZ), a calculated area where high energy levels may exceed the maximum permissible exposure (MPE). The MPE is the level at which a person may be exposed without harmful effect and with an acceptable degree of safety.

Additional target areas or targets would be assessed using environmental management and bioenvironmental engineering criteria to assure that minimal risk to human health, biological, cultural, and other resource areas would occur.

Ground testing activities could include the following:

- HPM system servicing that would be accomplished per developer, test plan, and safety requirements.

- Construction and placement of targets made of materials designed to replicate real world targets, but mounted with an array of sensors and telemetry instruments. Targets could be stationary or mounted on vehicles.
- Testing of developmental HPM systems in the G/G, G/A, and A/G modes as applicable to the particular system.
- Long-distance targeting capability out to 10–15 nautical miles. (Currently, due to limitations on the size of the transmitting antenna, the maximum distance from the HPM-equipped aircraft or ground platform to the target would be approximately 15 nautical miles; however, as the technology and the ability to focus the HPM beam improved, distances between the source and the target would be expected to increase.)
- Development and testing of HPM countermeasures.
- Characterizing the acquisition, tracking, and pointing subsystems.
- Developing and evaluating operational system software for command and control.
- Survivability studies.

2.4.1.2 Flight Test Activities

Aircraft-mounted developmental HPM systems that radiate RF energy to targets on any of the Edwards AFB Management Areas will be permitted for testing as authorized by Environmental Management, Bioenvironmental Engineering, the Range Control Office, and the Range Safety Office. The SDZ for each test scenario would be calculated and approved by the Range Control Office prior to any HPM testing event. The SDZ is a function of modeling and simulation which is currently under development. Knowledge of the SDZ for each HPM system is critical in allowing HPM systems to be tested on any of the pre-designated A/G targets on Edwards AFB due to land use constraints based on biological resources.

The HPM testing performed in the air would be used to evaluate beam targeting and collateral effects for the developmental HPM systems per the approved test plan. Surrogate systems with reduced power could be used to test and evaluate many of the targeting and beam characteristics; however, low power surrogate systems could not be used to evaluate the full range of effects. Calibrations of system software packages to HPM beam control and command would also be tested and evaluated. Flight test activities could include the following:

- In-flight servicing of HPM systems accomplished per developer, test plan, and safety requirements;
- Construction and placement of targets made of materials designed to replicate real world targets, but mounted with an array of sensors and telemetry instruments. Targets could be mounted on simulated air platforms or designated air targets designed to minimize RF reflections;
- Testing developmental HPM systems in the A/A and A/G modes as applicable to the particular system;
- Long-distance targeting capability out to 15 nautical miles (Currently, due to limitations on the size of the transmitting antenna, the maximum distance from the HPM-equipped aircraft or ground platform to the target would be approximately 15 nautical miles; however, as the technology and the ability to focus the HPM beam improved, distances between the source and target would be to increase.);
- Development and testing of HPM system countermeasures;
- Developing and evaluating operational system software for command and control; and
- Survivability studies.

2.4.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Alternative B is similar to Alternative A, except only surrogate HPM systems with reduced power levels would be tested in the G/G, G/A, A/G, and A/A modes against targets on Edwards AFB and in restricted area R-2515. The capability and power from surrogate HPM systems would be similar to the present surrogate laser sources, which project the energy from a 10–14 watt source with an effective power of less than 1 watt when it leaves the device. In comparison, a common hand-held hair dryer is rated between 1,200 and 1,600 watts (1.2 to 1.6 kilowatts). High power tests of HPM systems would occur at locations to be determined by supplemental analysis and would not be authorized by the analysis in this EA. Ground testing of surrogate HPM systems would be conducted from ground stations and man-transportable and/or ground vehicles located in positions on Edwards AFB as determined by the test plan. HPM testing performed in the air would be used to evaluate beam targeting for the surrogate HPM systems per the approved test plan. Under Alternative B, the range of collateral effects (on the equipment and personnel for enemy or friendly forces) that would result from conducting full power test for either ground or flight related activities could not be determined. Environmental Management, Bioenvironmental Engineering, the Range Control office, and Range Safety office would provide recommendations to 95th Air Base Wing Commander, 412th Test Wing Commander, Air Force Flight Test Center Commander, and/or Operations Group Commander, who would determine if the level of risk anticipated by the specific HPM test activity was acceptable before the test and safety plan would be approved. Refer to Section 2.4.1 for a detailed description of the types of systems and test activities.

2.4.3 Alternative C (No-Action Alternative)

Alternative C (No-Action Alternative) is the status quo; the open-air HPM system integration and developmental testing would not occur against targets on Edwards AFB or within restricted area R-2515.

2.4.4 Alternatives Eliminated From Further Consideration

The CEQ regulations require that NEPA documents evaluate all reasonable alternatives, briefly discuss those alternatives eliminated from detailed analysis, and provide the reasons for elimination of any alternatives (40 CFR 1502.14(a)). "Reasonable is defined as practical or feasible from a common sense, technical, and economic standpoint." (51 *Federal Register* [FR] 15618, April 25, 1986).

2.4.4.1 Establishing High Power Microwave Targets Throughout the R-2508 Complex

The testing of HPM systems throughout the R-2508 Complex was considered but eliminated from consideration because of the potential constraints from and impacts to populated areas between firing positions and target sites.

2.4.4.2 Testing High Power Microwave Systems Where High Power Microwave Equipped Aircraft Remained over Edwards AFB for all Phases of A/A, A/G, and G/A Modes

This alternative was evaluated but eliminated from consideration because flight profiles requiring an aircraft to remain over Edwards AFB could not be achieved. Normal flight operations from Edwards AFB would not impose such a restriction on other types of tests due to the required turning radius for test and target aircraft.

2.4.4.3 Testing High Power Microwave Systems Only in Indoor Facilities on Edwards AFB

Testing HPM systems only in indoor facilities would not allow full system integration and testing inherent in the AFFTC mission. Environmental factors and impacts associated with open air tests could not be ascertained in a closed indoor environment; therefore this alternative was eliminated.

2.4.4.4 Testing High Power Microwave Systems in the A/S and S/G Modes

The testing of HPM systems in the air-to-space (A/S) and space-to-ground (S/G) modes were considered, however, because an extremely large antenna size would be required to radiate sufficient RF energy in these modes, this potential alternative was eliminated.

2.5 ISSUES AND CONCERNS CONSIDERED

During the scoping process, the following issues and concerns were identified as requiring assessment when considering the potential environmental impacts of the alternatives.

- Air Quality. Emissions from the generators needed to produce the millions of watts of power required for this testing need to be considered. Emissions from HPM equipped aircraft and airborne targets should also be considered.

- Air Space Management. HPM activities would be performed primarily at Edwards AFB and within restricted area R-2515. The effects on aircraft electronic systems must be considered for other aircraft operations in restricted area R-2515, in the vicinity of the base, and in the surrounding airspace in the National Airspace System.

- Cultural Resources. There would be no anticipated direct effects on cultural resources. Target areas would not be located near any known cultural resources. However, this area will be evaluated to verify that no adverse impacts on cultural resources would result from the proposed testing.

- Hazardous Materials and Waste. The integration and developmental testing of HPM systems is not likely to create significant quantities of hazardous waste. HPM systems are typically closed loop systems; however, chemicals must be replaced in these systems periodically.

- Infrastructure. Testing and evaluation of HPM systems may require renovation and additions to existing facilities and utility systems. The addition of support personnel would also affect traffic flow on base during program activities. Installation of energy efficient systems would be part of the conservation measures to reduce energy consumption and operating costs. The effects on electronically driven infrastructure systems should be evaluated.

- Land Use. HPM systems could be directed at targets in the PIRA and at sites in portions of the Rogers Dry Lakebed, and other Management Areas as identified in test plans approved by the appropriate Wing or Group Commander. HPM system targets would be located in designated areas approved by Environmental Management (EM). Developmental HPM systems may require additional target sites be established in the PIRA and other Management Areas during G/G, A/G, and G/A tests. These sites would require environmental compliance review prior to designation as targets.

- Natural Resources. Potential impacts on natural habitats may result during the setting up of new target sites, when traveling to the firing points and target areas on the dirt roads, or when the HPM system radiates at a target site. There is also a potential for harm to wildlife, plant communities, and habitat during testing caused by the effects of RF energy.

- Noise. Potential impacts due to the additional personnel, traffic, and ground and flight activities will be assessed. Noise from the RF beam is not anticipated to occur.

- Safety and Occupational Health. The RF energy from HPM systems directed at targets could affect human life support systems. Effects on civilians and employees participating in the testing, as well as those who are not participating, must be considered. Effects on explosives and munitions should also be considered. The reflective properties of soils may create a hazard.

- Socioeconomics. An increase in support personnel during program activities would affect services and the economy on the Base and in the surrounding community.

- Public/Emergency Services. The operating areas selected for this proposed action are within the footprint of Edwards AFB for all ground-based activities. Flight related tests would be restricted to selected targets on Edwards AFB and to restricted area R-2515. Entrance to the base and target areas requires specific access. Test Plans would limit access to test and evaluation operations areas. Provisions for public and emergency services are established for the Base and the communities within restricted area R-2515 that are necessary to meet the needs of the AFFTC mission; however the effects on 911 service, cell phones, dispatch radios, and other emergency resources must be evaluated.

2.6 ISSUES AND CONCERNS DISCUSSED BUT NOT CONSIDERED RELEVANT FOR FURTHER ANALYSIS

The following issues and concerns were initially considered, but subsequently eliminated from further analysis in this EA. Consequently, they will only be briefly addressed in Chapters 3 and 4.

- Environmental Justice and Protection of Children. The Executive Orders (EOs) on Environmental Justice and the protection of children require federal agencies to identify and address disproportionately high adverse effects of their activities on minority and low-income populations and children. This action has been reviewed in accordance with EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, and EO 13045, *Protection of Children from Environmental Health and Safety Risks*. Given that all targets and construction activities would occur entirely on or over the Base, the U.S. Air Force has determined that this action would have no substantial, disproportionate impacts on minority, low-income populations, and/or children.

- Geology and Soils. Significant effects on geology and soils would not be anticipated. Seismic events are not expected to create significant impacts or effect from testing HPM systems.

- Water Resources. Significant effects on water quality and water resources would not be anticipated.

2.7 OTHER FUTURE ACTIONS IN THE REGION

Other actions within the region were evaluated to determine whether cumulative environmental impacts could result from implementation of the Proposed Action and Alternatives. Cumulative impacts result from "the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508.7).

Other actions within the geographic area of Edwards AFB and restricted area R-2515 and R-2508 special use airspace that could be considered to have the potential for cumulative effects include other flight test programs. However, because appropriate range safety requirements are in place to ensure a safe environment to conduct flight tests, along with coordination with the FAA, these actions would not be expected to have cumulative impacts. Refer to Section 4.15 for a discussion of cumulative impacts resulting from this Proposed Action.

2.8 COMPARISON OF ENVIRONMENTAL IMPACTS

Table 2-4 presents a summary of anticipated environmental impacts for each alternative.

Table 2-4

Anticipated Environmental Impacts for the Affected Environment

Resource Area	Alternative A	Alternative B	Alternative C
Air Quality	Minimal	Minimal	None
Air Space	Minor	None	None
Cultural Resources	Minimal	None	None
Geology and Soils	None	None	None
Environmental Justice	None	None	None
Hazardous Waste/Hazardous Materials	Minimal	Minimal	None
Infrastructure	Moderate	Minimal	None
Land Use	Minor	Minimal	None
Natural Resources	Minor	Minimal	None
Noise	Minimal	None	None
Public/Emergency Services	Moderate	Minimal	None
Safety	Moderate	Minimal	None
Socioeconomics	Minor	Minimal	None
Water Resources	None	None	None

Notes: Minimal: The impacts are not expected to be measurable, but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so the impact is not substantial.

Minor: The impacts are measurable, but are within the capacity of the impacted system to absorb the change, or the impacts can be compensated for with little effort and resources so the impact is not substantial.

Moderate: Potentially adverse impacts that are measurable; but do not violate any laws or regulations and are within the capacity of the impacted system to absorb the change, or the impacts can be mitigated with effort and resources so that they are not significant.

None: There are no impacts expected.

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3.0 AFFECTED ENVIRONMENT

This chapter describes existing environmental conditions likely to be affected by Alternatives A, B, and C. The Region of Influence (ROI) consists of restricted area R-2515 (airspace) and Edwards AFB (airspace and land). The ROI for each action will be discussed in terms of: (1) restricted area R-2515 and (2) Edwards AFB, where applicable. The land area of Edwards AFB lies beneath the southern portion of restricted area R-2515. Target areas and firing points on Edwards AFB would be limited to 5 acres per site, with a maximum of 100 acres total that could be disturbed under this Proposed Action and Alternatives for the designated sites and future undesignated sites.

Resources within the ROI have been identified under the following categories: air quality, airspace, cultural resources, *environmental justice and protection of children*, *geology and soils*, hazardous waste/hazardous materials/solid waste, infrastructure, land use, natural resources, noise, public/emergency services, safety and occupational health, socioeconomics, and *water resources*. Resource categories shown in italics will be briefly covered.

3.1 AIR QUALITY

Air quality in a given location is defined by the concentration of various pollutants in the atmosphere and is typically expressed in parts per million or micrograms per cubic meter. By comparing a pollutant concentration in the atmosphere to federal and/or state ambient air quality standards, the significance of its presence can be determined. These standards represent the maximum allowable atmospheric concentrations that may occur while still protecting public health and welfare with a reasonable margin of safety. The federal standards are established by the U.S. Environmental Protection Agency (U.S. EPA) and are termed the National Ambient Air Quality Standards (NAAQS). The NAAQS are defined as maximum acceptable ground-level concentrations that may not be exceeded more than once per year, with the exception of annual standards that may never be exceeded. These standards include concentrations for ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter 10 microns or less in diameter (PM_{10}), particulate matter 2.5 microns or less in diameter ($PM_{2.5}$), and lead. The California Air Resources Board (CARB) has established state standards termed the California Ambient Air Quality Standards (CAAQS). The CAAQS are at least as restrictive as the NAAQS and include pollutants for which there are no national standards. The national and state ambient air quality standards are shown in Table 3-1.

Table 3-1

National and California Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards	National Standards[a]	
			Primary[b,c]	Secondary[b,d]
Ozone	1-hour	0.09 ppm	0.12 ppm	Same as primary
	8-hour	---	0.08 ppm	Same as primary
Carbon monoxide	1-hour	20 ppm	35 ppm ($40\ mg/m^3$)	None
	8-hour	9.0 ppm	9 ppm ($10\ mg/m^3$)	None
Nitrogen dioxide	1-hour	0.25 ppm	---	---
	Annual (arithmetic mean)	---	0.053 ppm ($100\ \mu g/m^3$)	Same as primary
Sulfur dioxide	1-hour	0.25 ppm	---	---
	3-hour	---	---	0.5 ppm ($1{,}300\ \mu g/m^3$)
	24-hour	0.04 ppm	0.14 ppm	---
	Annual (arithmetic mean)	---	0.03 ppm	---
PM_{10}	24-hour	$50\ \mu g/m^3$	$150\ \mu g/m^3$	---
	Annual (arithmetic mean)	$20\ \mu g/m^3$	$50\ \mu g/m^3$	Same as primary
$PM_{2.5}$	24-hour	---	$65\ \mu g/m^3$	---
	Annual (arithmetic mean)	$12\ \mu g/m^3$	$15\ \mu g/m^3$	Same as primary
Lead	30-day average	$1.5\ \mu g/m^3$	---	---
	Quarterly average	---	$1.5\ \mu g/m^3$	Same as primary

Notes: a – Other than for ozone and those based upon annual averages, standards are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than 1.

b – Concentrations are expressed first in the units in which they were promulgated. Equivalent units are given in parentheses.

c – Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than 3 years after the U.S. EPA approves the state's implementation plan.

d – Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after the U.S. EPA approves the implementation plan.

EPA – Environmental Protection Agency

Table 3-1

National and California Ambient Air Quality Standards (Continued)

Notes: (Continued)

$\mu g/m^3$ – micrograms per cubic meter
mg/m^3 – milligrams per cubic meter
$PM_{2.5}$ – particulate matter 2.5 microns or less in diameter
PM_{10} – particulate matter 10 microns or less in diameter
ppm – parts per million

Source: California Air Resources Board 2003a

The pollutants considered in the impact analysis of this EA include volatile organic compounds (VOCs), ozone, CO, NO_2, SO_2, and PM_{10}. Since conformity guidelines do not present threshold levels for $PM_{2.5}$ and only negligible sources of lead are associated with the proposed project, $PM_{2.5}$ and airborne emissions of lead are not considered in this EA. Emissions of NO_2 and VOCs are of particular concern, as they are precursors to the formation of ozone.

Ozone concentrations are generally highest during the summer and coincide with the period of maximum insolation, or the maximum amount of solar radiation striking the earth's surface. Maximum ozone concentrations tend to be regionally distributed due to the homogeneous dispersion of precursor emissions in the atmosphere. Concentrations of inert pollutants, such as CO, tend to be the greatest during the cooler months of the year and are often a product of light wind conditions and nighttime/early morning surface-based inversions. Maximum inert pollutant concentrations are usually found near an emission source.

Evaluating impacts to air quality in the ROI requires knowledge of (1) the types of pollutants being emitted, (2) emission rates of the pollutant source, (3) the proximity of project emission sources to other emission sources, (4) topography, and (5) local and regional meteorological conditions. The area of effect for emissions of inert pollutants (pollutants other than ozone and its precursors) is generally limited to a few miles downwind from the source. The area of effect for ozone generally extends much further downwind. In the presence of solar radiation, the maximum effect of precursor emissions on ozone levels usually occurs several hours after their release and, therefore, many miles from the source.

The U.S. EPA designates all areas of the United States as having air quality better than (attainment) or worse than (non-attainment) the NAAQS. The criteria for non-attainment designation vary by pollutant. An area is (1) in non-attainment for ozone if its NAAQS has been exceeded more than three discontinuous times in 3 years at a single monitoring station and an area is (2) in non-attainment for any other pollutant if its NAAQS has been exceeded more than once per year. Pollutants in an area are often designated as unclassified when there are insufficient ambient air quality data for the U.S. EPA to form a basis for attainment status. The CARB considers an area to be in non-attainment of a CAAQS for a particular pollutant if (1) the standards for ozone, CO (except Lake Tahoe), SO_2 (1- and 24-hour), NO_2, PM_{10}, and visibility reducing particles have been exceeded or (2) the standards for the remaining pollutants have been equaled or exceeded.

Air quality regulations were first promulgated with the federal Clean Air Act (CAA). This Act established the NAAQS and delegated the enforcement of air pollution regulations to the states. In areas where the NAAQS are exceeded, the CAA requires preparation of a State Implementation Plan (SIP) that describes how a state will attain the standards within mandated time frames. The CAA Amendments revised the attainment planning process, basing new requirements and compliance dates for reaching attainment upon the severity of the air quality standard violation.

Federal conformity guidelines included in the CAA Amendments state that a federal agency cannot support an activity unless the agency determines that the activity will conform to the state's most recent SIP approved by the U.S. EPA within the region of the proposed action. These guidelines state that federally supported or funded activities must show that the proposed actions will not (1) cause or contribute to any new air quality standard violation in any area, (2) interfere with programs outlined in any SIP for maintenance of any standard, (3) increase the frequency or severity of any existing standard violation in any area, or (4) delay the timely attainment of any standard or any required interim emission reductions or other milestones in any area. The activities proposed herein are considered exempt from this rule as long as there is no increase in emissions above the *de minimis* levels specified in the rule. Therefore, a screening to determine the applicability of the conformance guidelines was performed. Table 3-2 presents the *de minimis* threshold levels presented in the conformity rule for non-attainment areas.

Ensuring reasonably foreseeable direct and indirect emissions do not exceed the *de minimis* thresholds comprises only half of the screening process. In addition to this requirement, a federal action must also not be considered regionally significant. A regionally significant action is defined as a federal action for which direct and indirect emissions of any pollutant represent 10 percent or more of a nonattainment or maintenance area's emissions inventory for that pollutant.

If a federal action meets both of the abovementioned criteria, it is exempt from further conformity analysis pursuant to 40 CFR Part 93.153. However, although an action may be considered exempt, should it be altered in any way to cause an increase in the reasonably foreseeable emissions, or if attainment areas are reclassified based on changes to the NAAQS or the U.S.EPA-approved SIP, a revision to the conformity analysis may be required.

Table 3-2

Conformity Analysis *De Minimis* Thresholds

Pollutant	**Degree of Non-attainment**	***De Minimis* Level (tons/year)**
Nonattainment Areas		
Ozone ($VOCs$ or NO_2)	Serious	50
	Severe	25
	Extreme	10
	Marginal and Moderate (outside an ozone transport region)	100
	Marginal and Moderate (inside an ozone transport region)	50 (VOC) 100 (NO_2)
CO	All	100
PM_{10}	Moderate	100
	Serious	70
SO_2 or NO_2	All	100
Lead	All	25

Notes: CO – carbon monoxide
NO_2 – nitrogen dioxide
SO_2 – sulfur dioxide
VOC – volatile organic compound

Source: 40 CFR, Chapter I, Subchapter C, Part 51.853, last updated July 2003.

The impact on visibility from air pollutant emission sources is an issue with regard to federally mandated Class 1 areas, such as national parks and wilderness areas, where any appreciable deterioration in air quality is considered significant.

Areas in attainment with the NAAQS are regulated under the Prevention of Significant Deterioration (PSD) program authorized by the CAA Part C, Sections 160–169. PSD areas require owners and/or operators of new or modified sources to obtain a PSD permit prior to construction of a major source (40

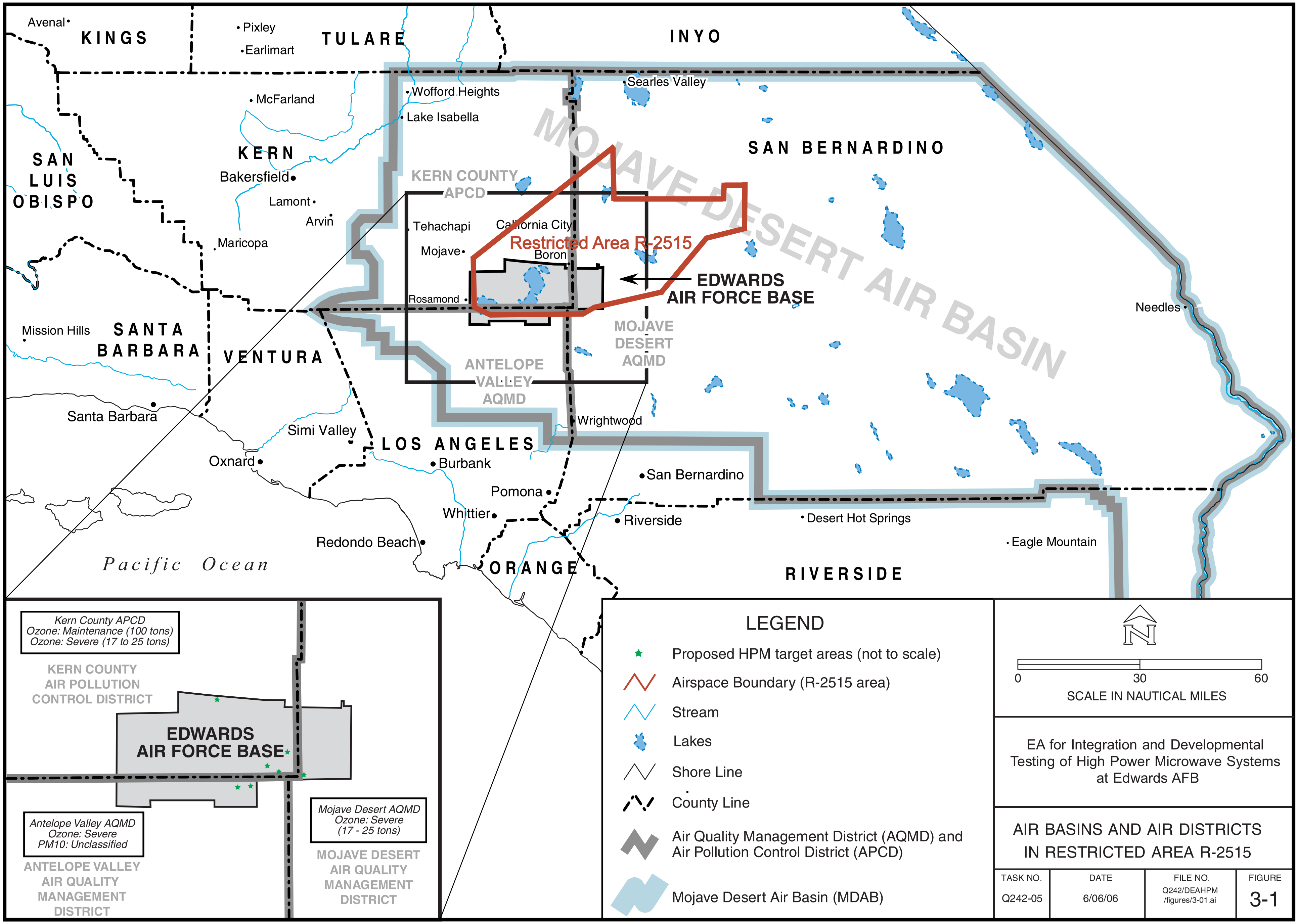
CFR Part 5221) in attainment or unclassified areas. A major source is defined by PSD regulations as being a specific type of source listed by the U.S. EPA that has a potential of emitting 100 tons per year of a regulated pollutant. Potential to emit is based on the maximum design capacity of a source and takes into account pollution control efficiency. If the U.S. EPA does not list a source, it may still be considered major if it has the potential to emit 250 tons per year of a regulated pollutant.

3.1.1 Air Quality—Restricted Area R-2515

The following sections provide a description of the climate, baseline air quality and emissions, and regulatory setting for restricted area R-2515. The majority of proposed emissions from criteria air pollutants (or their precursors) for the Proposed Action and Alternatives are expected to occur below the atmospheric mixing height of 3,000 feet above ground level (AGL). Only approximately 5 percent of aircraft related events would generate emissions below 3,000 feet AGL. The Proposed Action proposes the use of the entire restricted area R-2515 for testing, indicating that emissions above and below 3,000 feet AGL would occur.

Restricted area R-2515 extends into portions of Kern, Los Angeles, and San Bernardino Counties and is part of the Mojave Desert Air Basin (MDAB), which includes local air districts that maintain jurisdiction over the area: the Kern County Air Pollution Control District (KCAPCD), Antelope Valley Air Quality Management District (AVAQMD), and the Mojave Desert Air Quality Management District (MDAQMD) (Figure 3-1). The current attainment status of these districts is summarized in Table 3-3. These data show the majority of the region is in non-attainment of both state and national standards for PM_{10} and ozone. It should be noted that the eastern portion of Kern County was recently designated as in attainment of the national 1-hour ozone standard but remains in nonattainment of both the national 8-hour ozone standard and the state standard.

Therefore, this area was still considered a nonattainment area for ozone when conducting the screening process to determine applicability of the conformity guidelines. The area is in attainment or unclassified for the remaining criteria pollutants including CO, NO_2, and SO_2.



KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
Avenal
Pixley
Earlimart
McFarland
Wofford Heights
Lake Isabella
Searles Valley
Bakersfield
Lamont
Arvin
Maricopa
Tehachapi
Mojave
California City
Boron
Rosamond
Mission Hills
Santa Barbara
Oxnard
Simi Valley
Burbank
Pomona
Whittier
Redondo Beach
San Bernardino
Riverside
Wrightwood
Desert Hot Springs
Eagle Mountain
Needles
Pacific Ocean
MOJAVE DESERT AIR BASIN
KERN COUNTY APCD
ANTELOPE VALLEY AQMD
MOJAVE DESERT AQMD
Restricted Area R-2515
EDWARDS AIR FORCE BASE
Kern County APCD
Ozone: Maintenance (100 tons)
Ozone: Severe (17 to 25 tons)
KERN COUNTY AIR POLLUTION CONTROL DISTRICT
Antelope Valley AQMD
Ozone: Severe
PM10: Unclassified
ANTELOPE VALLEY AIR QUALITY MANAGEMENT DISTRICT
Mojave Desert AQMD
Ozone: Severe
(17 - 25 tons)
MOJAVE DESERT AIR QUALITY MANAGEMENT DISTRICT
LEGEND
Proposed HPM target areas (not to scale)
Airspace Boundary (R-2515 area)
Stream
Lakes
Shore Line
County Line
Air Quality Management District (AQMD) and Air Pollution Control District (APCD)
Mojave Desert Air Basin (MDAB)
N
0
30
60
SCALE IN NAUTICAL MILES
EA for Integration and Developmental Testing of High Power Microwave Systems at Edwards AFB
AIR BASINS AND AIR DISTRICTS IN RESTRICTED AREA R-2515
TASK NO.
Q242-05
DATE
6/06/06
FILE NO.
Q242/DEAHPM /figures/3-01.ai
FIGURE
3-1

Table 3-3

National/California Ambient Air Quality Standards

Attainment Designations for Restricted Area R-2515 Project Area

County	Ozone	CO	NO_2	SO_2	PM_{10}
Kern/MDAB[(a)]					
National	N/A[c]	U*	U*	U	N
California	N	U/A	A	A	U/N
San Bernardino/MDAB[(b)]					
National	N	U*	U*	U	N
California	N	A	A	A	N
Los Angeles/MDAB					
National	N	U*	U*	U	U
California	N	A	A	A	N

Notes: Designation status: A=attainment, N=non-attainment, U=unclassified, and U*=unclassified/attainment.

a – With regard to the CAAQS for CO, the eastern portion of the county, located in the MDAB, is unclassified while the western portion of the county is in attainment. With regard to the NAAQS for PM_{10} the entire county within the MDAB is unclassified for the federal standard, except the Searles Valley Planning Area, which is non-attainment.

b – With regard to the NAAQS for ozone, the southwestern portion of San Bernardino County within the MDAB is non-attainment, and the northwestern and eastern portions are considered unclassified/attainment. The area was recently determined to be in attainment for the 1-hour national ozone standard but remains in non-attainment of the 8-hour standard. Therefore, for the purpose of this screening process, the area was considered to remain in non-attainment for ozone.

c – The eastern portion of Kern County was recently re-designated as in attainment and is now in maintenance. Therefore, it was included in the conformity screening to ensure it conforms to the most recent U.S. EPA-approved SIP.

CO – carbon monoxide
MDAB – Mojave Desert Air Basin
NO_2 – nitrogen dioxide
PM_{10} – particulate matter 10 microns or less in diameter
SO_2 – sulfur dioxide

Source: California Air Resources Board 2003b. This information was supplemented with the latest information obtained from the *Federal Register*, April 22, 2004.

Eastern Kern County is located on the western edge of the Mojave Desert and is separated from populated valleys and coastal areas to the west and south by several mountain ranges. These valleys and coastal areas are the major source of ozone precursor emissions affecting ozone exceedances within Kern County's part of the MDAB. Although the sources of pollution in eastern Kern County do not by themselves result in exceedances of the federal ozone standards; this region is largely impacted by ozone transport from both the San Joaquin Valley Air Basin and the South Coast Air Basin.

Elevated levels of PM_{10} are primarily associated with fugitive dust, which is produced through a combination of high winds, dry soil conditions resulting from an arid climate, and ground-disturbing activities such as mining, agriculture, and construction.

Baseline Air Quality Emissions

The main base at Edwards AFB is located in the eastern portion of Kern County, which is under the jurisdiction of the KCAPCD and is the largest contributor to air emissions in restricted area R-2515. Because those activities proposed herein that could impact air quality would mainly occur on the main base, discussions of environmental effects to air quality are analyzed in relation to baseline air quality in the KCAPCD.

Table 3-4 provides a summary of aircraft emissions at Edwards AFB in 2004 for comparison to the flights associated with test and evaluation of HPM systems. These are baseline quantities for emissions below the mixing layer of 3,000 feet AGL for operations on Edwards AFB.

Table 3-4

Summary of Existing Emissions at Edwards AFB (tons/year)

VOC	CO	NO_x	SO_2	PM_{10}
204.82	457.55	195.82	18.63	11.95

Notes: Represents emissions that occurred in 2004 (AFFTC 2005a).
CO – carbon monoxide
NO_x – nitrogen oxides
PM_{10} – particulate matter equal to or less than 10 microns in diameter
SO_2 – sulfur dioxide
VOC – volatile organic compound

The MDAB is currently impacted by fugitive dust emissions. Edwards AFB is situated in the MDAB portion of Kern County; therefore, current and forecasted baseline emissions, including PM_{10} emissions, for this portion of Kern County are listed in Table 3-5.

Table 3-5

MDAB Portion of Kern County

Baseline and Forecasted Emission Baseline (tons/year)

Year	VOC	NO_x	PM_{10}
1985[(a)]	8,395	9,855	9,855
1990[(a)]	7,665	14,235	16,060
1995[(a)]	4,745	10,585	10,585
2000[(a)]	4,380	11,315	11,315
2005[(b)]	4,380	10,950	12,410
2010[(b)]	4,015	10,950	13,505

Notes: a – actual
b – estimated
NO_x – nitrogen oxides
PM_{10} – particulate matter 10 microns or less in diameter
VOC – volatile organic compound

Source: California Environmental Protection Agency 2005.

Climate

The climate of restricted area R-2515 is similar to the climate of Edwards AFB. Hot summers, cool winters, low rainfall, large diurnal ranges in temperature, and abundant sunshine characterize the climate at Edwards AFB. The arid climate of the region is mainly due to rainshadow effects of the Sierra Nevada and San Gabriel Mountains; the prevailing westerly winds deposit most of their moisture on the western slopes of these mountain ranges. Data collected at Edwards AFB from 1979 to 1989 are used to describe the climate of the project region (National Oceanic and Atmospheric Administration 2001).

The dominant weather feature in the project region is the Eastern Pacific high-pressure system. This system is most prevalent during the summer, when it occupies a northern position over the Pacific Ocean. Concurrent with the presence of high pressure, a low-level, thermal low-pressure system persists over the desert regions due to intense surface heating. The relative strengths and positions of the high-pressure system and the interior thermal trough are largely responsible for the general climatic conditions of the region.

Precipitation

During the winter, the Eastern Pacific high-pressure system weakens and moves southward, allowing polar storm systems to migrate through the region. Although the systems that reach the region have dried out considerably after traversing the elevated terrain to the west, they are responsible for most of the annual precipitation in the area. The average annual precipitation at Edwards AFB is 4.9 inches. Rainfall during the summer usually occurs from thunderstorms. Moisture from these storms originates from tropical air masses that move into the region from the south-southeast. Snow can occur in the region, although the average total is only about 2 inches per year.

Temperature

The annual average temperature at Edwards AFB is 62 degrees Fahrenheit (°F). Daily mean high and low temperatures for January are 57° F and 31° F, respectively. Daily mean high and low temperatures for July are 98° F and 66° F, respectively. Extreme temperatures that occurred during the 10-year monitoring period ranged from 4° F to 113° F.

Prevailing Winds

The combination of the Eastern Pacific high-pressure system over the Pacific Ocean and the thermal low over the interior desert produces a prevailing southwest wind in the region. Strong winds occur during the spring and summer, when the pressure gradient between the offshore Pacific High and the interior thermal trough is the greatest. However, extreme wind gusts can also occur with thunderstorms. Calm conditions increase during the fall and winter, when cold continental air replaces the thermal low and produces weak pressure gradients.

Eastern Kern County is located on the western edge of the Mojave Desert and is separated from populated valleys and coastal areas to the west and south by several mountain ranges. These valleys and coastal areas are the major source of ozone precursor emissions affecting ozone exceedances within Kern County's part of the MDAQMD. Although the sources of pollution in eastern Kern County do not by themselves result in exceedances of the federal ozone standards, this region is largely impacted by ozone transport from both the San Joaquin Valley Air Basin and the South Coast Air Basin.

Elevated levels of PM_{10} are primarily associated with fugitive dust, which is produced through a combination of high winds, dry soil conditions resulting from an arid climate, and ground-disturbing activities such as mining, agriculture, and construction.

Regulatory Setting

In California, the CARB is responsible for enforcing air pollution regulations. The CARB has, in turn, delegated the responsibility of regulating stationary emission sources to local air agencies. There are no stationary sources of emissions associated with the proposed project. This area is within the eastern portion of Kern County, which is part of the MDAQMD. Therefore, the analysis will include only the portion of Kern County within the MDAQMD. In-flight aircraft emissions are generally unregulated within the project region, and are not considered for planning purposes above the mixing height.

The U.S. EPA typically uses 3,000 feet AGL as the default mixing height that inhibits the rapid vertical transfer of air. Pollutants emitted above the mixing height become diluted in the very large volume of air in the troposphere before they are slowly transported down to ground level. These emissions have little or no effect on ambient air quality. Therefore, air quality impacts below 3,000 feet AGL are the emphasis of the conformity analysis.

As stated in an entry to the *Federal Register* on April 22, 2004, the MDAQMD region of Kern County is now in attainment of the national 1-hour NAAQS for ozone but remains in nonattainment for both the 8-hour national standard and the state standard. Therefore, because the U.S. EPA has not outlined how the process of determining conformity will be applied to the 8-hour standard, the area was considered to be in attainment (maintenance) and the corresponding *de minimis* level was utilized when conducting the conformity analysis screening presented in Section 4.0.

3.1.2 Air Quality—Edwards AFB Area

The air districts, air basins, and emissions baseline for the Edwards AFB area are the same as presented in Section 3.1.1.

3.2 AIRSPACE

3.2.1 Overview

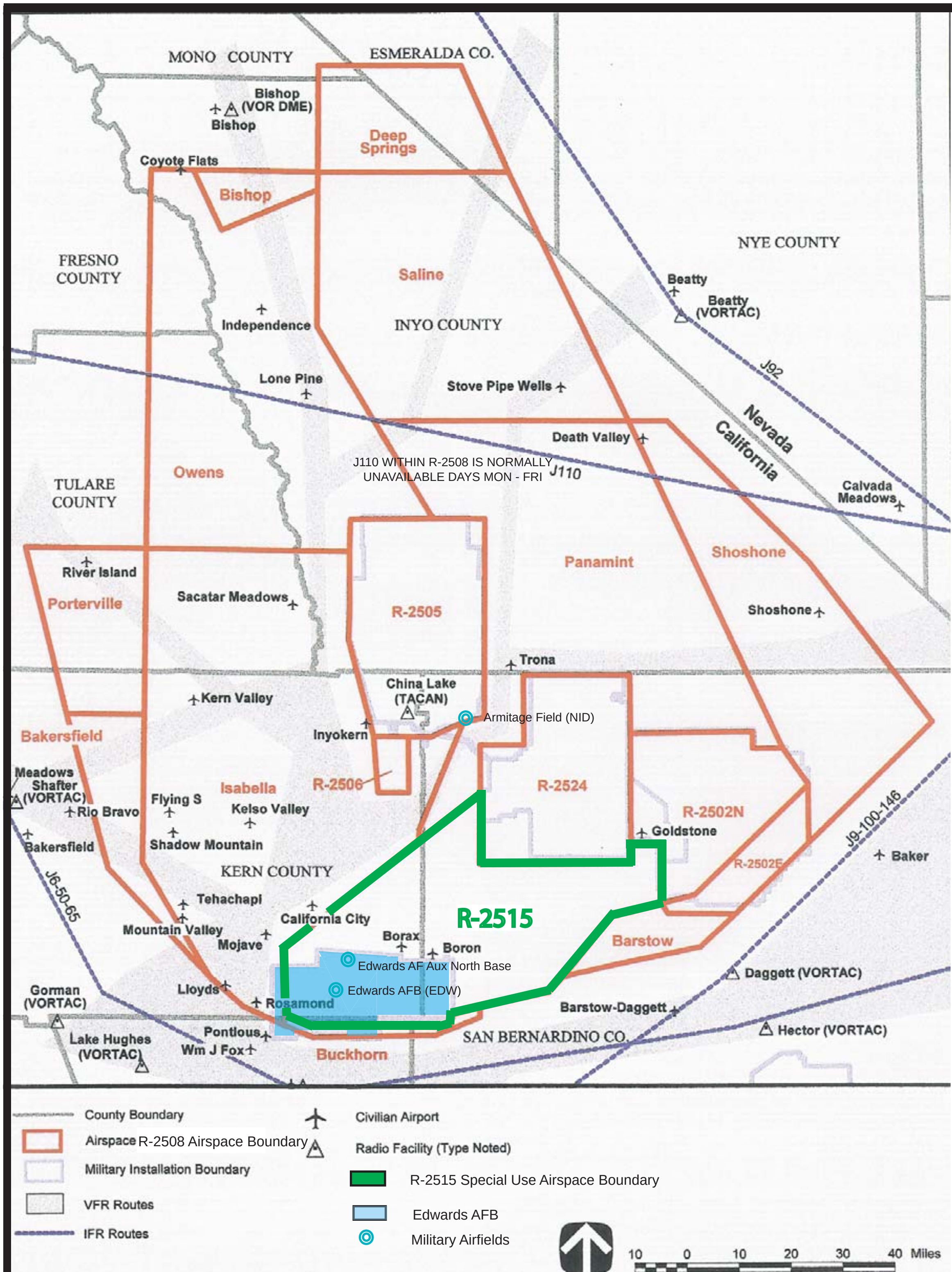
The FAA manages the airspace in the United States for safe and efficient use. The FAA designates Special Use Airspace (SUA), which consists of airspace in which activities must be confined because of their nature, or from which other aircraft operations must be limited because of those activities. A restricted area is one type of SUA which may include unusual, often invisible hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. An aircraft may not enter a restricted area unless permission has been obtained from the controlling agency. Restricted areas are depicted on aeronautical charts and are published in the *Federal Register*. The ROI for HPM operations would be restricted area R-2515, which is depicted in Figure 3-2. Another type of SUA is a military operations area (MOA). A small area called the Buckhorn MOA lies along the south border of R-2515. While it is immediately adjacent to R-2515 no HPM operations would be conducted in the Buckhorn MOA because all civil aircraft are not prohibited from entering a MOA.

3.2.2 Airspace—Restricted Area R-2515

The AFFTC and Edwards AFB are the primary users of restricted area R-2515 airspace. The majority of operations include flight testing of a variety of aircraft and use by the Air Force Test Pilot School, which trains test pilots, navigators, and flight test engineers. Additionally, the National Aeronautics and Space Administration (NASA) Dryden Flight Research Center (DFRC) conducts aeronautical research on different types of aircraft. Army helicopters from Ft. Irwin are one of the larger users of R-2515 airspace outside of AFFTC and Edwards AFB. Maintenance check flight missions in the High Altitude and Black Mountain Supersonic Corridors are conducted by units from Naval Air Weapons Station (NAWS) China Lake and Naval Air Station Lemoore. Civilian users are allowed to fly in R-2515 on a very limited basis under a specific letter of agreement with the AFFTC and then only when prior arrangements are made for positive control of entry and operations in the airspace. Detailed information on restricted area R-2515 is available in the *R-2508 Users Guide* that can be found at http://r2508.edwards.af.mil/. The targets used to support the testing and evaluation of HPM systems will be within R-2515.

3.2.2.1 Special Use Airspace

The airspace above Edwards AFB is located within the restricted area R-2515. Only small areas of the Isabella and Buckhorn MOAs, on the western and southern border of the base, are within the ROI for the on-base portion of SUA (Figure 3-2).



Airspace, Jet Routes, Airports, and Airfields in Restricted Area R-2515	Q242-04	Figure 3-2

3.2.2.2 En Route Victor Airways and Jet Routes

There are no en route victor airways or jet routes over Edwards AFB.

3.2.2.3 Airports/Airfields/Airstrips

The only airports/airfields/airstrips in restricted area R-2515 are the main runways for Edwards AFB, Edwards North Base and South Base runways, the dry lakebed runways on Rogers Dry Lake and Rosamond Dry Lake, Borax, and Boron (Figure 3-2).

3.2.2.4 Air Traffic Control

Restricted area R-2515, the ROI for Alternatives A and B, lies exclusively within the Los Angeles Air Route Traffic Control Center's boundaries (National Aeronautical Charting Office 2004a). Hi-Desert Terminal Radar Approach Control (TRACON) is the controlling agency and the AFFTC is the using agency for R-2515. A military air traffic control facility (call sign SPORT) which is a unit of the AFFTC manages air traffic within R-2515. During the published hours of use (identified in Table 3-6), the using agency is responsible for all flight activity within R-2515 and ensuring its perimeters are not violated. When the airspace is scheduled to be inactive, AFFTC releases it back to Hi-Desert TRACON, and in effect the airspace is no longer restricted. If no activity is scheduled during some of the published hours of use, the using agency releases the airspace to the controlling agency for non-military operations for that period of inactivity (Illman 1993).

Table 3-6

Special Use Airspace In and Surrounding Alternatives A and B

Number/Name	Effective Altitude (feet)	Time of Use (PST)	Controlling Agency
R-2515	Unlimited	Continuous	Hi-Desert TRACON
Buckhorn MOA	200 AGL[2]	0600–1800 M– F[1]	Hi-Desert TRACON
Isabella MOA	200 AGL[2,3]	0600–1800 M– F[1]	Hi-Desert TRACON

Notes: 1-Other times by NOTAM.
2- Up to but not including FL 180.
3- Excluding 3,000 feet AGL and below over Domeland Wilderness Area.
AGL- above ground level
FL- flight level (FL 180 = approximately 18,000 feet above mean sea level)
MOA- Military Operations Area
NOTAM- Notice to Airmen
R- restricted
TRACON- Terminal Radar Control

Source: National Aeronautical Charting Office 2004a, b, and c.

3.2.2.5 Military Training Routes

The proposed airspace that would be used under Alternatives A and B contain several instrument flight rules and visual flight rules (VFR) low-altitude training routes and one slow-speed, low-altitude training route (SR-390) (Figure 3-3). All routes within the ROI that transit the boundaries of the R-2515 SUA are governed by the flight restrictions and requirements to "see and avoid" other aircraft when operating under VFR.

All routes are designated as "military assumes responsibility for separation of aircraft" operations, which are established by coordinated scheduling. Hours of operation are normally daylight hours. Other hours are by Notice to Airmen (NOTAM), except for Instrument Routes 236 and Visual Routes 1205 and 1206 which have continuous hours of operation (National Geospatial Intelligence Agency 2004). All test and evaluation flight profiles for Alternatives A and B are inside the boundaries of restricted area R-2515.

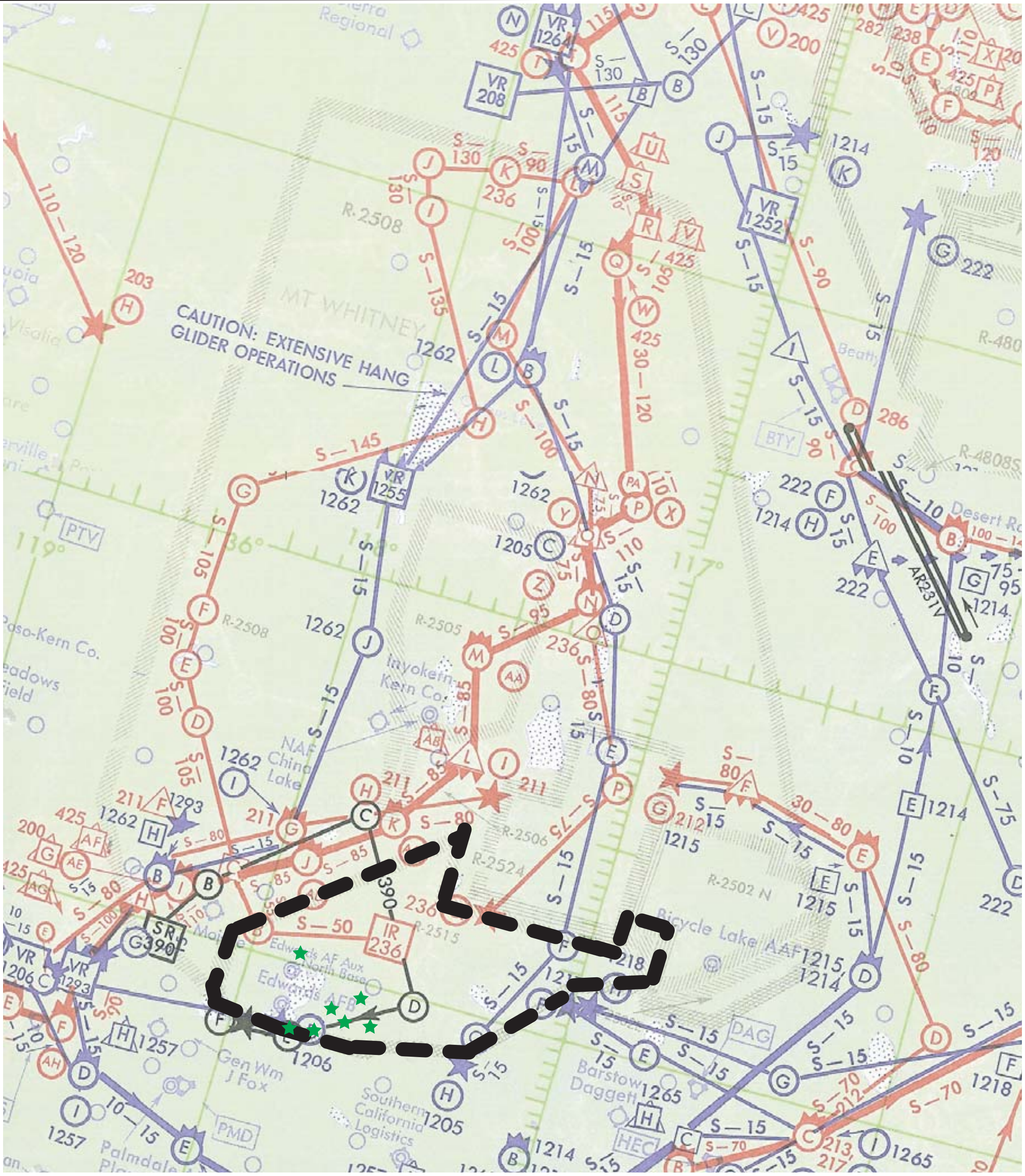
3.3 CULTURAL RESOURCES

3.3.1 Overview

Cultural resources are defined as historic properties, landscapes, cultural items, archeological resources, sacred sites, or collections subject to protection under the National Historic Preservation Act; the Archaeological Resources Protection Act; the Native American Graves Protection and Repatriation Act; EO 13007, *Indian Sacred Sites*; and the *Guidelines on Curation of Federally Owned and Administered Collections* (36 CFR Part 73).

Cultural resources are locations of human activity, occupation, or use. They include expressions of human culture and history in the physical environment, such as buildings, structures, objects, districts, or other places. Cultural resources can be natural features, plants, and animals that are considered to be important to a culture, subculture, or community. Cultural resources also include traditional lifeways and practices. For this EA, cultural resources have been organized into the categories of prehistoric resources, historic resources, and traditional cultural properties (TCPs) and practices. These types are not exclusive and a single cultural resource may have multiple components.

Prehistoric cultural resources refer to any material remains, structures, and items used or modified by people before Euro-Americans established a presence in the region. In southern California, the earliest direct contact of native populations with Euro-Americans occurred on the coast and Channel Islands and later in inland areas. The earliest brief encounters by explorers began in the mid-sixteenth century followed by colonization and settlement by the late eighteenth century. Examples of prehistoric cultural



LEGEND

R-2515 Special Use Airspace

Proposed HPM target areas (not to scale, location is approximate)

Civilian Airport

Military Airfields

Instrument Route (IR) Military Training Route

Visual Route (VR) Military Training Route

Slow Route (SR) Military Training Route

0 15 30

SCALE IN NAUTICAL MILES

EA for the Integration and Developmental Testing of High Power Microwave Systems at Edwards Air Force Base

MILITARY TRAINING ROUTES IN RISTRICTED AREA R-2515

TASK NO.	DATE	FILE NO.	FIGURE NO.
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resources recorded in the region include the archaeological remains of villages, camps, quarries, rock shelters, rock art, milling features, cemeteries, and scatters of prehistoric artifacts such as stone tool-making debris or groundstone artifacts.

Historic cultural resources include the material remains and landscape alterations that have occurred since the arrival of Euro-Americans in the region. Examples of historic cultural resources in the region include homestead and agricultural features, foundations, roads, buildings, scatters of historic artifacts, post-contact Native American villages, and locations or structures that are associated with historic events or people.

Traditional cultural properties are places associated with the cultural practices or beliefs of a living community. These sites are rooted in the community's history and are important in maintaining cultural identity. Examples of TCPs include natural landscape features, places used for ceremonies and worship, ancestral villages or burial sites, places where plants are gathered that are used in traditional medicines and ceremonies, places where artisan materials are found, places where traditional arts are practiced or passed on, and features of traditional subsistence systems. Impacts to the continued use and maintenance of traditions are considered in NEPA analyses.

3.3.2 Historic and Prehistoric Resources—Restricted Area R-2515 and Edwards AFB Area

The extent and type of cultural resources identified on the land underlying restricted area R-2515 are based primarily on information from Edwards AFB, the Bureau of Land Management, the Pacific Pipeline Project, and the Black Mountain Supersonic Corridor Environmental Assessment. Less than 1 percent of the total ground acreage encompassed by restricted area R-2515 has been inventoried for cultural resources.

Edwards AFB has conducted comprehensive cultural resource identification with more than 450 archaeological surveys covering more than 134,032 acres having been completed on base. As a result of this work, 1,642 prehistoric sites, 1,269 historic sites, and 78 military sites have been recorded on base (Crosby 2005). Thirteen traditional cultural properties have been recorded (Norwood 2003).

The most common prehistoric site types are lithic scatters, temporary camps, hearth features, and milling stations. Common historic archaeological site types include refuse scatters, homestead sites, mining sites, and various agricultural features. Military resources include the sites of inactive military camps, buildings or ruins (Earle *et al*. 1997; Ronning *et al*. 2000). Those site types which could be affected by airspace operations are those with above-surface structural manifestations such as rock shelters, caves, and rock art panels on geological outcrops.

Rock art sites are not common near the dry lakes but have been identified in the Superior Valley. Three of the four areas of critical environmental concern (ACECs) identified by Bureau of Land Management (BLM) contain rock art components. These include the Steam Wells ACEC, Squaw Spring ACEC, and the Black Mountain/Inscription Canyon and Black Canyon ACEC.

The fourth ACEC in R-2515, Rainbow Basin/Owl Canyon, includes a prehistoric component. Owl Canyon is a small habitation site containing lithic, groundstone, shell beads, and fire affected rock.

Most of the archaeological sites have not been formally evaluated for the National Register of Historic Places (NRHP). Nineteen prehistoric sites and eight historic archaeological sites have been determined individually eligible for NRHP with the concurrence of the California Office of Historic Preservation.

One prehistoric National Register District, Squaw Spring Archaeological District, is listed on the NHRP for the R-2515 area.

Another 70 sites are considered potentially eligible and 68 sites have been determined as not eligible for the NRHP. There are two archaeological historic districts, one at North Base consisting of five contributing sites and the South Base Sled Track.

Studies of the built environment on Edwards AFB generally address military buildings and structures associated with three historic themes: World War II, the Cold War, and Man in Space. Many of the military buildings and structures on Edwards AFB are less than 50 years old and must possess "exceptional significance" to be found eligible for the NRHP. To date, 82 buildings or structures have been determined eligible. Another 29 are considered potentially eligible and 229 have been determined not eligible for the NRHP.

There are four historic building districts. The Jet Propulsion Laboratory includes 53 eligible contributing elements. Air Force Research Laboratory includes 5 eligible contributing elements, 27 potentially eligible structures, and 69 unevaluated structures. The South Sled Track includes 10 eligible buildings and structures. The X-15 Engine Test Complex consists of 7 eligible buildings (Norwood 2003).

Rogers Dry Lake is a National Historic Landmark and the primary resource responsible for the establishment of Edwards AFB and the Dryden Flight Research Facility. The lakebed is associated with historic aviation developments including the flight of the Bell X-1, the first plane to break the sound barrier, in 1947 and the first Space Shuttle landing in 1981 (Earle *et al*. 1998).

Table 3-7 summarizes selected cultural resources for the R-2515 area (the land below the airspace designated as restricted area R-2515).

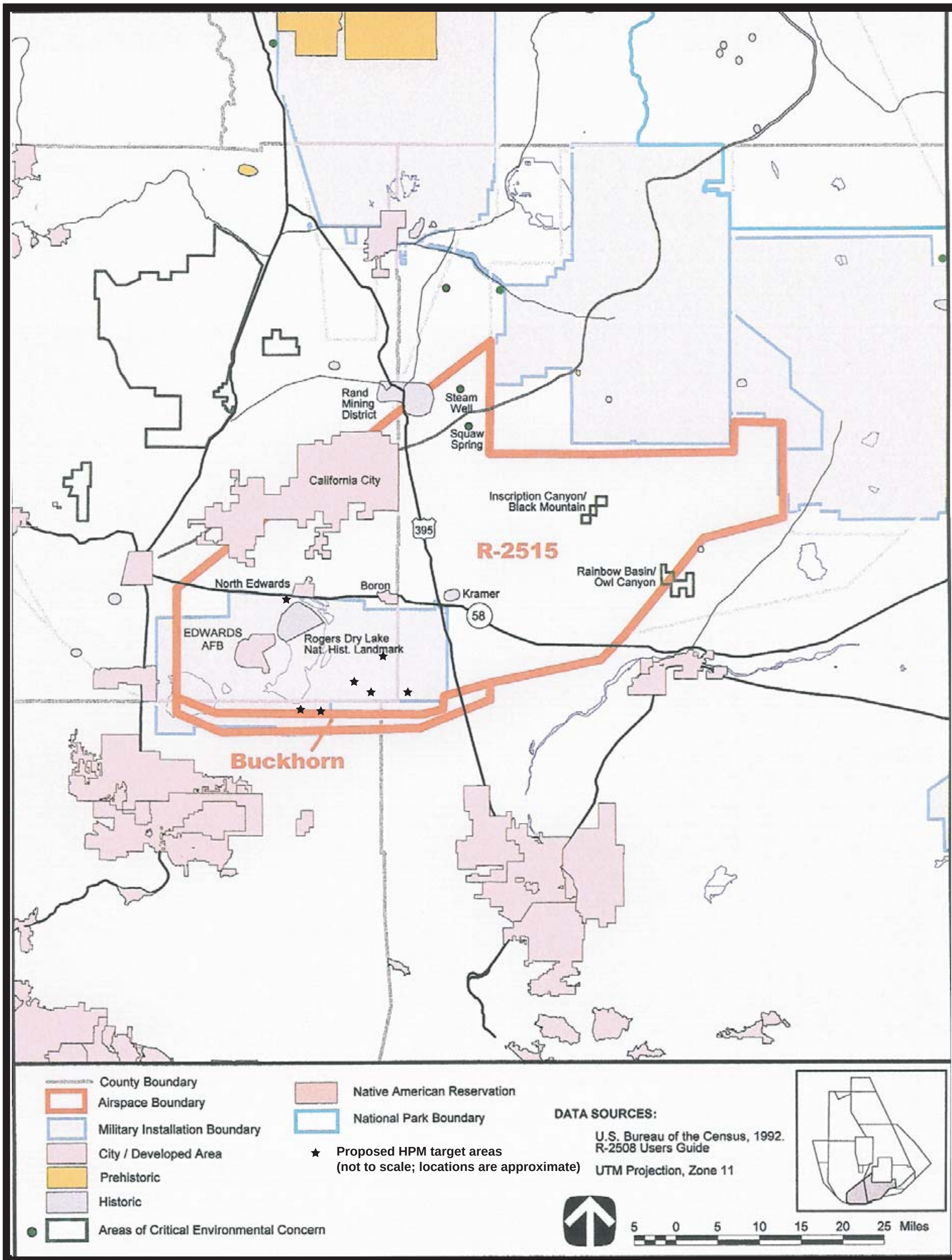
Table 3-7

Selected Cultural Resources in the R-2515 Area

	Type			Status			
Resource	**Prehistoric**	**Historic**	**Native American**	**NRHP[1] (L)**	**NHRP[2] (E)**	**SHL**	**NHL**
Rogers Dry Lake		X		X			X
Sites CA-SBR-1008A, B, C		X		X			
Squaw Spring Archaeological District	X			X			
<u>**ACECs**</u>							
Squaw Spring	X						
Steam Well	X						
Black Mountain/Inscription and Black Canyon	X		X				
Rainbow Basin/Owl Canyon	X						

Notes: 1 – NHL – National Historic Landmark
2 – NHRP - National Register of Historic Places Eligible (E) – but not formally listed, Listed (L)
ACEC – areas of environmental concern.
SHL – State Historic Landmark

Cultural resources in the R-2515 area defining the boundaries of Alternatives A and B include a wide variety of physiographic features and environments (Figure 3-4). The types of cultural resources present reflect the complexities of the human use and modification of these lands during the recent past and throughout at least 10,000 years of human occupation. Hundreds of cultural resources are recorded below restricted area R-2515; however a full inventory of all cultural resources in the ROI has not taken place. Integrity of setting is generally most relevant to the significance of buildings and TCPs rather than archaeological sites.



Cultural Resources in the R-2515 Area	Figure 3-4	Q242-04	9/12/05

3.3.3 Native American Resources—Restricted Area R-2515 and Edwards AFB Area

The restricted area R-2515 was occupied or used by a number of Native American groups including the Kawaiisu and Kitanemuk near the Tehachapi Mountains, the Tataviam and Vanyume on the Mojave River, and the Southern Paiute, Chumash, and Chemehuevi. The nature of their presence in the region varied with some groups forming semi-permanent settlements and others merely visiting the area to exploit seasonal resources (95 ABW and AFFTC 2005).

The Superior Valley is within the traditional use area of the Panamint Shoshone, Kawaiisu, Southern Paiute, and Chemehuevi. Native American Resources associated with the Superior Valley include rock shelters, ground figures or intaglios, rock art sites, and occupation sites. Those site types which could be affected by airspace operations are those with above-surface structural manifestations such as rock shelters, caves, and rock art panels on geological outcrops.

Many prehistoric resources in the region may be considered sacred by Native American groups and may include mountaintops, springs, and natural features. The Native American component of the Black Mountain/Inscription Canyon and Black Canyon ACEC is designated as Black Mountain. Native American resources in this ACEC include one of the largest concentrations of petroglyphs, as well as cairns and trail shrines associated with the myth and ritual performance for many Native American groups (BLM 1980).

3.4 ENVIRONMENTAL JUSTICE AND THE PROTECTION OF CHILDREN

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires federal agencies to develop environmental justice strategies and make environmental justice a part of its mission by identifying and addressing disproportionately high adverse effects of its activities on minority and low-income populations. Agencies are required to ensure their programs and activities affecting human health or the environment do not directly or indirectly use criteria, methods, or practices that discriminate on the basis of race, color, or national origin.

Restricted area R-2515 includes Edwards AFB and the communities surrounding the base. The eastern portion of the restricted area R-2515 is sparsely populated and does not contain any cities (95 ABW and AFFTC 2005). Population concentrations in restricted area R-2515 include California City and Boron. General population characteristics—according to the U.S. Census 2000—for the Boron and Edwards AFB census designated places (CDPs) and California City are shown in Table 3-8.

Table 3-8

Population Characteristics per the U.S. Census 2000

for the Boron and Edwards AFB Census Designated Places and California City

Geographic Area	Total Population	Percent White	Percent Black or African American	Percent American Indian and Alaska Native	Percent Asian, Native Hawaiian or Other Pacific Islander	Hispanic or Latino (of any race)	Some Other Race
Boron CDP	2,025	85	2.2	2.9	1.7	9.0	4.7
California City	8,385	68.2	12.8	1.6	4.0	17.0	7.4
Edwards AFB CDP	5,909	72.7	10.4	0.8	4.8	11.7	5.4

Source: U.S. Census Bureau 2000

The total 2000 census population of California City was 8,385, and for the Boron CDP it was 2,025 (U.S. Census Bureau 2000). The Edwards AFB CDP population was 5,909. The dominant race in each of these population areas is White. For a summary of the socioeconomic distribution of these areas refer to Section 3.13 (Socioeconomics).

Executive Order 13045, *Protection of Children from Environmental Health and Safety Risks* (April 21, 1997) requires federal agencies to address the potential for disproportionately high and adverse environmental effects of their actions on children. The EO further requires federal agencies ensure that their policies, programs, activities, and standards address these risks. This document has been prepared in compliance with EO 13045 to identify and, if necessary, mitigate health and safety risks with the potential to disproportionately affect children.

The proposed HPM testing and evaluation program would occur on Edwards AFB and the airspace over Edwards AFB and from restricted area R-2515. All ground targets and airborne targets would be located on or over Edwards AFB. Flight test plans would be developed to ensure that RF energy radiated from the test activities would not be directed towards schools. The specific absorption rate (SAR) levels would be calculated to ensure that RF energy from these proposed tests would be below Occupational Safety and Health Administration thresholds.

Edwards AFB has three elementary schools and one junior/senior high school, all of which are under the jurisdiction of the Muroc Unified School District. Children would be restricted from the proposed HPM testing areas on Edwards AFB; these test areas would be authorized by the Range Safety Office and

Range Control Office prior to the HPM testing event. These testing areas would not be in areas where schools or playgrounds would be located or similar areas where children are frequently present.

3.5 GEOLOGY AND SOILS

Geologic resources consist of naturally formed minerals, rocks, and unconsolidated sediments. Soil refers to the uppermost layers of surficial geologic deposits and the weathering of those deposits. Concerns associated with the geologic setting, which could either affect or be affected by a proposed project, include topography and soil erosion on base. Normal military activities at Edwards AFB or within restricted area R-2515 do not increase exposure to seismic hazards or other geologic hazards including landslides, subsidence, or volcanic eruption.

This section provides a brief description of the topography, geology, soils, and seismicity for the land underlying restricted area R-2515 and Edwards AFB.

3.5.1 Topography—Restricted Area R-2515 and Edwards AFB Area

The area under restricted area R-2515 is classified by the National Hierarchical Framework of Ecological Units (U.S. Forest Service 2004) as the American Semi-Desert and Desert Province. Elevations up to 3,400 feet above mean sea level (MSL) can be found on the land underlying restricted area R-2515. The mountains rise abruptly from outwash aprons and alluvial fans. Near the bases of some mountains, gravel or bare rock covers the ground. Little soil accumulates on the steep slopes due to erosion from heavy desert rainstorms.

The western portion of the Mojave Desert and the area immediately surrounding the base is dominated by the Antelope Valley, which is bordered to the south by the San Gabriel Mountains, to the northwest by the Tehachapi Mountains, and to the east by low hills. Layers of eroded material from the surrounding mountains have built up over bedrock to form alluvial fans. Rock outcroppings, ranging from small, single rocks to small mountains or ridge formations, spot the ground surface (NASA 1997).

Edwards AFB is located in the Antelope Valley. The valley floor comprises of several closed topographic depressions that contain the three major playas: Rogers, Rosamond, and Buckhorn Dry Lakes.

The base can be characterized as having three physiographic regions: an upland area located in the northwest portion of the base north of Rosamond and west of Rogers Dry Lake, a lowland area occupying the central and southwestern portions of the base, and an upland area extending east of Rogers Dry Lake to the eastern boundary of Edwards AFB. Slope and relief on the PIRA varies from flat to gently sloping plains interspersed with broad domes and, in a few places, more resistant hills that rise sharply above the surrounding plains. Slopes range from zero percent near Rogers Dry Lake to greater than 30 percent by Kramer Hills.

3.5.2 Geology—Restricted Area R-2515 and Edwards AFB Area

The geologic setting in the vicinity of Edwards AFB and the R-2515 area is characterized by three major rock types or geologic complexes: a basement complex of igneous and metamorphic rocks, an intermediate complex of continental volcanic and sedimentary rocks, and valley fill deposits.

3.5.3 Soils—Restricted Area R-2515 and Edwards AFB Area

The soils at Edwards AFB and the R-2515 area can be characterized as predominantly alkaline, consisting of loams, sandy loams, and loamy sands, all of which are susceptible to wind and water erosion. Plant growth is inhibited by the high salinity and exchangeable sodium ion content of some soils, particularly soils in the lakebed basins (AFFTC 2002a).

The *Grazing and Cropland Management Plan* (U.S. Natural Resources Conservation Service [1997) identified five groups of landforms based on soil types that range from playas at the lowest elevation to hills and rock pediments. These landforms include dry lakebeds, including Rogers Dry Lakebed, are most often covered by about 95 percent Wherry soils, alluvial fans in the areas surrounding the dry lakes are composed primarily of Leuhman, Norob, and Voyager soils, dunes and sand sheets around the dry lakes are an intermediate form between the alluvial flats and the fan piedmonts. Fan piedmonts contain mostly Helendale soil with smaller portions of Destazo, Lavic, Helendale Taxadjunct, and Cajon soils. Rock pediments and hills around Randsburg, Hi Vista, Machone, Muroc, and Sparkhule consist of soils, interspersed with rock outcrops.

Alluvial sediments that surround scattered, topographically higher outcrops of granitic rock dominate the surface of Edwards AFB.

According to the *Soil Survey of Edwards Air Force Base, California, Interim Report* (U.S. Department of Agriculture, Soil Conservation Service 1998) the soils at Edwards AFB and the surrounding area underlying restricted area R-2515 are given erosion hazard ratings of slight to severe for wind erosion and slight to moderate for water erosion.

3.5.4 Seismicity—Restricted Area R-2515 and Edwards AFB Area

Like much of Southern California, Edwards AFB is subject to earthquake activity and associated seismic hazards. At least eight minor faults are known, or are suspected because of their trends, to be present within the boundaries of Edwards AFB; however, no fault has been active in the last 11,000 years.

Few earthquakes have been recorded within the triangular area formed between the San Andreas and Garlock Faults that includes Edwards AFB (U.S. Geological Survey [USGS] 1998). Of these, just four have been recorded with epicenters within or near the Base boundary, and all had Richter magnitudes less than 4.4. Seismic activity in the Antelope Valley is most prevalent along, and northwest of, the Garlock Fault and along, and southwest of, the San Andreas Fault (AFFTC 1997d).

3.6 HAZARDOUS MATERIALS/HAZARDOUS WASTE

For purposes of this analysis, the terms "hazardous material" and "hazardous waste" are those substances defined by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Resource Conservation and Recovery Act (RCRA).

A hazardous material is any material whose physical, chemical, or biological characteristics, quantity, or concentration may cause or contribute to adverse effects in organisms or their offspring; pose a substantial present or future danger to the environment; or result in damage to or loss of equipment, property, or personnel.

Hazardous wastes are substances that have been "abandoned, recycled, or are inherently waste like," and that (because of their quantity, concentration, or characteristics) may cause increases in mortality or serious irreversible illness, or pose a substantial hazard to human health or the environment if improperly treated, stored, transported, or disposed of.

Solid waste refers to non-hazardous garbage, refuse, sludge, and any other discarded solid material resulting from residential, commercial, and industrial activities or operations. Solid waste can be classified as construction/demolition waste, non-hazardous recyclable waste, or non-hazardous non-recyclable waste.

Hazardous materials, hazardous waste, and solid waste management in the R-2515 region includes the purchase, storage, and distribution of hazardous materials such as paints, solvents, lubricants, batteries, and other substances containing chemicals that are potentially harmful to the affected environment.

3.6.1 Hazardous Materials

Edwards AFB is the primary user of hazardous materials in the R-2515 SUA. Edwards AFB uses a wide variety of hazardous materials in support of research activities on base and its mission requirement to support all types of aircraft. Hazardous materials are used for aircraft repair and maintenance, aircraft launch and recovery, aerospace ground equipment (AGE) repair and maintenance, building remodeling, and construction. Some of the most commonly used hazardous materials include jet and motor fuel, other types of petroleum products, paints, thinners, adhesives, cleaners, lead-acid batteries, hydraulic fluids, and halogenated and non-halogenated solvents (U.S. Air Force 1995b).

Hazardous materials are used to support rocket propulsion research and development at the Air Force Research Lab (AFRL). Typical hazardous materials used include liquid and solid rocket propellants. Other hazardous materials used at the AFRL include batteries, antifreeze, cleaning/degreasing solvents, and machinery lubricants, which are used in component fabrication, repair, maintenance, and assembly operations (AFFTC 1998a).

The types of hazardous materials most commonly used during construction projects include acids, corrosives, caustics, glycol, compressed gases, paints and paint thinners, solvents, sealant, adhesives, cements, caulking, fire retardant, and hot asphalt (140^0 F or greater). Building and facility maintenance requires the use of heating fuels, paints, aerosols, and fluorescent light bulbs, all of which are hazardous materials.

Implementation of the Hazardous Materials Pharmacy approach accomplishes several important management goals, including reducing the volume of hazardous materials purchased and hazardous wastes generated through improved materials management. Edwards AFB uses the pharmacy concept to issue hazardous materials for use by Air Force personnel. The Hazardous Materials Pharmacy monitors shelf life and tracks usage of hazardous materials on base. One common database is used to manage issued hazardous material products. Hazardous materials purchased through the pharmacy are bar code labeled upon their arrival at Supply Central Receiving and distributed to the various satellite issue points or Hazardous Materials Distribution Support Centers located throughout Edwards AFB.

All organizations and contractors are required to maintain strict inventories of all their hazardous materials. Furthermore, organizations are required to reduce the quantity of hazardous materials used or to replace them with non-hazardous material, if possible, as a part of the Pollution Prevention Program. Guidelines used by Edwards AFB include Air Force Instruction 32-7086, *Hazardous Materials*

Management; Air Force Instruction 32-7042, *Solid and Hazardous Waste Compliance*; and AFFTC Instruction 32-19*, Hazardous Material Management Process.*

3.6.2 Hazardous Waste

Hazardous materials/waste recycling is addressed in Title 22 California Code of Regulations (CCR) 66266.1–66266.130; Assembly Bill 3474; and the California Health and Safety Code, Section 26143.2. This includes commercial chemical products, used or contaminated solvents (halogenated, oxygenated, hydrocarbon), used or unused petroleum products, pickling liquor, unspent acids, unspent alkalis, and unrinsed empty containers of iron or steel used for pesticides or other hazardous chemicals.

The use of hazardous materials results in generation of hazardous waste (e.g., paint waste, used oil, contaminated rags), which requires proper handling. The U.S. EPA enforces the RCRA (40 CFR 260–272), which provides guidelines for the generation, storage, transportation, and disposal of hazardous waste. The California Environmental Protection Agency enforces hazardous waste laws embodied in 22 CCR Chapters 10–20 and the California Health and Safety Code (Section 25100). The 95 ABW/CEV at Edwards AFB manages hazardous waste accumulation. Guidelines used by Edwards AFB include the *AFFTC Hazardous Waste Management Plan* 32-7042, which was prepared in accordance with Air Force Instruction 32-7042*, Solid and Hazardous Waste Compliance*. It establishes procedures to achieve compliance with applicable federal, state, and local regulations for hazardous waste management, except munitions, explosives, biohazard, and radioactive waste. Specifically, it contains requirements for solid and hazardous waste characterization, training, accumulation, turn-in and disposal, as well as procedures for inspections, permits, and record keeping.

Hazardous waste by-products are managed at the point of generation. These hazardous wastes are stored at an initial accumulation point at or near the point of generation and then sent to a 90-day accumulation point or to the Hazardous Waste Storage Facility where they are managed and disposed of according to state and federal guidelines.

These wastes must be containerized, labeled, stored, and transported in accordance with U.S. EPA and state requirements. In California, the Department of Toxic Substances Control (DTSC) administers most aspects of RCRA directly. In 1997, the DTSC delegated oversight of hazardous waste generation to the local Certified Unified Program Agencies. The California Hazardous Waste Control Law provides a separate regulatory framework for hazardous waste management within the state. This state framework incorporates all federal RCRA requirements as well as many stricter state standards.

Geologic resources (i.e., soil and groundwater) are susceptible to contamination from the surface. Releases of hazardous chemicals such as petroleum products and solvents have resulted in soil contamination at military installations. Contaminated soil or groundwater may require physical removal or extensive remediation to ensure the protection of public health and safety.

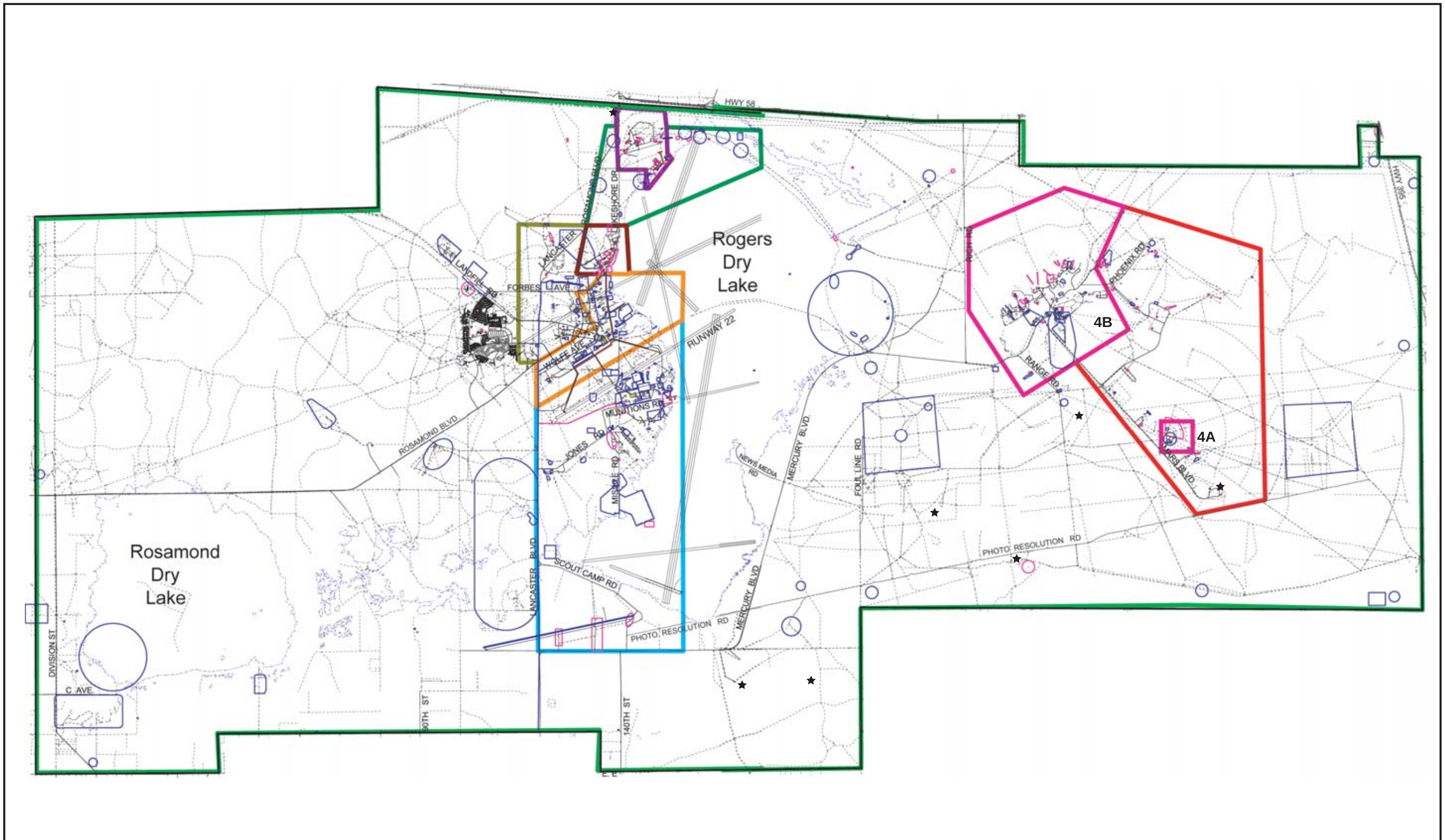
The Installation Restoration Program (IRP) was established to identify, investigate, assess, and clean up hazardous waste at former disposal sites on the base in compliance with CERCLA. Under the IRP, a Preliminary Assessment was conducted at Edwards AFB to locate potential areas of concern that may have resulted from past activities on the 301,000-acre base.

Edwards AFB has identified 471 IRP sites and areas of concern with potential contamination. The IRP sites at Edwards AFB are grouped into 10 Operable Units (OUs), generally based on geographic location. IRP sites, areas of concern, and OUs are shown in Figure 3-5. Runway 22 lies within OU 2; several IRP sites are located adjacent to the runway.

3.6.3 Solid Waste

Solid waste management activities are monitored by the California Integrated Waste Management Board.

Edwards AFB operates a non-hazardous (municipal solid) waste landfill within the Main Base area. At current disposal rates, the landfill is expected to reach permitted capacity in the year 2024. Due to the volume of construction/demolition waste generated on base, most current construction contracts require the contractor to dispose of such wastes at an approved off-base landfill in order to reduce the impacts to the Main Base Landfill. The base actively participates in a recycling program, which is operated by a contractor with program oversight provided by Environmental Management. Some waste metals generated during construction and demolition projects, as well as the routine operations of various base organizations, are diverted to the Defense Reutilization and Marketing Office for resale.



LEGEND

- Unpaved Roads
- Paved Roads
- Stream and Lakes
- Taxiways
- Base Boundary
- Buildings
- Area of Concern
- IRP Site

OPERABLE UNITS (OUs)

- OU 1
- OU 2
- OU 3
- OU 4A
- OU 4B
- OU 5
- OU 6
- OU 7
- OU 8
- OU 9
- OU 10

0 2 4 6

SCALE IN STATUTE MILES

★ **Proposed HPM target Areas (not to scale, locations are approximate)**

EA FOR THE INTEGRATION AND DEVELOPMENTAL TESTING OF HIGH POWER MICROWAVE SYSTEMS AT EDWARDS AFB

Sites, Areas of Concern, and Operable Units at Edwards AFB

TC#	DATE	DRAWN BY	FILENAME	FIGURE NO.
Q242-04	9/14/05	Knight	Fig3-5.ai	3-5

3.7 INFRASTRUCTURE

Infrastructure refers to the physical components that are used to deliver something (e.g., electricity, traffic) to the point of use. Elements of infrastructure typically include energy, water, wastewater, electricity, natural gas, liquid fuel distribution systems, communication lines (e.g., telephone, computer), and circulation systems (streets and railroads).

The R-2515 SUA, which encompasses the ROI for Alternatives A and B, was selected because only a few rural communities with low population densities would be located under them. The associated infrastructure includes rural distribution systems for telephones, electricity, and natural gas/liquid fuels.

Water treatment and waste management facilities that support these rural communities are also located under the corridors.

Figure 3-6 shows the distribution of infrastructure underlying restricted area R-2515.

3.7.1 Energy Resources

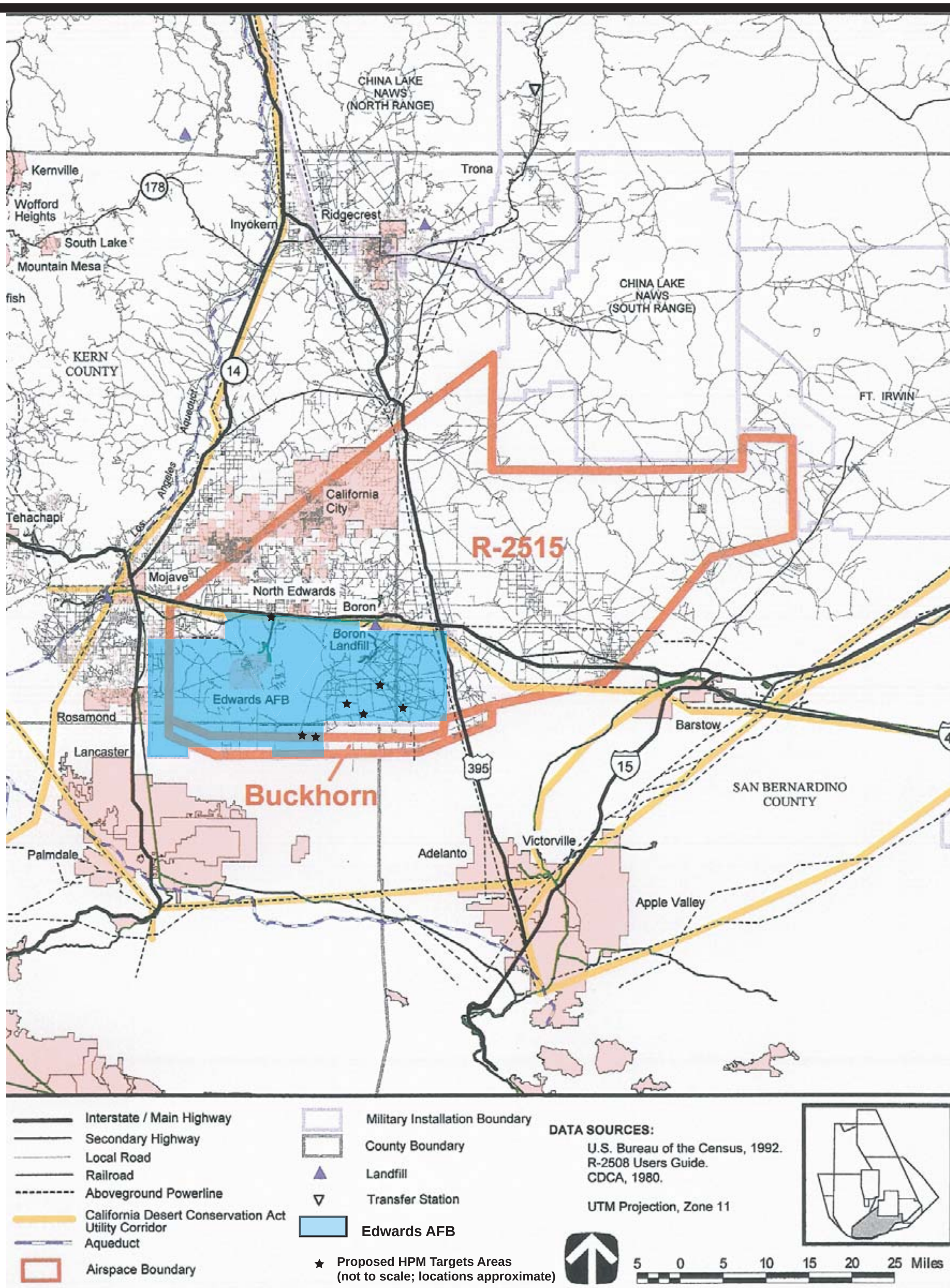
3.7.1.1 Solar Energy Production on the Land Underlying Restricted Area R-2515

The Kramer Junction Company is the Managing General Partner of the five 30-Megawatt solar thermal electric generating facilities located in the Mojave Desert at Kramer Junction, California. The designed total combined output of the plants was to be approximately 165 Megawatts at full capacity.

The Kramer Junction Solar Electric Generating System (SEGS) projects are a series of utility-scale solar thermal electric power plants, which were designed and developed in the mid-1980s.

The plants operate on solar driven power, to ensure uninterrupted power during peak demand periods, cloudy days or early evenings, an auxiliary natural gas–fired heater is available and operates to supplement sources of power (the energy supplied by natural gas is limited by regulations to 25 percent of the total effective annual plant energy input). Operations are constantly monitored and optimized by customized computer controls.

The Kramer Junction project has a 30-year exclusive contract to provide energy agreements to sell to the local electric utility company Southern California Edison. The Kramer Junction SEGS projects are "peaking" facilities. This means they provide the major portion (over 80 percent) of their output



Infrastructure Under Restricted Area R-2515	Figure 3-6	Q242-04	9/13/05

during those hours when there is the greatest demand on the utility's power supply, particularly on hot afternoons.

3.7.1.2 Energy at Edwards AFB

The general policy of the Air Force regarding energy is as follows:

> Energy is essential to the Air Force's capability to maintain peacetime training, readiness, and credible deterrence; to provide quality of life; and to perform and sustain wartime operations. In short, energy is an integral part of the weapon system. The most fundamental Air Force energy policy goal is to ensure energy support to the national security mission of the Air Force in a manner that emphasizes efficiency of use, effectiveness of costs, and independence from foreign sources for mission-essential operations… (AFFTC 1995b).

Edwards AFB uses electricity, solar power (e.g., photovoltaic panels to run traffic lights and heat water), natural gas/propane and other petroleum-based products (gasoline, jet fuel, and diesel) as sources of energy to operate facilities, vehicles, equipment, and aircraft.

Southern California Edison provides electricity to Edwards AFB. The base uses this energy source to operate a variety of systems including lighting, heating and cooling, computers, and pumps for gas and water. Pacific Gas and Electric supplies natural gas to Edwards AFB. The base uses natural gas to run boilers, furnaces, and two standby generators. Propane is used in areas where natural gas services are unavailable and is used to operate one standby generator. Edwards AFB uses solar energy for hot water and forced air heating systems; to provide light (i.e., skylights); and to operate the emergency phone system on major portions of Rosamond, Lancaster, and Mercury Boulevards.

Edwards AFB is responsible for approximately 13.4 miles of petroleum pipeline used to transport JP-8 jet fuel to various locations throughout the base. The supply pipeline for the base is the CalNev Pipeline. Edwards AFB receives JP-8 fuel from a spur line from the George AFB terminal.

3.7.2 Water Distribution System

The AFFTC purchases potable water from the Antelope Valley East Kern (AVEK) Water Agency. This water is distributed through a system located in Boron, California. The water distribution system for Edwards AFB consists of a series of pipes ranging in size from 4 to 24 inches in diameter, booster pump stations, and storage tanks. Five storage tanks, three at the Main Family Housing area and two at North

Base, provide a potable water storage capacity of 4.3 million gallons. Additional storage tanks dedicated to fire suppression are located throughout the base. The distribution system, although presently adequate, requires continuous repairs and replacement to sustain its capacity (AFFTC 1997a).

3.7.3 Wastewater/Storm Water/Landfills

There are two sanitary sewer collection and treatment systems on Edwards AFB. These systems service the Main, North, and South Base areas and the AFRL. The collection network for the existing system is composed of gravity lines, force mains, and pump stations. The Main Base Waste Water Treatment Plant provides tertiary treatment of wastewater.

The storm water distribution system at Edwards AFB consists of conveyance structures and drainage ditches (unpaved). Storm water conveyance structures include channels, gutters, drains, and sewers (not tied into the sanitary sewer system) that collect storm water runoff and direct its flow. The storm water system at Main Base conveys storm water to a pretreatment facility, which consists of an oil-water separator and an evaporation pond (AFFTC 1998b). Storm water from the undeveloped portions of the base flow into the nearest dry lake (AFFTC 1994).

There are two permitted landfills in the area, one in Boron and one on Edwards AFB.

3.7.4 Communication Systems

The BLM maintains a joint-use corridor through the middle of restricted area R-2515. The corridor—designated as Utility Corridor “G”—is 2 miles wide and roughly parallels U.S. Highway 395. Two additional contingency corridors designated as Corridors “Q” and “P” are adjacent to the northern boundary of Edwards AFB and roughly parallel Highway 58. Corridor Q is 5 miles wide and contains coaxial cable. Corridor P, which is adjacent to the eastern boundary of the base, roughly parallels U.S. Highway 395. The corridor is 2 miles wide and contains power lines.

Communication systems on Edwards AFB include telephone, microwave, and local area networks. The distribution system for these networks generally consists of copper-pair cable, fiber-optic cable, and a communication manhole/conduit system.

3.7.5 Transportation Systems

The transportation systems beneath the R-2515 SUA include traffic circulation systems such as highways and byways, unpaved roads, non-maintained roads, railroad lines, and other systems involved in mass transportation.

There are two main transportation corridors within restricted area R-2515: U.S. Highway 395, which extends north-south through the entire area, roughly parallel to and forming the eastern boundary of Edwards AFB, and State Highway 58, which extends east-west, connecting the towns of Mojave and Barstow. Highway 58 runs parallel to and forms the north border of Edwards AFB.

Edwards AFB is accessed by way of Rosamond Boulevard from the west or north, and by Lancaster Boulevard/120th Street East from the south. Primary access to Edwards AFB from the adjacent roadways is by way of North Gate, West Gate, and South Gate, each of which is in operation 24 hours a day, 7 days a week. All gates contain two inbound and two outbound lanes (USACE and AFFTC 1994).

Internal circulation on-Base is by way of paved and unpaved primary, secondary, and tertiary roads. Primary roads connect Edwards AFB components such as the flightline, Engineering and Administration, and support areas to entry points. Secondary roads connect Edwards AFB components to one another and support facilities such as commercial or housing areas. Tertiary roads are unpaved access roads or residential streets within the housing area (AFFTC 1997b).

The primary base streets currently carry all rush-hour traffic without significant congestion problems. The traffic flow at the West Gate is approximately 5,300 vehicles daily or 40 percent of total base traffic volume. The South Gate has a traffic flow of approximately 4,600 vehicles daily or 34 percent of the total base traffic volume. The North Gate services approximately 3,500 vehicles daily or 26 percent of the total. The West Gate provides the best free flow during morning rush-hour traffic, while the South and North Gates allow sufficient flow without exceeding design capacity.

Traffic consists of government, contractor, and privately owned vehicles belonging to those that live and/or work on-Base. In addition, commercial vehicles deliver material to businesses and facilities in the area. Commercial and Air Force vehicles are used for service and construction work done in the area. Emergency vehicles require access to all buildings and roads. In addition to the paved roadways, an extensive network of unimproved, dirt roadways exists, essentially equivalent to the paved network. These roads have posted speed limits and provide access to various installation facilities and sites.

Two railroads are adjacent to the base. The Southern Pacific line runs parallel to the base's west boundary and adjacent to Sierra Highway. The north/south main line does not provide service to Edwards AFB. The Atchison, Topeka, and Santa Fe Railroad is located south of California Highway 58 and along the northern boundary of the Base. Two rail spurs, one at Edwards Station and the other at Boron Station connect to the Main Base and AFRL, respectively (AFFTC 1994).

3.8 LAND USE

The land area considered in this EA is represented by the area beneath restricted area R-2515 which is predominantly over military use land (Edwards AFB).

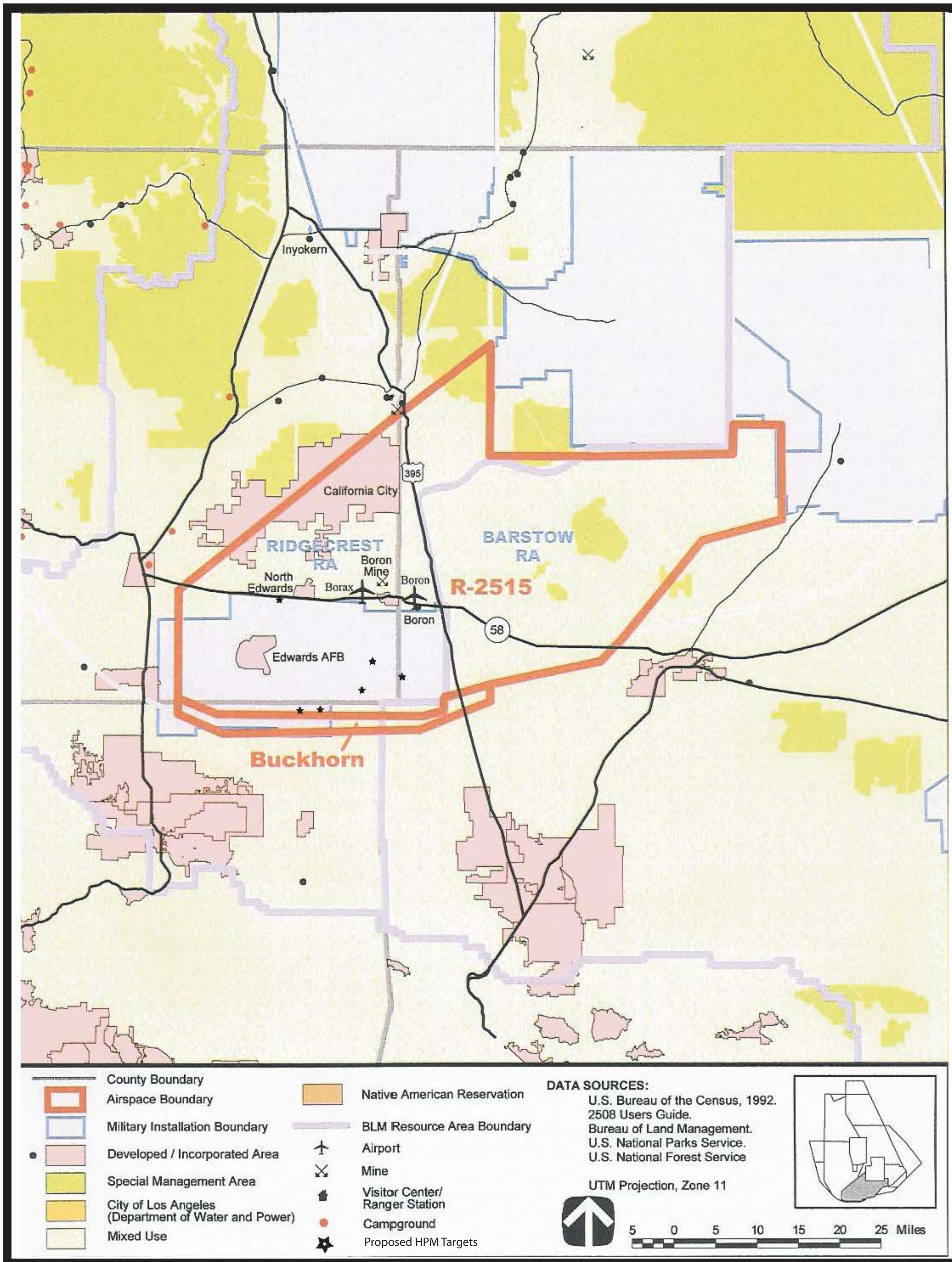
3.8.1 Land Use—Restricted Area R-2515

The land under restricted area R-2515, which is in portions of Kern, San Bernardino, and Los Angeles Counties, is generally divided in half by U.S. Highway 395. Land use densities under restricted area R-2515 range from developed areas that include Edwards AFB, California City, Boron, and North Edwards to the west to sparsely developed rural and recreational areas to the east of U.S. Highway 395. Restricted area R-2515 is part of a major range and test facility located in the western Mojave Desert of Southern California (R-2508 Complex). The primary land owners or managers of the land encompassed by restricted area R-2515 are the DoD and BLM. There are also local government and private lands under restricted area R-2515. Land use for the area under restricted area R-2515 is shown in Figure 3-7.

The majority of the information on land use for the area under restricted area R-2515 is summarized from the *R-2508 Complex Environmental Baseline Survey* except where indicated (95 ABW and AFFTC 2005).

3.8.1.1 Bureau of Land Management Resource Areas

The land under restricted area R-2515 that is not part of Edwards AFB is in the Ridgecrest and Barstow Resource Areas. ACECs are BLM land use designations which highlight areas where special management attention is needed to protect important historic, cultural, and scenic values; flora and fauna; or to protect people from natural hazards. ACECs under restricted area R-2515 include the Steam Well,



Land Use in the R-2515 Area	Figure 3-7	Q242-04	9/13/05

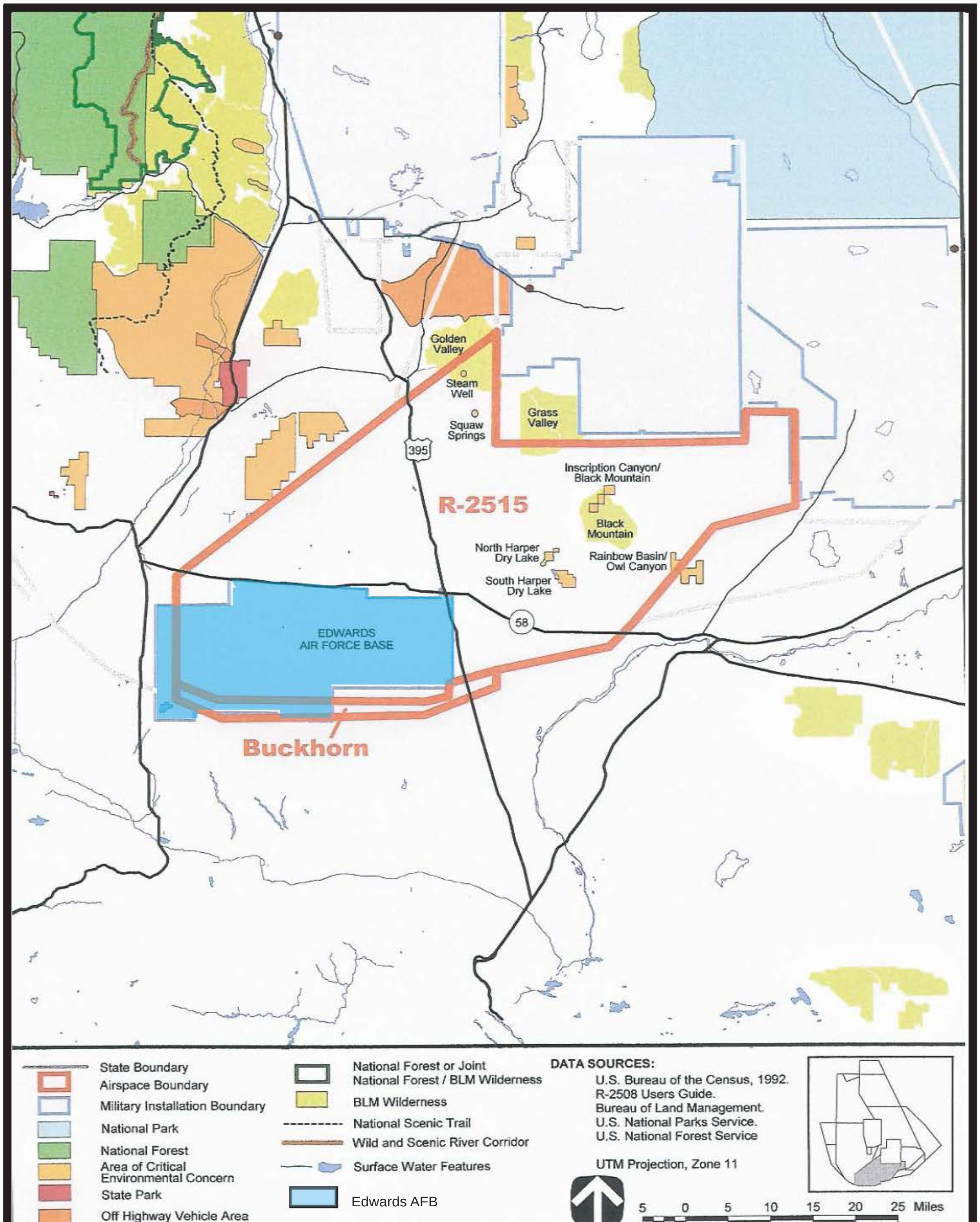
Squaw Spring, North Harper Dry Lake, Harper Dry Lake, Black Mountain/Inscription and Black Canyon, and Rainbow Basin/Owl Canyon (Figure 3-8).

The Steam Well ACEC consists of approximately 40 acres of land under the northern portion of restricted area R-2515, approximately 25 miles east of U.S. Highway 395. The Steam Well was nominated to protect prehistoric values near Red Mountain in western San Bernardino County. The Squaw Spring ACEC consists of approximately 661 acres west of the Steam Well ACEC and was also designated to protect prehistoric resources. The Harper Dry Lake ACEC encompasses 480 acres on the Harper Dry Lake and was designated to protect the marsh species because of the presence of unique soil types. The North Harper Dry Lake ACEC encompasses 400 acres adjacent to the western side of Harper Dry Lake and was designated to protect the Barstow woolly sunflower, a federal species of concern. The Black Mountain/Inscription and Black Canyon encompass approximately 500 acres in western San Bernardino County and was designated to protect cultural and Native American resources as described in Section 3.3.2.2. The 2,100 acres of the Rainbow Basin/Owl Canyon ACEC was designated to protect the unique geological and paleontological resources (Owl Canyon) and for recreational value (Rainbow Basin). Located approximately 10 miles northwest of Barstow, this ACEC contains sedimentary rocks with geological structures clearly exposed. The area is also an important source of Miocene vertebrate fossils (BLM 1980).

3.8.1.2 Wilderness Areas

Wilderness areas are federal lands that have been designated by Congress as part of the National Wilderness Preservation System. Land use designations in wilderness areas are undeveloped open space and primitive recreational uses. These areas are generally managed by one or more federal agencies who own the property containing the wilderness. Wilderness areas under restricted area R-2515 include Black Mountain, a portion of Golden Valley, and a portion of Grass Valley.

The Black Mountain Wilderness consists of 20 square miles of federal, state, and private lands located approximately 25 miles northwest of Barstow, California. It is a volcanic flow and mesa with a sand dune in the southeast corner. Golden eagles and prairie falcons are known to forage in this area, which is also known for an array of wildflowers in the spring. The Golden Valley Wilderness consists of approximately 60 square miles of federal, state, and private lands located approximately 24 miles southeast of Ridgecrest, California. This wilderness is surrounded by the Lava Mountains on the northwest and the Almond Mountains on the southeast. The Grass Valley Wilderness consists of



Areas of Critical Concern Under Restricted Area R-2515	Figure 3-8	Q242-04	9/13/05

approximately 50 square miles of federal, state, and private lands located approximately 37 miles southeast of Ridgecrest, California. Only 10 square miles of the Grass Valley Wilderness is under restricted area R-2515. Vegetation within the area is typically creosote bush scrub with some Joshua trees. Raptors, desert tortoises, and the Mohave ground squirrel inhabit Golden Valley and Grass Valley wilderness areas, which are in the BLM Ridgecrest Resource Area.

3.8.1.3 Cities and Towns

The majority of the area under restricted area R-2515 is sparsely developed and most of the cities and towns are located west of U.S. Highway 395. The cities and towns range in size from a small cities such as North Edwards with a population of 1,227 and Boron with a population of 2,231 to Edwards AFB CDP with a population of 7,679 (U.S. Census Bureau 2000). It should be noted that only a portion of California City, population 8,311 (U.S. Census Bureau 2000), underlies restricted area R-2515.

3.8.1.4 Private Lands

The greatest concentrations of private land occur in the west of Edwards AFB. Private land uses include residential, agricultural (mostly ranching), and mining. Mining areas throughout restricted area R-2515 include the Boron and Borax mines and other mines in the Rand Mountains and Granite Mountains on the northeast border of restricted area R-2515. The Boron mine is one of the largest open pit mines in the world. Over 1.8 million tons of borate minerals are removed from the mine annually.

3.8.2 Land Use—Edwards AFB Area

Edwards AFB is the predominant land use under restricted area R-2515. Edwards AFB, situated in Kern, Los Angeles, and San Bernardino Counties, is approximately 60 miles northeast of the city of Los Angeles. The base lands are classified and managed using three land categories of improved, semi-improved, and unimproved. Approximately 290,957 acres of largely undeveloped or semi-improved land are used to support flight-testing of a wide variety of military, civilian, and experimental aircraft. Unimproved lands comprise 95.3 percent of total base lands; semi-improved lands account for about 1.5 percent of the total, and improved land accounts for about 3.2 percent.

Semi-improved lands include areas that are generally located in proximity to airfields, runways, test facilities, parking ramps, fence lines, some recreational areas, and relatively undeveloped areas such as open storage areas (AFFTC 2002a).

The developed portion of the base is concentrated on the west side of Rogers Dry Lake. It includes clear areas around test facilities and improved runways (AFFTC 2002a). Developed areas include Main Base, North Base, South Base, Family Housing areas, and the AFRL. The *Edwards Air Force Base Comprehensive Plan* describes long-range development for Edwards AFB, establishing goals, policies, plans, and anticipated action regarding the physical, social, and economic environment (AFFTC 1994). Land use designations, including total acreage and percent of the base area, are described in Table 3-9.

Table 3-9

Land Use Designations at Edwards AFB

Land Use Designation	Total Square Miles	Total Acres	Percentage of Total Base Property (%)
Aircraft Clearance, Quantity-Distance	4.86	3,110.40	1.00
Aircraft Pavement, Runways	0.91	582.40	0.20
Lakebed Painted Runways	3.12	1,996.80	0.070
Lakebed Non-maintained Landing Site	61.00	39,040.00	13.00
Aircraft Operations and Maintenance	0.2	128	0.04
Engineering Test	27.83	17,811.20	5.90
Aircraft Test Ranges	336.23	215,187.20	71.50
Industrial	12.18	7,795.20	2.60
Administrative	0.19	121.60	0.04
Community Commercial	0.21	134.60	0.04
Community Service	0.30	192.00	0.10
Medical	0.07	44.80	0.01
Housing	1.52	972.80	0.30
Outdoor Recreation	3.83	2,451.20	0.80
Buffer Zone	17.75	11,360.00	3.80
Water	0.00	0.00	0.00
Total[1]	**470**	**300,800**	**100**

Note: 1- Rounded to the nearest whole number.

Source: AFFTC 1994

Within these various land use categories, specific areas have been designated for a particular purpose. These include, but are not limited to, the off-road vehicle areas I and II, the Combat Arms Range, hunting and fishing areas, the PIRA, and the AFRL.

A portion of Edwards AFB is designated for the NASA DFRC, which is a major installation on-Base, covering 838 acres. DFRC's existing land-use plan divides its facility into three basic use zones: (1) the flightline, (2) support services, and (3) explosive hazard zones. The flightline zone is adjacent to Rogers Dry Lake, is restricted to flight research activities, and includes aircraft hangars, test facilities, pavement, and runways. Support services are behind the flightline zone and include warehouses, project support complexes, and administrative support. Western Aeronautical Test Range zones include a remote site and a small triangular section of the facility adjacent to Lily Avenue that includes a radio tower. The remote site includes the facility's water tower and several radio towers. The two explosive hazard zones overlap the flightline and support services zone. These two circular zones extend for a minimum distance of 1,200 feet from the shuttle loading area (NASA 1997).

3.8.2.1 Land Use Planning

Air Force land use policies and guidance are only applicable to lands under their control. Policies established by the Air Force and identified in the *Edwards AFB General Plan*, which is periodically updated, designate applicable land use which includes residential, industrial, commercial, agricultural, recreational, and military use. As part of the review and approval process, the Edwards AFB Planning and Zoning Committee grants final siting approval for all construction and activity-related projects. Specialized land uses may include areas such as radio transmission areas, bombing/missile ranges, wildlife areas, explosive ordnance ranges, and airfields.

Edwards AFB has three paved runways that provide the principal landing surfaces for the base. The Main Base Runway (Runway 22) is the primary airstrip on-Base. Additional runways can be found on North and South Base. Edwards AFB also has 18 runways painted on dry lakebeds and uses the remaining lakebed areas for emergency landings.

3.8.2.2 Management Areas A through G

The ROI for the Proposed Action includes the area under restricted area R-2515 and, in particular, target areas in Management Areas B and G. Ground testing of HPM systems would be conducted in existing testing facilities, such as the Birk Flight Test Facility, and from ground stations and mobile vehicles located in positions on Edwards AFB as determined by the test plan. High power microwave systems would be directed over open land to ground targets that would be established near the dry lakebeds, Grinnel, Mt. Mesa, Jackrabbit Hill, and Haystack Butte (Figure 3-9). Testing of aircraft-mounted developmental HPM systems would occur within restricted area R-2515 and would involve beaming RF energy to targets on any of the Edwards AFB Management Areas A through G. The test programs would use existing facilities and modify buildings on an as-needed basis.

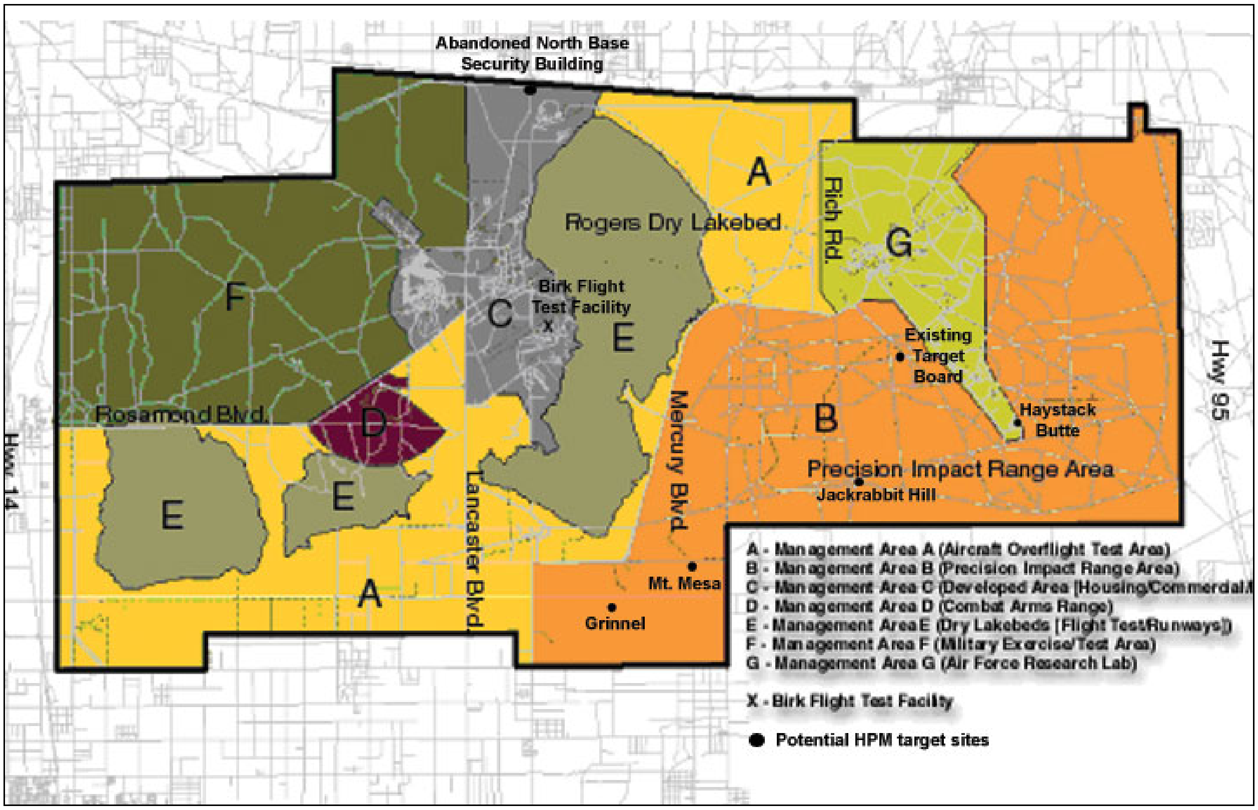


Figure 3-9 Proposed Target Areas in Management Areas A–G

Individual management plans have been developed to ensure the implementation of best management practices when planning and conducting mission activities. A more detailed description of each of the management areas is provided in the base's *Integrated Natural Resources Management Plan* (Edwards AFB 2004). A summary of the management areas is provided below.

Management Area A (Aircraft Overflight Test Area)

This management area is generally undeveloped and used to support aircraft test activity, including a jettison area at the end of the runway for emergency offloading. It extends just northeast of Rogers Dry Lake, and some of the area is used as a buffer zone around Main Base Runway 04/22. Included in the management area are well fields, clay pan playas, and natural and man-made water sources, which are used by wildlife and include Branch Memorial Park Pond and Piute Ponds. These areas also provide for various outdoor recreational uses. Projects in the area concentrate on infrastructure improvement and maintenance.

Management Area B (Precision Impact Range Area)

Covering a large portion of the eastern part of the base, this management area is used for aircraft flight-testing, explosive ordnance disposal, placement of communication equipment, testing of aircraft targeting equipment, and for practice in precision bombing. It is also being considered for the use of high explosives weapons testing. The PIRA supports high desert tortoise densities, sensitive non-listed species, and some of the base's highest quality wildlife habitat. Proposed HPM target areas in the PIRA include Grinnel, Mt. Mesa, and Jackrabbit Hill.

Management Area C (Developed Area [Housing/Commercial/Industrial])

The Main Base, North Base, South Base, NASA, and the base landfill are included in this management area. It also contains the runway and airfield support facilities, operations and maintenance, engineering, other industrial use areas, and research and development facilities such as the Birk Flight Test Facility. Mission activities include aircraft testing, operation, maintenance, site demolition and redevelopment, administrative, medical, educational, and commercial uses. Water resource issues are of concern in this management area. Other environmental concerns include bird/aircraft strike hazard (BASH) management, pest management, desert tortoise protection, and vegetation recovery.

Management Area D (Combat Arms Range)

This management area includes the Combat Arms Range, the Rod and Gun Club, and outdoor recreational areas. The area includes desert tortoise and other protected species, and is located apart from other developed areas and facilities for safety and noise considerations.

Management Area E (Dry Lakebeds [Flight Test/Runways])

The Rogers, Rosamond, and Buckhorn Dry Lakebeds, distinctive features of Edwards AFB, are included in this management area. They will be used to continue to support aircraft and space mission activities. Minimizing ground disturbance and development in the dry lakebeds, especially Rogers Dry Lake, is important in order to minimize impacts to the surface. Maintaining the surface of the dry lakes is critical for aircraft test activities.

Management Area F (Military Exercise/Test Area)

Located in the northwest corner of the base, mission activities within this management area include aircraft testing and a buffer zone for military housing. Subunits in the management area include designated hunting areas and off-road vehicle use areas; the remainder of the area is primarily open space under aircraft test areas. Development in this area will support continued aircraft testing. Future planned projects include airfield (emergency runway) improvement and radar reflector repair. The area is relatively undeveloped and includes desert tortoise and Mohave ground squirrel populations. It also provides good nesting and roosting habitat for bird and bat species.

Management Area G (Air Force Research Laboratory)

This management area is a relatively isolated developed area in the northeastern portion of the base surrounded by undeveloped aircraft test and targeting areas. Mission activities conducted at the laboratory include but are not limited to testing rocket engines, extensive safety zones surrounding the test cells, and administrative, industrial, and research and development uses. The area includes Haystack Butte and Leuhman Ridge, which support special wildlife species including the federally protected peregrine falcon. Sensitive plant species in this area include Barstow woolly sunflower and desert cymopterus. Proposed HPM ground target areas include Haystack Butte and an existing target board (see Figure 3-9).

3.8.3 Visual/Aesthetic Resources

The BLM illustrated the Visual Resource Management Program, which divided the base into four sub-units and rated them according to the following factors: landform, vegetation, water, color, influence of adjacent scenery, scarcity, and cultural modification.

- **Class A.** These areas contain a combination of the most outstanding characteristics of each rating factor. There are no Class A areas on base.

- **Class B.** These areas contain a combination of some outstanding features and features fairly common to the physiographic region. Areas with lakebeds (i.e., Management Area E), the more scenic and relatively undisturbed hills and ridges, the denser Joshua Tree woodlands, and Leuhman Ridge in Management Area G fall into Class B. Class B areas can be found primarily through the central part of the PIRA (Management Area B), from Mercury Boulevard to U.S. Highway 395.

- **Class C.** These areas contain features fairly common to the physiographic region and include the remainder of the base, with the exception of the developed areas. Class C areas can be found primarily along the northern, southern, and southeastern boundaries of the PIRA (Edwards AFB 1996). Landforms on the PIRA consist of claypans, edge playas, flat to rolling terrain, and scattered rugged hills and ridgelines. Unique visual resources on the PIRA include

  - Mount Mesa complex, located on the southwest portion;
  - Jackrabbit Hill and surrounding ridges that mark the southern boundary;
  - Red Buttes, located in the southeast portion;
  - Kramer Hills on the east boundary; and
  - The flat plains that make up the West, East, and PB-6 Ranges.

- **Class D.** These areas are so heavily developed and/or extensively disturbed that they lack positive aesthetic attributes, thereby diminishing the visual quality of surrounding areas. These areas include several areas in Management Area C such as Main Base, North Base, South Base, NASA, and housing, and the AFRL in Management Area G (AFFTC 1994).

The PIRA is relatively devoid of manmade objects with the exception of the graded areas for the West Range and buildings painted white (e.g., Phillips Laboratory water system, instrumentation and observation buildings). The PIRA contains both Class B and C areas, in approximately equal proportions.

Edwards AFB contains two areas with special ecological concerns: desert tortoise critical habitat and Significant Ecological Areas (SEAs). These areas are discussed further in Section 3.9, Natural Resources.

3.8.4 Land Management

Land use planning laws affecting federal land management agency administration of the land under the R-2515 include the Federal Land Policy and Management Act and the California Desert Protection Act. Applicable regional plans include the California Desert Conservation Area Plan, the West Mojave Land Tenure Adjustment, the West Mojave Coordinated Management Plan, and the Northern and Eastern Mojave Planning Effort. Descriptions of these land use planning laws and regional plans are provided in the *R-2508 Complex Environmental Baseline Survey*.

A Memorandum of Understanding has been signed between the AFFTC and the BLM, California Desert District, regarding land use decisions on acreages in the R-2515 that are managed by the California Desert Conservation Area Plan.

3.9 NATURAL RESOURCES

Biological resources are defined as terrestrial and aquatic ecosystems with the native plants and animals that occur throughout these ecosystems. This includes plant populations and communities; wildlife populations and their relationship to habitat; and aquatic habitat, and riparian ecosystems. Plant and animal species that are proposed for, candidates for, or are listed as threatened or endangered by the U.S. Fish and Wildlife Service (USFWS), and species having equivalent status at the California state level, are referred to as special-status species and are given special consideration by law for their preservation. The ROI for natural resources is the land under restricted area R-2515 and Edwards AFB.

Critical habitat for a threatened and endangered species is defined under the federal Endangered Species Act (ESA) as specific areas within the geographical area occupied by the species at the time it is listed that contain the physical or biological features that are essential to the conservation of the species and may require special management considerations or protection, and specific areas outside the geographic area occupied by the species at the time it is listed that are also essential to the conservation of the species.

The USFWS identifies primary physical and biological constituent elements of an area designated as critical habitat that are essential to the conservation of the species (50 CFR 424.12). Primary constituent elements may include, but are not limited to, roost sites, nesting grounds, spawning sites, feeding sites, seasonal wetlands or drylands, water quality or quantity, host species or plant pollinators, geological formations, vegetation types, tides, and specific soil types (50 CFR 424.12).

Under Section 7 of the ESA consultation with the USFWS is required for federal projects if such actions could directly or indirectly affect listed species or destroy or adversely modify critical habitat; a conference is required if such action could directly or indirectly affect a proposed listed species or proposed critical habitat. The Air Force developed management goals and objectives as specified in Integrated Natural Resource Management Plan (INRMP) as required by the Sikes Act. This INRMP provides guidance for protecting sensitive species, sensitive communities, and habitats recognized by state and local agencies when evaluating impacts of a project.

The area under restricted area R-2515 is located in the southern portion of the R-2508 Complex and within the western Mojave Desert. The airspace overlies Edwards AFB and nearly 1,400 square miles of private and public lands. The area has little topographical variation, and is dominated by arid plains with intermittent low mountain ranges. Several dry lake basins are located within the R-2515 area including Rogers, Rosamond, and Buckhorn (U.S. Air Force 1995a).

A description of the plant communities and wildlife under restricted area R-2515 and on Edwards AFB is presented in Sections 3.9.1 and 3.9.2. The natural resources information on the R-2515 area is summarized from the *R-2508 Environmental Baseline Study* (95 ABW and AFFTC 2005) and *Integrated Natural Resources Management Plan* (Edwards AFB 2004).

3.9.1 Plant Communities

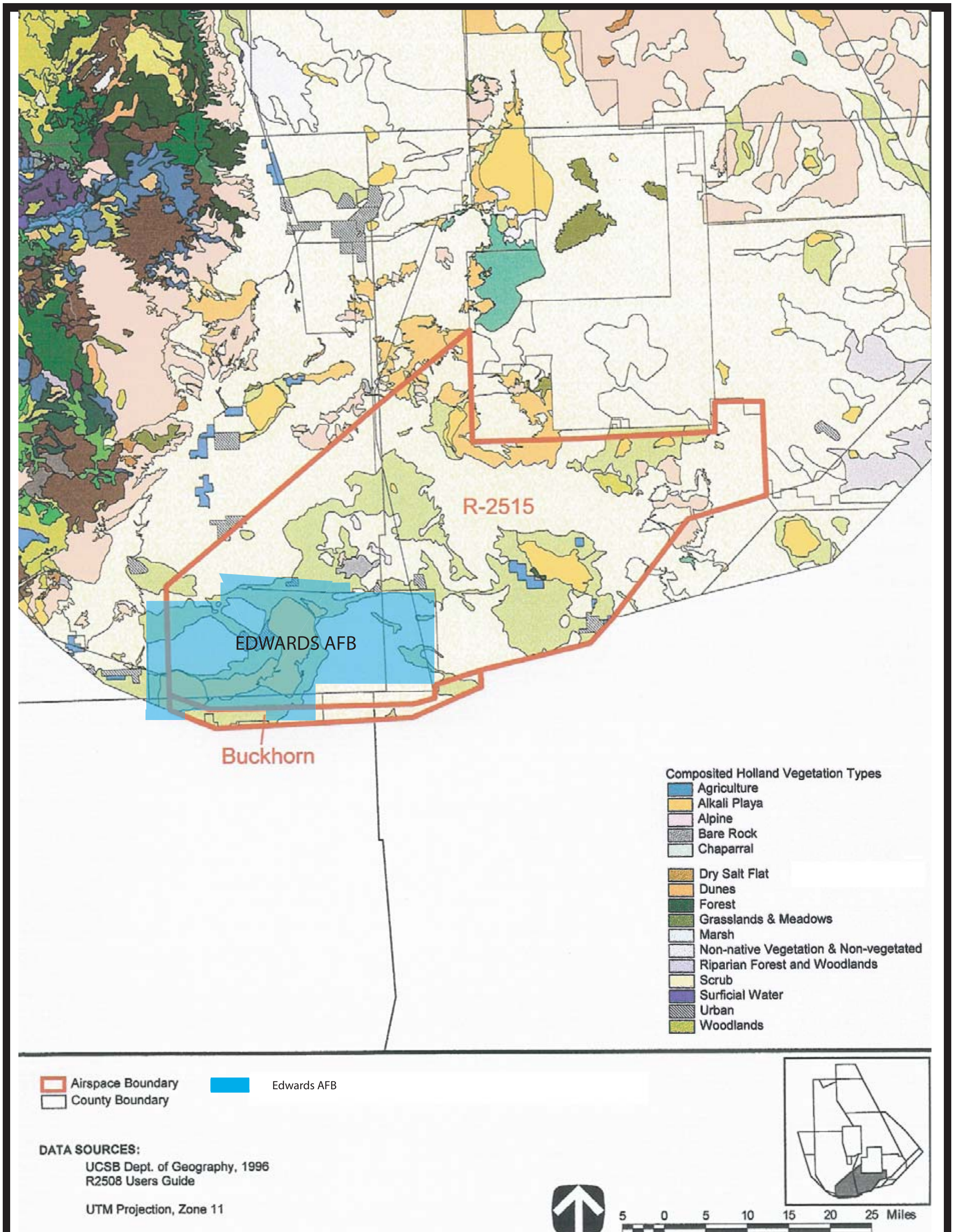
3.9.1.1 Plant Communities in the R-2515 Area

Several plant communities are found in the R-2515 area. Creosote bush scrub is the most common community and is found throughout the Mojave and Sonora deserts of southeastern California. The creosote bush (*Larrea divaricata*) comprises approximately 60 percent of plant communities found within the R-2515 area. Table 3-10 identifies the proportion of Holland vegetation types found within the R-2515 area. Figure 3-10 shows the distribution of plant communities found within the R-2515 area.

Table 3-10

Proportion of Holland Vegetation Types found within R-2515 Area

Vegetation Type	Area (square miles)	Proportion
Agriculture	8.32	0.47
Alkali playa	118.11	6.60
Bare rock	0.41	0.02
Desert saltbrush scrub	463.42	25.91
Mojave creosote bush scrub	1,087.76	60.81
Mojave mixed woody scrub	23.05	1.29
Non-native grassland	7.21	0.41
Quarry	8.40	0.47
Shadscale scrub	51.19	2.86
Transmontane alkali marsh	0.95	0.05
Urban	16.43	0.92
Wildflower field	3.61	0.20
Total	**1,788.88**	**100.00**



Plant Communities found within the R-2515 Area	Figure 3-10	Q242-04	9/13/05

Few species possess the broad ecological tolerances of the creosote bush. Species composition varies widely between creosote bush scrub communities, depending on local conditions. Joshua tree woodland also occurs in areas where creosote bush scrub community is located and is similar to the creosote brush scrub in species composition, except for the presence of Joshua trees (*Yucca brevifolia*). Both communities have common associates, including burrobush (*Ambrosia dumosa*), winter fat (*Ceratoides lanata*), cheesebush (*Hymenoclea salsola*), and Nevada tea (*Ephedra nevadensis*) (Mitchell *et al.* 1993). Most Joshua tree woodlands found within the R-2515 area occur in relatively small patches.

Desert saltbush scrub communities generally occur in soils that are alkaline, have a high soluble salt content, and have an impervous claypan or caliche layer. Desert saltbrush scrub constitutes approximately 26 percent of the plant found within the R-2515 area and may also be found on upland slopes with stony soils. Mojave creosote bush scrub and desert saltbush scrub combined account for approximately 85 percent of the plant communities found within the R-2515 area.

The shadscale scrub community occurs primarily on heavy soils that contain an underlying hardpan in their profiles. Generally found at elevations between 3,000 and 5,000 feet above MSL, the shadescale scrub is sometimes referred to as arid-phase saltbush scrub. It comprises approximately 3 percent of the plant community found within the R-2515 area and is mostly found in wetter areas adjacent to alkali playas and claypans. Species found in this community include, but are not limited to, spiny hop-sage (*Grayia spinosa*), budsage (*Artemisia spinescens*), snakeweed (*Gutierrezia sarothrae*), and winter fat. The most common grass, foxtail chess (*Bromus rubens*), is an invasive non-native species in this community.

Alkali playas constitute over 118 square miles of the R-2515 area. The majority of these comprise Rosamond, Rogers, and Buckhorn Dry Lakes on Edwards AFB. Alkali playas are characterized by poorly drained, highly alkaline and/or saline soils. These playas are generally devoid of vascular plants, but may support widely spaced saltbush (*Atriplex confertifolia*, *A. parryi*), iodine bush (*Allenrolfea occidentalis*), and greasewood (*Sarcobatus vermiculatus*) (Holland 1986).

Mojave mixed woody scrub is dominated by various scrub species including cheesebush, boxthorn (*Lycium andersonii*), and peachthorn (*Lycium cooperi*) with goldenhead (*Acamptopappus sphaerocephalus*) and spiny hop-sage. These areas typically lack creosote bush or saltbush as a dominant species. This community often occurs on alluvial plans with sandy soils.

Non-native grasslands, urban areas, quarries, and agricultural fields are also found within the R-2515 area, but comprise only about 30 square miles. Species in urban areas include eucalyptus (*Eucalyptus* sp.), cherry and almond trees (*Prunus* sp.), and pepper trees (*Schinus* sp.). A variety of shrubs used for landscaping have also become noxious weeds (e.g., pampas grass [*Cortaderia selloana*], Spanish broom [*Spartium junceum*], and other broom species [*Cytisus* sp.]).

3.9.1.2 Sensitive Plant Communities Found Within the R-2515 Area

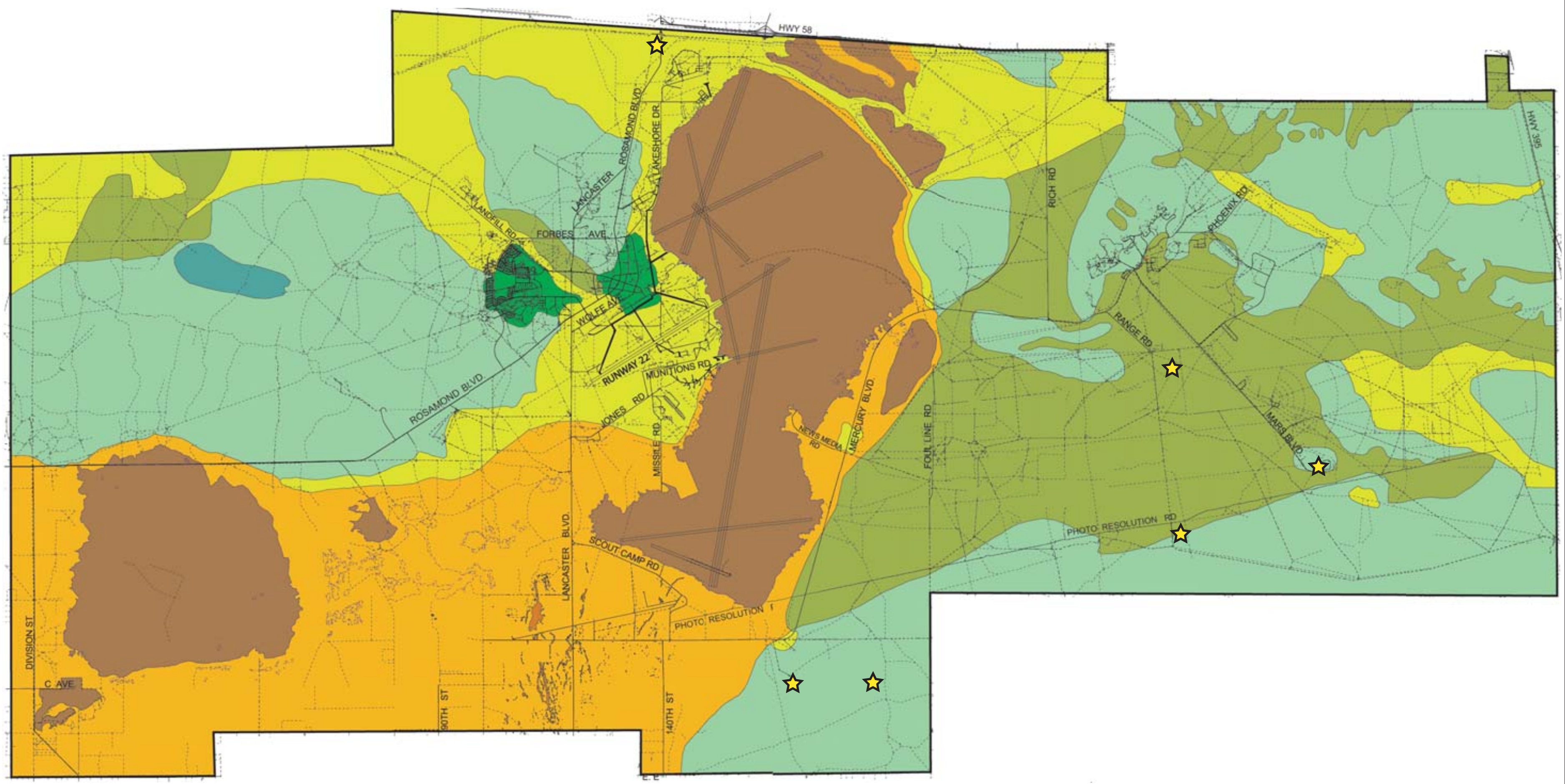
Two plant communities that are considered sensitive occur within the area. Sensitive habitats are those considered rare, support unique associations, or support sensitive plans or wildlife. Within the R-2515 area the mesquite woodlands and transmontane alkali marsh are of particular importance.

Mesquite woodlands are generally limited to desert washes in the south-central part of the R-2515 area and serve as important wildlife resources. These communities are dominated by honey mesquite (*Prosopis glandulosa* var. *torreyana*) or screw bean mesquite (*P. pubescens*). Mesquite plays an integral role in bank stabilization and encourages the accumulation of silt rich in organic matter. Mesquite is a deep rooted shrub characteristic of floodplains or other sites with an available groundwater source, thus its distribution is dependent on available groundwater.

Transmontane alkali marsh within the R-2515 area is limited to the northwest edge of Harper Dry Lake and can be characterized by standing water or saturated soil during most of the year, with a growing season restricted to summer. This community occurs at elevations ranging from 3,000 to 7,000 feet above MSL. Characteristic species include yerba mansa (*Anemopsis californica*), sedge (*Carex* sp.) saltgrass (*Distichilis spicata* var. *stricta*), rush (*Juncus cooperi*), bulrush (*Scirpus* sp.), and cattail (*Typha* sp.).

3.9.1.3 Plant Communities found within Edwards AFB Area

The five major plant communities found within Edwards AFB area are creosote bush scrub, Joshua tree woodland, halophytic phase saltbrush scrub, xerophytic saltbrush scrub, and mesquite woodland (Figure 3-11). Four of the five plant communities occurring on Edwards AFB occur on the PIRA. Two of the proposed target sites that occur at Mt. Mesa area are in creosote bush scrub, two proposed target sites are in transition areas between creosote bush scrub and Joshua tree woodland, and one proposed target is in Joshua tree woodland. Three of the proposed target sites are located on alluvial fans and two proposed target are located on rocky hillsides.



LEGEND

- Unpaved Roads
- Paved Roads
- Taxiways
- Base Boundary

HABITATS AND PLANT COMMUNITIES

- Xerophytic Saltbush Scrub
- Urban/Developed Areas
- Playa
- Mesquite Woodland
- Joshua Tree Woodland
- Halophytic Saltbush Scrub
- *Hymenoclea-Lycium* Scrub
- Creosote Bush Scrub

N

0 2 4 6

SCALE IN STATUTE MILES

Target Areas (not to scale; locations are approximations)

EA FOR THE INTEGRATION AND DEVELOPMENTAL TESTING OF HIGH POWER MICROWAVE SYSTEMS AT EDWARDS AFB

HABITATS AND PLANT COMMUNITIES AT EDWARDS AFB

TC#	DATE	DRAWN BY	FILENAME	FIGURE NO.
Q242-04	9/14/05	Knight	Q242-04 HPM-3-11.ai	3-11

Creosote bush scrub is dominated by creosote bush (*Larrea divaricata*). At Edwards AFB, there are approximately 160 square miles of creosote bush scrub, which comprises approximately 34 percent of the base area. Creosote bush scrub is distributed throughout the northwestern and eastern portions of the base and supports the highest plant diversity on base (Edwards AFB 2004). Common species found in this community include winter fat (*Ceratoides lanata*), cheesebush (*Hymenoclea salsola*), and Nevada tea (*Ephedra nevadensis*).

Joshua tree woodland is dominated by Joshua trees (*Yucca brevifolia*) and is most prevalent east of Rogers Dry Lake, with small patches occurring in the northwest. At Edwards AFB, there are approximately 82 square miles of Joshua tree woodland, which comprises approximately 17 percent of the area of the base. Common species found in this community include the native desert dandelion (*Malacothrix glabrata*), pincushion (*Chaenactis* sp.), and fiddleneck (*Amsinckia tesselata*).

Halophytic phase saltbrush scrub is dominated by four species of the genus *Atriplex*: spinescale (*A. spinifera*), shadscale (*A. confertifolia*), four-wing saltbush (*A. canescens*), and quailbush (*A. lentiformes*). At Edwards AFB, there are approximately 86 square miles of halophytic phase saltbush scrub, which comprises approximately 18 percent of the area of the base. A common species found in this community includes saltgrass (*Distichlis spicata*).

Arid phase saltbrush is dominated by allscale (*Atriplex polycarpa*). At Edwards AFB, there are approximately 71 square miles of arid phase saltbush scrub, which comprises approximately 15 percent of the area of the base. Common species found in this community include burrobush (*Ambrosia dumosa*), goldenhead (*Acamptopappas sphaerocephalus*), and cheesebush (*Hymenoclea salsola*).

Lakebeds, claypans, and dunes occur from Piute Ponds in the southwestern corner of the base through Rosamond and Rogers Dry Lakes, to an area between the northeastern limits of Rogers Dry Lake and Rich Road. Smaller playas and claypans are found throughout the rest of the base.

Azonal habitats are those natural and human-influenced plant and wildlife associations that are not restricted by elevation, but by other biotic and abiotic factors such as human disturbance or waste. Azonal habitats found within the R-2515 area include

- Dry wash with mesquite woodlands;
- Dry wash without mesquite woodlands;

- Hymenoclea-Lycium scrub;
- Artificial aquatic habitats;
- Urban landscape;
- Rock outcrops and hillsides;
- Caves and mines;
- Dunes;
- Claypans;
- Alluvial fans;
- Alkali meadow; and
- Ditches and canals.

3.9.1.4 Sensitive Plant Species

Twelve sensitive plant species have been documented on Edwards AFB. Of these seven occur on the PIRA or Desert Tortoise Management Area (Table 3-11).

Desert cymopterus has a limited range within the West Mojave Desert, primarily between Rogers Lakebed and Superior Valley. Its habitat is limited to deep sandy soils. Most populations occur within the PIRA on Edwards AFB, with the largest populations south of Mars Boulevard. Adjacent populations to the proposed target sites are shown on Figure 3-12. Small scattered populations can be found in sandy areas throughout the PIRA. Although this species is a perennial, not all the plants come up each year. Populations increase in size in proportion to rainfall. Accurate records of population boundaries can only be documented if rainfall is over 10 inches in a season. None of the sites will directly affect known desert cymopterus populations.

Populations potentially impacted by this project would consist of scattered individuals and would not be significant. Approximately 75,000 plants have been documented by recent studies. Significant populations have been identified outside of Edwards AFB.

Table 3-11

Sensitive Plant Species at Edwards AFB

Common Name	Scientific Name	CNPS	Habitat	Range
Desert cymopterus*	*Cymopterus deserticola*	1B	any sandy substrate	W Mojave endemic
Barstow woolly sunflower*	*Eriophyllum mohavense*	1B	clay pan edges	W Mojave-endemic
Lancaster milkvetch	*Astragalus preussei laxiflorus*	1B	Halophytic saltbush	W Mojave/Nevada
Alkali mariposa lily*	*Calochortus striatus*	1B	Halophytic saltbush	Widespread at springs
Pygmy poppy*	*Canbya candida*	IB	Joshua Tree Woodland	Widespread
Twisselman poppy	*Eschscholtzia twisselmanii*	1B	Creosote Bush Scrub	El Paso Range-vicinity endemic
Mojave spineflower*	*Chorizanthe spinosa*	4	saltbush scrub	W Mojave endemic
Yellow spiny cape*	*Gilmania luteola*	4	Halophytic saltbush	Widespread
Sage loeflingia*	*Loeflingia squarrosa artemisiarum*	4	Halophytic saltbush	Widespread
Crowned onion	*Muilla coronata*	4	Xerophytic saltbush	Widespread
Slender threadstem	*Nemacladus gracilis*	4	sand dunes/fields	Widespread
Hoover's woolly star	*Eriastrum hooveri*	4	sandy soils	Central Valley, scattered in desert

Notes: * - Documented on the PIRA/Complex 1 Charlie (Edwards AFB *Desert Tortoise Management Plan 2004*).
CNPS - California Native Plant Society Status
List 1B – Plants of very limited distribution; global populations potentially threatened
List 4 – Widespread and common - status does not warrant further consideration at this time.

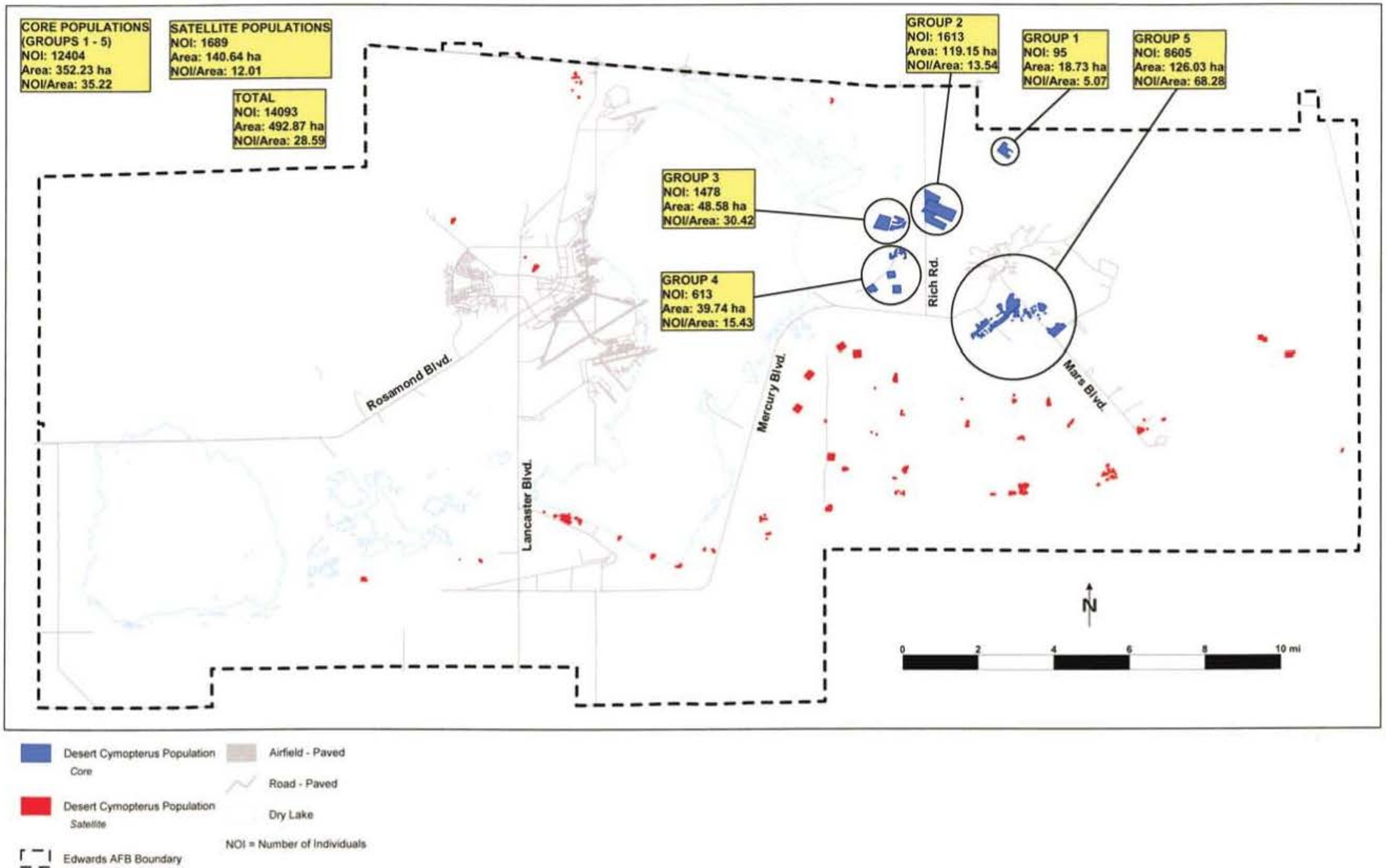


Figure 3-12

Distribution of Desert Cymopterus at Edwards AFB

Barstow woolly sunflower is also a West Mojave Desert endemic, occurring from Buckhorn Lake on Edwards AFB east to Coolgaardie Mesa. This small annual's habitat is limited to the edges of bare areas primarily in xerophytic phase saltbush scrub. Barstow woolly sunflower has been documented only in the northeastern portion of the PIRA. Known populations are not located near any proposed sites.

Alkali mariposa lily is a rare endemic of moist alkaline areas in the arid interior of southern California and southern Nevada. In California, populations are scattered in Kern, northeastern Los Angeles, and southern and central San Bernardino counties. Alkali mariposa lily grows in calcareous sandy soil in seasonally moist alkaline habitats such as alkali meadows, ephemeral washes, vernally moist depressions and at seeps within saltbush scrub at 300 to 4,500 feet above MSL. These plants are not found in soils with surface salts, or wetter areas with permanent standing surface water. The bulb remains dormant and does not sprout in dry years. There were about 6,000 plants reported for Kern County from 1988 to1992. Even though this species occurs on a large number of quads, most of the populations are small with the exception of the metapopulation extending from Lancaster to Edwards AFB. There are as many as 165,000 plants in 67 areas documented on Edwards AFB (Greene and Sanders n.d.). This species will not be impacted by proposed construction because this is a lowland species, and all the target sites are in upland habitat.

Pygmy poppy occurs in scattered small populations in sandy soils throughout the western and northern Mojave Desert. Several scattered populations occur north of Mars Boulevard on the PIRA. Otherwise other known locations on Base occur near Buckhorn Lakebed. No documented populations occur near the proposed sites.

Mohave spineflower was delisted from List 1B because it was found to be more common within its limited range after surveys for this species were conducted in the 1990s. In addition, spineflower grows well in disturbed soils. Spineflower habitat is limited to saltbush scrub. The proposed sites are not located in this plant community.

Yellow spiny cape and sage loeflingia occur in sandy soils on flats in halophytic phase saltbush scrub. Yellow spiny cape prefers salt encrusted dune swale habitat and sage loeflingia prefers loose sand. Such habitat occurs on the western edge of the Mt. Mesa Desert Tortoise Management Area along with the alkali mariposa lily. No sites are proposed in this habitat.

3.9.2 Wildlife

3.9.2.1 Wildlife Found Within the R-2515 Area

Characteristic invertebrate species found within the R-2515 area include harvester ants (*Pogonomyrmex* sp.), termites (Order: Isoptera), creosote bush grasshoppers (*Bootettix argenteus*), desert clicker grasshopper (*Ligurotettix coquilletti*), Jerusalum crickets (*Stenopelmatus fuscus*), broad necked darkling beetles (*Coelocnemis californicus*), tiger beetles (*Cicindela* sp.), tarantula hawks (*Hemipepsis* sp.), and desert tarantulas (*Aphonopelma chalcodes*). Butterflies in the area include Becker's white (*Pontia beckerii*), common sulphur (*Colias philodice*), *Plebejulina emigdionis*, and square-spotted blue (*Euphilotes bauri*) (MacMahon 1992; Powell and Hogue 1979; Pratt and Pierce 1995). The alkali playas, as well as smaller claypans and roadside pools, support a variety of invertebrates including clam shrimp (*Eocyzicus digueti*), tadpole shrimp (*Lepidurus lemmoni*), and three species of fairy shrimp (*Branchinecta mackini*, *B. gigas*, and *B. lindahli*) (AFFTC 1992).

Because there are few perennial water sources found within the R-2515 area, fisheries habitat is extremely limited. Introduced species include the arroyo chub (*Gila orcutti*), mosquitofish (*Gambusia affinis*), and a variety of stocked gamefish that can be found in recreational ponds.

Amphibian habitat found within the R-2515 area is also limited. Amphibians include the Pacific treefrogs (*Hyla regilla*), spadefoots (*Scaphiopus* sp.), and introduced bullfrogs (*Rana catesbiana*), which are generally confined to areas containing perennial or near perennial water. There are 15 species of reptiles recorded on Edwards AFB including chuckwalla (*Sauromalus obesus*), zebra-tailed lizards (*Callisaurus draconoides*), desert iguanas (*Diposaurus dorsalis*), sidewinders (*Crotalus cerastes*), and the desert tortoise (*Gopherus agassizii*) (Mitchell *et al.* 1993; Mitchell *et al.* n.d.).

Desert scrub habitats found within the R-2515 area support a diversity of birds. Species include sparrows, larks, ravens, dove, quail, woodpeckers, kingbirds, wrens, thrashers, and flycatchers. Common raptors found in the area include hawks, owls, kestrels, harriers, vultures, eagles, and falcons.

Carnivorous mammals found within the R-2515 area include the coyote, desert kit fox, and bobcat. Although somewhat less common, gray foxes, badgers, and mountain lions also occur. Abundant diurnal species include black-tailed jackrabbits, desert cottontails, antelope ground squirrels, and the California ground squirrel. Less common is the state-listed Mohave ground squirrel (*Spermophilus mohavensis*). The most abundant nocturnal animals that have adapted to arid conditions include the Merriam's kangaroo rat (*Dipodomys merriami*) and deer mice (*Perognathus maniculatus*). Other common species include the saltbrush-adapted Great Basin kangaroo rat (*Dipodomys microps*), desert kangaroo rat (*D. deserti*), Panamint kangaroo rat (*D. panamintinus*), little pocket mouse (*Perognathus longimembris*), San Joaquin pocket mouse (*Perognathus inornatus*), and the carnivorous grasshopper mouse (*Onychomys torridus*). Other species generally found within the R-2515 area include the desert woodrat (*Neotoma lepida*), western harvest mice (*Reithrodontomys megalotis*), and California voles (*Microtis californicus*) (95 ABW and AFFTC 2005).

Migratory Birds

Migratory birds and resident waterfowl use the perennial water sources such as Piute Ponds, Branch Park Ponds, the sewage treatment ponds at Edwards AFB, the marsh at Harper Dry Lake, as well as the ephemeral alkali playas as stopover areas. Some of the most common and abundant waterfowl in these areas include geese, teals, mallards, pintails, and coots.

3.9.2.2 Sensitive Wildlife found within the R-2515 Area

Fifty sensitive animal species that are listed as federal protected, federal endangered, federal threatened, federal species of concern, state endangered, state threatened, or state species of concern have been documented in this ROI. This includes 4 reptile species, 8 mammal species, and 38 bird species. Table 3-12 is a comprehensive list of sensitive wildlife species and habitats which occur in this area. It also includes their respective federal and state status. The list of sensitive species was obtained using the CNNDB in association with Geographic Information System (GIS) data for the defined R-2515 airspace boundary, as shown on Figure 3-13. Sensitive biological resources in the area include federally listed species as reported by the California Department of Fish and Game (CDFG) CNDDB and designated critical habitat. Nine federally listed wildlife species, desert tortoise (*Gopherus agassizii*), Yuma clapper rail (*Rallus longirostris yumanensis*), bald eagle (*Haliaeetus leucocephalus*), western snowy plover (*Charadrius alexandrinus nivosus*), Mountain plover (*Charadrius mountanus*), California Least Tern (*Sterna antellarum brownie*), American Brown Pelican (*Pelicanus occidentalis californicus*), American Perigrine falcon (*Falco peregrinus anatum*) and Mohave tui chub (*Gila bicolor mohavensis*) occur in the area (CNNDB 2004 and 95ABW/CEV 2006). In addition, seven state listed wildlife species, Mohave ground squirrel (*Spermophilus mohavensis*), Swainson's Hawk (*Buteo swainsonii*), Bank Swallow (*Riparia riparia)*, Willow Flycatcher (*Epidonax traillii*), California Least Tern (*Sterna antellarum brownie*), American Brown Pelican (*Pelicanus occidentalis californicus*), American Perigrine falcon (*Falco peregrinus anatum*) occurs in the area. The species accounts were obtained from the CDFG

Table 3-12

Sensitive Animal Species in the R-2515 and Edwards AFB

Common Name	Scientific Name	Status	Habitat	Range
Reptiles				
Desert tortoise	*Gopherus agassizii*	FT	scrub	Mojave-Sonoran Desert
Chuckwalla	*Sauromalus obesus*	FSC/CSC	rock outcrops	California Desert
Desert horned lizard	*Phrynosoma coronatum*	CSC	alluvial fans	California Desert
Mojave fringe-toed lizard	*Uma scoparia*	CSC	sand dunes, washes	Limited endemic
Mammals				
Mohave Ground Squirrel	*Spermophilus mohavensis*	FSC/ST	scrub	Mojave Desert
Pallid Bat	*Antrozus pallidus*	CSC	feed throughout the base	North America
Pocketed free-tailed bat	*Nyctimops femerosaccus*	CSC	feeds over water	Extreme SE California
Western Mastiff Bat	*Eumops perotis californicus*	FSC/CSC	feed throughout the base	North America
Spotted bat	*Euderma maculatum*	CSC	feed over water	North America
Big Free-tailed bat	*Nyctimops macrotis*	CSC	often feed over water	North America
Townsends' big-eared bat	*Plecotus townsendii*	CSC	often feed over water	North America
American Badger	*Taxus taxus*	CSC	scrub	North America
Birds				
Cooper’s Hawk	*Accipiter cooperi*	CSC	trees, housing	North America
Ferruginous Hawk	*Buteo regalis*	FSC	poles along roads	North America
Swainson’s Hawk	*Buteo swainsonii*	ST	poles along roads	North America
Golden Eagle	*Aquilia chrysaetos*	CSC	poles along roads	North America
Northern Harrier	*Circus cyaneus*	CSC	basewide	North America
Prairie falcon	*Falco mexicanus*	CSC	Piute Ponds, adjacent scrub	North America
Short-eared owl	*Asio flammeus*	CSC	Piute Ponds	no longer breeds in California
Long-eared owl	*Asio otus*	CSC	mesquite woodland	riparian woodlands NA
Burrowing owl	*Speotyto cunicularia*	CSC	scrub, Basewide	throughout california
Osprey	*Pandion haliaetus*	CSC	hunts at ponds for fish	large bodies of water Coastal
Vaux’s swift	*Chaetura vauxi*	CSC	hunts insects in flight	breeds along coastal California

Table 3-12, Page 1 of 3

Table 3-12 (Continued)

Sensitive Animal Species in the R-2515 and Edwards AFB

Common Name	Scientific Name	Status	Habitat	Range
Birds (Continued)				
LeConte's thrasher	*Toxostoma lecontei*	CSC	hunts insects on ground	Central Valley-Desert
Loggerhead shrike	*Lanius ludovicianus*	FSC	hunts insects-lizards	California lower elevations
Bank Swallow	*Riparia riparia*	ST	hunts insects in flight	California west of deserts
Yellow warbler	*Dendroica petechia*	CSC	hunts insects on foliage	California, skips desert except riparian
Willow Flycatcher	*Epidonax traillii*	SE	hunts insects on foliage	Most of California except desert and
California gull	*Larus californicus*	CSC	Piute, Main Base, South Base	Widespread breeds at Mono Lake
Sharp-shinned hawk	*Accipiter striatus*	CSC	Piute, Main Base, South Base	Found throughout California breed in
Western Least bittern	*Ixobrychus exilis*	CSC	hunts fish/amphibians in ponds	Central Valley-Salton Sea
White-faced ibis	*Pilegadis chihi*	CSC	Piute Ponds	California, breeds in Central Valley
Western snowy plover	*Charadrius alexandrinus*	CSC	playa edges	Coastal California and brackish inland
Gray vireo	*Vireo vicinior*	CSC	hunts insects on foliage	Lower Mountain slopes of California
Common loon	*Gavia immer*	CSC	hunt for fish	North America
American White Pelican	*Pelecanus erythrorhynchos*	CSC	hunts fish in ponds	North America
Fulvous Whistling Duck	*Dendrocygna bicolor*	CSC	eat grain, rice in fields	Coastal California
Harris hawk	*Parabuteo unicinctus*	CSC	rabbits and squirrels	Sonoran Desert
Double crested cormorant	*Phalacrocorax auritus*	CSC	hunts on ponds	Coastal California and brackish inland
Gull-billed tern	*Sterna nilotica vanrossemi*	CSC	Breeds at Salton Sea, Colorado River	Coastal California and brackish inland
Purple martin	*Progne subis*	CSC	hunts on the fly over base	riparian woodlands NA
Mountain Plover	*Charadrius montanus*	CSC/FPFT	eats ground insects	Prairie
Long-Billed Curlew	*Numenius americanus*	CSC	invertebrates in salt flats	Prairie endemic
Tricolored Blackbird	*Agelaius tricolor*	CSC	insects and grain	Central Valley
California Least Tern	*Sterna antellarum brownii*	ST/FE	Common in July	West coast of NA
Red-shoulder hawk	*Buteo lineatus*	CSC	rodents and birds	Calif subspecies primarily the Central
Yellow Breasted Chat	*Icteria virens auricollis*	CSC	insects	edges of woodlands insectivor

Table 3-12, Page 1 of 3

Table 3-12 (Continued)

Sensitive Animal Species in the R-2515 and Edwards AFB

Common Name	**Scientific Name**	**Status**	**Habitat**	**Range**
Birds (Continued)				
California Horned Lark	*Eremophilia alpestris*	CSC	insects	grasslands, desert edge
American Brown Pelican	*Pelicanus occidentalis*	FE/SE	fish	coastal
American peregrine Falcon	*Falco peregrinus anatum*	FE/SE	small birds	Statewide, nests coastal only

Table 3-12, Page 1 of 3

Notes: CSC – California species of Concern
FE – Federal Endangered
FP- Federal Protected
FT – Federal Threatened
FSC – Federal Species of Concern
SE – State Endangered
ST – State Threatened

Habitat Conservation Planning Branch (CDFG 2004a, c) and 95ABW/CEV Environmental Management office.

The desert tortoise (*Gopherus agassizii*) is listed as threatened by the federal government and by the State of California. It can occur throughout the Colorado and Mojave deserts at elevations up to 4,100 feet, although ideal habitat typically occurs between 1,000 and 3,000 feet (Edwards AFB 2004). The desert tortoise can occur in almost every desert habitat, but is most common in desert washes, desert scrub, creosote bush, and Joshua tree habitats. This species finds cover in burrows that are usually under bushes and requires loose, dry, sandy soil for nest building. The desert tortoise is a herbivorous reptile whose native range includes the Sonoran and Mojave deserts of southern California, southern Nevada, Arizona, extreme southwestern Utah, and Sonora and northern Sinaloa, Mexico. Desert tortoise habitat is highly fragmented and degraded as a result of human activities, including livestock grazing, energy and mineral development, off-highway vehicle use, road and trail construction, and collection.

The Yuma clapper rail, listed as federal endangered species and by the state of California as threatened species and is found in marshland along the lower Colorado River from just north of Needles in San Bernardino County, south through Riverside and Imperial counties to the river’s delta. Other nesting areas include the Salton Sea and its drainages in California and the Salt and Gila Rivers in Arizona. No known populations are on Edwards AFB.

The bald eagle (*Haliaeetus leucocephalus*) is a federal and State-listed endangered species. This species is reported by the USFWS (2001) as a potentially occurring species in the Antelope Valley region. This species utilizes most of California's lakes, reservoirs, river systems, and coastal wetlands. Bald eagles typically forage on large bodies of water or free flowing rivers with abundant fish. Although fish are the primary food source, bald eagles will also opportunistically hunt sick or wounded ducks across water and feed on carrion. Nesting or foraging habitat for this uncommon migrant is not likely in the target area.

The western snowy plover (*Charadrius alexandrinus nivosus*) is a federal threatened species and California Species of Special Concern. The western snowy plover nests in the West Mojave on certain alkali playas and wetland areas, which include Rosamond Dry Lake and the Paiute Ponds (CNDDB, 2001). Nesting sites consist of a simple scrape marked with twigs, debris, and grass tufts lined with bird of concealing ornaments (Ehrlich et al., 1999). This species nests with regularity at the Paiute Ponds on Edwards AFB (The West Mohave Plan 1999). Target sites of HPM tests are not near the Paiute Ponds; and therefore should not result any impacts on nesting sites and foraging by the western snowy plover.

The distribution of breeding habitat around the ponds is not fully known, however, nesting may occur on the surrounding levees, on the dry desert claypan below the levees, and on Rosamond Dry Lake. During the course of a week, overflows from the Paiute Ponds to Rosamond Dry Lake in the spring and early summer may provide foraging habitat to tens of thousands of shorebirds. During this overflow period, birds concentrate in the area between the Paiute Ponds and the Rosamond Dry Lake edge (Garrett pers. comm. 2001). Western snowy plover are expected to forage extensively in this area, especially if nesting near the Paiute Ponds wetland complex. The continued compatible management of Paiute Ponds as western snowy plover habitat is a main conservation strategy of the West Mohave Plan (1999). Other reported nest locations are Harper Dry Lake, Koehn Lake, China Lake, Rosamond Lake, Dale Lake, and the evaporation ponds at the Edison facility in Daggett, although the birds may not use these sites every year. Suspected nesting habitat is found along the shoreline at Searles Lake. All of these sites may be used by this bird in winter.

Mountain plovers are found almost exclusively in plowed or burned agricultural fields in winter. Original, ancestral wintering habitat is not well defined, but is though to be edges of playas with short ground cover, such as alkali sink scrub. Currently Mountain plovers are found in relatively limited portions of the agricultural area in western Antelope Valley near the Kern - Los Angeles County line. They have also been recorded at Harper Dry Lake, primarily in the fallow agricultural fields. Potential habitat exists along the Mojave River near Helendale and in the Mojave Valley.

The California least tern is one of five geographic races described in the Americas. All five subspecies are similar to the coastal Sterna antillarum. The California least tern is found along the Pacific Coast of California, from San Francisco southward to Baja California. The California populations are localized and increasingly fragmented, where the least tern is federally listed as endangered. Both the coastal and interior breeding populations of least terns winter broadly across the marine coastlines of Central and South America. California least terns nest in colonies on relatively open beaches kept free of vegetation by natural scouring from tidal action. The typical colony size is 25 pair; pairs remain monogamous. The California least tern is only found in the United States in California, along the Pacific coastline. They winter along the Pacific coast of southern Mexico and the Gulf of California.

The California least tern population increased from approximately 600 pairs in 1973 to 2,750 pairs in 1994. The number of colonies in California, however, has remained relatively stable at 25-30 sites from 1978 to 1994. The species is also listed as endangered in Mexico, where the Gulf of California population was estimated at 400 pairs in the 1992-1994 censuses.

Rare everywhere, the American brown pelican — federally listed as endangered — is almost never seen anywhere but coastal areas. The only recorded sighting of an American brown pelican at Edwards occurred on April 12, 2006.

The American peregrine falcon (*Falco peregrinus anatum*) is a California Endangered species and is protected by the federal Migratory Bird Treaty Act. This large falcon occurs in California both to breed and as a winter visitor. The peregrine falcon nests on cliffs and often on artificial structures such as buildings or bridges that provide a platform for egg laying, and rarely nests on trees or nest cavities. Nests are typically located near wetlands, lakes, or other bodies of water. They feed primarily on birds, which are usually captured in flight. The home range for this species can encompass an area as large as 125 square miles, largely depending upon prey availability. Peregrine falcons have been observed in ROI (West Mohave Plan, 1999; EAFB, 1991; 1993a).

The Mohave tui chub (*Siphateles bicolor mohavensis*—formerly *Gila bicolor mojavensis*), listed as endangered by the federal government, can be found east of the R-2515 area at Soda Springs, California (Desert Research Center).

The Mohave ground squirrel, listed by the state of California as threatened, is found in the Mojave Desert in San Bernardino, Los Angeles, Kern, and Inyo Counties including Edwards AFB in restricted area R-2515. Populations are known to occur north and south of Rogers Dry Lake and the PIRA. This species is rare throughout its range. Populations in southwestern San Bernardino County appear to be extirpated. Optimal habitats for the Mohave ground squirrel are open desert scrub, alkali desert scrub, and Joshua tree; this species also feeds in annual grasslands. Mohave ground squirrels live in underground burrows, frequently among the roots of the creosote bush and have been found at elevations between 1,800 and 5,000 feet MSL. They spend more time above ground in March through May.

The Swainson’s hawk (*Buteo swainsoni*) is a State-listed threatened species that has suffered substantial population declines over the past century. Swainson's hawks in California breed mostly in the southern Sacramento and northern San Joaquin Valleys, but also breed in Sierra Nevada valleys in Inyo and Mono counties and elsewhere. This hawk typically nests at the edge of narrow bands of riparian vegetation, in oak woodland, and in lone trees, roadside trees, and farmyard trees (England et al., 1997). Pair formation begins on return to the nesting grounds, which can be as early as March in central California. Foraging areas include grasslands and various agricultural lands, including wheat and alfalfa. In the Central Valley, Swainson’s hawks often forage in row, grain, and hay crops. However, these hawks cannot forage in most perennial or annual crops that grow higher than native grasses, apparently because they cannot locate their prey in higher cover. During nesting, prey consists primarily of mammals. In California, voles are an important part of the diet (Estep, 1989), which can also include ground squirrels, pocket gophers, and deer mice (England et al., 1997).

Swainson's hawks have been observed on Edwards AFB and in the Piute Ponds area (EAFB, 1991; 1993a). Nesting has not been identified at Piute Ponds. Swainson's hawks are potential foragers in the upland portions of the project area, and unlikely nesters, with the exception of the Piute Ponds area where Fremont's cottonwood, willow, and other trees provide nesting habitat.

Bank Swallow (*Riparia riparia*). In general the Bank swallow is fairly common migrant in the spring and fall through the California deserts on broad fronts concentrating over marshes, ponds, and agricultural fields. It is casually seen in Southern California during the winter; though not dependent on riparian vegetation, as it is mostly seen over open water. Known areas of migrant concentrations occur at Harper Dry Lake, China Lake, and Piute Ponds. Bank Swallows are diurnal, aerial insectivores; the proximity to water is important during all seasons where wetlands provide a steady source of insects and a buffer against extreme temperatures. Most breeding in California occurs in Shasta, Siskiyou, Modoc, and Lassen Counties where they nest in colonies. Nesting is typically associated with eroded banks near flowing water. There are no known roosting sites in the ROI.

The Southwest Willow flycatcher (*Epidonax traillii*) is a rare breeder in Southern California, typically arriving in the spring and leaving by early September. It occurs principally along the south fork of the Kern River, Santa Ynez River, Prado Basin, Santa Margarita River, and San Luis Rey River. Like the Bank Swallow it is a diurnal insectivore that catches its prey on the wing usually in the middle story of riparian woodlands. It breeds only in riparian woodlands with a canopy and understory of shrubs and saplings, typically adjacent to or over open water. Historically 86 percent of the egg collections indicate nesting occurs in willows, with egg laying as early as 24 May and as late as 31 July with approximately 24-28 days from when eggs are laid until the young are fledged. The closest jurisdictional occurrences to the target areas would be Victorville and part of San Bernardino County.

Figure 3-13 shows the distribution of sensitive wildlife species in the R-2515 area.

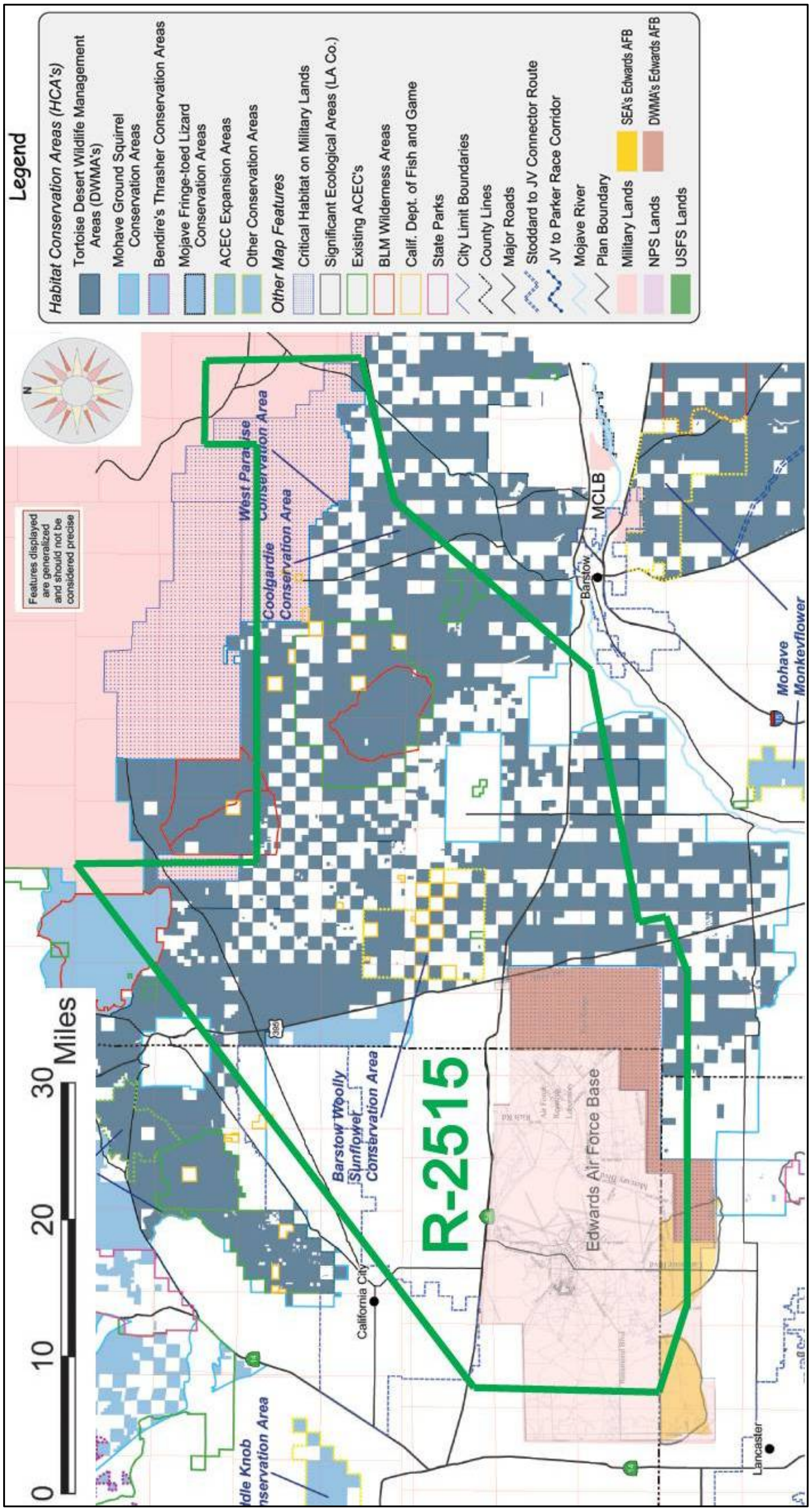


Figure 3-13
Sensitive Wildlife and Critical Areas of Concern in the R-2515 Area

Other sensitive bird species of concern (birds of prey) in the ROI could include:

The Cooper's hawk (*Accipiter cooperi*) is a California Species of Special Concern that ranges over most of North America, and may be seen throughout California. It is more common as a winter migrant, and nesting pairs have declined throughout the lower elevation, more populated, parts of the state. The Cooper's hawk forages in open woodlands and wood margins and nests in tall trees, often in riparian areas (Ehrlich et al., 1988). There are no records for this species at the Piute Ponds (CNDDB, 2001; Edwards AFB, 1993a; 1993b), though potential nesting habitat occurs at the ponds. Cooper's hawks are occasionally reported at Edwards AFB (Edwards AFB, 1991), but their breeding status at the Piute Ponds is not known. Based on these indications and the known breeding range for the species, Cooper's hawks are considered an unlikely breeder at the Piute Ponds. No other portions of the project area provide habitat for this species.

The burrowing owl (*Athene cunicularia*) is a California Species of Special Concern and is protected under the federal Migratory Bird Treaty Act. Burrowing owls are year-round residents of the Central Valley, as well as other areas of open, dry grassland and desert habitats. They are frequently found in open grasslands and shrublands where perches and suitably sized rodent burrows are available for nesting and shelter, particularly California ground squirrel burrows. Burrowing owls are opportunistic feeders, preying primarily on insects and other arthropods, but also prey on small mammals, reptiles, birds, and carrion (Zeiner et al., 1990). Breeding takes place from March through August, with peak in April and May (Zeiner et al., 1990). Owls have not been documented during Edwards AFB surveys or surveys of the Piute Ponds area. Suitable habitat may occur in and surrounding agricultural lands west of SR-14 and owls may occasionally forage and potentially nest in undiscovered burrows. The burrowing owl home range, or geographic area over which the owls habitually wander, has been documented in the range of 0.1 to 4 acres per nesting pair, with greater variations found elsewhere (Thomsen, 1971). At a minimum, suitable foraging habitat for burrowing owls may be within the home range for off-site nests.

The short-eared owl (*Asio flammeus*) is a California species of special concern. This species requires dense vegetative cover such as tall grasses and freshwater emergent vegetation for roosting and resting. Nesting occurs from April through July, with nests constructed on dry ground in depressions concealed by dense vegetation. The dense tules, water smartweed, and other emergent vegetation associated with the Piute Ponds provide suitable nesting and foraging habitat for this species. Members of this species usually arrive in California in September or October and stay until April, although this species occasionally still breeds in northern California. A 1932 record of this species is reported by the CNDDB from Rosamond Dry Lake (CNDDB, 1999). More recently, incidental observations of short-eared owls have been reported at Edwards AFB (1993a). Nesting habitat for this species is limited to the area surrounding the Piute Ponds, with foraging habitat in areas closest to the ponds.

The long eared owl (*Asia otus*) is a California Species of Special Concern. This species nests in coniferous and mixed coniferous deciduous forests, especially near water bodies (Ehrlich et al., 1988). The willow and cottonwood riparian groves of the Piute Ponds provide suitable nesting sites. Because the owls disperse widely, migrate long distances, and appear to exhibit low fidelity to individual nest sites, the protection of woodland habitat is considered more important than protection of individual nest sites for the conservation of this species (West Mohave Plan, 1999). Incidental occurrences for this species are reported at Edwards AFB (1993a). Nesting habitat for this species is limited to the area surrounding the Piute Ponds, with foraging habitat in areas closest to the ponds.

The golden eagle (*Aquila chrysaetos*) is a California Species of Special Concern and a state fully protected species. This species is protected under the federal Bald and Golden Eagle Protection Act. The golden eagle occurs throughout much of California and has been observed in the project region incidental to focused surveys for special status species (Edwards AFB, 1991; 1993a). The golden eagle is a widespread species in mountainous areas in the West Mojave Desert, with important nest sites at the China Lake NAWS, the Eagle Crags, and southern Sierra Nevada Mountains (West Mojave Plan, 1999). This large, wide-ranging predator frequents open habitats, especially in mountains or hilly county. It nests on cliff faces or in large trees with nests frequently used for many years by the same breeding pair. The breeding territory of this species may range from 20 over 100 square miles with small to medium sized mammals as the primary food source (West Mojave Plan, 1999). This species is identified as a “covered species” in the West Mojave Plan, with threats to this species identified from human disturbance at nest sites and shooting as a minor threat. The biological goal for this species identified in the West Mojave Plan (1999) is to preserve all nest sites. The take of foraging habitat was not identified as a potential threat to golden eagle. Nesting sites do not occur in the general project vicinity.

3.9.2.3 Wildlife at Edwards AFB

Five eubranchiopod shrimp species have been identified in Rogers Dry Lake: clam shrimp (*Eocyzicus digueti*), tadpole shrimp (*Lepidurus lemmoni*), and three species of fairy shrimp (*Branchinecta mackini*, *B. gigas*, and *B. lindahli*) (AFFTC 1992). Eubranchiopods lie dormant in the soil of dry lakebeds until flooding creates the aquatic habitat necessary to complete their life cycles. These shrimp are a food source for a variety of migratory shorebirds that congregate at Rogers Dry Lake when water is present.

To date, the only amphibians identified on base include the western toad (*Bufo boreas*), Pacific treefrog (*Hyla regilla*), red-spotted toad (*Bufo punctatus*), and African clawed frog (*Xenopus laevis*). These species were identified at Piute Ponds by U.S. Geological Survey biologists during a survey in 1997. The African clawed frog is a problematic introduced species that feeds on native wildlife, including other amphibians, small reptiles, and fish (AFFTC 1997c). Common reptiles on base include the desert spiny lizard (*Sceloporus magister*), side-blotched lizard (*Uta stansburiana*), western whiptail *(Cnemidophorus tigris)*, zebra-tailed lizard (*Callisaurus draconoides)*, glossy snake (*Arizona elegans*), coachwhip (*Masticophis flagellum*), gopher snake (*Pituophis melanoleucus*), and the Mojave green rattlesnake (*Crotalus scutulatus*).

Common birds include the turkey vulture (*Cathartes aura*), common raven (*Corvus corax*), sage sparrow (*Amphispiza belli*), barn owl (*Tyto alba*), house finch (*Carpodacus mexicanus*), and western meadowlark (*Sturnella neglecta*). Joshua tree woodlands support cactus wren (*Campylorhynchus brunneicapillus*) and adder-backed woodpecker (*Picoides scalaris*). Common bird species found in creosote scrub include the horned lark (*Eremophila alpestris*), black-throated sparrow (*Amphispiza bilineata*), and sage sparrow. The seasonal inundation of lakebeds and claypans attracts wading bird species, including the black necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americana*), and greater yellowlegs (*Tringamelanoleuca*). Birds associated with ponds include the yellow-headed blackbird (*Xanthocephalus xanthocephalus*), black-crowned night heron (*Nycticorax nycitorax*), and green heron (*Butorides striatus*).

Horned larks are commonly found in open habitat with sparse vegetation or areas of low shrubs (i.e., open field, agricultural areas, desert habitat, prairies, and grassland communities). The main runways on base are surrounded by arid phase saltbush scrub. Combined with open areas along the flightline, this habitat is suitable for horned larks. The vegetation adjacent to the runways is periodically graded, creating a buffer area devoid of vegetation, which also provides additional foraging habitat for horned larks. Methods that have been used at Edwards AFB to control the bird airstrike problem with horned larks include revegetation with native plants and use of a falconer.

The storm water retention pond along the flightline attracts other types of birds (e.g., waterfowl, shorebirds) and possibly bats associated with aquatic habitats. Barn owls (*Tyto alba*) are known to inhabit buildings on the flightline. During the evening, owls feed on small rodents adjacent to the runways and in other areas nearby.

Common mammals on Edwards EFB include the black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audobonii*), and coyote (*Canis latrans*). Common rodents include the deer mouse (*Peromyscus maniculatus*), grasshopper mouse (*Onychomys torridus*), little pocket mouse (*Perognathus longimembris*), Merriam's kangaroo rat (*Dipodymus merriami*), and desert woodrat (*Neotoma lepida*). Common bats include the western pipistrelle (*Pipistrellus hesperus)*, and little brown bat (*Myotis lucifugus*).

Migratory Birds

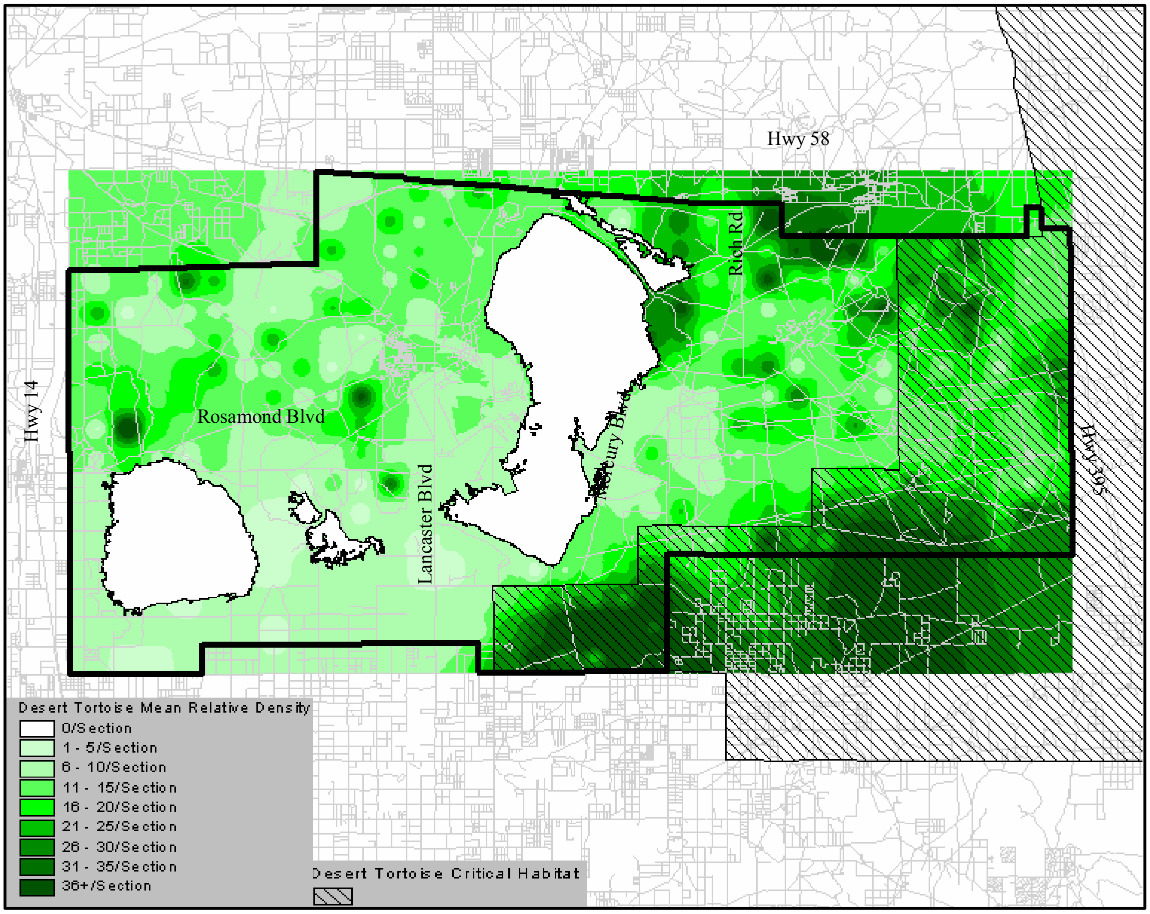
Seasonal migratory birds use both permanent and temporary bodies of water for foraging on shrimp and other food items at Edwards AFB. These birds include ducks and geese such as the ruddy duck (*Oxyura jamaicensis*), northern mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), Canada goose (*Branta canadensis*), and snow goose (*Chen caerulescens*). Ducks and geese are hunted in designated areas on Edwards AFB.

3.9.2.4 Sensitive Wildlife Species at Edwards AFB

Desert Tortoise and Mohave Ground Squirrel

A more detailed listing of sensitive wildlife species can be found in the Edwards AFB *Integrated Natural Resources Management Plan* (Edwards AFB 2004). Of particular interest for this project are the desert tortoise and the Mohave ground squirrel. The desert tortoise is listed as threatened by the federal government and by the State of California. It can occur throughout the Colorado and Mojave deserts at elevations up to 4,100 feet, although ideal habitat typically occurs between 1,000 and 3,000 feet (Edwards AFB 2004). The desert tortoise can occur in almost every desert habitat, but is most common in desert washes, desert scrub, creosote bush, and Joshua tree habitats. This species finds cover in burrows that are usually under bushes and requires loose, dry, sandy soil for nest building. They are more active during the spring and summer months. The desert tortoise is a herbivorous reptile whose native range includes the Sonoran and Mojave deserts of southern California, southern Nevada, Arizona, extreme southwestern Utah, and Sonora and northern Sinaloa, Mexico. The distribution of the desert tortoise on Edwards AFB in shown on Figure 3-14.

The Mohave ground squirrel listed by the state of California as threatened is found in the Mojave Desert in San Bernardino, Los Angeles, Kern, and Inyo Counties including Edwards AFB in the R-2515 area. Populations are known to occur north and south of Rogers Dry Lake and the PIRA. This species is rare throughout its range. Populations in southwestern San Bernardino County appear to be extirpated.



Source: Edwards AFB Comprehensive Range Plan

Figure 3-14

Desert Tortoise Relative Density Estimates on Edwards AFB

Optimal habitats are open desert scrub, alkali desert scrub, and Joshua tree and they also feed in annual grasslands. Mohave ground squirrels live in underground burrows, frequently among the roots of the creosote bush and have been found at elevations between 1,800 and 5,000 feet MSL. They spend more time above ground in March through May. The distribution of the Mohave ground squirrel under restricted area R-2515 is shown on Figure 3-13 and the distribution on Edwards AFB in shown on Figure 3-15 (Figure 6-2 from the INRMP).

3.9.2.5 Areas of Critical Environmental Concern found within the R-2515 Area

The BLM has designated the area adjacent to the western side of Harper Dry Lake as an ACEC (North Harper Lake ACEC). This area supports a population of Barstow woolly sunflower, a federal species of concern. Harper Dry Lake was designated by BLM because of its substantial transmontane alkali marsh. The marsh, which is fed in part by adjacent agriculture, provides a habitat for a variety of waterfowl. Areas of critical concern within the R-2515 are shown on Figure 3-13.

3.9.2.6 Designated Critical Habitat found within the R-2515 Area and Edwards AFB Area

Critical habitat on the PIRA generally consists of bedrock with a layer of blown sand. This portion of the PIRA primarily consists of a west-facing slope with a rise between Leuhman Ridge and Haystack Butte. Critical habitat is located on the southern border of Edwards AFB. In the west, the level portions of the land surface contain saltbush scrub on pan and dune habitat. East of the slope, as elevations increase, soils become deeper and very sandy. The slopes contain creosote bush scrub vegetation with varying densities of Joshua trees. The Joshua trees average in size between small and moderate. In general, the health of the Joshua trees is not good. Sandy soils generally contain a relatively large

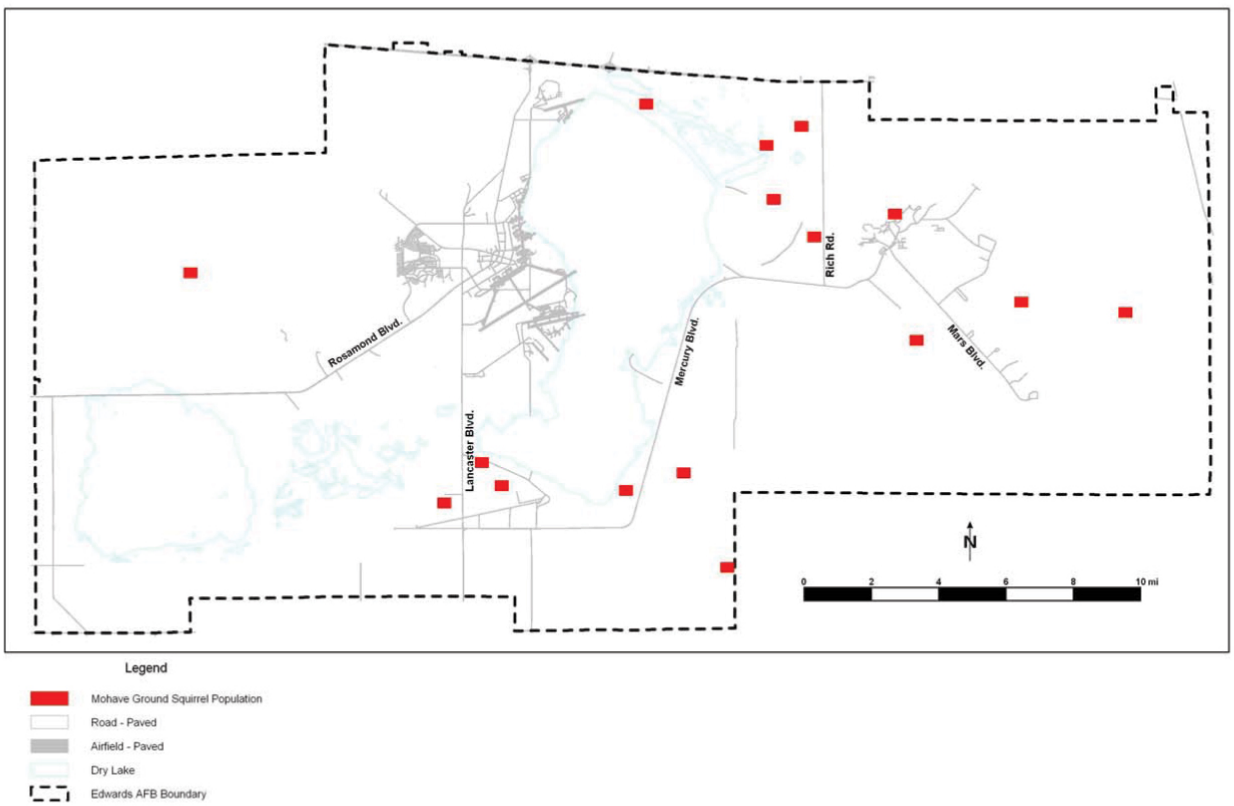


Figure 3-15

Distribution of the Mohave Ground Squirrel at Edwards AFB

diversity of shrubs and annuals, but the PIRA is an exception. Many areas of the PIRA are dominated by fiddleneck, but the timing of the rainfall and quantity of rain can result in spectacular wildflower displays.

In 1994, impacts to critical habitat were assessed in a Biological Opinion (USFWS 1994a). Determination of critical habitat area for the Mojave population of the desert tortoise was established by the Final Rule; FR, 50 CFR Part 17, 59 FR 5820, February 8, 1994. Approximately 65,000 acres of the Base fall within the critical habitat of the Fremont-Kramer Desert Tortoise Critical Habitat Unit, which includes portions of the PIRA and Mt. Mesa (Management Area B) and the AFRL (located in Management Area G) (Figure 3-16).

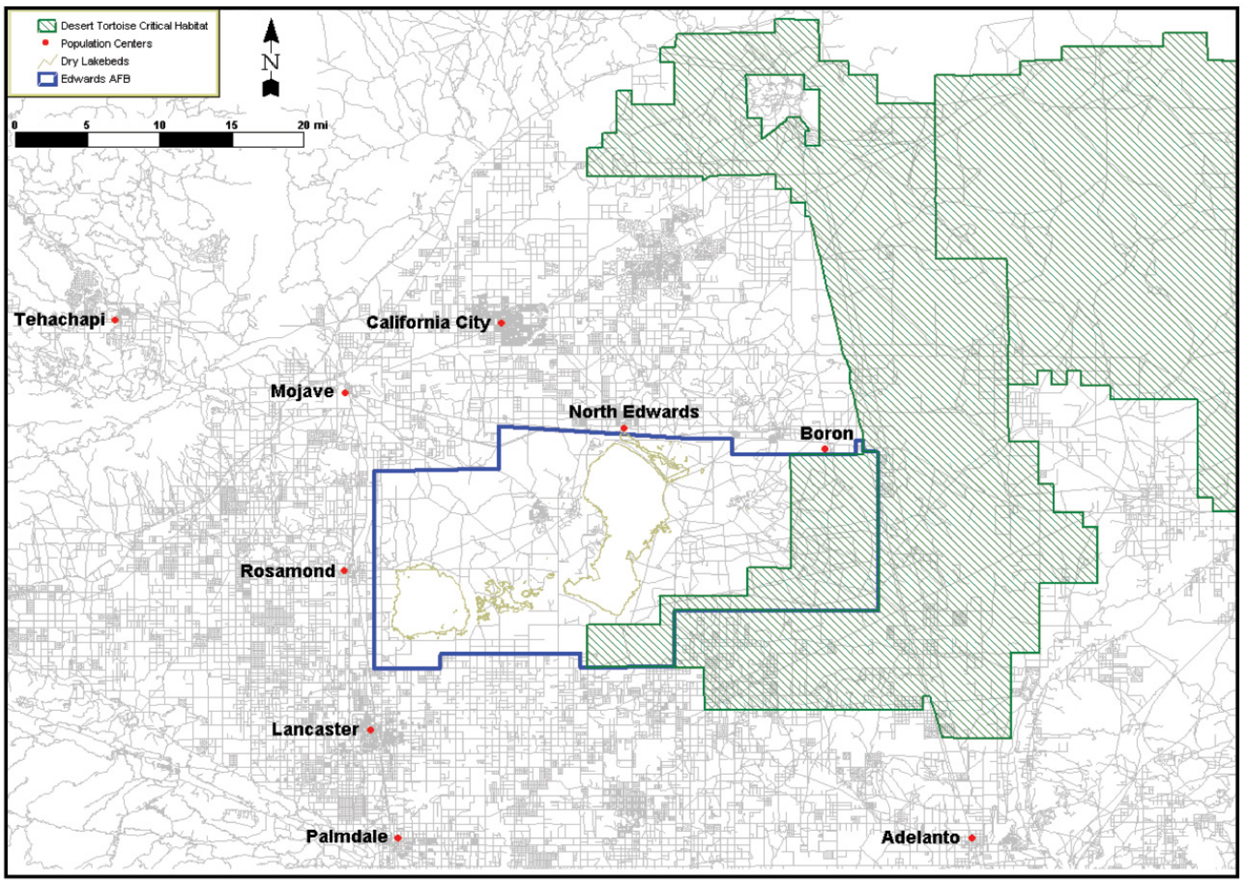


Figure 3-16

Regional Desert Tortoise Critical Habitat

3.9.2.7 Desert Tortoise Management Zones at Edwards AFB

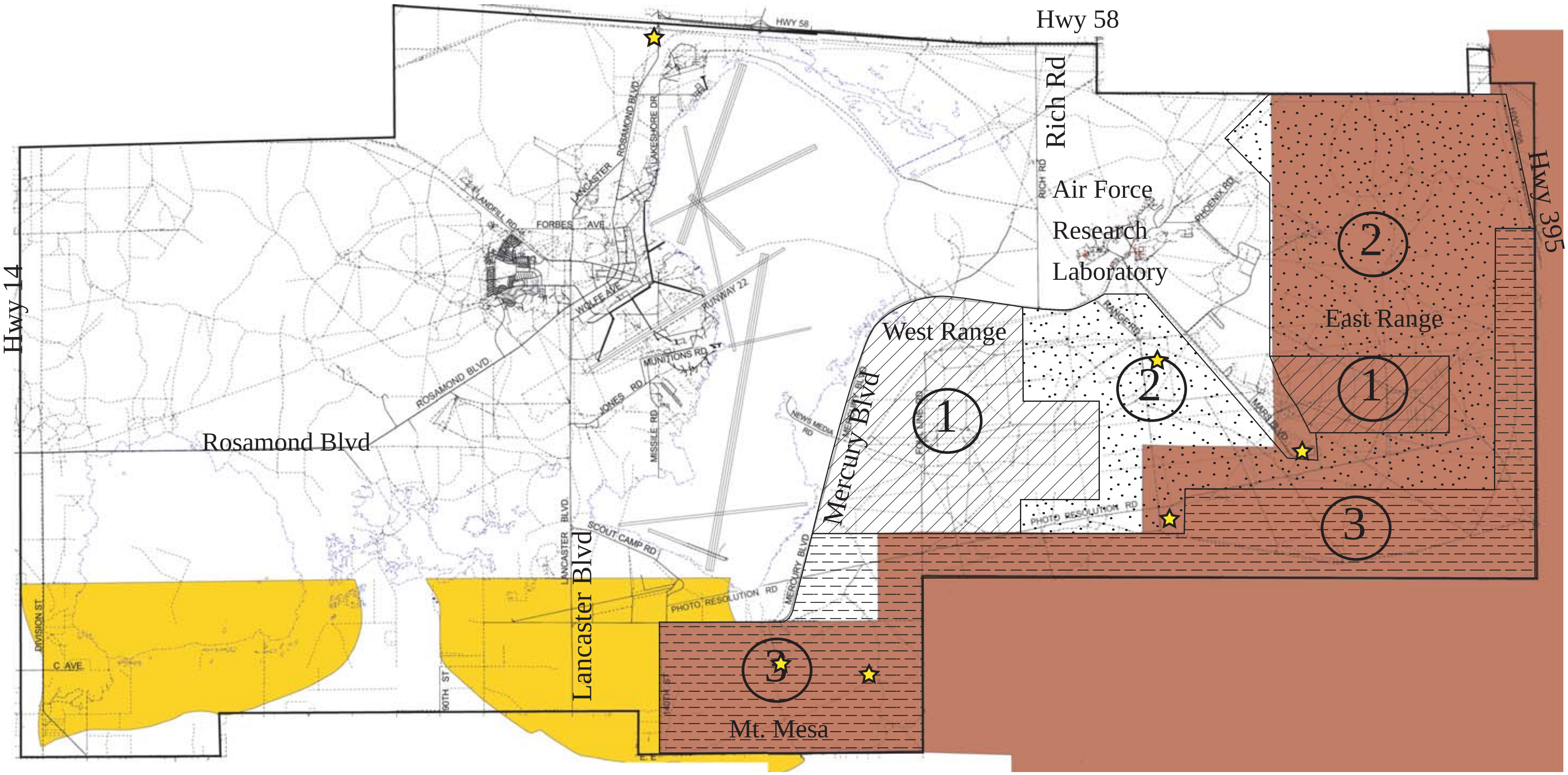
Desert Tortoise Management Zones, as shown on Figure 3-17, were determined by their relationship to Critical Habitat Designation, prior historical military use of the PIRA, topography, and past desert tortoise density data. The area is managed in conjunction with the West Mojave Plan's Fremont-Kramer Desert Wildlife Management Area (DWMA). The western portion of the Edwards AFB Desert Tortoise Management Area (Mt. Mesa) is also located within the eastern portion of the Edwards SEA. This is the outflow of the Little Rock Creek drainage from the Transverse Range into Rogers Dry Lakebed. This drainage is also identified as important habitat by the Nature Conservancy Ecosystem Management Plan.

3.9.2.8 Topographical Relief Areas at Edwards AFB

Several areas of topographic relief occur on the base, including Leuhman Ridge, Rosamond and Bissell Hills, and the cliffs just north of Rosamond Dry Lake. These areas contain nesting habitat for raptors and shelter areas for many mammal species (e.g., prairie falcon, little brown bat, and bobcat [*Felix rufus*]). These areas also contain relatively large areas of sensitive plants.

3.9.2.9 Significant Ecological Areas found within the R-2515 and Edwards AFB Areas

The County of Los Angeles General Plan establishes 61 SEAs, which represent a wide variety of biological communities within the county. The SEAs function to preserve this variety to provide a level of protection to the resources within them. The SEAs are intended to be preserved in an ecologically viable condition for the purposes of education, research, and other non-disruptive outdoor users, but are not intended to preclude limited compatible development. Los Angeles County has identified two SEAs on Edwards AFB: Edwards AFB (SEA #47) and Rosamond Lake (SEA #50). The locations of these SEAs within restricted area R-2515 are shown on Figure 3-13 and the locations of these SEAs on Edwards AFB are shown on Figure 3-17. SEA #47 contains botanical features that are unique and limited in distribution in Los Angeles County. They include the only good stands of mesquite (*Prosopis glandulosa*) in Los Angeles County. The area contains fine examples of creosote bush scrub, alkali sink, and the transition vegetation between the two. Mesquite woodlands provide habitat for a variety of mammals, birds, and reptiles. The best example of shadscale scrub and alkali sink biotic communities in Los Angeles County are in SEA #50. It also contains Piute Ponds, which are located in the southwestern corner of the base. Piute Ponds support a variety of wildlife, especially birds. An important aspect of these ponds is that they provide a stopover area for migratory birds.



LEGEND

- Unpaved Roads
- Paved Roads
- Taxiways
- Base Boundary

SENSITIVE WILDLIFE HABITAT

- Los Angeles County Significant Ecological Area (SEA)
- Desert Tortoise Critical Habitat
- Desert Tortoise Management Zone 1
- Desert Tortoise Management Zone 2
- Desert Tortoise Management Zone 3

N

0 2 4 6

SCALE IN STATUTE MILES

★ Target Areas (not to scale; locations are approximations)

EA FOR THE INTEGRATION AND DEVELOPMENTAL TESTING OF HIGH POWER MICROWAVE SYSTEMS AT EDWARDS AFB

TWO SENSITIVE WILDLIFE HABITATS AT EDWARDS AFB

TC#	DATE	DRAWN BY	FILENAME	FIGURE NO.
Q242-04	9/13/05	Knight	3-17 HPM.ai	3-17

3.10 NOISE

3.10.1 Noise Characteristics

In 1972, Congress enacted the Noise Control Act, P.L. 92-574. Among the requirements under the NCA was a directive to the U.S. EPA to "…publish information on the levels of environmental noise, the attainment and maintenance of which in defined areas under various conditions as requisite to protect the public health and welfare with an adequate margin of safety." The U.S. EPA published EPA-550/9-47-004, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, in 1974 (Levels Document) (U.S. EPA 1974).

The characteristics of sound include parameters such as amplitude, frequency, and duration. The decibel (dB), a logarithmic unit that accounts for the large variations in amplitude, is the accepted standard unit measurement of sound. Different sounds may have different frequency content. When measuring sound to determine its effects of the human population, A-weighted sound levels (dBA) represent adjusted sound levels. The adjustments, created by the American National Standards Institute (ANSI) in 1983, are established according to the frequency content of the sound. Examples of typical A-weighted sound levels are shown in Figure 3-18.

Noise is usually defined as sound that is undesirable because it interferes with communication and hearing, is intense enough to damage hearing ability, or is otherwise annoying. Noise levels often change with time. Therefore, to compare levels over different time periods, several descriptors were developed to account for the time variances. These descriptors are used to assess and correlate the various effects of noise on humans, including land use compatibility, sleep and speech interference, annoyance, hearing loss, and startle effects.

- A-weighted decibel scale (dBA). This scale simulates the range of sound that is audible by the human ear. The A-weighted scale significantly reduces the measured pressure level for low frequency sounds while slightly increasing the measured pressure levels for middle frequency sounds. A-weighted sound levels are typically measured between 1,000 to 4,000 hertz (Hz).
- The long-term equivalent A-weighted sound level (Leq). This describes time-varying noise energy as a steady noise level.

- Day-night average noise level (DNL). The DNL, often referred to as L_{dn}, has been adopted by federal agencies as the standard for measuring noise. The DNL is an A-weighted, 24-hour average of hourly averages. Each hourly average represents the sound energy of all the disparate sounds that occurred during that hour. The hourly average would be a continuous, uniform sound whose total sound energy would be equal to the sum of the individual sound energies of all the real sounds occurring during that hour. Typically, different hours of the day would have different hourly averages. For this reason, and for standardization, the DNL is defined as the average of the 24 hourly averages of the day.

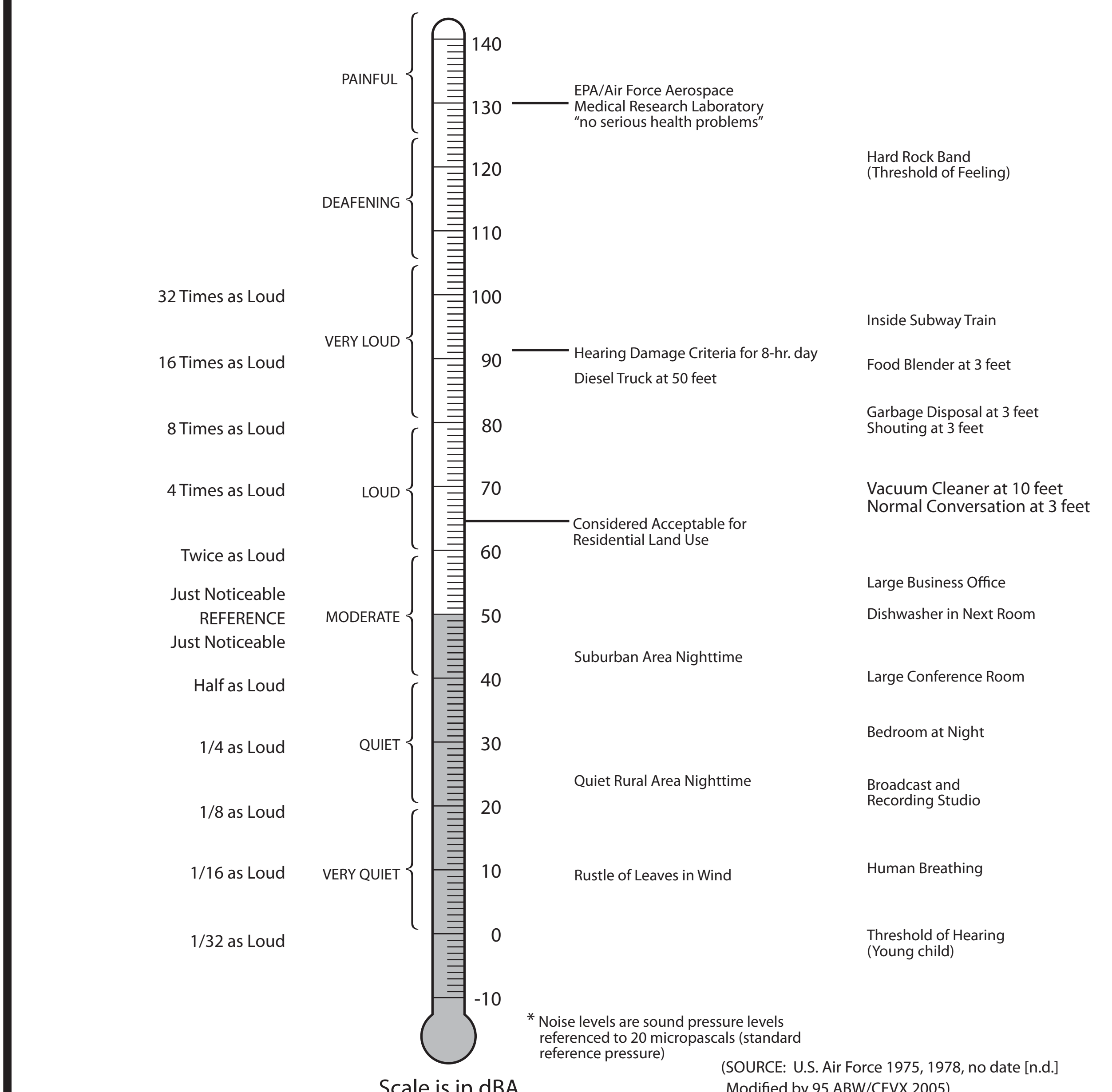
- C-weighted sound level. C-weighting measures sound levels in dB, with no adjustment to the noise level over most of the audible frequency range except for a slight de-emphasis of the signal below 100 Hz and above 3,000 Hz. C-weighting is used as a descriptor of low-frequency noise sources, such as blast noise, explosive detonations, and sonic booms.

- C-weighted day-night level (CDNL) is the C-weighted sound level averaged over a 24-hour period, with a 10-dB penalty added for noise occurring between 10:00 p.m. and 7:00 a.m. CDNL is similar to DNL, except that C-weighting is used rather than A-weighting. CDNL is used to evaluate human response or annoyance to noise sources, such as blast noise and sonic booms.

- Sound exposure level (SEL) considers both the A-weighted sound level and duration of noise. SEL converts the total A-weighted sound energy in a given noise event with a given duration into a 1-second equivalent and, therefore, allows direct comparison between sounds with varying intensities and durations.

- C-weighted sound exposure level (CSEL) is an SEL measurement based on the C-weighted level rather than the A-weighted level.

- Sound pressure level (SPL) is a logarithmic scale, using dB as units, and a reference pressure that corresponds approximately to the minimum audible sound pressure.



Examples of Typical A-Weighted Sound Levels	Figure 3-18	Q242-04	6/06/06

- Community noise equivalent level (CNEL) has been adopted by the State of California as the descriptor for measuring noise levels. The CNEL is similar to the DNL, except that it includes a 5 dB penalty for evening noise (7:00 p.m. to 10:00 p.m.) in addition to the 10 dB “penalty” for nighttime noise.

In the Levels Document, the U.S. EPA reported that the best metrics to describe the effects of environmental noise in a simple, uniform, and appropriate way were:

- The L_{eq}; and
- The DNL or L_{dn} (a variant of L_{eq} that incorporates a 10-dB “penalty” for nighttime noise).

Another factor that describes how noise is characterized and analyzed is whether the noise source is continuous or impulsive. Continuous noise sources are from highways, construction sites, and cities with heavy traffic and large airports. Impulsive noise generated from munition and ordnance explosions resulting from being targeted by a RF energy would be fundamentally different from the continuous noise. For example, permanent damage to unprotected ears due to continuous noise occurs at approximately 85 dB based on an 8-hour-per-day exposure, while the threshold for permanent damage to unprotected ears due to impulsive noise is approximately 140 dB peak noise based on 100 exposures per day (Pater 1976).

Thus given the continuous noise versus impulsive type of noise, the variations in frequency and period of noise exposure, and the fact that the human ear cannot perceive all pitches and frequencies equally well, a number of different measures of noise levels are used in this assessment: the peak sound level (dBP), the SEL, and the DNL.

3.10.2 Measurements of Aircraft Noise Impact on Human Annoyance

In 1977, at the request of the U.S. EPA, the National Academy of Science's Committee on Hearing, Bioacoustics and Biomechanics (CHABA) proposed guidelines for the uniform description and assessment of the various noise environments associated with various projects (CHABA 1981). In 1982, the U.S. EPA published *Guidelines for Noise Impact Analysis*, based on the CHABA Guidelines. According to CHABA Guidelines, the L_{eq} and DNL were selected as the appropriate descriptors for noise because they reliably correlate with health and welfare effects. From data on community social surveys, DNL has been found to correlate with community annoyance, as measured in terms of percentage of exposed persons who are “highly annoyed” (Table 3-13).

Table 3-13

Relationship Between C-Weighted and A-Weighted Sound Levels

and Percent of the Population Annoyed

CDNL (C-weighted)	% Highly Annoyed	DNL (A-weighted)
48	2	50
52	4	55
57	8	60
61	14	65
65	23	70
69	35	75

Note: CDNL can be interpreted in terms of "equivalent annoyance" DNL.

Source: CHABA 1981

Ambient sound in a wilderness setting is in the range of DNL 20 to 30 dB, while rural residential areas range from DNL 30 to 50 dB, and the average urban residential areas average from DNL 60 to 70 dB (Federal Interagency Committee on Noise 1992). However, in outdoor areas where quiet is a basis for use, there is no reason to suspect that the general population will be at risk from any of the identified effects of noise" (i.e., activity interference or annoyance) when sound levels are DNL 55 dB or less (U.S. EPA 1974). The ANSI has also suggested that land uses in "extensive natural wildlife and recreation areas" are likely to be considered compatible with DNL 60 dB or less (Central Utah Water Conservation District [CUWCD] 2005). The methodology employing DNL and percent highly annoyed has been successfully used throughout the Unites States and in a variety of settings ranging from urban to rural.

Correlation between DNL and CDNL has been established based on community reaction to impulsive sounds (CHABA 1981). The DoD has followed the recommendations of CHABA in describing high-intensity impulsive sounds, such as explosions, in terms of C-weighted sound exposure level. Table 3-13 shows the relationship between the percent of the population highly annoyed by sound levels expressed as DNL and CDNL.

A DNL of 65 dBA or lower is considered to be acceptable (see Table 3-13); a DNL above 65 dBA but not exceeding 75 dBA is normally unacceptable unless some form of noise attenuation is provided; a DNL higher than 75 dBA is unacceptable. Daily exposure to impulsive noise of CDNL of 61 C-weighted decibels (dBC) or less is comparable to the DNL 65 dBA significance level for non-impulsive noise and is normally considered compatible with most land uses.

3.10.3 Measurements of Noise Impact on Land Use Compatibility

In 1980, the Federal Interagency Committee on Urban Noise (FICUN) published guidelines for considering noise in land use planning (FICUN 1980). Federal agencies have adopted these guidelines as the standard when making recommendations to local communities on land use compatibility issues. Table 3-14 shows the types of land uses that would be appropriate based on a range of DNL values.

3.10.4 Existing Noise Setting found within Restricted Area R-2515

Noise levels found within restricted area R-2515 are determined by both subsonic and supersonic aircraft operations. Supersonic operations are conducted in the Black Mountain Supersonic Corridor, the Alpha Corridor, Precision Impact Range Area Supersonic Area, and the High Altitude Supersonic Corridor. Noise models for these supersonic corridors are described in detail in the 1998 *Environmental Assessment of R-2515, Edwards AFB, California*. The Military Operations Area (MOA) Range NOISEMAP (MR_NMAP) noise model was used to develop the ambient noise contours for restricted area R-2515. The models in MR_NMAP together are representative of the way aircraft fly in military airspace. There are three general representations: broadly distributed operations that generally occur in MOAs and ranges, distributed parallel tracks that occur along military training routes, and specific tracks that occur in target areas. The noise models contained in MR-NMAP assume operations in MOAs and restricted airspace areas are uniformly distributed which accounts for noise contours following the borders of the airspace (Lucas and Calamia 1996). The total noise contours as shown in Figure 3-19 include the effects of distributed aircraft operations and that of low level and other test routes that lie within restricted area R-2515.

As shown in Figure 3-19, the day-night sound levels on the A-weighted dB scale (L_{dn}) noise contours resulting from subsonic aircraft operations in restricted area R-2515 SUA show the maximum L_{dn} value of 45 dB along the perimeter of the area. The surface L_{dn} values for most of the interior of the airspace range from 50 to 55 dB. Noise contours for 65 dB and above lie completely within the boundary of Edwards AFB, therefore, ambient noise levels in regions adjacent to Edwards AFB for Alternatives A and B would be anticipated to be below a CNEL of 65 dB under normal conditions (95 ABW and AFFTC 2005). However, there are areas within the R-2515 area where noise levels exceed 65 dB due to freeways, major highways, airports, and other noise-generating operations.

Table 3-14

Land Use Compatibility

Land Use	**Yearly Day-Night Average Sound Level (DNL) in Decibels**					
	Below 65	**65–70**	**70–75**	**75–80**	**80–85**	**Over 85**
Residential						
Residential, other than mobile homes and transient lodgings	Y	N[1]	N[1]	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N[1]	N[1]	N[1]	N	N
Public Use						
Schools	Y	N[1]	N[1]	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoria, and concert halls	Y	25	30	N	N	N
Government services	Y	Y	25	30	N	N
Transportation	Y	Y	Y[2]	Y[3]	Y[4]	Y[4]
Parking	Y	Y	Y[2]	Y[3]	Y[4]	N
Commercial Use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail—building materials, hardware, and farm equipment	Y	Y	Y[2]	Y[3]	Y[4]	N
Retail trade—general	Y	Y	25	30	N	N
Utilities	Y	Y	Y[2]	Y[3]	Y[4]	N
Communication	Y	Y	25	30	N	N

Table 3-14, Page 1 of 2

Table 3-14

Land Use Compatibility (Continued)

Land Use	Yearly Day-Night Average Sound Level (DNL) in Decibels					
	Below 65	**65–70**	**70–75**	**75–80**	**80–85**	**Over 85**
Manufacturing and Production						
Manufacturing, general	Y	Y	Y[2]	Y[3]	Y[4]	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y[6]	Y[7]	Y[8]	Y[8]	Y[8]
Livestock farming and breeding	Y	Y[6]	Y[7]	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y[5]	Y[5]	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

Table 3-14, Page 2 of 2

Notes: Numbers refer to notes.

* - The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable or unacceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise-compatible land uses.

1 - Where the community determines that residential or school uses must be allowed, measures to achieve outdoor-to-indoor Noise Level Reduction (NLR) of at least

Notes: (Continued)

25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide an NLR of 20 dB; thus the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year-round. However, the use of NLR criteria will not eliminate outdoor noise problems.

2 - Measures to achieve NLR 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

3 - Measures to achieve NLR 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.

4 - Measures to achieve NLR 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise-sensitive areas, or where the normal noise level is low.

5 - Land-use compatible provided special sound reinforcement systems are installed.

6 - Residential buildings require an NLR of 25.

7 - Residential buildings require an NLR of 30.

8 - Residential buildings not permitted.

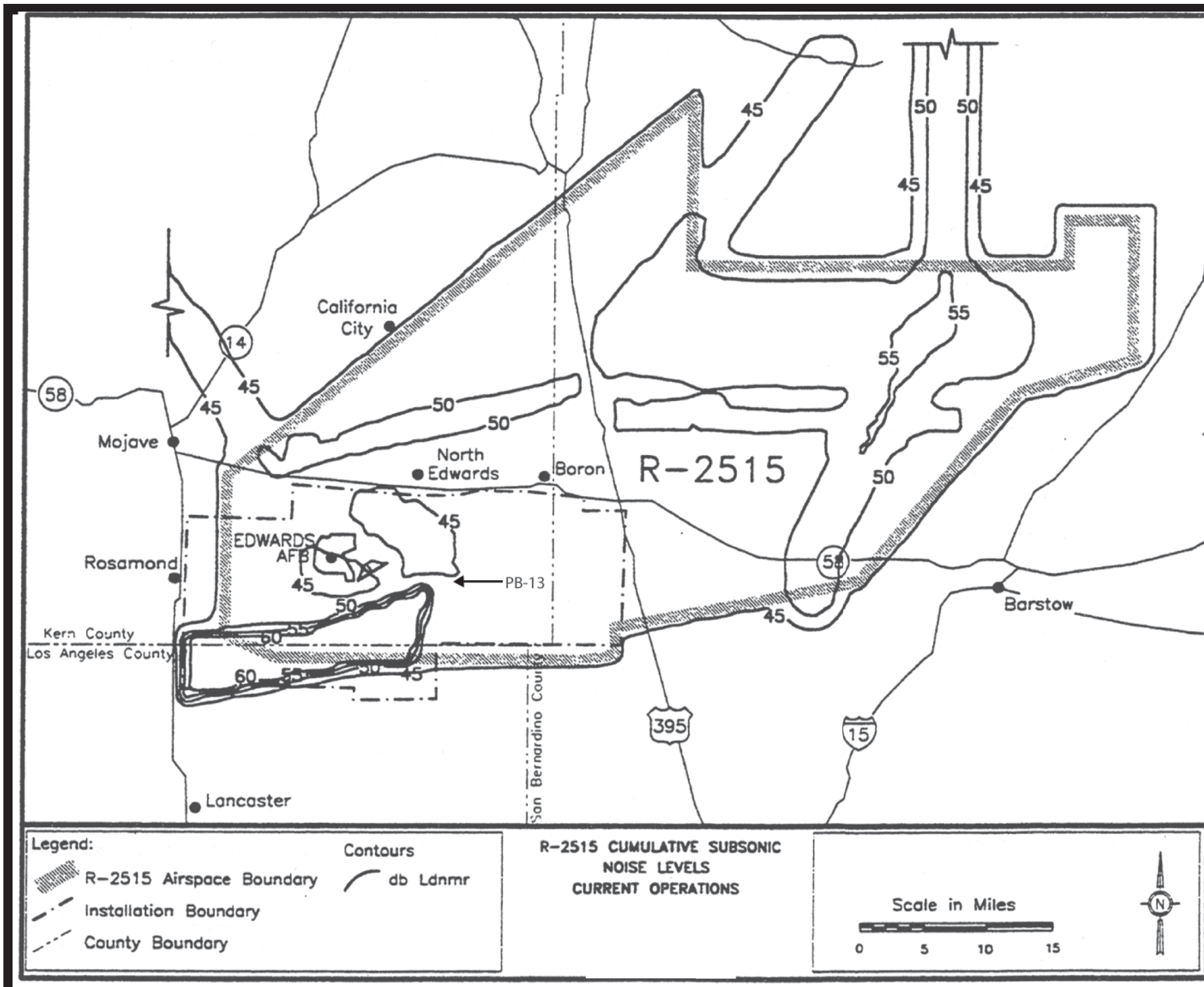
Y (Yes) - Land Use and related structures compatible without restrictions.

N (No) - Land Use and related structures are not compatible and should be prohibited.

NLR - Noise Level Reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.

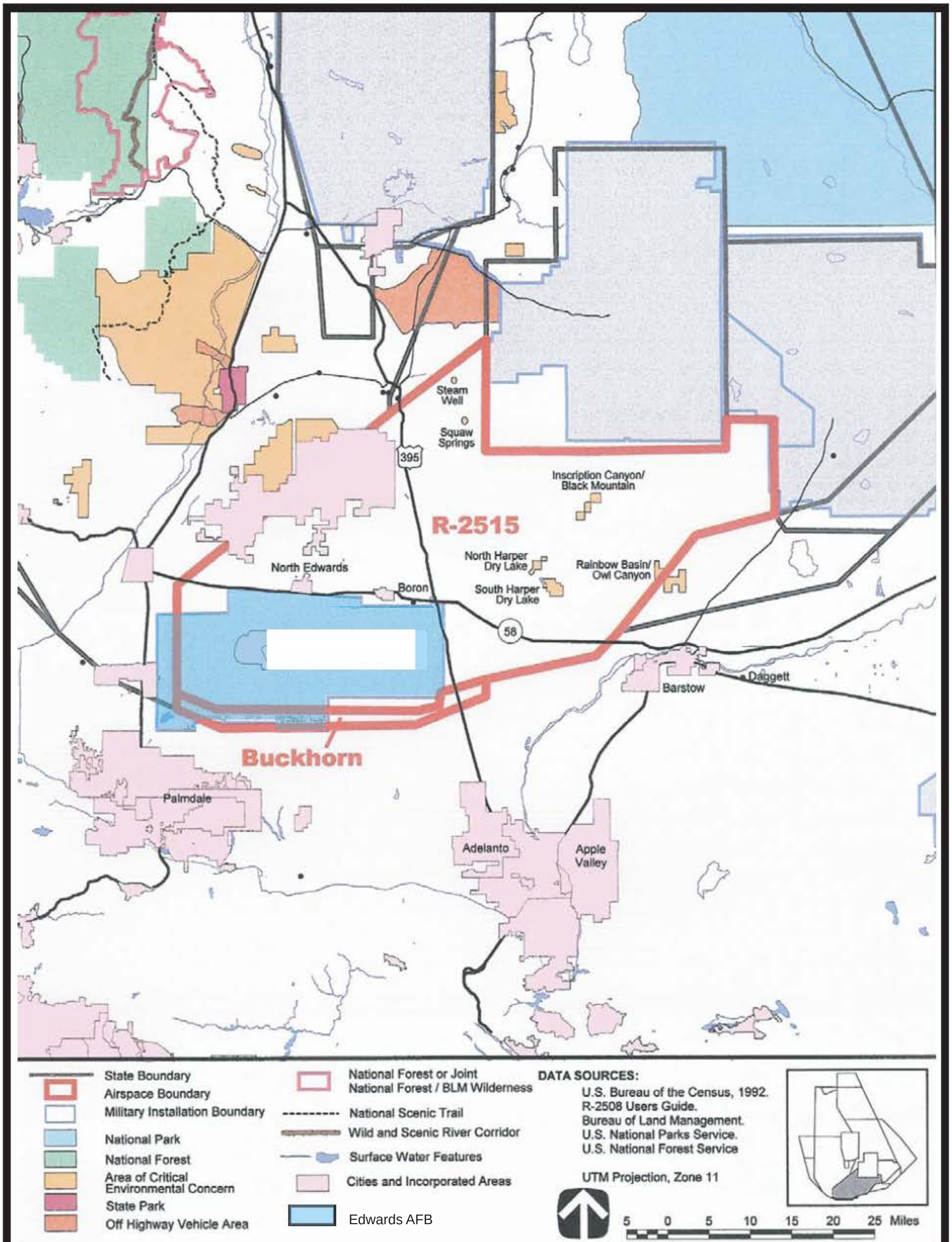
25, 30, or 35 - Land Use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structures.

Source: 14 CFR Part 150



Source: AFFTC 1995b and Spectrum Sciences

Noise Contours in the R-2515 Area	Figure 3-19	Q242-04	06/06/06



Sensitive Noise Areas under Restricted Area R-2515	Figure 3-20	Q242-04	06/06/06 1/06/05

Sensitive noise areas within the R-2515 area are shown in Figure 3-20. This figure summarizes the noise receptors as associated with land use for recreational areas, cities and incorporated areas including schools, hospitals, and residential areas.

3.10.5 Existing Noise at Edwards AFB

Major noise sources at Edwards AFB are aircraft operations that include rotary wing air traffic, engine testing, sonic booms, and vehicle traffic on streets. The major sources of motor vehicle-related noise at Edwards AFB are Lancaster Boulevard, Rosamond Boulevard, and primary and secondary streets on the base. Noise estimates are usually presented as noise contours. Noise contours are lines on a map of an airfield and its vicinity where the same noise level is predicted to occur. The 5-dB interval chosen to represent noise contours reflects the U.S. Department of Housing and Urban Development (HUD) noise criteria commonly used for airfield noise (HUD 1978). Figure 3-21 presents CNEL noise contours at Edwards AFB.

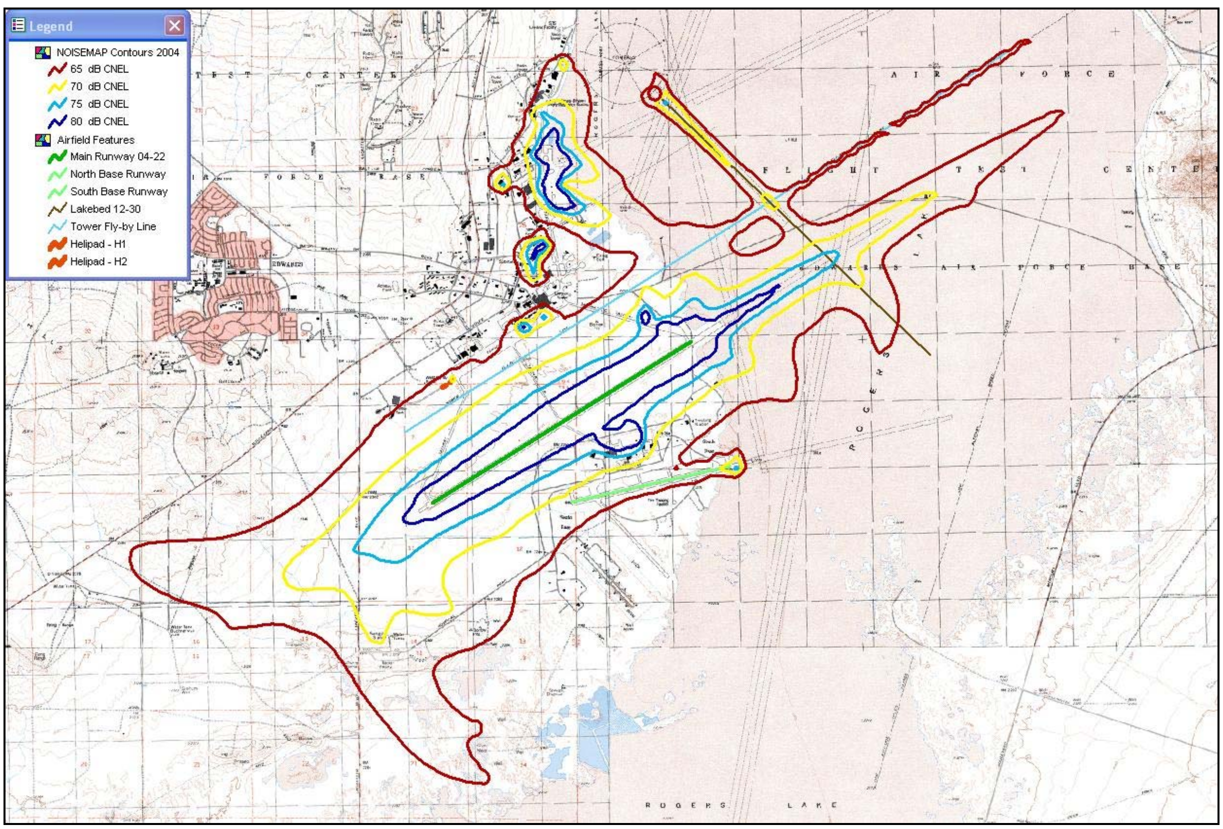


Figure 3-21

Noise Contours Around Runway 04/22 at Edwards AFB

As shown in Figure 3-21, Runway 04/22 noise contours for a CNEL of 65 dB and above lie completely within the boundary of Edwards AFB. Recreation areas that lie between the 65- and 70-dB contours include the Edwards AFB Rod and Gun Club (Combat Arms Range), base golf course, off-highway vehicle area number 1, and some of the picnic areas and athletic fields. The Main Base residential area is outside the 65-dB contour. The Main Base has a range of exposure from 65 to 85 dB; the South Base 70 to 85 dB. On-base land under the 80-dB noise contours is primarily open space and test program support areas.

The South Base and a portion of the Main Base are currently within the 80-dB noise level; therefore, small areas of administrative, commercial, and industrial land are subject to these noise levels.

The area around AFRL is subject to very high levels of noise during rocket engine tests. Test firings occur during daytime hours for 1 to 3 minutes on an infrequent basis. Personnel at the test site remain in buildings designed to protect them from high noise levels. Smaller engines are also tested at this location, and noise levels are less than half those produced by the large Titan engines. Approximately 1,750 people reside within the 80-dB contours of Titan test firings.

The BFTF is one of the designated control areas for HPM test and evaluation. The noise levels at the BFTF, located on the southeast side of the main runway and approximately 1.5 nautical miles from the Main Base, is between the 65- and 75-dB noise contours (U.S. Air Force 1997a).

3.11 PUBLIC/EMERGENCY SERVICES

Public/emergency services refer to the capability of ensuring protection of people and property. Public/emergency services within the ROI for Alternatives A and B include services provided by Edwards AFB, state and local fire protection services, police, National Guard, and medical/hospital services. These services would be utilized by the public during accidents, disasters, or events commonly requiring such public/emergency services.

The primary public and emergency services found within the R-2515 area are provided by trained personnel and equipment from Edwards AFB. The public/emergency service umbrella at Edwards AFB consists of the Fire Department, Security Forces, and the Medical Group.

3.11.1 Fire Protection/Prevention

Fire protection on base comprises personnel and equipment that are organized and trained to respond to a series of emergencies. The emergency response time of the Fire Protection Division is contingent upon the distance to the emergency site and the availability of personnel, support equipment, and supplies. All areas of the base are currently covered. Fire protection and prevention programs for on-Base personnel are guided by AFFTC Instruction 32-11, *Fire Prevention and Protection Program*.

The aircraft supporting HPM test and evaluation for Alternatives A and B would utilize Runway 22 for takeoff and landing. This area is located near and serviced by Fire Station No. 1. This station is a 26,200-square-foot facility providing fire protection and emergency medical service as needed for the entire base. Vehicles assigned to this fire station include two engines, five Aircraft Rescue Fire Fighting vehicles, one rescue vehicle, a 5,000- and a 2,000-gallon water tender, and two airfield surveillance vehicles. A maximum of 35 firefighters are housed in this facility.

There are a total of five fire stations on base. Fire Station No. 2 is located in the housing area, Fire Station No. 3 is located on South Base, Fire Station No. 4 is located at the AFRL, and Fire Station No. 5 is located on North Base. A maximum of 73 firefighters could be found at these five fire stations.

Emergency response times are contingent upon the distance to the emergency site, availability of personnel, support equipment, and supplies. All areas of the base are covered and, given additional advance notice, additional areas can be accommodated. Response times generally range from 5 to 20 minutes.

Edwards AFB has entered into a number of support agreements and memorandums of understanding and agreement. Support agreements are entered into with county agencies to provide no cost, mutual aid. Edwards AFB has support agreements and memorandums of understanding and agreement with NASA, Base associates, Boron Prison, Plant 42, and others. The Base would establish a new agreement or modify an existing one if necessary to accommodate a proposed action.

3.11.2 Security

Security forces provide general law enforcement on Edwards AFB. Law enforcement duties include traffic stops, domestic disputes, and police investigations. Security forces (police) on base comprise personnel and equipment organized and trained to respond to a series of emergencies, as well as to provide a daily security presence. Security programs provide the means to counter threats during peacetime, mobilization, or wartime.

3.11.3 Medical Services

Medical services at Edwards AFB include equipment and trained personnel that are organized to respond to a series of emergencies. Air Force Instruction 41-106, *Medical Readiness Planning and Training*, establishes procedures for medical readiness, planning, and training during peacetime and wartime operations.

3.11.4 Local Emergency Services Other Than At Edwards AFB

Local emergency services other than those provided by Edwards AFB include local police and sheriff offices in Boron and California City. Ambulance services are provided by Hall Ambulance Service, which maintains a dispatch office in Boron.

The fire department in California City, located in the northern portion of the R-2515 area, has a team of 12 full-time firefighters, 5 on-call paid firefighters, and 14 auxiliary volunteers. Normal response is provided by 3 full-time, 2 auxiliary, and up to 5 on-call firefighters. Equipment includes three engines, a 1,000-gallon water truck, brush fire truck (300 gallons), breathing support truck (for filling self-contained breathing apparatus), ladder truck, and helicopter. Communications equipment is linked via microwave to fire departments in Bakersfield and Boron and includes the base station, 10 mobile very high frequency radios, and 10 two-way radios. The California City Fire Department typically responds to half of the emergencies that Fire Station 17 in Boron, California also responds to (Martinov 2005).

The city of Boron has two fire trucks and two firefighters at Station 17 at all times. Other equipment includes a radio system linked by microwave to Bakersfield and their wide area network. Their computer system and radios are all connected to through this system to support emergency response. The radio system consists of a base station and two mobile units, one for each of the two fire engines. Four additional radios are available for backup and communication with San Bernardino County and other interagency requirements (Van Andel 2005). The closest support outside the R-2515 area would be provided by emergency services from the city of Mojave.

Additional local emergency services are available at the U.S. Borax Mine. U.S. Borax has a team of 35 volunteers on their emergency response team. These volunteers are primarily trained to support mine related emergencies; however, Doug Barlow (U.S. Borax), indicated they would assist Edwards AFB or other agencies if requested. Electronic equipment includes two-way radios with dedicated frequencies, command center radios, Nextel cellular phones (approximately 500), global positioning system/radio telecommunications, and computers. U.S. Borax operates their own ambulance service. A fleet of pickup trucks, earth moving equipment, and a dedicated rescue trailer with an air fill station (not yet operational) are also located at the mine (Barlow 2005).

3.12 SAFETY AND OCCUPATIONAL HEALTH

Safety is defined as the protection of workers and the public from hazards. The total accident spectrum encompasses not only injury to personnel, but also damage or destruction of property or products. For worker safety, the boundary of the immediate work area defines the ROI. For public safety, a much larger area must be considered. This area varies depending upon the nature of the operation, but may extend for miles beyond the source of the hazard. The primary safety and occupational health concerns within the R-2515 area include radiological, biological, chemical (including explosives), blasting hazards, physical hazards, flight hazards (from general aviation and bird strikes), ground, range, and test [systems] safety.

Flight safety is greatly enhanced in restricted area R-2515 because it is restricted airspace. In non-technical terms, this means that no aircraft, civil or military, is allowed in the airspace without permission from the controlling/using authority/agency. Intrusion into the airspace without permission is a violation of FAA regulations, and violators are subject to discipline by the FAA. The restricted area R-2515 controlling agency is the Hi-Desert TRACON, which is located at Edwards AFB and operates 24 hours a day. During normal operating hours (approximately 6:00 a.m. to 8:00 p.m. depending on daily flight schedules), the FAA passes control of the airspace to the military radar control facility (call sign: SPORT). SPORT is an air traffic control facility that provides standard air traffic control services, traffic advisories, boundary calls, and other requirements within R-2515. When the military is not using the airspace, normally during non-duty hours and on weekends, the airspace reverts to, and is controlled by, the FAA Hi-Desert TRACON. By limiting the number and types of aircraft entering the airspace, and providing restrictions and controls on those aircraft that do fly there, safety for all aircraft and pilots is increased. Edwards AFB has over 50 letters of agreement that allow aircraft, including civil aircraft, to use the airspace. These letters of agreement establish radio and control procedures to help protect all users of the airspace. The *R-2508 Complex Environmental Baseline Study* states that in 1993, civilian operations constituted only 0.37 percent (62 operations) of all operations (16,615 total operations) in restricted area R-2515.

3.12.1 Areas of Concentrated Air Traffic

Concentrated air traffic, other than around Edwards AFB, occurs close to Mojave Airport (located outside of the restricted area), along State Highway 58 and U.S. Highway 395, south of restricted area R-2524 in holding patterns, and in the north and east of restricted area R-2515 where helicopters from Fort Irwin cross the airspace en route to and from restricted area R-2524.

Edwards AFB has letters of agreement permitting civilian light aircraft to fly along State Highway 58 en route to Boron Airport and Kramer Junction (intersection of State Highway 58 and U.S. Highway 395). There are also letters of agreement that allow law enforcement and utility company aircraft to fly along the highways or utility lines (AFFTC Instruction 11-1, *Aircrew Operations*). For safety reasons, these flights are conducted at 1,000 feet AGL or less. As long as non-military aircraft (from hang gliders to helicopters) respect the restricted airspace, and the Air Force pilots comply with Air Force regulations, there should be no impacts. U.S. Army helicopter operations occurring in the northeast corner, as well as most other helicopter operations, are normally conducted at low altitude and pose little interference with most high-speed flight activity. Aircraft in holding patterns south of restricted area R-2524 are part of the Air Warrior training program and operate in the airspace north and east of restricted area R-2515. The aircraft fly in holding patterns and at altitudes that keep them away from most of the testing and training originating from Edwards AFB.

3.12.2 Bird Aircraft Strike Hazard

The Air Force, and Edwards AFB, has an active BASH program to assist pilots in preventing bird strikes on aircraft. The program calls for modifications to operations according to bird watch threat conditions. During low threat conditions, normal operations prevail. Under moderate threat conditions, some restrictions will apply, such as limiting takeoffs, increasing altitude, and decreasing speed on low-level training routes. During severe bird strike threat conditions, all flying activity is either stopped or greatly curtailed until the threat is reduced.

Bird strike threat conditions are included in the BASH program and defined by the DoD (DoD 1997) procedures as follows:

- Condition SEVERE: Heavy concentration of birds on or immediately above the active runway or other specific location that represents an immediate hazard to safe flying operations. Aircrews must thoroughly evaluate mission need before operating in areas under condition SEVERE.

- Condition MODERATE: Concentration of birds observable in locations that represents a probable hazard to safe flying operations. This condition requires increased vigilance by all agencies and extreme caution by aircrews.

- Condition LOW: Normal bird activity on and above the airfield with a low probability of hazard.

Based on the Bird Avoidance Model predictions for the R-2508 Complex, which include restricted area R-2515, there is a period of moderate bird activity and moderate threat of bird strike 1 hour before sunrise and 1 hour after sunset, from October through March. Edwards AFB does not normally schedule low-level training during these times and only schedules low-level test flights when they are required to meet test objectives.

Edwards AFB records bird airstrikes that occur along the flightline as well as other areas involving aircraft operations. Over a 10-year period from 1985 to 1995, approximately 128 bird airstrikes were recorded at Edwards AFB. Most of the birds involved in aircraft strikes along the main runway were identified as horned larks (*Eremophilia alpestris*) (AFFTC 1995a).

Horned larks commonly occur in open habitat with sparse vegetation or areas of low shrubs. The vegetation along the runways is periodically graded, creating a buffer area devoid of vegetation that is typically used by the horned lark for habitat and foraging. Methods of reducing the BASH problem include revegetation with native plants and the use of a falconer.

During the wet season, Rosamond, Rogers, and Cuddeback Dry Lakes can be areas of bird strike activity. Harper Dry Lake is an important stopover point for migrating water fowl and is a potential bird strike area year-round. The landfills at Edwards AFB Main Base and Boron and the wastewater treatment plants at Main Base and AFRL are potential sites of bird strike activity. Large numbers of birds also congregate in the Piute Ponds area.

3.12.3 Other Potential Aircraft Safety Concerns

Edwards AFB has established procedures in AFFTC Instruction 11-1, *Aircrew Operations*, to reduce the potential for accidents and to promote pilot safety. These procedures include:

- Maximum crosswind limits for formation takeoffs and practice landings on the lakebed runways;

- Victorville, Palmdale, Apple Valley, Lancaster, Mojave, Tehachapi, Adelanto, Boron, Rosamond and other residential communities will not be overflown lower than 3,000 feet AGL at any time except in an emergency or when directed to by the air traffic control agency;

- Minimum altitude over the AFRL is 5,300 feet above MSL unless prior coordination for lower flight has occurred;

- Minimum altitude over the Borax mine is 4,500 feet above MSL; and

- Minimum altitude over the Edwards AFB small arms firing range is 6,800 feet above MSL.

To reduce the threat to flight operations, Edwards AFB has letters of agreement with various agencies asking them to advise base officials when any new towers, or other vertical obstructions, are planned. If the agency is aware of the routes, they can put restrictions in their zoning ordinance and general plan documents (either in noise and/or safety elements). However, if a landowner or agency is not aware of the route, or does not have any restrictions, obstacles can be built that can pose a hazard. Tall power lines, such as those that parallel U.S. Highway 395 along the eastern border of Edwards AFB, can also pose a threat to very low flying aircraft. However, most flight operations normally occur above the nominal 100 to 150 foot height of these towers and power lines. In addition, the Air Force requires low-level routes to be flown and re-certified every 1 to 2 years, usually at the lowest altitude for that route segment. Certified pilots traverse a route in a slow-flying aircraft in order to observe any new obstacles. As a further precaution, when new aeronautical charts are published, they are normally updated with new obstacles.

Other potential hazards within restricted area R-2515 include reduced visibility from blowing dust and sand originating off the dry lakebeds and projectiles from blasting at mines. Strong surface winds experienced on the Rosamond and Rogers dry lakebeds blow particulates (i.e., dust and sand) thousands of feet into the air and pose a hazard to low-level aircraft operations due to the reduced visibility or aircraft equipment damage. Reduced visibility and aircraft damage are also of concern around the U.S. Borax mine in Boron and the Rand gold mine on the northern border of restricted area R-2515. Blasting from these mines sends dust and debris as much as 400 feet into the air (95 ABW and AFFTC 2005).

3.12.4 Safety and Occupational Health Program

The AFFTC's institutional occupational safety program is intended to minimize accidental injury, illness, and loss of property. AFFTC's Safety Office is responsible for monitoring the safety programs through a system of inspections, surveys, audits, and follow-up investigations. Elements of the safety program include accident and injury prevention and reporting, fire prevention and protection, emergency preparedness, and hazardous material and waste management. An Emergency Response Plan is in place to address emergencies such as earthquakes, aircraft accidents, fires and explosions, bomb threats, civil disturbances, nuclear emergencies, and toxic vapor releases or chemical spills. A base-wide safety reporting system encourages employees to report their concerns about workplace safety.

Industrial hygiene and occupational health for AFFTC personnel is managed by the 95 AMDS/Bioenvironmental Engineering Flight. The AFFTC's occupational health program is intended to recognize, evaluate, and control workplace factors or stresses that may cause sickness, impaired health, or significant discomfort to employees. To protect AFFTC personnel from noise hazards, hearing protection is used if personnel are exposed to noise levels exceeding 85 dBA. The program identifies and quantifies worker exposure to hazardous chemicals, noise, and radiation. Through AFFTC's Hazardous Communication Program, employees are educated regarding proper chemical management principles and procedures.

Occupational health and safety issues related to aircraft operations (both routine and emergency management) involving ground personnel working near operating aircraft during taxiing and inspection activities, aircrews using runways (lakebed and non-lakebed surfaces), and personnel present during emergency operations, aircraft malfunction, or other mishap are specifically addressed in Air Force Flight Test Center Instruction (AFFTCI) 11-1, *Air Operations,* and AFFTCI 11-2, *Ground Operations*. These instructions address in-flight operations, flight preparation, and ground procedures directly related to the safety of personnel on the ground, as well as emergency procedures for the protection of all personnel at Edwards AFB.

A fundamental requirement of the Edwards AFB Flight Safety Program is that each unit conducting or supporting flight operations have a flight safety program as well as a Midair Collision Avoidance Program.

3.12.5 Range Safety

The national range system, established by Public Law (P.L.) 81-60, was originally sited based on two primary concerns: location and public safety. Thus, range safety, in the context of national range activities, is rooted in P.L. 81-60 and Department of Defense Directive 3200.11*, Use Management*, and *Operation of Department of Defense Major Range and Test Facilities*; both provide the framework under which the national ranges operate and provide services to range users. To provide for the public safety, the ranges, using a Range Safety Program, ensure that the weapons delivery testing presents no greater risk to the general public than that imposed by overflight of conventional aircraft.

It is the policy of the Edwards AFB Range to ensure that the risk to the public, military personnel, government civilian workforce, contractors, and national resources is minimized to the greatest degree possible. This policy is implemented by using risk management in the areas of public safety, launch area safety, and landing area safety. Range users are required by Edwards AFB to demonstrate, through risk modeling, that the lowest possible risk is achieved, consistent with AFFTC mission requirements and risk guidance. The AFFTC Chief of Safety has responsibility for approving proposed flight test safety plans and flight safety criteria. The AFFTC Commander has final authority for approval of test and evaluation activities and responsibility for the safety on the ranges. The AFFTC Commander may deviate from mission criteria based on geography, weather, and national need; however, the basic standard is no more risk than that voluntarily accepted by the general public in normal day-to-day activities (NASA 1997).

3.12.6 Radiation Hazards

Radiation hazards (RADHAZ) describes the hazards of electromagnetic radiation to fuels, electronic hardware, ordnance, and personnel. These hazards are generally segregated as follows:

- Hazards of Electromagnetic Radiation to Personnel (HERP);
- Hazards of Electromagnetic Radiation to Ordnance (HERO); and
- Hazards of Electromagnetic Radiation to Fuel (HERF).

Current industrial specifications for RADHAZ are contained in ANSI/IEEE C95.1-1992. Limits for radiation hazards to personnel and ordnance are shown in Figure 3-22.

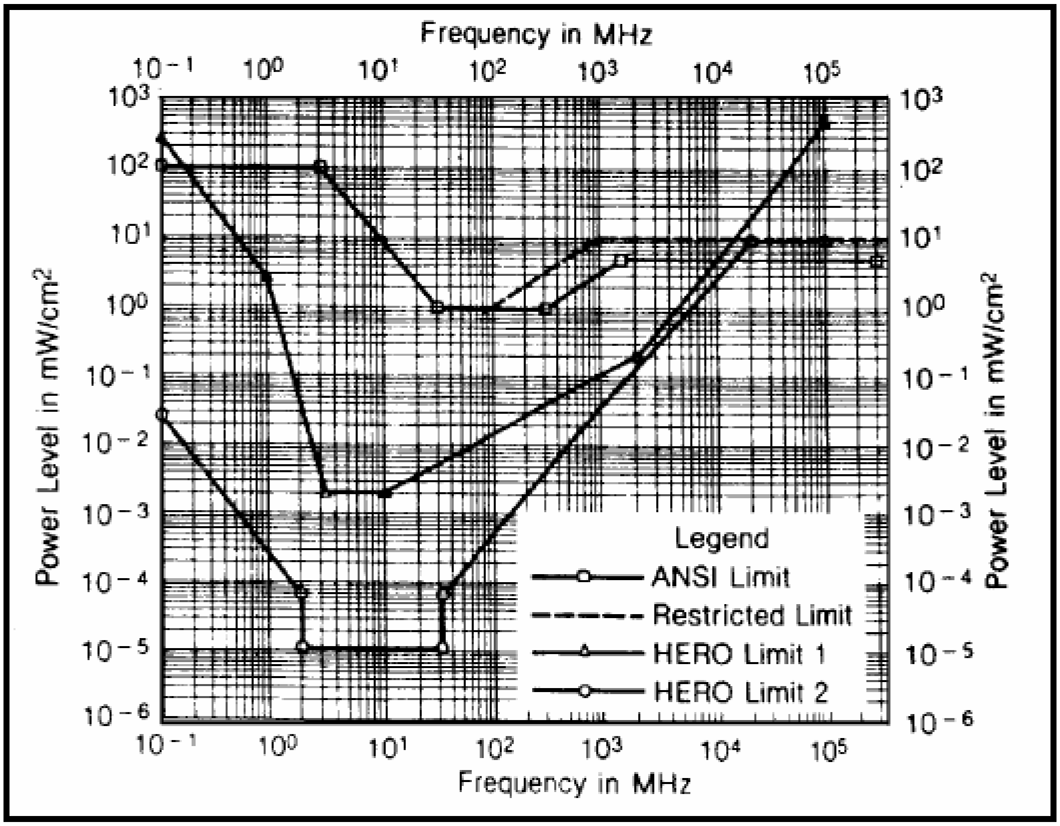


Figure 3-22

Radiation Hazards to Ordnance and Personnel

These limits as shown as average power density. The potential dangers to ordnance and fuels are obvious because an explosion could set off an explosive "chain reaction"; consequently, these limits are generally lower than personnel limits. There are three HERO categories. The HERO limit 2 is set for HERO "unsafe" or "unreliable" explosive devices with exposed wires arranged in optimum (most susceptible) receiving orientation. This usually occurs during the assembly/disassembly of ordnance, but also applies to new/untested ordnance until it is proven "safe" or "susceptible." The HERO limit 1 is for HERO susceptible ordnance that is fully assembled and undergoing normal handling and operations. HERO safe ordnance requires no RF radiation precautions.

The danger of HERP occurs because the body absorbs radiation and significant internal heating may occur without an individual's knowledge because the body does not have internal sensation of heat. Thus, tissue damage may occur before the excess heat can be dissipated. As shown in Figure 3-22, the current restricted limit is for individuals more than 55 inches tall because they have more body mass and may be exposed to the higher limit of 10 milliwatts per square centimeter (mW/cm^2).

Two maximum hazard limits are defined:

- Controlled Environments. Personnel are aware of the potential danger of RF exposure concurrently with employment, or exposure which may occur incidental to passage through an area; and

- Uncontrolled Environments. A lower maximum level where there is no expectation that higher levels should be encountered, such as living quarters.

The permissible exposure limits (PELs) are based on a safety factor of ten times the SAR which might cause bodily harm. The Federal Communication Commission has established SAR limits for localized exposure to RF as shown in Table 3-15.

Table 3-15

Specific Absorption Rates

Occupational/Controlled Exposure 100 kHz – 6 GHz	General Uncontrolled Exposure 100 kHz – 6 GHz
< 0.4 W/kg whole body ≤ 8 W/kg partial body	< 0.08 W/kg whole body ≤ 1.6 W/kg partial body

Source: Federal Communication Commission 1999

The term PEL is equivalent to the term MPE and radio frequency protection guides found in other publications.

There are several exceptions to the maximum limits in Figures 3-23 and 3-24 (in some cases higher levels are permitted):

- HPM systems exposure in a controlled environment which has a single pulse or multiple pulses lasting less than 10 seconds and has a higher peak E-field limit of 200 kilovolts per meter (kV/m). An E-field is the electric field component of an electromagnetic wave expressed in volt/meter.

- Electromagnetic Pulse Simulation Systems in a controlled environment for personnel who are exposed to broadband RF limits are limited to a higher peak E-field of 100 kV/m.

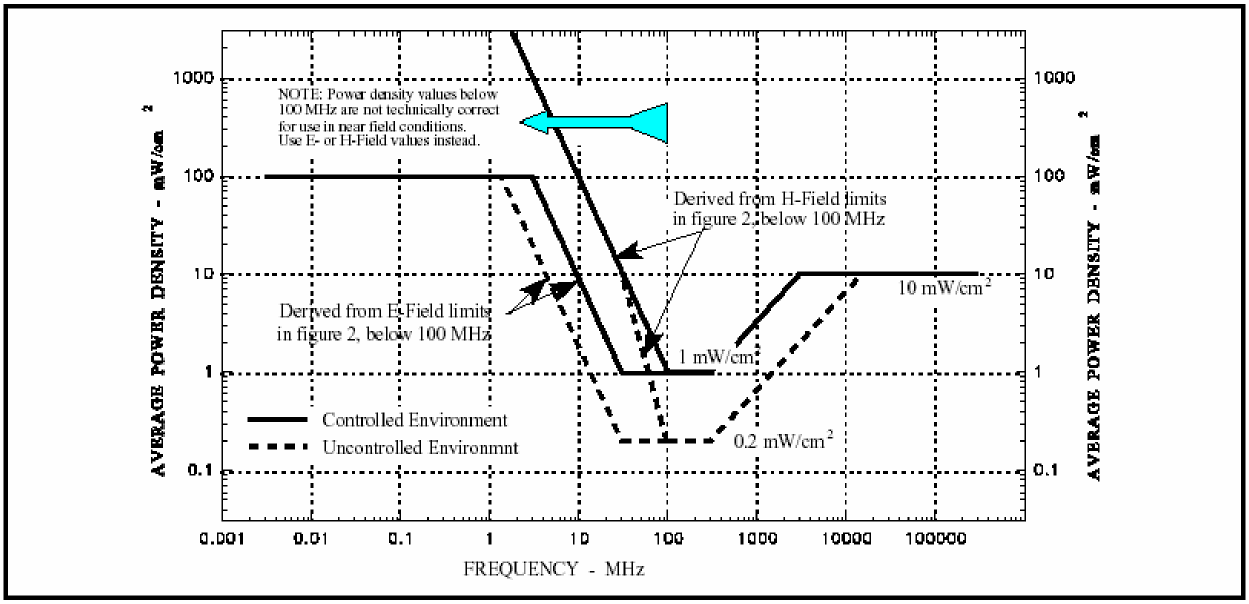


Figure 3-23 Lower Frequency HERP

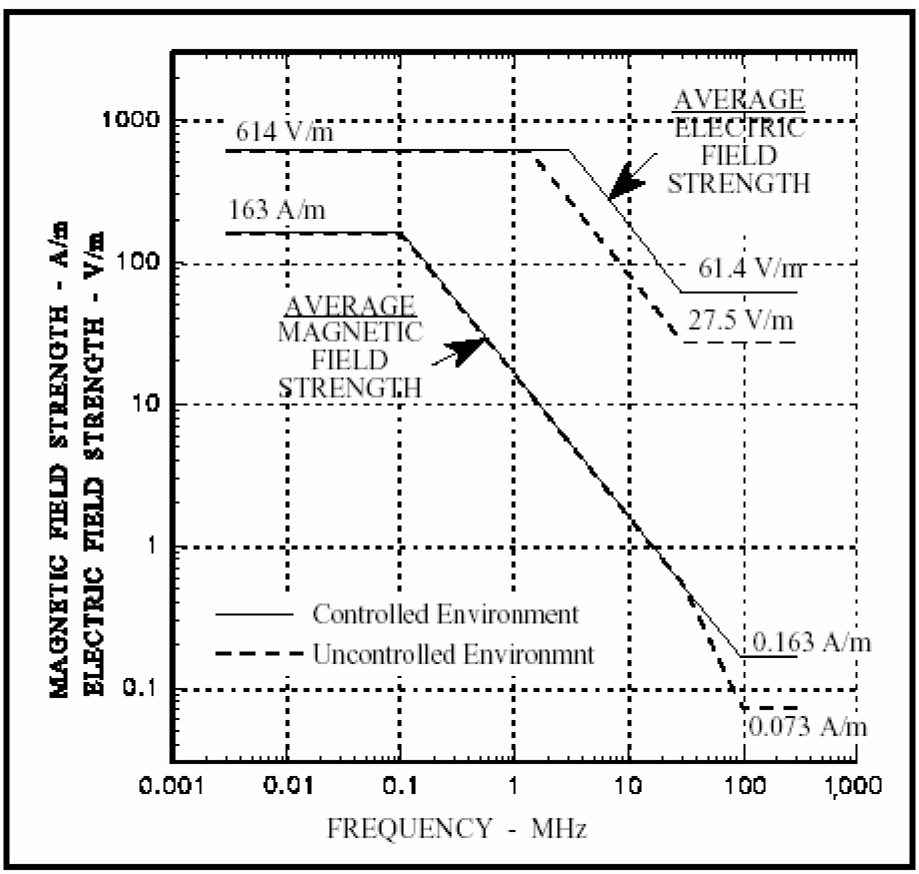


Figure 3-24 Radiation Hazards to Personnel

- EMP Simulation Systems in a controlled environment for personnel who are exposed to broad-band (0.1MHz to 300 GHz) RF are limited to a higher peak E-field of 100 kV/m.
- The given limits are also increased for pulsed RF fields. In this case the peak power density per pulse for pulse durations less than 100 milliseconds and no more than 5 pulses in the period is increased to: PEL = PEL x T Pulse AVG / 5 x Pulse Width, and the peak E-field is increased to 100 kV/m. If there are more than 5 pulses or they are longer than 100 milliseconds, a time averaged P should not exceed that shown in Figure 3-23.
- A rotating or scanning beam likewise reduces the hazard, so although an on-axis hazard might exist, there may be none with a moving beam. The power density may be approximated with: PD = PD (2 x Beam Width / scan angle) scan fixed.
- Many other special limitations also apply, such as higher limits for partial body exposure, additional information can be found in DoD Instruction 6055.11, *Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers* in detail. Field measurements may be taken in accordance with IEEE C95.3-1991.

The PELs listed in Figures 3-23 and 3-24 were selected for an average RF exposure time at various frequencies. In a controlled environment, this averaging time was selected as 6 minutes for 0.003 to 15,000 MHz. If the exposure time is less than 6 minutes, then the level may be increased accordingly. Similar time weighted averages apply to uncontrolled environments, but vary enough with frequency such that DoD Instruction 6055.11 should be consulted. Special training is required for individuals who work in areas which emit RF levels which exceed the uncontrolled levels. Warning signs are also required in areas which exceed either the controlled or uncontrolled limits.

Although E-Field, H-Field, and power density can be mathematically converted in a far-field plane wave environment, the relations provided earlier do not apply in the near field; consequently the E- or H-field strength must be measured independently below 100 MHz. An H-field is the magnetic field component of an electromagnetic wave expressed in units of amperes per meter (A/m). Lower RF limits in DoD Instruction 6055.11 on HERP are in average (RMS) E-field values. Upper frequency restrictions are based on average (RMS) values of power density in both regulations except under certain circumstances. Table 3-16 shows the relationship of power density in commonly used units for free-space, far-field conditions. HERF precautions are of more general concern to fuel truck operators.

However, some general guidelines are as follows:

- Do not energize a transmitter (radar/communications) on an aircraft or motor vehicle being fueled or on an adjacent aircraft or vehicle.
- Do not make or break any electrical, ground wire, or tie-down connector while fueling.
- Radars capable of illuminating fueling areas with a peak power density of 5 watts per centimeter (W/cm) should be shut off.
- Antennas radiating 250 watts or less should be installed at least 50 feet from fueling areas.
- For antennas which radiate more than 250 watts, the power density at 50 feet from the fueling operation should not be greater than the equivalent power density of a 250 watt transmitter located at 50 feet.

Table 3-16

Power Density Conversion Table for Free-Space Far-Field Conditions

W/m^2	**mW/cm^2**	**µW/cm^2**	**V/m**	**A/m**
0.01	0.001	1	2	0.005
0.1	0.01	10	6	0.015
1.0	0.1	100	20	0.05
10	1	1,000	60	0.15
100	10	10,000	200	0.5
1,000	100	100,000	600	1.5
10,000	1000	1,000,000	2,000	5

Notes: A – amperes, cm – centimeter , m – meters, µW – microwatts, W – Watts.

3.12.6.1 Non-ionizing Electromagnetic Radiation Sources

Non-ionizing electromagnetic radiation (EMR) comes from two major sources on Base: radio frequency emitters (i.e., radars, radar-jamming transmitters, and radio communication equipment) which are regulated by Air Force Occupational Safety and Health (AFOSH) Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program*, and laser/microwave emitters, which are regulated in accordance with AFOSH Standard 48-139, *Laser Radiation Protection Program* and DoD Instruction 6055.11, *Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers*. Sources of EMR exist throughout the flightline areas, and include fixed location radar, airfield management equipment, and aircraft equipment/instrumentation. Electromagnetic radiation can cause thermal and photochemical injuries to humans, particularly to the eyes and skin. Standards and practices are in place to shield and isolate workers from operational hazards of existing EMR sources.

Bioenvironmental Engineering periodically makes visits to and evaluates the operations of all known AFFTC industrial radiation users as a part of the Industrial Hygiene Surveillance Program. This office also verifies (annually) the list of on-Base radio frequency radiation emitters and systems. Any proposed use of emitters is evaluated using a preliminary radiation hazard analysis. Using a PEL and MPE, a proper hazard analysis is accomplished. The PEL and maximum exposure limit are expressed in terms of safe distance limits from the emitting source. Compliance with these limits is required as a Standard Operating Procedure (AFFTC 1997b).

Microwaves

Microwave sources found within the R-2515 area include sources used for telecommunications purposes such as cellular radio, personal communication services, microwave point-to-point communications, transmission links between ground stations and orbiting satellites, and in broadcasting operations such as studio-to-transmitter and electronic news gathering radio links. Microwave radar systems provide information on air traffic and weather and are used extensively in police and military applications. Medical applications of microwave devices include therapeutic and selective heating of tumors as an adjunct to chemotherapy treatment (microwave hyperthermia). Radiofrequency radiation, especially at microwave frequencies, efficiently transfers energy to water molecules. At high microwave intensities the water molecules can transfer heat in water-rich materials such as food or tissue. The operation of the microwave oven is based on this principle.

3.12.6.2 Explosives and Propellants

Explosives and propellants are used and stored in a number of locations throughout Edwards AFB. An inhabited building separation distance (or clear zone) has been established around each of the existing explosives and/or propellant use/storage locations. The size of the clear zone varies based on the quantity and type of explosive used, or propellant stored. Clear zones ensure the safety of all personnel in the area from the potential overpressure hazard associated with use and storage of these materials.

3.13 SOCIOECONOMICS

Socioeconomic resources are the economic, demographic, and social assets of a community. Key elements include fiscal growth, population, labor force and employment, housing stock and demand, and school enrollment.

3.13.1 Socioeconomics—R-2515 Area

The population found within the R-2515 area is sparse. The population centers of incorporated cities range in size from small cities, such as North Edwards with a population of 1,227 and Boron with a population of 2,231 to Edwards AFB with a population of 7,679 (U.S. Census Bureau 2000). It should be noted that only a portion of California City, with a population of 8,311 (U.S. Census Bureau 2000), is in the R-2515 area. Four of the most important job categories include public administration; educational, health, and social services; retail trade; and professional, scientific, management, administrative, and waste management services (U.S. Census Bureau 2000). The one military installation in restricted area R-2515 also contributes significantly to the employment in nearby communities.

3.13.2 Socioeconomics—Edwards AFB Area

Edwards AFB makes a substantial contribution to the economic status of the surrounding communities within the Antelope Valley. The Antelope Valley has a labor force of approximately 161,031 persons with an unemployment rate of 13.6 percent. The labor force is employed in a variety of industries including services, manufacturing, construction/mining, retail, government, and agriculture. The military labor force comprised two percent and the government labor force comprised 6 percent of those employed in the Antelope Valley in 1997 (Alfred Gobar Associates 1997).

The daytime population at Edwards AFB comprises the Combined Test Forces, which include military and civilian personnel and their dependents. According to the Public Affairs office at Edwards AFB an estimated 3,850 military personnel, including officers and enlisted members, work at the base. The civilian population working on base numbers 7,835 and the dependent population is approximately 4,290. The estimated total daytime population at Edwards AFB is approximately 15,980 (Edwards AFB 2002b).

According to the 2000 census, Edwards AFB supports an on-base residential population of approximately 5,900 people (U.S. Census Bureau 2000).

Edwards AFB provides permanent party housing for military members in the form of dormitories, military family housing, and mobile home park spaces. Unaccompanied enlisted members and designated key and essential personnel are required to live on-Base. Family housing units at Edwards AFB consist of 310 units for officers and 1,360 for enlisted members; however, these numbers fluctuate due to the demolition of older units and construction of new units. The number of units ranges from 1,640 to 1,777. Edwards AFB maintains a 188-space mobile home park for privately owned mobile homes; personnel with families and unaccompanied members are allowed to reside in the park (MARCOA Publishing, Inc. 1998). Two- and three-story dormitories for 32 to 84 members in single and double rooms; bachelor officer housing of 62 apartment-style units; and senior non-commissioned officer housing of 16 apartment-style units is available (Edwards AFB 2002a). Edwards AFB has an occupancy rate goal of 98 percent. Transient quarters are available through the Billeting Office.

Four schools are located on Edwards AFB: Bailey Elementary school for students in kindergarten, first, and second grades; Branch Elementary school for students in third, fourth, and fifth grades; and Edwards Middle School for those in sixth, seventh, and eighth grades (Edwards AFB 2002a). In addition, Desert High School is located on-Base and has approximately 420 students in grades 9 through 12. Edwards AFB houses a child development center for children 6 weeks to 5 years old, a Teen Center, a Youth Activities Center, and a Boy Scout camp on South Base (Edwards AFB 2002a).

In 2004 Boron and North Edwards had three schools: North Edwards High School, Boron Junior/High School, and West Boron Elementary School with an enrollment of 28, 296, and 274 students, respectively, in kindergarten through grade 12 (City Locator 2005).

Several additional school districts exist within the Antelope Valley. According California Department of Education for the 1998 to 1999 school year, total enrollment in these school districts was 128,029. Numerous private schools also exist within this region.

In fiscal year 1998, Edwards AFB expended $3,186,230 for training and education of active duty personnel and civilians. Impact Aid provided by the Department of Education to school districts that are associated with Edwards AFB was $4,631,541 for fiscal year 1998. This aid is provided to schools attended by children who reside on-Base or whose parents work on base, or both. These parents may be active duty military or civilians (Levell 1999).

3.14 WATER RESOURCES

This section describes the surface water and groundwater resources including their source, quantity, and quality.

3.14.1 Water Resources—R-2515 Area

A detailed discussion of water resources found with the R-2515 area is provided in the *R-2508 Complex Environmental Baseline Study* updated in 2005 (95 ABW and AFFTC 2005). This discussion of water resources is summarized from that section. Several bodies of water and dry lakes are found within the R-2515 area and are used for a variety of purposes including water supply (e.g., irrigation, domestic and municipal purposes), recreational uses, and aircraft landing areas.

The Antelope Valley and Mojave Desert runoff from the two large watersheds in this area is deposited into four major dry lakes in the region: Rogers and Rosamond Dry Lakes within Edwards AFB, Harpers Dry Lake, and Cuddeback Lake.

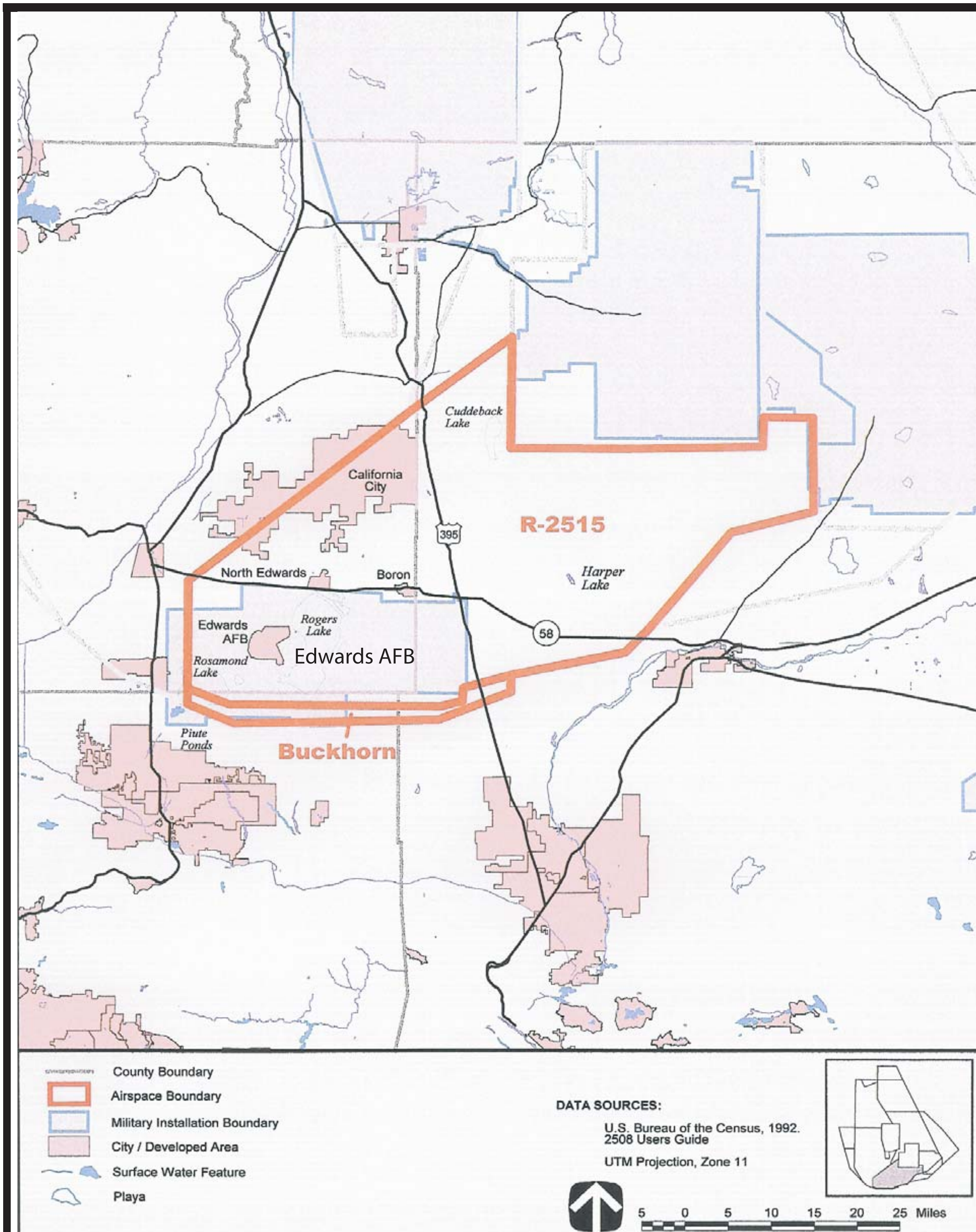
Major playas located in the complex include Rogers Dry Lake, Rosamond Dry Lake, and Buckhorn Dry Lake. There are no designated Wild and Scenic Rivers found within the R-2515 area. Figure 3-25 shows water resources found within the R-2515 area.

3.14.2 Water Quality—Edwards AFB Area

3.14.2.1 Water Quantity and Source

Jurisdictional waters of the United States do not occur within Edwards AFB (USACE 1996). Non-jurisdictional water resources at Edwards AFB include groundwater, water from the AVEK Water Agency, storm water drainage/flood prone areas, treated wastewater effluent, artificial ponds supporting aquatic habitat and recreation, dry lakes, and ephemeral streams. The AFFTC purchases potable water from the AVEK Water Agency through a water distribution system located in Boron, California. Treated wastewater effluent is used for some urban landscape irrigation and feeds some artificial ponds (Edwards AFB 2004).

The Antelope Valley is a single, undrained, closed basin. The principal source of recharge to the aquifer system in the Lancaster subbasin is infiltration of rainfall runoff through alluvial fans of creeks flowing off the San Gabriel Mountains on the southern boundary of the Antelope Valley (Edwards AFB 2004). Recharge from infiltration in the hills on the eastern and northwestern parts of the Edwards AFB area is minimal because precipitation is low and evaporation is high. Major faults that cut through the alluvial deposits in the Antelope Valley act as partial barriers to the movement of groundwater. Water-level differences of more than 300 feet in the same aquifer may be present. Storm water may enter the groundwater directly through giant desiccation cracks and fissures, but this is considered to be a small source of recharge because of the low permeability of the lakebed surface (Edwards AFB 2004).



Water Resources in the R-2515 Area	Figure 3-25	Q242-04	9/13/05

Groundwater has been an important source of water for the Antelope Valley since development began there in the late 1800s, and for the base since 1947. In recent years of rapid urban growth and drought, between 50 and 90 percent of all water demands in the Valley were satisfied by groundwater. Groundwater pumping and irrigation of crops began to decrease when water levels declined. Groundwater depth has declined approximately 90 feet since 1947 (AFFTC 1999). Edwards AFB uses 15 groundwater wells, 10 of which are reserved for drinking water purposes (Edwards AFB 2004). South Track, near the southern boundary of Rogers Dry Lake, has 8 of the wells in production and taps the deep aquifer to provide potable water to the main Base. The 10 potable water wells have a maximum combined production capability of 15.6 million gallons per day (Edwards AFB 2004).

3.14.2.2 Water Quality

The U.S. EPA's Office of Water establishes the groundwater and drinking water quality standards found in the National Primary Drinking Water Regulations (or primary standards) that are legally enforceable and apply to public water systems. Edwards AFB must also conform to standards for clean water set by the California Department of Health Services. The Lahontan Regional Water Quality Control Board and California Department of Health Services, Southern California Field Operations Branch, Tehachapi District, administer these standards locally. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. The Bioenvironmental Engineering Office monitors base groundwater quality, and compliance with drinking water standards.

Because of the history of the PIRA and its size, past practices may have contributed to soil and/or groundwater contamination. In the past, ranches, homesteads, and mining operations were prevalent in the Antelope Valley including the area that is now within PIRA boundaries. Past activities on the PIRA may have included improper storage, disposal and/or burial of solid or hazardous materials. Section 3.6 describes the environment with respect to identified hazardous materials that have the potential to contribute to soil or groundwater contamination.

3.14.2.3 Storm Water Drainage/Flood Prone Areas

Edwards AFB is situated at the bottom of Antelope Valley Watershed Basin, a roughly 2,400 square mile watershed with no outlet. Rainfall in the San Gabriel Mountains southwest of Edwards AFB, and in the Tehachapi Mountains northwest of the Base, drains in relatively well-defined streams toward the valley.

The streams flow to the valley floor and transition to an overland sheet flow pattern. Sediment deposition has resulted in the following landforms:

- Transitional alluvial fans nearest the mountains with loamy, sandy, and gravelly sediments of high permeability;
- Desert plateaus toward the middle of the valley with sandy and silty sediments of intermediate permeability; and
- Playa lakebeds at the central low points of the valley with silty and clayey sediments of low permeability.

There are no perennial streams on Edwards AFB. Storm water runoff for the entire watershed is directed toward three large playa lakebeds: Rogers, Rosamond, and Buckhorn Dry Lakes. Playas are expansive, ancient dry lakes that fill with water during the rainy season. Water may be retained in these playas for several months due to mostly impermeable, alkaline, saline soils that contain high levels of solute, sodium, and total dissolved solids. Any water reaching these lakebeds is trapped and subsequently evaporates (Edwards AFB 2004; USGS 1998).

In general, drainage tends to flow toward the nearest dry lakebed. Rosamond and Buckhorn Dry Lakes, in turn, drain towards Rogers Dry Lake (AFFTC 1993). Water level elevations (above MSL) for Rosamond Dry Lake during flood conditions are described in Table 3-17 (USACE 1996).

Table 3-17

Water Level for Rosamond Dry Lake Flooding Events

Flood Level	Lake Elevation (feet above MSL)
50-year	2,280.9
100-year	2,282.2
200-year	2,283.4

Despite the apparent potential for the formation of a sizable lake, the playa lakebeds remain dry most of the time due to arid climate conditions. The average annual rainfall at the base is approximately 5 inches; the maximum recorded 1-year rainfall was 15.5 inches, which occurred in 1983. The average annual evaporation, as measured by a nearby Mojave pan evaporation gauge from 1939 to 1959, is 11.4 inches.

The Mojave Creek Floodplain is a well-defined drainage that runs southeast along the north and east of the residential area of Main Base along Lancaster Boulevard and crosses Rosamond Boulevard where it runs southward just west of South Base and empties into Rogers Dry Lake. Mojave Creek is dry for most of the year, but periodic flooding does occur during above-normal rainfall periods (AFFTC 1993). Per the base *Stormwater Pollution Prevention Plan* (September 1998), the storm water collection system consists of drainage ditches (flowing east to Rogers Dry Lake) and storm water retention ponds (located on the west edge of Rogers Dry Lake) (Edwards AFB 2004).

In 1993, a flood study of the base was conducted to determine floodplain constraints (AFFTC 1993). Rogers Dry Lake, Rosamond Dry Lake, and Mojave Creek (which empties into Rogers Dry Lake) were identified as the most critical flood-prone areas. A small portion of Rogers Dry Lakebed extends into the PIRA along the Mercury Boulevard/West Range boundary in the North Flank areas. Other flood-prone areas on-base are in the residential area, where no channels are present to divert heavy storm water runoff.

The AFFTC 1993 flood study estimated a flood-of-record inundation elevation to be used for planning purposes and performed a risk of flooding analysis of existing base facilities near Rogers Dry Lake. This level represents the maximum water surface elevation that would occur during a flood of reasonably high return interval (e.g., 50 years, 100 years). The level of flooding that occurred in 1943 was estimated to be the flood-of-record level. Most development on Edwards AFB is above this estimated flood-of-level of 2,277.4 feet (North American Vertical Datum of 1988). Only a small portion of the NASA ramp and North Base are affected. Relatively high flooding in 1993 remained more than 3 feet below the estimated flood-of-record level (AFFTC 1993).

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential environmental consequences and impacts associated with Alternatives A, B, and C. Changes to the natural and human environment that could result from Alternatives A and B were evaluated relative to the existing environmental conditions described in Chapter 3.0. Alternative C, the No-Action Alternative, would not result in any significant environmental consequences or impacts for this ROI because no new actions would take place.

This EA only addresses the impacts associated with the testing and evaluation process for HPM systems within restricted area R-2515 and Edwards AFB, California. While this analysis looks at the effects of the Proposed Action and Alternatives, it does not cover other types of microwave devices or other segments of the HPM life cycle. Analysis of other phases (e.g., weapons design and development, production, transportation) will be the responsibility of the intended test program office; separate environmental documentation that complies with NEPA would be required under these phases of the program. The environmental consequences for this EA are based on the assumption that ground targets would be physically located within the land surface area of Edwards AFB (see Figure 2-13) and airborne targets would fly in restricted area R-2515, but would only be radiated by HPM systems when the airborne target is physically over Edwards AFB. Each target site or firing point would be limited to 5 acres with a maximum total of 100 acres that could be disturbed or removed from available habitat on Edwards AFB. Aircraft and other airborne platforms that would radiate these HPM systems could either be located in the airspace above Edwards AFB or within restricted area R-2515 depending on the alternative selected and parameters being tested as identified in the specific test plan. Ground platforms radiating HPM systems would be located on Edwards AFB.

During most HPM test missions the duration of the radiating HPM RF energy to ground or airborne targets would be less than 10 seconds (Montoya 2005).

In general, impacts described in this chapter address normal operations and use of HPM technology in a controlled test environment. Potential impacts are described for flight test activities (A/A, A/G, and G/A modes) and ground test activities (G/G mode).

4.1 AIR QUALITY

The following evaluation was prepared for emission impacts from aircraft based on 128 flight missions per year utilizing C-17, C-130, and C-135 aircraft and X-45/X-47 (UAV) from 2008 through 2012. Each

A/A mission would consist of one test aircraft and one towed or tethered target drone, weather balloon, or remotely piloted vehicle (RPV). Emissions from AGE and ground support equipment (GSE) were also estimated and included in the total emissions resulting from test flights for each projected year of testing. Emissions from aircraft for ground tests were estimated by assuming 48 G/G HPM test missions per year from 2008 through 2012. Emissions for generators supporting non–aircraft related G/G HPM missions were based on a total of 100 operational hours in 2006 and 600 operational hours per year from 2007 through 2012. Transportation of HPM systems between NAWS China Lake and Edwards AFB was assumed to require 12 hours in 2006 and 48 hours per year from 2007 through 2012.

4.1.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

Alternative A, the Proposed Action Alternative, is to conduct open-air integration and developmental testing of HPM systems against targets on or over Edwards AFB and within restricted area R-2515 in the G/G, G/A, A/G, and A/A modes. The following summarizes sources of potential emissions from various testing activities associated with Alternative A.

4.1.1.1 Air Quality–Restricted Area R-2515

Emissions occurring in restricted area R-2515 would include those released on the ground and in the air while HPM systems are operating within the boundaries of Edwards AFB and restricted area R-2515. Based on the conformity applicability screening analysis presented in Section 4.1.4, air emissions created during flight and ground test activities would be below *de minimis* levels; therefore, air quality impacts would be less than significant.

Flight Test Activities

Flight test activities would consist of one landing and takeoff (LTO) event for the test aircraft or RPV and an LTO for the aircraft towing targets or RPV targets. Typically, only emissions released from aircraft and RPVs below 3,000 feet AGL are considered for their potential effects to air quality. Emissions from aircraft and RPVs operating in airspace above 3,000 feet AGL were not considered because these emissions would be released above the mixing height and effectively blocked from dispersion to the surface. Estimated emissions from the test aircraft and RPVs are summarized in Section 4.1.4 and were included in the conformity applicability screening analysis.

Each mission would require, in addition to the HPM-equipped aircraft or RPV and the aircraft towing the target or RPV target, additional AGE and GSE to effectively carry out the test plan. This equipment includes the generators necessary to prepare aircraft for take-off and the equipment for loading/unloading necessary system components and cargo. If an airborne target similar to the Proteus aircraft was used, then air emissions from its engines would be included. These emissions are summarized in Section 4.1.4 and were included in the conformity applicability screening analysis.

Air emissions from testing HPM electronic munitions would be similar to the air emissions created when testing armed munitions containing up to 500 pounds of net explosive weight (NEW) at PB-13. In the *Environmental Assessment for Armed Munitions Integration Testing on the Precision Impact Range Area* (AFFTC 2005c), the air emissions created by 100 detonations of 500 pounds NEW would be below *de minimis* levels and would also be less than 0.2 percent of the total inventory for the applicable air districts; therefore, it would be expected that air emissions from 128 HPM electronic munition detonations would also be well below *de minimis* levels.

The HPM systems used during flight testing would not create air emissions when radiating because the chemicals used in these systems are enclosed in the hardware and are not released to the atmosphere under normal conditions.

Ground Test Activities

Test activities that would generate air emissions in addition to those currently generated at Edwards AFB would include HPM system testing in the G/G and G/A modes as determined by the test plan.

In the G/G and G/A modes, air emissions would be generated from the ground platform on which the HPM system is mounted (such as the hybrid diesel/electric Hummer [high mobility multi-wheeled vehicle or HMMWV]) or from the vehicle used to move to the platform to a firing position and the generator used to produce the electrical energy for the HPM system. Emissions expected to be generated from the vehicle used for the G/G and G/A modes are summarized in Section 4.1.4 and have been included in the conformity applicability screening analysis.

Other potential air emissions would include those resulting from the HPM system in the G/G and G/A modes by platforms that normally would be used for A/A or A/G testing (e.g., C-17, C-130, C-135, and X-45/X-47). Emissions expected to be generated from aircraft used for the G/G and G/A modes are summarized in Section 4.1.4 and have been included in the conformity applicability screening analysis.

The HPM systems used during ground testing would not create air emissions when radiating because the chemicals used in these systems are enclosed in the hardware and not released to the atmosphere under normal conditions.

Target materials could include aluminum, steel, composites, or other alloys. Proposed targets include unmanned jets, trucks, HMMWVs, tanks, personal computers, cellular phones, communications gear, and instrumented target boards. There is no common method for estimating the emissions generated from radiating microwave systems at these types of targets; however, microwave energy (RF energy) is not expected to generate significant emissions from these tests. The RF energy is expected to affect these targets by creating electrical short circuits which would deny, degrade, or disrupt equipment use, or render it unusable. The air emissions would be expected to be similar to those created when wires and electrical connections are shorted out on home appliances. Therefore, these emissions have not been quantified and were not included in the conformity applicability screening analysis.

4.1.1.2 Air Quality—Edwards AFB Area

Emissions in the Edwards AFB area include those released on the ground and in the air while operating within the boundaries of Edwards AFB. Air emissions created during flight test and ground test activities on and over the Edwards AFB area and documented in the conformity applicability screening analysis would be the same as identified in Section 4.1.1.1.

Based on the conformity applicability screening analysis presented in Section 4.1.4, air emissions created during flight and ground test activities would be below the *de minimis* level for criteria pollutants and would be considered less than significant.

4.1.1.3 Mitigation Measures

Air emissions during flight and ground test activities conducted as a result of implementing Alternative A would be below *de minimis* levels for criteria pollutants and would be considered less than significant. No mitigation would be required as a result of implementing Alternative A.

4.1.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Alternative B would be similar to Alternative A, except surrogate HPM systems with reduced power levels would be tested in the G/G, G/A, A/G, and A/A modes against targets at Edwards AFB and restricted area R-2515. High power tests of HPM systems would occur at locations to be determined by supplemental analysis. Ground testing of surrogate HPM systems would be conducted from ground stations and human-transportable and/or ground vehicles located in positions on Edwards AFB as determined by the test plan. HPM testing performed in the air would be used to evaluate beam targeting for the surrogate HPM systems per the approved test plan. Under Alternative B the range of collateral effects (on the equipment and personnel for enemy or friendly forces) that would result from conducting a full power test for either ground or flight related activities could not be determined.

4.1.2.1 Air Quality—Restricted Area R-2515

For Alternatives A and B air emission evaluations and estimates were calculated based on expected HPM platform equipment operation rather than HPM system only operation. Therefore, emission estimates are independent of HPM power settings, and the expected emissions for testing under Alternative B would be similar to those of Alternative A. Air emissions created during flight tests activities in restricted area R-2515 as documented in the conformity applicability screening analysis would be the same as identified in Section 4.1.1.1. These emissions would be below the *de minimis* level for criteria pollutants, and air quality impacts would be considered less than significant. No differentiation was made when performing the conformity applicability screening analysis.

4.1.2.2 Air Quality—Edwards AFB Area

Air emissions created during flight test and ground test activities on and over the Edwards AFB area associated with implementing Alternative B and documented in the conformity applicability screening analysis would be the same as identified in Section 4.1.1.1. These emissions would be below the *de minimis* level for criteria pollutants, and air quality impacts would be considered less than significant.

4.1.2.3 Mitigation Measures

Air emissions during flight and ground test activities conducted as a result of implementing Alternative B would be below *de minimis* levels for criteria pollutants, and air quality impacts would be considered less than significant. No mitigation would be required as a result of implementing Alternative B.

4.1.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM system testing would not occur at Edwards AFB or in restricted area R-2515. No impacts on air quality in restricted area R-2515 or the Edwards AFB area would result from implementing Alternative C. No mitigation would be required as a result of implementing Alternative C.

4.1.4 Conformity Applicability Screening Analysis

Because air pollutant emissions are expected to be similar for Alternatives A and B, they were evaluated simultaneously in the following conformity applicability screening analysis. Only pollutants emitted from aircraft operations during landing and takeoff at Edwards AFB and for 5 percent of the remaining mission operating time were considered in the conformity applicability screening analysis. This is because 95 percent of all other aircraft operations associated with HPM missions would occur above the 3,000 feet AGL mixing layer so these emissions are not considered in a conformity applicability screening analysis.

Sources of emissions generated under Alternatives A and B include

- Privately owned vehicles of current Air Force or contractor personnel required for temporary duty for weapons support;
- One LTO for one HPM-equipped aircraft or RPV;
- One LTO for one target towing aircraft or RPV during A/A or G/A events;
- AGE;
- GSE used for loading and unloading HPM systems (consisting of one light-duty gasoline vehicle, one light-duty gasoline truck, one heavy-duty gasoline truck, and one light-duty diesel truck); and
- Generators used to produce the power for ground based HPM systems (like those used on the ADS or HMMWV).

Emissions from the C-17, C-130, C-135, X-45/X-47, and Proteus aircraft were considered in the conformity applicability screening analysis calculations. The C-17, C-130, C-135, and X-45/X-47 aircraft would be used as the platform conducting the HPM test and evaluation operations. The X-45/X-47 and Proteus aircraft could be airborne targets or be used for towing HPM targets. Projected aircraft utilization for the HPM test and evaluation missions is shown in Table 4-1.

Table 4-1

Annual Aircraft Utilization for HPM Missions (2008—2012)

Type of Event Support	Percent Utilized	Number of Flight Missions	Number of Ground Missions
HPM Equipped Aircraft			
C-17	25	32	12
C-130	25	32	12
C-135	25	32	12
X-45/X-47	25	32	12
Target Aircraft/Tow Platform			
X-45/X-47	20	26	N/A
Proteus	20*	26	N/A

Note: * - The Proteus aircraft could be targeted over Edwards AFB for HPM missions. For evaluation purposes, approximately 20 percent of the 128 flight missions would involve the Proteus aircraft.
Source: Hagenauer 2005.

Since there would be no new construction or specialty equipment required, the actual emissions resulting from and assessed under Alternative A would occur primarily from privately owned vehicles, HPM-equipped and target aircraft, AGE, and GSE.

The HPM aircraft flight missions are anticipated to be 3 hours in duration with approximately 5 percent of that time spent below 3,000 feet AGL. Emissions from aircraft LTOs and flights were calculated using engine emission factors specific to each potential engine and engine-operating mode (Air Force Institute for Environmental, Safety and Occupational Health Risk Analysis [AFIERA] 2002). Engine emission factors were multiplied by:

- The total number of operations expected to occur per test and evaluation event;
- The number of engines operating during a particular operation;
- The time in each engine mode and expected fuel flow for the particular operation; and
- The estimated amount of time the flights are expected to be below 3,000 feet AGL.

The AGE/GSE emissions were calculated using emission factors obtained from *AP-42: Compilation of Emission Air Pollutant Factors* (AFIERA 2002; U.S. EPA 1999). AGE emissions were calculated based on the number of missions per year, phase of each mission, and the type of aircraft being supported. The GSE emission calculations were performed utilizing duration of activity or miles driven and vehicle engine emissions for the given size ground transport vehicles.

The air emissions from current Air Force or contractor personnel vehicles required for temporary duty for HPM testing events are not evaluated in this analysis because they are exempt under 40 CFR 51.853(c)(2)(vii) and (x). Only vehicle emissions generated as a direct result of project activities were considered. The routine, recurring transportation of personnel and the future activities conducted would be similar in scope to those currently being conducted at existing facilities. This would result in no emission increases or emissions that are clearly below *de minimis* threshold levels. Therefore, those actions (transportation of personnel, in this case) are exempt.

The total project emissions for aircraft, AGE, and GSE for Alternatives A and B for typical HPM events are summarized in Table 4-2. Details of the emission calculations from each activity are provided in Appendix A.

An air conformity applicability screening analysis was conducted for the proposed project. The Kern County portion (East Kern County) of Edwards AFB is now in attainment of the federal 1-hour ozone standard and is now under a federally approved SIP maintenance plan (*Federal Register* 2004). The proposed project would conform to the most recent U.S. EPA-approved SIP if the total direct and indirect emissions remained below *de minimis* thresholds established in the U.S. EPA's conformity rule for general federal actions. For KCAPCD the conformity *de minimis* levels for ozone and ozone precursors (nitrogen oxides and VOCs) are 100 tons per year per pollutant. Because the area is in attainment or unclassified for the remaining criteria pollutants, no screening analysis was necessary. Emissions analyzed for conformity applicability analysis from aircraft LTOs and flights and AGE/GSE sources are summarized in Table 4-2.

The primary area that would be affected by the emissions shown in Table 4-2 is the immediate area around Edwards AFB, situated in the MDAB portion of Kern County. The Valley portion of Kern County, situated in the SJVAPCD, was not included in the conformity applicability analysis screening. The Valley portion is not anticipated to be affected by the proposed project because the test aircraft would be well above 3,000 feet AGL in these areas. Table 4-2 indicates the ozone precursor emissions (NO_2 and VOCs) would be less than the *de minimis* thresholds of 100 tons per year for a serious ozone nonattainment area for the MDAB portion of Kern County (40 CFR Part 93 Subpart 153[b][2]) for all areas. In addition, the emissions of ozone precursors would not exceed 10 percent of the total Kern County inventories (40 CFR Part 93 Subpart 153[i]), and the ozone precursors and PM_{10} would be less than 10 percent of the AVAQMD inventory.

There are no local concerns for carbon monoxide within the ROI for the proposed project. Emissions from the proposed project would not result in any carbon monoxide hot spots since traffic congestion and carbon monoxide nonattainment in the ROI are not local issues.

Based on the conformity applicability criteria, the proposed project would conform to the most recent U.S. EPA-approved SIP, and no further detailed conformity applicability screening analysis is required.

Table 4-2

Conformity Applicability for Total Emissions Sources Associated with Alternatives A and B (emissions in tons per year)

Emissions Source	NO_2	VOC	PM_{10}	SO_2	CO
Year: 2006					
Aerospace Ground Equipment (generators, semi-truck, HMMWV)	0.212	0.006	0.025	0.015	0.019
Ground Support Equipment (LDVs)	0.025	0.041	0.273	0.000	0.314
Total	**0.237**	**0.047**	**0.298**	**0.015**	**0.333**
Year: 2007					
Aerospace Ground Equipment (generators, semi-truck, HMMWV)	1.251	0.035	0.134	0.089	0.105
Ground Support Equipment (LDVs)	0.430	0.709	4.709	0.000	5.420
Total	**1.681**	**0.744**	**4.844**	**0.089**	**5.525**
Year: 2008 through 2012 (per year) (128 Air/48 Ground Missions)					
Aircraft LTOs/TGOs[a]					
HPM Equipped Aircraft					
C-17, C-130, C-135, and X-45/47					
Ground Tests (48 missions)	1.858	16.552	3.056	0.045	22.538
Air Tests (128 missions)	2.527	5.372	1.403	0.026	7.198

Table 4-2, Page 1 of 3

Table 4-2 (Continued)

Conformity Applicability for Total Emissions Sources

Associated with Alternatives A and B (emissions in tons per year)

Emissions Source	NO_2	VOC	PM_{10}	SO_2	CO
Target Aircraft/Tow Platform					
Proteus and X-45/47 (52 flights)	0.102	0.163	0.034	0.001	0.427
Aerospace Ground Equipment					
(generators, semi-truck, HMMWV)	1.251	0.035	0.134	0.089	0.105
Ground Support Equipment (LDVs)	0.430	0.709	4.709	0.000	5.420
Total	**6.169**	**22.831**	**9.338**	**0.162**	**35.688**
Totals					
Year 2006	**0.237**	**0.047**	**0.298**	**0.015**	**0.333**
Year 2007	**1.681**	**0.744**	**4.844**	**0.089**	**5.525**
Year 2008	**6.169**	**22.831**	**9.338**	**0.162**	**35.688**
Year 2009	**6.169**	**22.831**	**9.338**	**0.162**	**35.688**
Year 2010	**6.169**	**22.831**	**9.338**	**0.162**	**35.688**
Year 2011	**6.169**	**22.831**	**9.338**	**0.162**	**35.688**
Year 2012	**6.169**	**22.831**	**9.338**	**0.162**	**35.688**
De minimis thresholds AVAQMD	25	25	N/A	N/A	N/A
De minimis thresholds KCAPCD	100	100	N/A	N/A	N/A
AVAQMD inventory[b]	10,220	12,775	N/A	N/A	N/A
Kern County, MDAB portion of inventory[c]	10,950	4,380	N/A	N/A	N/A
Percentage of Inventory[d]					
Year 2006	0.002	0.001	N/A	N/A	N/A
Year 2007	0.016	0.017	N/A	N/A	N/A
Year 2008	0.060	0.520	N/A	N/A	N/A
Year 2009	0.060	0.520	N/A	N/A	N/A
Year 2010	0.060	0.520	N/A	N/A	N/A
Tear 2011	0.060	0.520	N/A	N/A	N/A
Year 2012	0.060	0.520	N/A	N/A	N/A

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Notes: a – Does not include emissions above 3,000 feet above ground level.

b – Expected inventory based on 1994 California State Implementation Plan and California Air Resources Board (CARB) 2000 estimated average annual emission.

Table 4-2 (Continued)

Conformity Applicability for Total Emissions Sources

Associated with Alternatives A and B (emissions in tons per year)

Table 4-2, Page 3 of 3

Notes: (Continued)

c –Inventory for 2005 based on CARB 2005 Almanac Data (Cal/EPA 2005).

d- Percentage of inventory is based on the lowest value for Kern County Air Pollution Control District (Mojave Desert Air Basin portion) and Antelope Valley Air Quality Management District.

CO – carbon monoxide

LDV – light duty vehicle

LTO – landing and takeoff

N/A – not applicable

NA – not available

NO_2 – nitrogen dioxide

PM_{10} – particulate matter 10 microns or less in diameter

SO_x – sulfur oxides

TGO – touch and go

VOC – volatile organic compound

The area that would be affected by the emissions shown in Table 4-2 is the immediate area around Edwards AFB, situated in the MDAB portion of Kern County. Table 4-2 indicates that the ozone precursor emissions (NO_2 and VOCs) and PM_{10} emissions would be less than the *de minimis* thresholds of 100 tons per year for a serious ozone maintenance area and 70 tons per year for a serious PM_{10} nonattainment area such as the current MDAB portion of Kern County (40 CFR Part 93 Subpart 153[b][2]) for all areas. In addition, the emissions of ozone precursors and PM_{10} would not exceed 10 percent of the total Kern County inventories (40 CFR Part 93 Subpart 153[i]).

There are no local concerns for carbon monoxide within the ROI for the proposed project. Emissions from the proposed project would not result in any carbon monoxide hot spots since traffic congestion and carbon monoxide nonattainment in the ROI are not local issues.

Based on the conformity applicability screening analysis, the proposed project would conform to the most recent U.S. EPA-approved SIP, and no further detailed conformity analysis would be required.

4.2 AIRSPACE

The airspace used for Alternative A and Alternative B would be identical.

4.2.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

Since the airspace above Edwards AFB is part of restricted area R-2515, analysis of airspace impacts to both areas would be the same.

4.2.1.1 Flight Test Activities

There would be no additional impact to any airspace by flight operations during HPM test missions under Alternative A. Under Alternative C, the No-Action Alternative, restricted area R-2515 is activated for military use by the AFFTC as described in Section 3.2 and is not available for any other use. Aircraft operations under Alternative A would remain within restricted area R-2515 and would occur during the normal operating periods of Alternative C. Ground targets used under Alternative A would all be on the land area of Edwards AFB which would be within restricted area R-2515. Thus there would be no additional impact to availability of the airspace for general use.

A limited number of civilian aircraft are allowed to operate in restricted area R-2515 as described in Section 3.2.2. These aircraft include both those that only travel through restricted area R-2515 and those that fly in and out of the Boron and Borax airfields. While their access in and through restricted area R-2515 would likely be limited during HPM missions for safety reasons, the slight increase in non-availability due to the small number of HPM missions would not be significant.

4.2.1.2 Ground Test Activities

There would be no additional impact to any airspace by ground operations during HPM test missions under Alternative A. The G/G HPM tests would occur on Edwards AFB. Ground tests involving radiating the HPM systems could require establishing a temporary CFA. This CFA would be activated by a NOTAM, and pertinent information would be placed on the Edwards Automated Terminal Information Service. However the CFA would be totally within a portion of restricted area R-2515 and would be in effect during normal operating periods of restricted area R-2515. Thus there would be no additional impact to availability of the airspace for general use.

4.2.1.3 Mitigation Measures for Alternative A

Since there would be no impacts to airspace from Alternative A, no mitigations would be required.

4.2.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Under Alternative B, surrogate HPM systems would be operated at a low power setting, below maximum established SAR levels (See Section 3.12.6). The use of airspace would be the same as under Alternative A. Since there were no impacts on airspace identified under Alternative A there would also be no impacts on airspace under Alternative B, and no mitigations would be required.

4.2.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Use of restricted area R-2515 by the AFFTC would continue as it has as described in Section 3.2 with no change. Consequently, there would be no impacts on airspace, and no mitigation would be required.

4.3 CULTURAL RESOURCES

4.3.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

4.3.1.1 Cultural Resources—Restricted Area R-2515

Cultural resources (prehistoric, historic, Native American and areas of critical environmental concern) exist within the R-2515 area (see Figure 3-4).

Flight and ground test activities by HPM system aircraft operating in restricted area R-2515 would be similar to current flight activities. Aircraft would take off from Edwards AFB, conduct flight operations in restricted area R-2515, and return to land at Edwards AFB. While HPM beam radiating activities during these flight tests would originate from outside of Edwards AFB airspace or over Edwards AFB, all radiated energy would be focused on ground targets on Edwards AFB and airborne targets inside the airspace above Edwards AFB (inside restricted area R-2515).

The primary impacts from testing HPM systems would be related to thermal effects and effects on electronic components. Thermal effects are realized when water molecules are heated by the RF energy (like heating food in a microwave oven). The effects on electronic components result from electric and magnetic fields coupling with circuits which produce damaging current and voltage surges (Burrell 2003). Cultural artifacts are generally devoid of water content and are not electronic components. Therefore, the potential to impact any cultural artifacts would not be anticipated.

The spiritual connection between the Native Americans tribes and Black Mountain is of concern to the Air Force. Native American participation in traditional rites and use of Black Mountain for ceremonies are not currently affected by Air Force activities because visits to these areas for traditional purposes are conducted when the range is not being used for aircraft training and test missions. As such, current range flight tests have a less than significant impact on traditional cultural properties and Native American access to established areas for religious and traditional purposes. While no direct impacts on cultural resources in the R-2515 area would be anticipated, the Air Force would ensure that RF energy from these HPM systems would not be directed over the Black Mountain area.

4.3.1.2 R-2515 Area Mitigation Measures

Any new proposed target areas will be investigated by 95 ABW/CEV to verify that cultural artifacts are not present prior to designating them as approved target areas. Test plans involving ground targets at Edwards AFB will be designed so that target impacts occur at one of the designated target sites on the PIRA or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Recovery of the target from designated target sites will be done in a way that minimizes ground disturbance and potential impacts on undiscovered cultural artifacts or sites on-base. Range personnel will use existing roads, whenever possible, to recover and transport targets for analysis. To ensure there is no impact to cultural resources in the R-2515 area, flight tests will be developed to ensure HPM RF energy avoids areas of critical environmental concern as shown in Figure 3-4.

4.3.1.3 Cultural Resources—Edwards AFB Area

Flight and ground testing (A/A, A/G, G/A, and G/G modes) targets for HPM systems would be primarily located at one of the pre-existing target sites on the PIRA. These existing sites were selected because cultural artifacts are not located nearby. Test plans involving airborne targets over Edwards AFB would be designed so that target impacts would occur at one of the designated target sites on the PIRA or at a controlled impact area on Edwards AFB that has been verified not to contain cultural artifacts. Project personnel would use existing roads when traveling to observe and collect targets from designated target sites, thus minimizing ground disturbance and potential impacts on undiscovered cultural artifacts or sites.

The northern portion of Rogers Dry Lake, a National Historic Landmark, is a significant cultural resource on Edwards AFB. The continued use of the landmark in assessing leading-edge technology enhances its role in the history of technological advances in aviation and aerospace. This asset has been used to support flight and ground test missions for over 50 years. Range personnel would use existing roads, whenever possible, to recover and transport targets for analysis. Therefore, there would be no adverse effects on this landmark or other known cultural resources. Since these tests would not occur in close proximity to any known cultural resources, no significant impacts would be anticipated.

4.3.1.4 Edwards AFB Area Mitigation Measures

Any new proposed target areas will be investigated by 95 ABW/CEV to verify that cultural artifacts are not present prior to designating them as approved target areas. Test plans involving ground targets at Edwards AFB will be designed so that target impacts occur at one of the designated target sites on the PIRA or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Recovery of the target from designated target sites will be done in a way that minimizes ground disturbance and potential impacts on undiscovered cultural artifacts or sites on-base. Range personnel will use existing roads, whenever possible, to recover and transport targets for analysis. To ensure there is no impact to cultural resources in the Edwards AFB area, flight tests will be developed to prevent HPM RF energy from being directed in areas of critical environmental concern as shown in Figure 3-4.

4.3.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Under Alternative B, surrogate HPM systems would be operated at a low power setting, below established SAR thresholds and equipment immunity levels. Since the RF energy radiated by the surrogate HPM system would result in energy levels at any potential target or unsuspecting receptor that are less than SAR levels for humans and immunity levels for electronic equipment, no new impacts associated with radiating the RF energy would be expected to occur. The potential effects to cultural resources would result from personnel and vehicles traveling to designated targets.

4.3.2.1 Mitigation Measures

Since the target areas for flight and ground tests identified under Alternative B would be identical to those identified under Alternative A, the same mitigation measures would be required. Any new proposed target areas will be investigated by 95 ABW/CEV to verify that cultural artifacts are not present prior to designating them as approved target areas. Test plans involving ground targets at Edwards AFB will be designed so that target impacts occur at one of the designated target sites on the PIRA or an impact area on Edwards AFB that has been verified not to contain cultural artifacts. Recovery of targets from designated target sites will be done in a way that minimizes ground disturbance and potential impacts on undiscovered cultural artifacts or sites. Range personnel will use existing roads, whenever possible, to recover and transport targets for analysis.

4.3.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on cultural resources, and no mitigation would be required.

4.4 ENVIRONMENTAL JUSTICE

The RF energy generated by these HPM systems would not be radiated toward schools or areas inhabited by minority or low-income populations. Neither the source of the RF energy nor the target areas would be situated in close proximity to minority populations. As such, the conclusion that conducting integration and developmental testing of HPM systems at Edwards AFB would have no significant environmental effects is reasonable to assume. No new development would be required, and current Air Force and contractor personnel at Edwards AFB would be used for the program. Thus, there would be no disproportionately high or adverse environmental health or safety impacts on minority or low-income populations.

Similarly, the potential to generate disproportionately high environmental health and safety risks (including noise impacts) to children, which must be addressed as required by EO 13045, would be less than significant; therefore, no mitigation would be required.

4.5 GEOLOGY AND SOILS

No adverse significant impacts on soils or geology would occur from the proposed HPM integration and developmental testing. Any potential ground-disturbing activities (e.g., trenching, grading, off-road vehicle traffic) for Alternatives A and B for the construction or establishment of targets would be performed at existing target areas.

The primary impact of HPM testing on soils and geology would be associated with increased temperature in soils containing water. The RF energy from the HPM system could heat the water molecules in the soil, resulting in an elevated temperature. In extreme cases (not anticipated) this could cause the soil to solidify or lose compaction properties. Once the RF energy was removed, the temperature of the soil would return to its previous level. Since the RF energy pulses from the HPM testing would last for less than 10 seconds (usually from 1 to 5 seconds) this condition would be extremely temporary, and no significant impacts would be anticipated.

During missions such as the Airborne Electronic Attack, where a munition containing up to 500 pounds of NEW would be used, the munition would be detonated above ground level at target PB-13. The height of detonation (one of the factors used to determine the radius of the RF energy effect) would be determined by the test plan. The use of this target and effect on geology and soils are addressed in the *Environmental Assessment for Armed Munition Integration and Testing on the Precision Impact Range Area.* Analysis in that EA identified that no significant impacts on geology and soils would occur at PB-13 as a result of this type of detonation and test.

The use of Edwards AFB for HPM testing would not increase the likelihood of, or result in exposure to an earthquake event, slope failure, foundation instability, land subsidence, or other severe geologic hazards. The proposed testing would not result in the loss of soil used for habitat, loss of aesthetic value from a unique landform, loss of mineral resources, or severe erosion, or sedimentary processes. Potential soil contamination from targets being radiated by RF energy would not be anticipated.

4.5.1.1 Mitigation Measures

All earthwork will be planned and conducted to minimize the duration that soils area left unprotected. The extent of the area of disturbance necessary to accomplish the project will be minimized. Ground-disturbance activities will be delayed during high wind conditions (in excess of 25 knots [29 miles per hour]). Vehicular traffic, grading, and digging will not be permitted in the project area during high wind conditions. Use of vehicles off-road will be kept to a minimum. Whenever possible, the Air Force will use existing roads to establish target areas.

The target area will be cleared of any debris and before any additional HPM testing is conducted in a particular target area. Therefore, no significant impacts on soil contamination and fate and transport would be anticipated.

4.5.2 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on geology and soils, and no mitigation would be required.

4.6 HAZARDOUS MATERIALS /HAZARDOUS WASTE

4.6.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

The use of hazardous materials and any hazardous and solid wastes resulting from implementing the Proposed Action or Alternative B would be limited to occurrences on Edwards AFB (except for air emissions, which are addressed in Section 4.1). All normal project related setup, maintenance, launch, recovery, targeting, and cleanup activities would occur at Edwards AFB.

4.6.1.1 Flight Test Activities

Hazardous materials associated with aircraft involved in flight tests would include jet fuel and other petroleum, oils, and lubricants (POLs) required to support the HPM integration and developmental testing at Edwards AFB. Management of the POLs is governed by Air Force instructions. When the HPM system equipped aircraft and target aircraft are on the runway or flightline, hazardous materials and hazardous waste would be managed under the requirements of the AFFTC *Hazardous Waste Management Plan,* 32-7042. If a spill occurred, the hazardous waste would be cleaned up in accordance with the AFFTC SPR Plan 32-4002, *AFFTC Oil and Hazardous Substance Spill Prevention and Response Plan*.

The hazardous materials required for HPM system integration and developmental test at Edwards AFB are identified in Table 4-3.

Table 4-3

HPM System Hazardous Chemical

Hazardous Chemical	Quantity	Consumable Rate
Transformer oil	800 gallons	800 gallons/year
Sulfur hexafluoride	14,400 cubic feet	300 cubic feet/test
Hydrogen gas	300 cubic feet	300 cubic feet/year

Source: Montoya 2005

Plans for managing the onboard hazardous materials and waste would be identified by the system program office of the HPM system equipped aircraft. Sections 301–304 of the *Emergency Planning and Community Right-to-Know Act* (EPCRA) require the community to be informed of the storage and use of certain chemical and chemical compounds. Edwards AFB complies with these EPCRA requirements. Copies of material safety data sheets for all chemicals must be maintained. A Tier II report (EPCRA

Section 312) is required for jet fuel. Depending on the quantity of a chemical used, an annual summary of toxic release inventory (TRI) chemicals (EPCRA Section 313) (submitted on a Form R) may also be required. Based on the quantities of chemicals proposed, the threshold requirements (10,000 [chemical otherwise used] or 25,000 pounds [chemical manufactured/processed]) for submitting a TRI report is not required.

Chemicals used for these HPM systems are maintained in a closed loop system. Chemicals are replaced according to maintenance schedules established by the manufacturer. These maintenance activities occur on the ground, where a catch basin is used to prevent the spill of any of these hazardous chemicals.

4.6.1.2 Ground Test Activities

Hazardous materials such as jet fuel and other POLs would be required to support the integration and developmental testing of various kinds of HPM systems for ground test at Edwards AFB. Management of the POLs is governed by Air Force instructions. When the HPM-equipped aircraft are on the flightline, hazardous materials and hazardous waste would be managed under the requirements of the AFFTC *Hazardous Waste Management Plan,* 32-7042. If a spill occurred, the hazardous waste would be cleaned up in accordance with the AFFTC SPR Plan 32-4002, *AFFTC Oil and Hazardous Substance Spill Prevention and Response Plan*.

Under normal conditions there would be no adverse, significant impacts on hazardous waste or hazardous materials resulting from HPM test events. The hazardous contaminants likely to be released from the use of HPM systems would be similar to those released by other aircraft, ground equipment, or systems being tested at Edwards AFB. Since these test events would, in all likelihood, replace programs being completed at this test and evaluation base, the quantity of hazardous materials/waste and solid waste created by the HPM test and evaluation program would essentially be similar to the quantities of hazardous materials/waste and solid waste from other similar programs (i.e., flight related program replacing a flight related program). Thus, it is unlikely that significant quantities of the hazardous materials or waste compounds beyond those already being released would be released to the environment. These quantities would be within the capacity of Edwards AFB to manage.

Additional materials, such as shrapnel and other debris (solid waste) resulting from AEA missions, would be removed from the target area (PB-13) as part of regularly scheduled cleanup activities (AFFTC 1996). These pieces of debris would be recycled through the Defense Reutilization and Marketing Office

(DRMO) or sent to the landfill for disposal and would not be considered a significant impact to solid waste management activities.

4.6.1.3 Mitigation Measures

Since no significant hazardous materials/hazardous waste or solid waste impacts would be anticipated under Alternative A, no specific mitigation measures would be required. Flight and ground test activities associated with HPM systems would comply with existing hazardous material/waste and solid waste guidelines.

4.6.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Under Alternative B, surrogate HPM systems would be operated at a power setting below maximum established SAR levels; however, the hazardous materials used and hazardous waste created would be the same as under Alternative A.

Since no significant hazardous materials/hazardous waste or solid waste impacts would be anticipated under Alternative B, no mitigation would be required. Flight and ground test activities associated with HPM systems would comply with existing hazardous material/waste and solid waste guidelines.

4.6.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on hazardous materials, hazardous waste, or solid waste, and no mitigation would be required.

4.7 INFRASTRUCTURE

4.7.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

As noted in Section 3.7, the infrastructure in the R-2515 area includes energy systems (solar power generators and power lines), water distribution systems, wastewater/storm water distribution systems, communication systems, and transportation systems. Electronic components would be affected if the HPM systems directed RF energy coupled with of any of these systems at levels above the immunity level. The potential effects are not dependent on whether the tests are flight or ground related activities, but are dependent on the induced current density of the RF energy when it reaches components in the system.

Electromagnetic interference occurs when time-varying alternating current magnetic fields couple with any conductive object, including wires, electronic equipment and people, thereby circulating currents and voltages. In unshielded (susceptible) electronic equipment (computer monitors, video projectors, computers, televisions, local area networks, diagnostic instruments, magnetic media, etc.) and signal cables (audio, video, telephone, and data) electromagnetic induction generates electromagnetic interference, which may be manifested as visible screen jitter/color shifts in displays and noise, popping sounds, blanking/sync distortions, and data errors in signal cables.

Air Traffic Control facilities located on Edwards AFB could be affected by radiated energy from HPM system flight test activities. The effects of RF energy on ATC could result from RF coupling into various sensitive communication, navigational, and radar control systems. Coupling to sensitive electronics could occur directly via antennas and receivers (front door) or indirectly through apertures, seams, and unintentional antennas (back door). The impacts would range from loss of communications and navigational assistance with aircraft to disabling or destroying the electronic components for aircraft controlling facilities.

Generally, the threshold level for electromagnetic interference caused by the HPM system for unshielded electronic equipment and cables is 200 V/m E_{field}. The immunity to electromagnetic interference depends on the component layout, circuit design, outer case composition, geometry, and shielding factor (Vitale 1997). Other sources identify the threshold for interference at 100 V/m E_{field} (Mardiguian 2002). Table 4-4 shows the radiated power requirement and resulting electric field intensities for various distances assuming that:

$$E = 5.5 \sqrt{(PA)}/D$$

Where: E is the electric field in V/m;

P is the transmitter power in watts;

A is the antenna gain (assumed to be 1); and

D is the distance from the antenna in the near to far field and $D > \lambda/2\Pi$ (See Section 4.12 for a discussion on far field and near field).

Based on the data in Table 4-4, if the HPM RF transmitter radiated at 10 megawatts (MW) or less and was at least 1 kilometer from any unshielded electronic equipment, the level of electromagnetic interference would be less than 200 V/m E_{field}, and should not impact those devices. One kilometer is equivalent to approximately 0.5399 nautical mile, or approximately 3,280 feet. This distance is similar to the distance identified in Section 4.2 which provides a minimum safe distance for avoiding airports and airfields. The susceptibility of different types of single microcontrollers and complex microcontroller (computer components) against UWB and electromagnetic pulse (EMP) was evaluated by Camp *et al.* (n.d.). Their analysis showed that the field density needed to cause these systems to fail ranged from 4 to 12 kV/m for the UWB pulse to about 30 kV/m for a fast EMP. The difference would be dependent on rise time for the pulse and what components were on the boards being tested. Since operating any HPM systems at greater than 1 MW and closer than 1 kilometer to unshielded electronic components could deny, degrade, or disrupt equipment, or permanently render it unusable, mitigation measures would be implemented as discussed in Section 4.7.4.

Table 4-4

Electric Field Intensity and Various Distances and Radiated Power

	Distance					
	1 m	10 m	100 m	1 km	10 km	100 km
Power	**Electric Field Intensity**					
1 W	5.5 V/m	0.55 V/m	55 mV/m	5.5 mV/m	0.55 mV/m	0.055 mV/m
10 W	17.4 V/m	1.7 V/m	170 mV/m	17 mV/m	1.7 mV/m	0.17 mV/m
100 W	55 V/m	5.5 V/m	550 mV/m	55 mV/m	5.5 mV/m	0.55 mV/m
1 kW	174 V/m	17 V/m	1.7 V/m	170 mV/m	17 mV/m	1.7 mV/m
10 kW	550 V/m	55 V/m	5.5 V/m	550 mV/m	55 mV/m	5.5 mV/m
100 kW	1.74 kV/m	174 V/m	17 V/m	1.7 V/m	170 mV/m	17.0 mV/m
1 MW	5.5 kV/m	550 V/m	55 V/m	5.5 V/m	550 mV/m	55.0 mV/m
10 MW	17.4 kV/m	1.74 kV/m	174 V/m	17.4 V/m	1.74 V/m	0.174 V/m

Notes: km – kilometers (1,000 meters), kV – kilovolts (1,000 volts) m- meters, V – volts.

Source: EMIGuru 2005

4.7.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Under Alternative B, surrogate HPM systems would be operated at power setting below maximum established SAR levels and immunity levels for electronic equipment outside the HPM system platform. Since RF energy would not be radiated at levels beyond the threshold values for flight or ground activities, no impacts would be anticipated for infrastructure resulting from implementing Alternative B.

Therefore, no mitigation measures would be required for Alternative B.

4.7.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on infrastructure, and no mitigation would be required.

4.7.4 Mitigation Measures

To minimize potential HPM RF hazards, multiple controls will be used to reduce the potential for impacts on unsuspecting receptors. These controls would include shielding, distance, barriers and backdrops, and administrative controls.

Shielding. Shielding is an example of control at the source. Shielding works by absorbing the energy of the radiation. Shielding of microwave radiation and radiofrequency radiation is usually accomplished by enclosing the source, or less often the receptor, in an electrically conducted and grounded structure. Using this type of structure would be effective in absorbing and reflecting radiation for microwave and much of the radiofrequency portion of the spectrum (Morgan 1988). Because these HPM systems do not operate within the near- and far-infrared wavelengths of the electromagnetic spectrum, they are invisible to the unaided eye. Natural backdrops will be used to provide a vertical boundary from the main lobe of the HPM RF energy. Backdrops will minimize the amount of reflection leaving the range.

Distance, Horizontal, Vertical, and Longitudinal Buffer Zones. Distance is a form of control along the path from the source to the unsuspecting receptor. The intensity of the radiation decreases with the square of the distance. This means that doubling the distance between the source and the receptor reduces the intensity by one quarter, and increasing the distance by 10 times reduces the intensity by a factor of 100. Distance can be used as a control in a variety of ways. Dead space can be built into devices, so they occupy more space than is required. Barriers can be constructed around some devices, effectively keeping RF energy from the electronic components. Horizontal, vertical, and longitudinal buffer zones will be established for HPM testing activities. Buffer zones provide a margin of safety regarding accidental beam shifting or unanticipated beam divergence. Buffer zones are determined for each HPM system based on frequency and power density. The buffer distances for each test will be calculated to confirm that the HPM radiated energy is below threshold levels for unsuspecting receptors. The distances identified in Table 4-4 will be used as a guide for determining the buffer distances.

Administrative Control. Access to the range and target areas during HPM ground test activities will be restricted to authorized and properly trained personnel, thus reducing the possibility for ocular and skin exposure to HPM RF radiation. Prior to outdoor test activities, the range and target area will be physically checked to clear any unauthorized personnel from the area. Signs will be posted to identify the test area and the potential hazard to personnel. Each HPM system and test scenario will have specific procedures (approved by the AFFTC/CC and 412 TW/CC) to ensure operational safeguards and safety precautions are in place. Safety interlocks associated with the HPM system will be in place to stop the radiating activity if the beam exits the anticipated beam path. Frequency management will be coordinated with the Frequency Spectrum Manager at Edwards AFB to ensure adverse impacts on ATC, communications, and other critical electronic systems are minimized.

Prior to each HPM system test event, the Range Safety Office will be required to complete a Directed Energy RF Energy Assessment Model.

4.8 LAND USE AND VISUAL/AESTHETIC RESOURCES

4.8.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative and Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Implementation of Alternatives A or B would have no significant impacts on land use. Mitigation measures for land use and visual/aesthetic resources would not be required. The proposed testing would not conflict with approved land use plans, environmental plans or goals or other test programs conducted in the R-2515 or Edwards AFB areas. Use of controlled areas and existing targets on the PIRA would not create significant adverse land use impacts. Edwards AFB is a designated major test range base, and as such a facility, the land use designations are established for testing of current and future technologies.

Any potential site would be evaluated by Environmental Management, Bioenvironmental Engineering, the Range Control Office, and the Range Safety Office; however, the testing of aircraft-mounted or ground-based HPM systems that radiate RF energy toward targets on any of the Edwards AFB Management Areas would require approval by the AFFTC/CC. Part of the evaluation process would include calculating the surface danger zone for each HPM system test activity, the power density of the radiated RF energy at the target, and the MPE for the safety of personnel for a controlled and uncontrolled exposure. The calculations would be critical in allowing the HPM systems to be tested on any of the pre-designated A/G and G/A targets on Edwards AFB due to land use constraints based on biological resources.

Visual and aesthetic resources would not be significantly affected by implementing Alternatives A or B. Aircraft flights within restricted area R-2515 and over Edwards AFB are common daily occurrences. Considering that only one flight test and one ground test would occur per month under this program, the potential for impacts would be less than significant. The RF energy created would not be visible to humans because the wavelength would not be in the visible range (see Figure 2-1). The detonation of the HPM bomb during an AEA mission would only occur at PB-13, a site designated for the detonation of munitions with up to 500 pounds of NEW.

4.8.2 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on land use and visual/aesthetic resources, and no mitigation would be required.

4.9 NATURAL RESOURCES

4.9.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

Airborne targets for HPM system testing in the A/A and G/A modes would not be situated over any wilderness areas and special management areas including ACECs found within the R-2515 area. Therefore, no effects or significant impacts on these areas and their associated natural resources would be expected. Consequently, only the potential impacts on natural resources at Edwards AFB will be discussed below.

4.9.1.1 Plants

Many plant species, including plant species not protected under the ESA, are discussed here because they are considered "sensitive" by federal, state, or other agencies/organizations. Some of these species are former candidates for federal and state listing, meaning substantial research has been previously conducted and they are subjects of ongoing study and monitoring. Section 3.9.1.3 summarizes these plant species and a detailed analysis can be found in the INRMP (Edwards AFB 2004). Ground-disturbing activities have the potential to impact ground-dwelling plant communities as well as sensitive plant species. These impacts may be direct—physically killing individuals—or indirect—disturbing habitat or otherwise creating conditions which are adverse to species success. The RF energy from the HPM systems would not be radiated at plants or plant communities outside of the target areas on Edwards AFB;

therefore, no effects to plants or plant communities outside the Edwards AFB area would be anticipated. Because there would be no effects or impacts on plants or plant communities outside the Edwards AFB area; no mitigation would be required for test and evaluation of HPM systems in the other parts of restricted area R-2515 where the test platforms would be flying.

Plant Communities

Effects on plant communities from flight and ground activities associated with implementing the proposed action would be primarily associated with ground disturbing activities such as trenching, grading, off-road vehicle traffic, and target maintenance. The total area potentially impacted would be less than 100 acres for all target areas. Project activities would occur at one of the five established target areas or at controlled areas or new targets where 95 ABW/CEV Environmental Management Division biologists have determined that significant impacts to any of the five major plant communities are not likely to occur. Each of the target areas is less than 5 acres, and new target areas would be limited to 5 acres each where target boards, vehicles, or other types of targets would be positioned for test and evaluation events.

A series of dirt roads leading to the target areas, as shown on Figure 3-11, are graded and remain devoid of vegetation. Joshua Tree Woodlands and Creosote Bush Scrub plant communities dominate the land features around the target areas, which are also routinely graded and generally clear of these species. During test activities, reflections coming in contact with the plants would probably result in the destruction of part or all of an individual plant or small group of plants. If all the plants in the target area were radiated and subsequently eradicated, less than two-thousandths of the total Joshua Tree Woodlands plant community and less than one-thousandth of the Creosote Bush Scrub plant community on Edwards AFB would be impacted. Therefore, the impacts on these plant communities would be less than significant.

The proposed project would not require the removal of vegetation other than removal authorized at the proposed target areas, firing point, and access roads.

Other direct effects on plant communities at Edwards AFB would result from thermal heating of the water molecules in the plants which would be similar to heating that occurs in a microwave oven. Microwave ovens have been used by gardeners to sterilize soil and reduce the growth of unwanted plants. Typically, 1 minute of heating in a 1,000 watt microwave oven is required to sterilize the soil in a filled 2-inch square pot (Scutellaria Group Web Site 2005). This same principle would occur in the area around the target area if the energy was sufficient; however, because the microwave pulses would last less than 10 seconds, any significant effects are not anticipated. If these effects occurred, they would be limited to the plants in the target areas on Edwards AFB, where plant life has been previously disturbed. The highest power levels for the HPM system would be radiated from the main beam (see Figure 4-6 in Section 4.12). The side lobes of the beam radiated from the HPM system would be lower in power (up to 99 percent less power), thus the potential for impacts on plant communities and species outside the target area would be reduced.

Sensitive Plant Species

The alkali mariposa lily and desert cymopterus have been documented to occur within the PIRA. During species surveys for desert cymopterus at Edwards AFB, plant communities of this sensitive plant species have not been found on previously graded target areas; however, since surveys were not conducted during wet years, the presence of these species cannot be completely ruled out. Based on experience from past surveys, 10 inches of rainfall would be necessary to eliminate all changes on this species from occurring in the target areas. While these sensitive plant species are known to be in the PIRA they are not known to be at the target areas. Mitigation measures to ensure these sensitive plant species are not affected are addressed below.

4.9.1.2 Wildlife

No anticipated impacts from air emissions or noise on wildlife from the proposed HPM testing are expected to occur within the R-2515 or Edwards AFB areas.

Impacts from ground activities associated with implementing the Proposed Action would be primarily associated with ground disturbing activities such as trenching, grading, off-road vehicle traffic, and target construction/maintenance. The total area potentially impacted would be less than 100 acres. Project activities would occur at one of the proposed target areas or at controlled areas or new targets where 95 ABW/CEV Environmental Management Division wildlife biologists have determined that significant impacts to any of the species as identified in Section 3.9.2.1 are not likely to occur. Each of the target areas is less than 5 acres, and new target areas would be limited to 5 acres each where target boards, vehicles, or other types of targets would be positioned for test and evaluation events. As noted above, a series of dirt roads leading to the target areas would be graded and remain clear of vegetation and habitat for wildlife species.

Species of shrimp found in the Rogers Dry Lake area lie dormant in the dry soil (AFFTC 1992). During the rainy season when flooding creates the aquatic habitat necessary for them to complete their life cycles, testing would not occur on the lakebeds. Currently no target area or firing point is located on the Rogers Dry Lake. When new target areas or firing points are identified, 95 ABW/CEV wildlife biologists will evaluate the site to ensure the selection would not have a significant impact on the shrimp. Since these species are not found at the designated target areas, the potential for being lased or impacted would be unlikely.

Amphibians like the western toad, Pacific tree frog, red spotted toad, and African clawed frog typically found at Piute Ponds are more than 10 nautical mile from the target areas, which is outside the radiation hazard area; thus it is unlikely these species would be affected by laser test and evaluation events.

Common reptiles like the desert spiny lizard, side blotched lizard, western whiptail, and zebra-tailed lizard, are highly mobile. The glossy snake, coachwhip, gopher snake, and Mojave green rattlesnake may be around the target areas and individuals may be radiated, but due to the short duration of each HPM test event and the mobility of these species, the probability that more than one individual of the species would be affected would be low.

Individual members of the various wildlife species found on the PIRA could be affected by the HPM beam if they were in the path of the beam. Depending on their exact location at the time of HPM testing wildlife could be injured or killed. To minimize the potential impacts to wildlife, mitigation measures addressed in Section 4.9.4 would be implemented.

Migratory Birds

During flight tests (A/A, A/G, and G/A) project personnel may encounter migratory birds and shall comply with all measures in the *Migratory Bird Treaty Act* (MBTA). The United States Government is exempt from the MBTA permit requirements, but must minimize take caused by their activities. During nesting season base biologists would survey the target sites for raptor nests. If a nest was found on the target it would need to be moved prior to any planned test event. Edwards AFB has a depredation permit which allows a nest to be moved; thus minimizing impacts on the nest that could occur during HPM tests at the target sites.

The Air Force considers BASH a safety concern for aircraft operations. The BASH hazards are managed to reduce the probability of a bird/aircraft impact. Most birds typically fly at altitudes below 2,500 feet

AGL. Vultures sometimes rise over 10,000 feet (Stanford Alumni 2005). Long-distance migratory bird species start out at about 5,000 feet and climb to around 20,000 feet. Since most test aircraft would be operating above 3,000 feet AGL, except for 5 percent of planned tests and during aircraft takeoff and landing, the potential for impacts on test aircraft and birds would be the same as for other testing and evaluation aircraft missions. Methods used at Edwards AFB to control the bird air strike problem include the use of horned larks and use of a falconer, selective revegetation around the runway with native plants, and pilot notifications when there is a high concentration of birds in the immediate area. Therefore, the likelihood of a BASH incident is considered low.

While there may be occasional bird collisions with test aircraft, primarily during low-altitude HPM test events, there would be no significant impacts on bird species or other wildlife during HPM flight test activities. Aircraft would be flown to avoid migratory bird corridors during periods of seasonal migrations and in accordance with established flight procedures. There would be no HPM testing conducted over or from areas of critical concern as shown in Figure 3-13.

Sensitive Wildlife Species

Ground-disturbing activities such as establishing and maintaining firing points and target areas have the potential to impact desert tortoises as well as other ground-dwelling species like the Mohave ground squirrel. These impacts may be direct—physically injuring or killing individuals—or indirect—disturbing habitat or otherwise creating conditions which are adverse to species success.

Desert Tortoise and Mohave Ground Squirrel

Environmental Management coordinates the desert tortoise management program with 412 Test Wing/Range (412 TW/ENROR) to ensure compatibility with range requirements. Edwards AFB consults with the USFWS and coordinates with the BLM, California Department of Fish and Game, California State Parks, National Park Service, USGS, and others via the Desert Manager's Group in managing protected species and habitats. In addition, Edwards AFB collaborates with the National Resource Conservation Service, The Nature Conservancy, U.S. Army Corps of Engineers, and others on specific projects. Desert tortoises may be active during all seasons with very little time spent above ground during winter. Mohave ground squirrels are not active during most of the year and spend about 8 months underground. Range activities would include ground disturbing activities like the construction of targets, checking targets, and maintenance of the target areas and roads and the radiating the HPM RF energy at the targets. Mitigation measures will be included to minimize the potential impacts. Most active areas of the PIRA have a low density of desert tortoises (Figure 3-14). The most recent studies at Edwards AFB show that the tortoise populations for approximately 80 percent of the Base are estimated to be below 20 tortoises per square mile (AFFTC 2002a) and based on transects summarized in the *Range-wide Monitoring of the Desert Tortoise:2001-2005* populations of the desert tortoise in the Western Mojave were estimated to range from 7.81 tortoises per square kilometer in 2001 to 5.4 in 2004 (CDFG 2005).

Prior to conducting HPM test activities, visual inspection of the target area would be accomplished, or tortoise fences would be installed around the target area to verify that natural resources, particularly the desert tortoise, are not located there. If the tortoise fences are installed, the newly enclosed area would be inspected to ensure that tortoises are not located within the 5 acre target area. Compliance with the INRMP would minimize any potential impact, as would adhering to established testing procedures and the suggested mitigation measures as outlined in this EA. Edwards AFB is developing a basewide biological assessment as a primary objective in support of the USFWS Section 7 consultation process. Management of threatened and endangered species at Edwards AFB is based on compliance with measures contained in the ESA, Sikes Act, and various terms and conditions of the various biological opinions issued by the USFWS, including undertaking measures necessary to minimize incidental take of desert tortoises.

Desert tortoises appear to be unaffected by noise even up to levels over 100 dBA (U.S. Army 2004b).

The state-listed threatened Mohave ground squirrel is found on Edwards AFB in desert scrub habitat. Active management of desert tortoises affords some protection for the Mohave ground squirrel. Known populations of the Mohave ground squirrel as shown in Figure 3-15 are located within 2 miles of the target areas at Mt. Mesa, Grinnel, and the existing target board south of Downfall. Although the Mohave ground squirrel has been found in the area it has not been seen at the target areas (Edwards AFB 2004). Since the Mohave ground squirrel remains underground for 8 months during the year, and the known populations are not located at the target areas, it could reasonably be concluded that the potential for impact due to the effects of the HPM radiating beam would be minimal for two-thirds of the year. Because the vegetation and habitat at the target areas and firing points would be removed, the likelihood that an individual or group of Mohave ground squirrels would be within the target area during the HPM test, would also be expected to be extremely rare; therefore, impacts on the Mohave ground squirrel resulting from the actual firing of the HPM system would be less than significant. Aircraft noise and equipment noise may be sufficient to cause a startle response from the Mohave ground squirrel, but there is no evidence in the literature to suggest adverse impacts to this species or to small mammals in general.

There are no known HPM or high power RF energy studies on the desert tortoise or Mohave ground squirrel. Numerous other studies on the biological effects of radiofrequency energy on various animal species have been completed. These studies show that ocular effects including corneal lesions, retinal effects, and changes in vascular permeability have been observed after localized exposure of the eye of laboratory animals to both continuous wave and pulsed RF energy exposures, however, inconsistencies in these results are reasons why ocular effects are not useful in defining adverse effect level for RF exposure (Elder 2003). A long-term (1 to 4 years) investigation of monkeys exposed at high SARs (20 and 40 watts per kilogram to the monkey face) found no cataracts or other ocular effects or change in visual capability. Another study in which rats were exposed to a UWB pulse with a maximum E-field of 19-21 kilovolts per meter, with the pulse on for 2 seconds and off for 2 seconds for 2 minutes, resulted in no significant changes in heart rate or mean arterial blood flow. These results suggest that acute whole-body exposure to UWB pulses does not have a detrimental effect on the cardiovascular system (Jauchem *et al.* 1999). Effects on wildlife at Edwards AFB would result from thermal heating of the water molecules in tissue which would be similar to heating that occurs in a microwave oven. Because of the wavelength of the microwave pulse, the energy would penetrate just below the skin surface and heat the body. The change in body temperature of animals in the desert area may not result in an impact on these species if they can regulate their body temperature. (Adair and Black 2003) Wildlife such as the desert tortoise and Mohave ground squirrel spend most of their time in burrows, further reducing their chances of being affected by the RF energy.

Potential impacts on wildlife species would be minimized by implementing control techniques to monitor the width of the HPM, conducting sweeps of the firing points and target areas on Edwards AFB, and other controls to ensure the HPM system is focused on the intended target. Impacts on wildlife may be direct—physically injuring or killing individuals—or indirect—disturbing habitat or otherwise creating conditions, which are adverse to species success. During HPM testing activities, the HPM could potentially affect animal habitat if habitats are within the beam path. Other effects would include HPM beam scatter from beams traveling beyond the target and into animal habitat areas. An HPM pulse would last only about 10 seconds in duration and would have short-term impacts on biological resources.

Contaminants likely to be released from the use of HPM systems would be similar to those released by other aircraft, ground equipment, or systems being tested at Edwards AFB. Additional materials, such as shrapnel and other debris resulting from test missions would be removed from the target area (PB-13) as part of regularly scheduled cleanup activities (AFFTC 1996).

Sensitive Habitats

Edwards AFB provides sensitive habitat for one permanent resident species listed under the ESA, the desert tortoise (Edwards AFB 2002a). As noted above, ground-disturbing activities have the potential to impact the sensitive habitats of desert tortoise as well as other ground dwelling species. Most sensitive habitats at Edwards AFB have compatible land uses that do not notably degrade these areas. Threats to natural sensitive habitats are greater from unauthorized off-road vehicle use, now managed in part by fencing and security police patrols (Edwards AFB 2004). Impacts may be direct—physically injuring or killing individuals—or indirect—disturbing habitat or otherwise creating conditions which are adverse to completion of a species life cycle. Vegetation provides cover, feed, and shade among other key factors necessary to the success of the species. Furthermore, vegetation removal is known to result in soil erosion and contribute to flooding through alteration of water courses. Such changes to natural movements of soil and water can result in impacts to ground-dwelling species; however the 5-acre areas for the proposed target areas would not be expected to pose a significant impact because the target areas would be small and mitigation measures would minimize any long-term effect.

During HPM test activities, the beam could potentially affect animal habitat if habitats are within the beam. HPM test activities would occur for short durations and would have short-term impacts on these habitats.

The Proposed Action would not require the removal of vegetation except as authorized for road grading and road maintenance or in the immediate area of the established firing points and target areas. If required, construction activities associated with erecting new target boards would include digging holes for support poles and assembling the target boards at the target areas; however most of the target boards and data collection arrays would be mobile so they could be used at the various target areas depending on test plan requirements. Vehicles transiting to a target area or firing point would use established roads and procedures for operating in these sensitive habitat areas. This would result in a short-term impact to wildlife in the target area during the period of construction and an intermittent impact when the target area was checked following the HPM test event. Less than 5 acres at each target area and less than 100 total acres would be affected.

Designated Critical Habitat

The Proposed Action occurs within critical desert tortoise habitat. Within critical habitat, desert tortoise population relative densities are higher than those typically found in other areas on Edwards AFB. Therefore, the probability of encountering desert tortoises is comparatively higher in these areas. Project activities would also have the potential to negatively impact areas within critical habitat through temporary and/or permanent habitat disturbance. Approximately 1.0 percent of the critical habitat for the desert tortoise identified by the DWMA occurs on Edwards AFB. This critical habitat is located on the eastern and southeastern portion of Edwards AFB and includes portions of the AFRL and PIRA. Using these target areas would remove less than 0.0008 percent of the total designated critical habitat. Because so little habitat would be removed, these actions would not result in fragmentation of this resource even if the test sites were maintained for future use by other programs. In the *Biological Opinion for the California Desert Conservation Area Plan* (1-8-03-F-58), a 1-percent threshold for new ground disturbance for the 30-year life of the plan was established(BLM 2006). This would include any clearing, excavating, grading, or other manipulation of the terrain, whether or not a permanent use is proposed for the site. Allowable ground disturbance for the desert tortoise wildlife management areas is 13,000 acres. Therefore, disturbance of up to 100 acres total for this Proposed Action and Alternatives would equate to less than a 0.4 percent removal of allowable ground disturbance. This critical habitat consists of creosote bush scrub and Joshua tree woodland habitats, although other habitats, including xerophytic and halophytic saltbush and mesquite woodland, are also represented. Biological opinions applicable to the proposed laser testing program would include *Biological Opinion for Routine Operations and Facility Construction within the Cantonment Areas of Main and South Bases, Edwards Air Force Base, California (1-6-91-F-28)* (USFWS 1991) and *Biological Opinion for the Precision Impact Range Area, Edwards Air Force Base, California (1-8-94-F-6)* (USFWS 1994a). These biological opinions would apply to DE tests conducted at target areas PB-1, 8, 9, 10, 11, and 12. Mitigation measures derived from these Biological Opinions that will be implemented to minimize impacts on designated critical habitat are addressed in Section 4.9.4. Additionally, a basewide biological assessment is being developed to support the Section 7 consultation process with the USFWS.

Desert Tortoise Management Zones

The greatest potential for impact on the desert tortoise resulting from project activities is likely to occur when project personnel and vehicles are driving on the dirt roads to the target sites. Zone 3 Desert Tortoise Management Area encompasses 30,360 acres on the PIRA. Three potential HPM target sites, Mt. Mesa, Haystack Butte, and Mt. Grinnel, are within a designated desert tortoise critical habitat, Zone 3 Desert Tortoise Management Area (see Figures 3-13 and 3-14). Removal of 15 acres (3 sites at 5 acres each) would result in less than 0.049 percent reduction in critical habitat in Zone 3. Under the Biological Opinion (USFWS 1994a), individual projects are limited to 5 acres with a maximum total disturbance of 100 acres including the area of access roads. Individual target areas for the Proposed Action would be limited to 5 acres with a maximum total disturbance of 100 acres. To minimize potential impacts, targeting boards and targets would be transported along existing roads. Targets and transport vehicles would be positioned on existing roads to minimize further risk of ground disturbance. Avoidance of siting targets in Zone 3 would be considered to the maximum extent feasible. Because vegetation at the target areas would be removed, tortoises would not normally be expected to be present on the firing point or target area, but could occasionally transit through the area. Desert tortoises mate in the late spring and the early summer (usually April to July). The tortoises are most active in California during the spring and early summer when annual plants are most common and can be active throughout the year and also just prior to and after winter rainfalls. Desert tortoises spend the remainder of the year in burrows, escaping extreme desert conditions. Tortoise population densities were found to be low to very low throughout Edwards AFB and approximately 80 percent of the base has densities at or below 20 tortoises per 1 square mile (Edwards AFB 2004).

Sensitive Ecological Areas

Laser test events would not occur in or over the two sensitive ecological areas on Edwards AFB.

4.9.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Under Alternative B, surrogate HPM systems would be operated at power setting below maximum established SAR and immunity levels. Since RF energy would not be radiated at levels beyond the threshold values during flight or ground test activities, no impacts on natural resources would be anticipated from the radiating of the HPM beam. However, since vehicles would travel to target areas and firing points, opportunities to affect the sensitive wildlife species on Edwards AFB cannot be ruled out. Therefore, the mitigation measures for minimizing the potential impacts on the desert tortoise and Mohave ground squirrel as addressed in Section 4.9.4 would be adhered to by all project personnel.

4.9.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on natural resources, and no mitigation would be required.

4.9.4 Mitigation Measures

Base personnel and contractors will adhere to the standard basewide mitigation measures as described in the INRMP (Edwards AFB 2004). A biological assessment for these and other testing programs is currently in development by the 95 ABW/CEV Environmental Management Division and expected to be completed in 2006. This assessment will be submitted to the USFWS as part of a formal Section 7 consultation process. The assessment would recommend that biological surveys be conducted prior to establishing HPM firing points and target areas on the PIRA or other management areas to determine if the desert tortoise would be located in the projects' target area. Prior to initiating a HPM test on targets within one of the selected sites or other areas on the PIRA, the monitoring procedures outlined in Appendix E would be implemented.

Desert tortoises found within the project area will be removed from target areas and firing points and placed in outdoor desert tortoise pens located in a natural environment for up to 7 consecutive days. Tortoise pens will be limited to one tortoise per pen. If tortoise fences are installed around the target areas and firing points, then this removal from the target areas and firing points would be permanent. This Removal Action constitutes a short-term effect to the tortoises and will be reported to the USFWS. Relocating the tortoises out of harm's way will reduce the potential for disruption of their natural routine but may have long-term negative effects on local populations.

The following are examples of mitigation measures that will be applied, as appropriate, for G/G, A/G, and G/A HPM test activities to protect the desert tortoises.

(1) All workers and visitors to work sites will receive a desert tortoise and Mohave ground squirrel awareness briefing that defines their responsibilities and liabilities under the ESA. Project personnel should notify 95 ABW/CEV, Environmental Management Division, at least 3 days prior to starting project activities to schedule briefings, pre-surveys, and monitoring.

(2) If a desert tortoise burrow is encountered within the target area, the burrow will be avoided to the maximum extent practicable. If avoidance is not possible, an authorized AFFTC biologist will excavate the burrow according to the USFWS *Guidelines for Handling Desert Tortoises During Construction Projects*.

(3) Desert tortoises found aboveground within the project area will be temporarily moved out of harm's way by an authorized biologist according to the USFWS *Guidelines for Handling Desert Tortoises During Construction Projects*.

(4) During construction activities areas will be clearly fenced, marked, and flagged at the outer boundaries to define the limits of work activities. All workers will be instructed to confine their activities to the marked areas.

(5) Laydown, parking, and staging areas will be restricted to previously disturbed areas to the maximum extent practicable.

(6) Vehicles will, to the maximum extent practicable, remain on established roads. If this is not possible in the project area, an authorized biologist will survey the route to be traveled. Equipment and vehicle operators will be alert for desert tortoises and other wildlife in and along access routes. All desert tortoise burrows will be avoided during off-road travel. When traveling off-road, speed limits will not exceed 5 miles per hour and shrubs will be avoided as much as possible.

(7) At no time will project personnel or site visitors harass, harm, or kill any desert tortoise. Project personnel or site visitors will not touch or move any desert tortoise unless the tortoise is in danger of being killed or injured; and then only if they have been properly instructed and trained how to properly handle and move the desert tortoise and if a Base biologist cannot be located. Workers and visitors will immediately report all desert tortoise sightings to 95 ABW/CEV, Environmental Management Division.

(8) Workers and site visitors will check under parked vehicles for desert tortoises and other wildlife species before moving vehicles. If a desert tortoise is found under a vehicle, the 95 ABW/CEV, Environmental Management Division, will be notified immediately so an authorized biologist can move the desert tortoise to a safe area.

(9) All trash will be placed in raven-proof receptacles for proper disposal to reduce its attractiveness to desert tortoise predators (e.g., coyotes and common ravens).

(10) If any wildlife is trapped in excavations at work sites, the 95 ABW/CEV, Environmental Management Division, will be notified immediately. Excavations will be inspected for trapped wildlife before they are backfilled. All open excavations will have a ramp with a 3:1 slope at each end to facilitate escape of trapped wildlife. Excavations left overnight will be secured prior to leaving the site. Exclusionary fencing or plywood may be used to prevent wildlife from becoming trapped in excavations.

(11) Target designs will be reviewed in accordance with the Air Force EIAP process on a case-by-case basis to minimize where possible, perches or other parts of the target that may support nesting by ravens or other bird species. Stationary target boards will be inspected for active bird nests prior to HPM test activities.

(12) Contact the 95 ABW/CEV, Environmental Management Division, at 661-275-2435 or 277-2017 if an active bird nest is found within the project area.

(13) The total allowable cumulative habitat disturbance for project activities located in Desert Tortoise Management Area Zone 3 is 100 acres. Siting targets and conducting projects within Zone 3 will be avoided to the maximum extent feasible.

High power microwave targeting activities would be performed at target areas approved by 95 ABW/CC, 412 TW/CC, or the OG/CC.

4.10 NOISE

Noise impact criteria are based on land use compatibility guidelines and on factors related to the duration and magnitude of noise level changes. Annoyance effects are the primary consideration for most noise impact assessments. Because the reaction to noise level changes involves both physiological and psychological factors, the magnitude of a noise level change can be as important as the resulting overall noise level. The local residents would often consider a readily noticeable increase in noise levels a significant effect, even if the overall noise level was still within land use compatibility guidelines. On the other hand, noise level increases that are unnoticed by most people are not considered a significant change, even if the overall noise level is somewhat above land use compatibility guidelines. Some potentially significant thresholds include the following:

- An L_{DN} of 65 dBA, or a CDNL of 61 dBC for sonic booms, is the generally accepted limit for outdoor noise levels in residential areas for land use planning and long-term annoyance factors (U.S. Army 2001). Project-related noise levels 5 dB or more above 65 dBA or above 61 dBC would be considered a significant impact.

- Frequent occurrence of a CSEL greater than the generally accepted limit for outdoor noise levels of 61 dBC.

- Weapons-related dB (peak) sound levels above 130 dBP pose a high risk of noise complaints with the possibility of damage to windows, bric-a-brac, and plaster.

4.10.1 Community Response to the Exposure to Aircraft-Generated Noise

Noise is “adverse” in the degree to which it interferes with activities such as speech, sleep, listening to radio and television, and the degree to which human health may be impaired (e.g., hearing loss). Adverse effects remain fairly low in the DNL 55 to 64 dB range and increase rapidly above the 65 dB level. Noise can have both physiological and psychological impacts. Long-term (i.e., 40 years), continuous exposure to DNL 70 dB or greater, can induce hearing damage. This would be typical in an industrial setting where noise levels are continuous throughout the day. However, average noise levels due to aircraft operations do not fit this profile as they are more transient in nature. The real impact from the transient nature of aircraft-generated noise is psychological and is characterized as annoyance.

Agencies such as the Air Force, U.S. EPA, and HUD have considered the potential impacts of noise (i.e., subsonic and supersonic) on various activities and physical structures. A summary of those potential impacts is presented in the following sections for aircraft-generated noise in special use airspace and around airfields, and the potential physical and physiological impacts of sonic booms. These potential impacts form the basis for noise assessments in this document.

Tables 4-5 and 4-6 show the potential impact and community response to aircraft-generated noise in the vicinity of an Air Force installation and in lands underlying SUA (such as MOAs and Restricted Areas) or along low-altitude, high speed training routes. Although sonic booms are routinely heard throughout restricted area R-2515, no sonic booms are expected to be created by implementing Alternatives A or B.

Table 4-5

Criteria for Assessing Subsonic Operations

in Special Use Airspace or Along Low-Altitude High Speed Training Routes

(Onset Rate Adjusted Monthly Day-Night Average A-Weighted Sound Level [Ldnmr])

Noise Level	Potential Consequences
Ldnmr < 55 dB	Level recommended by the EPA as the maximum outdoor level to avoid any interference with outdoor activities. Less than 4% of population expected to be Highly Annoyed
Ldnmr ≥ 55 but < 65 dB	Four to 14% of population expected to be Highly Annoyed
Ldnmr ≥ 65 dB	Over 14% of population expected to be Highly Annoyed

Table 4-6

Criteria for Assessing Subsonic Operations

in the Vicinity of Air Force Installations (Day-Night Average A-Weighted Sound Level [DNL])

Noise Level	Potential Consequences
DNL (CNEL) < 60 dB	Less than 7% of the population expected to be Highly Annoyed. Average community reaction none to slight. Noise considered no more important than various other factors of the community. (U.S. Air Force 1984; U.S. EPA 1982)
DNL (CNEL) ≥ 60 and < 65 dB	Seven to 12% of population expected to be Highly Annoyed. Average community reaction expected to be slight to moderate. Noise may be considered an adverse impact of the community environment. (U.S. Air Force 1984; U.S. EPA 1982)
DNL (CNEL) ≥ 60 and < 65 dB	No special insulation is required for residence, classrooms, libraries, churches, hospitals, or nursing homes. (U.S. Air Force 1978) Noise exposure may be of some concern, but common building construction practices make the indoor environment acceptable and the outdoor environment will be reasonably pleasant for recreation and play. (HUD 1985)
DNL (CNEL) ≥ 65 dB	Greater than 12% of population expected to be Highly Annoyed. Average community reaction expected to be significant to severe (DNL ≥ 70 dB). Noise is considered an important aspect of the community environment. (U.S. Air Force 1984; U.S. EPA 1982)
DNL (CNEL) ≥ 75 dB	Average community reaction is expected to be very severe. Noise is likely to be the most important of all adverse aspects of the community environment. Very significant disturbance of normal voice or relaxed conversation would be likely outdoors. Hearing loss may begin to occur in sensitive individuals depending on actual noise levels received at the ear. (U.S. Air Force 1984; U.S. EPA 1982)

4.10.2 Noise Impacts Created by the HPM Beam

Experts have acknowledged that the emission of microwave pulses at low frequencies and regular intervals can cause the perception of hearing sounds like buzzing, clicking, hissing, or knocking behind the head. In some people this causes rapid heart beating or higher blood pressure. This effect has been observed and measured only at the frequency range of 216 MHz to 10 GHz. No reliable data are available for higher frequencies. A. Frey, a renowned expert, revealed these data to the public and also measured the phenomenon in 1962. He further stated that at the frequency of 95 GHz (the frequency for the ADS system) this phenomenon could not occur. Hearing this noise would be considered a biological effect without a health effect, and therefore, is not an adverse effect (Elder and Chou 2003).

4.10.3 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

4.10.3.1 Noise—Restricted Area R-2515

Flight Test Activities

High power microwave flight test aircraft would launch from Edwards AFB. Aircraft such as the C-17, C-130, C-135, or X-45/X-47, one target aircraft like the Proteus or X-45/X-47, or a tethered target balloon would be used. After launch, these aircraft would climb to minimum safe altitude as prescribed in the test and safety plan prior to beginning any HPM test activities. Sound exposure levels and L_{max} for proposed aircraft would be similar to those levels shown in Table 4-7.

Up to 180 flights would occur annually (128 flights by HPM-equipped aircraft and up to 52 flights by target aircraft). The *Supplemental Environmental Impact Statement for the Airborne Laser Program* states that for 255 test flights the DNL noise exposure at Edwards AFB would increase by 0.8 dBA and the DNL over the range would be less than 55 dBA (Air Force Center for Environmental Excellence 2003). Considering there could be 180 flights per year under this Proposed Action, and the fact that noise from these flights would not increase the noise contours at Edwards AFB or the range, no noise impacts would be anticipated for flight test activities. Airspeed for test and target aircraft would be expected to be subsonic; therefore sonic booms would not occur as a result of the Proposed Action or Alternatives.

Table 4-7

Summaries of Sound Levels for Proposed HPM System/Target Aircraft

	Altitude Above Ground Level[a]					
	Takeoff Power		Cruise Power		Approach Power	
	100 feet		2,000 feet		5,000 feet	
	SEL	L_{max}	SEL	L_{max}	SEL	L_{max}
Aircraft	dBA					
C-17[b]	64.3	53.4	67.6	58.1	70.9	57.9
C-130[b]	55.2	43.7	69.9	59.0	68.0	56.6
C-135[b]	65.6	56.1	66.8	61.8	71.2	62.2
Proteus	N/A	N/A	N/A	N/A	N/A	<85[c]
UAV[d]	N/A	96.0	N/A	66.9	N/A	54.0
X-45/X-47	N/A	N/A	N/A	N/A	N/A	<85[c]

Notes: a-Slant range to receptor is 6,000 feet.
c-Estimated
dBA- A-weighted decibel
N/A – not available

Sources: b- U.S. Air Force 2005b
d- U.S. Army 2003; U.S. Army 2004a

Ground Test Activities

Noise generated during ground testing events would result from activities such as vehicles transporting personnel to test facilities, construction of target boards, building earthen berms and enclosures, operating AGE and GSE, moving HPM platforms (self-propelled), and the noise from the radiation of HPM RF energy. Noise levels from ground power units (GPUs) like the Cummins QSB5.9 or Deutz Diesel GPU used to create the power for the HPM system are approximately 75 dBA at 10 feet from the unit (Houchin Aerospace 2005).

Vehicle noise levels associated with the movement of the HMMWV-mounted HPM system would conform to the Interstate Motor Carrier Noise Emission Standards. The drive-by exterior sound levels comply with the MIL-STD-1474B of 80 dBA. The noise for a fully loaded HMMWV traveling at 25 miles per hour is estimated to be less than 85 dBA (U.S. Army 2004a) at the crew position. It is well known and reported that the dominant factor in road noise is the interaction between tires and the road surface (for automobiles). The resulting noise level is exacerbated with higher vehicle speeds. Studies have shown there is a quantifiable relationship between vehicle running speed and sound pressure level which results in numerical relationships proportional to 12*Log(V) and 33*Log(V) for vehicle speeds less than 60 kilometers per hour and greater than 60 kilometers per hour, respectively (V = vehicle speed in km/h). For instance, a passenger car traveling at 60 kilometers per hour (~38 miles per hour) creates a sound pressure level of 95 dBA, while the same vehicle traveling at 80 kilometers per hour (~55 miles per hour) creates a sound pressure level of 100 dBA. Similar relationships have been developed for light and heavy trucks. All relationships noted above were based on the combined effects of engine noise and tire/road noise contributions (Colorado Department of Transportation 2004). Typical A-weighted noise levels for traffic on highways range from 60 dBA to 90 dBA (U.S. Department of Transportation 1980).

Since these noise levels would be less than or equal to the noise levels currently generated at Edwards AFB and the PIRA, no significant impacts would be anticipated as a result of implementing Alternative A.

Mitigation Measures

Hearing protection will be required for personnel in the immediate vicinity of the AGE, GSE, GPUs, and other noise sources as noted above. The types of hearing protection will be prescribed by test plans, standard operating procedures, and maintenance manuals for the equipment used during the ground test activities.

4.10.3.2 Noise—Edwards AFB Area

Flight Test Activities

After launch, test aircraft and target aircraft would climb to a minimum safe altitude as prescribed in the test and safety plan prior to beginning any HPM test activities. Test aircraft would operate above 3,000 feet AGL around airports and airfields except during the takeoff and landing phases of the flight tests. Sound levels created by test and target aircraft would be similar to current sound levels, as shown in Figure 3-17. No flight test related noise impacts would be anticipated for the Edwards AFB area.

Ground Test Activities

Ground test activities in the Edwards AFB area would be the same as described for restricted area R-2515, Section 4.10.3.1, Ground Test Activities. Potential mitigation measures are described below.

Mitigation Measures

Hearing protection will be required for personnel in the immediate vicinity of the AGE, GSE, GPUs, and other noise sources as noted above. The types of hearing protection will be prescribed by test plans, standard operating procedures, and maintenance manuals for the equipment used during the flight and ground test activities.

4.10.4 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

4.10.4.1 Flight and Ground Related Activities

Under Alternative B, surrogate HPM systems would be operated at a power setting below maximum established SAR and immunity levels. The same number of A/A and A/G flight tests would occur under Alternative B. Sound levels created by test and target aircraft would be similar to current sound levels, as shown in Figure 3-17. Sound levels created by ground equipment and test platforms would be consistent with sound levels produced by other equipment currently in use on the PIRA. No significant flight test or ground related noise impacts would be anticipated for the Edwards AFB area.

4.10.4.2 Mitigation Measures

Hearing protection will be required for personnel in the immediate vicinity of the AGE, GSE, GPUs, and other noise sources as noted above. The types of hearing protection will be prescribed by test plans, standard operating procedures, and maintenance manuals for the equipment used during the flight and ground test activities.

4.10.5 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on noise, and no mitigation would be required.

4.10.6 Noise Impacts on Wildlife

No significant noise impacts on wildlife would be expected for flight or ground test and evaluation events occurring on Edwards AFB or anywhere within restricted area R-2515. (Refer to Section 4.9 for a description of potential noise impacts on wildlife).

4.11 PUBLIC/EMERGENCY SERVICES

These services would be impacted if public and emergency services personnel were unable to perform their function because RF energy for these tests would affect equipment or personnel.

4.11.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

Potential impacts on public and emergency services for flight and ground activities would be similar to the impacts identified in Section 4.7, Infrastructure. Public and emergency services would be affected if the RF energy interfered with use of their electronic equipment or if personnel were radiated by the RF energy from the HPM system being tested.

4.11.1.1 Flight Test Activities

During flight test activities, HPM RF energy would be radiated at specific targets located at sites identified in the test plan. As discussed earlier, RF energy levels would be determined and test plans would be developed to prevent the RF energy from exceeding the immunity levels for equipment located at the public/emergency services locations identified in Section 3.11. The distances from the HPM system to the public/emergency services would be calculated and targeting solutions established to prevent impacts on these services.

4.11.1.2 Ground Test Activities

During ground test activities, HPM RF energy would be radiated at specific targets located at sites identified in the test plan. The RF energy levels would be pre-determined and test plans would be developed to prevent the RF energy from exceeding the immunity levels for equipment located at the public/emergency services locations as discussed in Section 3.11. The distances from the HPM system to the public/emergency services would be calculated and targeting solutions would be established to prevent impacts on these services.

4.11.1.3 Mitigation Measures

The RF energy levels will be pre-determined and test plans will be developed to prevent the RF energy from exceeding SAR levels and the immunity levels for equipment located at the public/emergency services locations as discussed in Section 3.11. The distances from the HPM system to the public/emergency services will be calculated and targeting solutions established to prevent impacts on these services or the unsuspecting personnel associated with these activities.

4.11.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Under Alternative B, surrogate HPM systems would be operated at power setting below maximum established SAR and immunity levels. Since RF energy would not be radiated at levels beyond the threshold values for flight or ground activities, no impacts would be anticipated for public/emergency services resulting from implementing Alternative B. Therefore, no mitigation measures would be required for Alternative B.

4.11.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on public/emergency services and no mitigation would be required.

4.12 SAFETY AND OCCUPATIONAL HEALTH

The AFFTC's Hazardous Communication Program and Institutional Safety and Occupational Health programs would be followed to reduce the potential for any risk to human health and safety from HPM system test activities. All HPM system test activities at Edwards AFB and within restricted area R-2515 must comply with Air Force Policy Directive 91-4, *Directed Energy Weapons Safety*, which implements DoD Instruction 6055.11, *Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers*. Air Force Occupational and Health Safety Standard 48-9, *Radio Frequency Radiation (RFR) Safety Program* provides the guidelines for managing RFR. HPM testing will not involve RF energy being intentionally directed at military or civilian personnel at Edwards AFB or within restricted area R-2515. Therefore, the safety and occupational health concerns discussed will focus on the potential impacts outside the target area, impacts that may be created by the HPM system and power source, and potential effects that may impact the personnel involved in the HPM tests.

4.12.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

4.12.1.1 Flight and Ground Test Activities

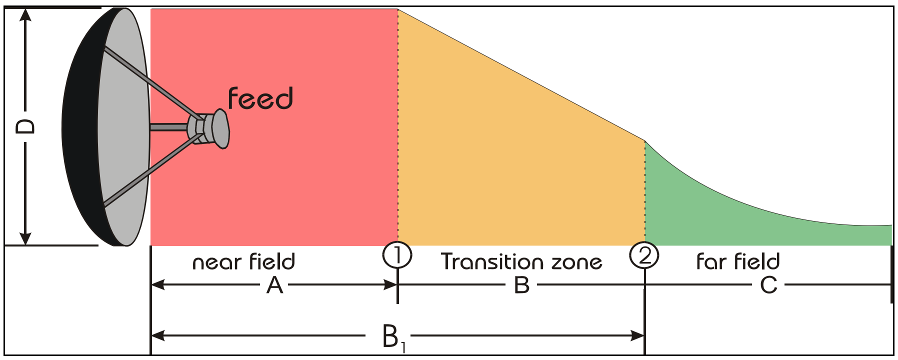
Primary concerns would include potential impacts that could impact aircrews, impacts on non-test personnel, and impacts on non-test aircraft. To understand these potential impacts, the effective range of the typical HPM system needs to be defined and how this RF energy is attenuated through the atmosphere needs to be identified.

Effective Range of a Microwave Antenna

A conventional microwave parabolic antenna has three radiation zones: near field zone (Rayleigh), transition zone (Fresnel), and far field zone (Fraunhofer). Figure 4-1 shows these three zones, which can be calculated as follows:

$$A = 0.25\ D^2/\lambda;\ B_1 = 0.6\ D^2/\lambda;\ \text{and}$$

Where: D is the diameter of the parabolic antenna in meters and λ is the wavelength in meters.



Source: Gregorac 2005

Figure 4-1

Conventional Microwave Parabolic Antenna and Radiation Zones

As an example, the effective ranges for these zones for parabolic antennas 1, 2, and 3 meters in diameter are shown in Table 4-8 where the frequency is 95 GHz (λ=3.16 millimeters). This is the frequency that would be associated with the ADS HPM system. The antenna for the ADS is a modified parabolic antenna, which improves performance over the conventional parabolic antenna shown in Figure 4-1. Electromagnetic radiation of microwave parabolic antennas is usually measured or calculated as power density, S (watts per square meter [W/m^2]), or electric field strength, E (volts per meter [V/m]) (current density).

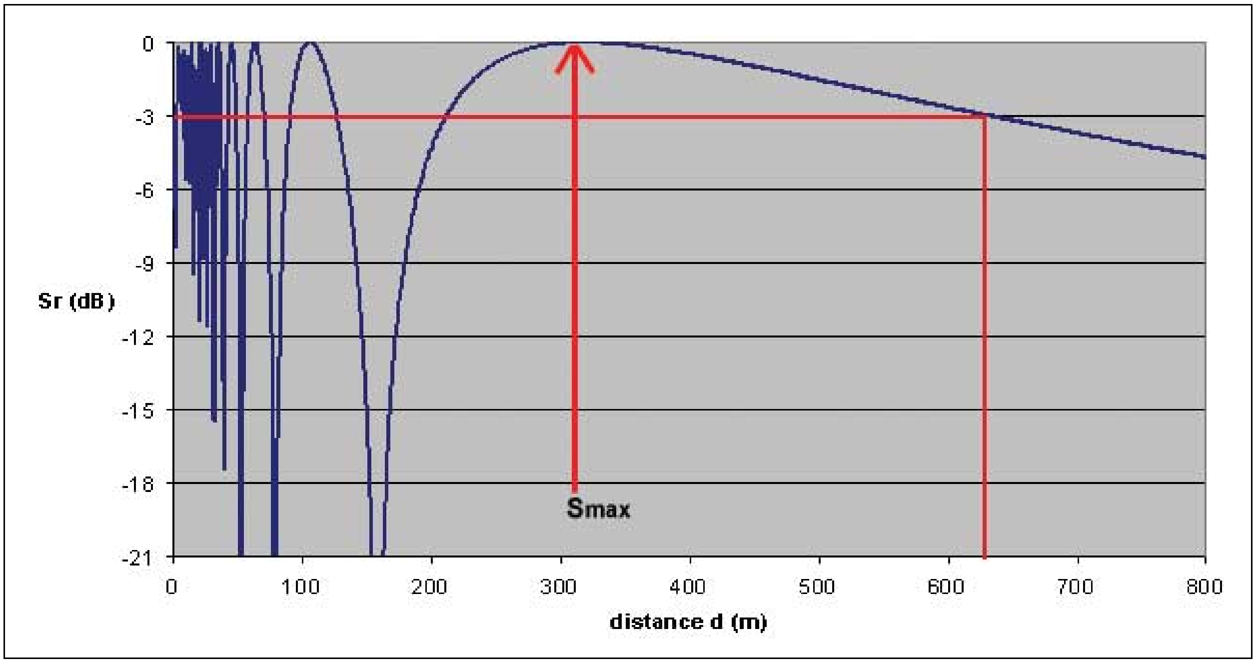
Table 4-8

Calculated Beam Width and Distances for Near Field and Transition Zone

Diameter of Antenna (meters)	Beam Width (degrees)	A (meters)	B_1 (meters)
1	0.22	79	190
2	0.11	317	760
3	0.07	712	1,709

Source: Gregorac 2005

In the near field zone the power density and the electric field strength (E) reach their maximum on the axis of the parabolic antenna. In the transition zone the power density is reduced linearly and in the far field zone the power density is reduced with the square of the distance. The distance where the power density is reduced from its maximum to half of the value (reduced by 3 dB) is called effective range. This is a generally accepted criterion for measuring electromagnetic radiation. The relative power density for a 100 kilowatt (kW), 2-meter parabolic antenna is shown in Figure 4-2.



Source: Gregorac 2005

Figure 4-2

Power Density for a 2-Meter Parabolic Antenna

The maximum power density (0 dB) for a 2 meter parabolic antenna similar to the ADS occurs at 317 meters and falls to half its value (-3 dB) at 640 meters.

The relative power can be calculated with using the following equation:

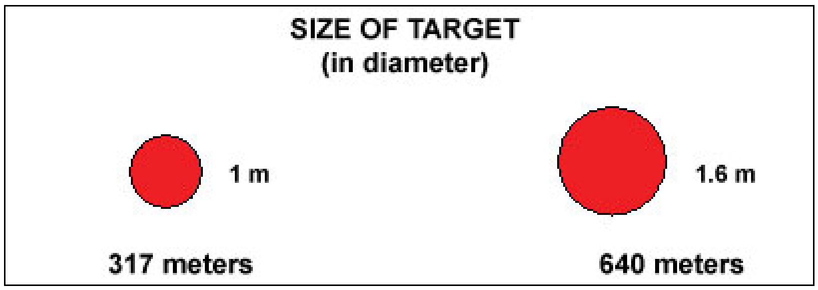
$$S_{max} = 16\ \eta\ P_{ef}/\Pi D^2$$

Where: η is the efficiency of the parabolic antenna,

P_{ef} is the average transmitter power, and

D is the diameter of the parabolic antenna.

The efficiency of a conventional parabolic antenna is approximately 50–60 percent. The spot size on the target at the maximum power density and at the edge of its effective range for a 100 kW transmitter is shown in Figure 4-3.



Source: Gregorac 2005

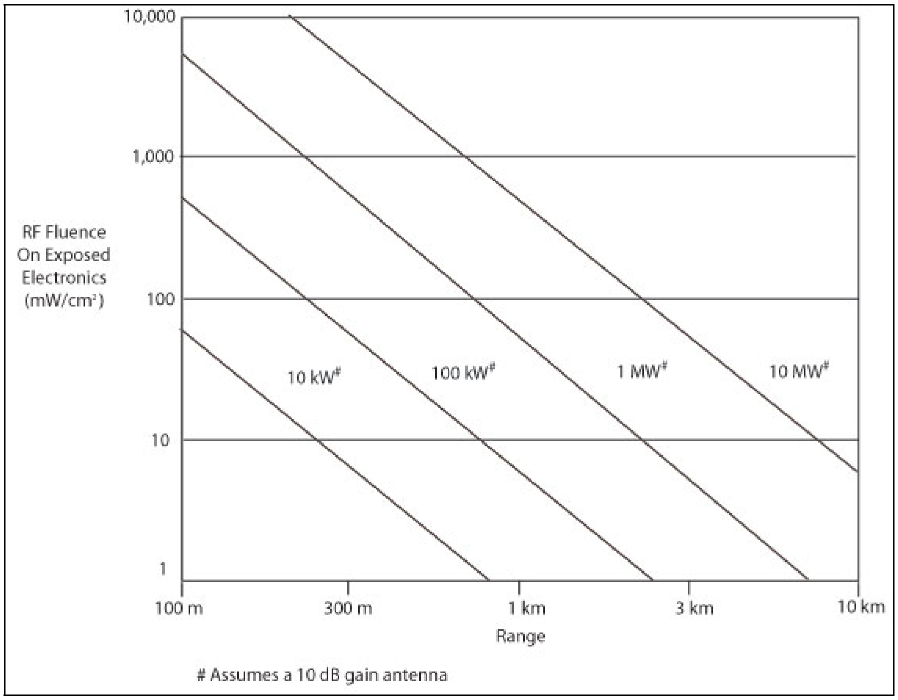
Figure 4-3

Beam Size for 2-Meter Parabolic Antenna

As the power density increases, the effective range would also increase. As an example, Figure 4-4 shows effective range versus power requirements and fluence on exposed electronics. The ADS HPM system operates at 95 GHz. This frequency supports the millimeter wave attenuation of electromagnetic waves through the atmosphere. Other potential frequencies include 34 GHz, 140 GHz, and 240 GHz, as shown in Figure 4-5.

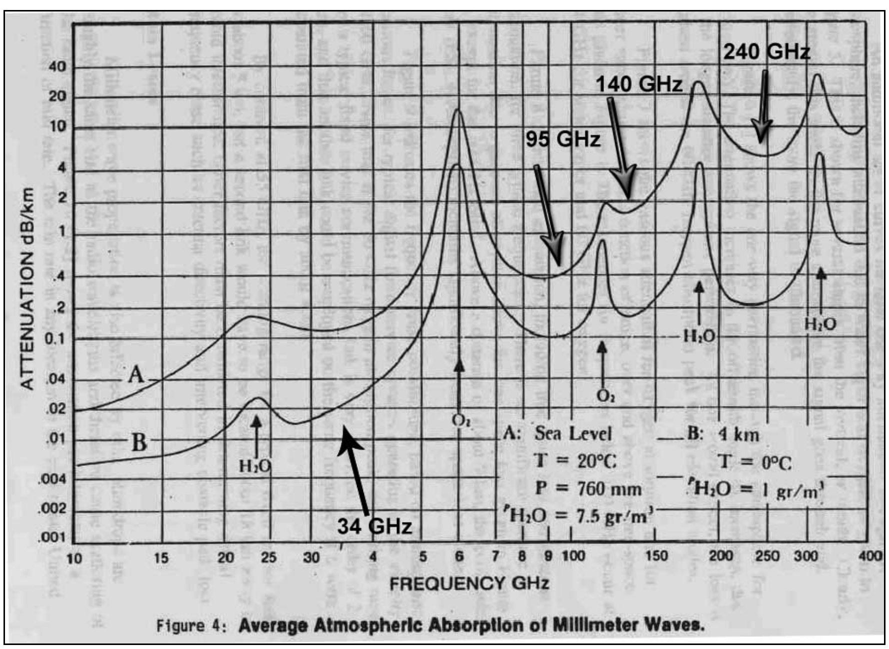
Typical Beam Pattern for Microwave Antennas

The typical beam pattern for a microwave antenna is shown in Figure 4-6. The maximum power density for the main beam is shown at the 0 dB circle. The smaller side beams are typically much lower in power density, but must be accounted for to ensure they do not impact the HPM system platform, ancillary equipment, or environmental resources. While this example shows the power density of this antenna



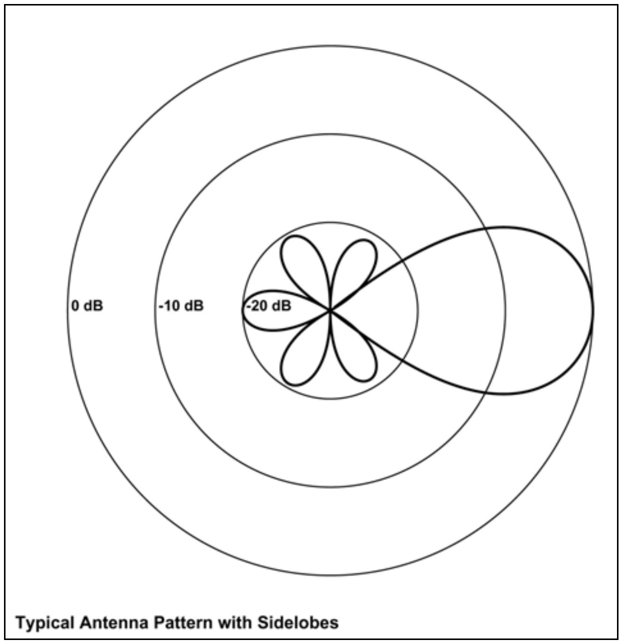
Source: Directed Energy Professional Society 2004

Figure 4-4 Example of Effective HPM Range versus Power



Source: Gregorac 2005

Figure 4-5 Atmospheric Attenuation of Millimeter Wave Frequencies



Source: Wade 1998

Figure 4-6 Typical Antenna Pattern for Microwave Antenna

beam pattern to be -20 dB down from the main lobes 0 dB, this value can vary depending on antenna design characteristics. The power density for RF energy that is -20 dB is equivalent to a 99 percent decrease in power from the main lobe. Table 4-9 shows the relationship between dB and power density.

Table 4-9

Decibels versus Power Density

Decibels	Power Density	Decibels	Power Density	Decibels	Power Density
10	10 times > D	1	1.25 times > D	-3	50 percent < D
6	4 times > D	0	D	-6	75 percent < D
3	2 times > D	-1	20 percent < D	-10	90 percent < D
2	1.6 times > D	-2	37 percent < D	-20	99 percent < D

Notes: < - less than; > - greater than; D – power density.
Source: Microwave 101 2005

For a comprehensive discussion on different types of antenna patterns refer to the *EW and Radar Systems Engineering Handbook* at https://ewhdbks.mugu.navy.mil/contents.htm.

Effects of Microwave Radiation on Humans

The effects of electromagnetic radiation on humans depend on the frequency, strength, and form of the signal. Strength and form are dependent on the transmitter power. The effect of microwave radiation may or may not result in an impact. Health effects have been observed in the resonance range from 30 MHz to 400 MHz (the frequency where the wavelength of the radiation is approximately equal to the length of the human body). At higher frequencies (400 MHz to 300 GHz) penetration of the body occurs. The depth of penetration depends upon the energy of the radiation and the type of tissue involved. Generally, it can be said that the longer the wavelength the greater the depth of penetration. Wavelengths of 3 centimeters or less (10 GHz or higher) are absorbed by the skin. Regardless of the frequency, the heating induced by RF energy produces normal physiological adjustments like sweating and vasodilation. If effective dissipation of heat is prevented by biological or environmental factors, the exposed tissue will be heated and possibly damaged. According to Patrick Mason at Brooks AFB in San Antonio, Texas, for systems like the ADS there are a few instances when humans would be exposed to relatively high levels of millimeter wave RF energy (i.e., 175 mW/cm^2); however it is clear that the skin blood flow response would provide adequate thermal protection, as it would efficiently remove heat from the skin before damage could occur (Microwave News 2004).

In general, exposure causes heating of the body tissue. In some cases, heating is not uniform and hot spots occur in various parts of the body. These effects can be described as thermal and non-thermal.

<u>Thermal Effects.</u> We are exposed to thermal effects from the sun on a daily basis. The maximum radiation power density of the sun has a usual value of 800 W/m^2. Using a magnifying glass, if the sunlight is reduced to an 8-millimeter focused beam, it causes a pain sensation in less than 1 second; in this case, using a 5-centimeter lens causes the radiated visible light to increase from 800 to 31,250 W/m^2. Tests conducted by the Department of Defense on a model human with a temperature of 34 degrees Celsius established that the model perceived variations in temperature for each 0.1 degree Celsius, which equates to a power density of 45 W/m^2. They determined that the pain threshold occurs at 10 degrees Celsius, which equates to the S_{min} = 12,500 W/m^2. Theoretically, to achieve the pain threshold at the edge of effective range of 640 meters for the ADS, the power density would need to be doubled to 25,000 W/m^2. Generally, a human subject would not know what power density would be required to withdraw without injury. However, tests showed that when the power density equals 25,000 W/m^2 only the pain threshold is reached. Assuming that this value would need to be doubled to cause severe pain, the power density S_{dmax} would be 50,000 W/m^2. In order for the ADS to reach this double threshold of pain at effective range for a 2-meter parabolic antenna with 95 percent efficiency, the transmitter would need to have 41,500 W of power. Consequently at the edge of the ADS effective range, double the power at the transmitter would be required (i.e., 83,000 W). However, when transferring RF energy from a transmitter to the antenna, approximately 20 percent of the power is lost. Considering this loss of power, a minimum of 100 kW would be required to effectively use the ADS at 640 meters from the platform.

Non-Thermal Effects. Human perception of pulses of RF energy is a well established phenomenon that is not necessarily considered an adverse effect. Radio-frequency induced sounds are similar to other common sounds such as a click, buzz, hiss, knock, or chirp. Furthermore, the phenomenon can be characterized as the perception of subtle sounds because, in general, a quiet environment is required for the sounds to be heard. To hear these sounds, an individual must be capable of hearing high-frequency acoustic waves in the kHz range and the exposure to a pulsed RF field must be in the MHz range. The effective radio frequencies that can be heard are reported in literature to range from 216 to 10,000 MHz. Hearing RF energy depends on a single pulse and not on average power density. Guy *et al.* (Guy and Chou 1975) found that the threshold for RF-induced hearing of pulsed 2,450 MHz radiation was related to an energy density of 40 microjoules per square centimeter per pulse, or energy absorption per pulse of 16 microjoules per gram. Audible sounds are produced by rapid thermal expansion, resulting from only a 5 X 10^{-6} degrees Centigrade temperature rise in tissue due to the absorption of the energy from an RF pulse. There is no evidence to suggest that direct stimulation of the central nervous system occurs from RF pulses. When compared to routine ultrasound pressures during medical diagnosis, including exposure of the fetus, research suggests that RF-induced pressures more than about five orders of magnitude greater than the pressure at the hearing threshold would be unlikely to cause significant biological effects (Elder and Chou2003).

Radio frequency energy has been shown to produce cataracts in experimental animals when the exposure is sufficient to raise the temperature of the lens to around 41 degrees Celsius. Localized exposure in rabbits, exposure for 1-hour to 2,450 MHz at 100 mW/cm^2, is sufficient to induce a cataract. However, these experiments would produce burns to the skin surrounding the eye before a cataract would form. Whole body exposures did not produce the same results as localized exposures to the eyes, because the animal would expire before the end of the experiment (U.S. Air Force 1997b).

Electronic medical devices such as artificial cardiac pacemakers can respond to pulsed RF radiation fields. Significant disruption of normal pacemaker function requires RF energy at frequencies between

0.1 and 5 GHz with pulse widths of greater than 10 microseconds, and electric field strengths greater than 200 V/m.

Non-Beam Effects. Fire, shock, RF burns, and electrocution are non-beam hazards that could be caused by using HPM power sources. People could experience electric shock or tissue burns when coming very near or in contact with metallic objects in the vicinity of HPM source that emits RF fields at frequencies below about 100 MHz. The primary factors that determine if someone would receive a shock or RF burn when they made contact with a conductive surface include:

- The strength of the electric field;
- The frequency;
- How well grounded they are; and
- How much of their body touches the conductive surface.

Specific absorption rates as described in Section 3.12 were established to limit potential effects of RF energy on humans. SAR defines heat absorbed into the body in units of watts per kilogram. Ultimately it was determined that much of this follows basic antenna theory. Conductivity is affected by the radio frequency and whether the subject is grounded. In the upright position the grounded adult body has a longitudinal resonance of around 35 MHz, whereas in the transverse and anterioposterior axes maximum absorption occurs at frequencies from 135 to 165 MHz. Ungrounded, the resonance is around 70 MHz. Generally, the higher the frequency the less able RF energy is to penetrate materials.

While these hazards are real, only qualified electricians and trained personnel would be working on these systems, thus limiting the possibility of shock or electrocution. Wiring and electrical support for ground test activities would be contained in the aircraft or other HPM ground platform. As such, electrical exposure to personnel other than those directly associated with the project should not create any significant impacts.

Bird/Wildlife Aircraft Strike Hazard

The Air Force considers BASH a safety concern for aircraft operations. Air Force Pamphlet 91-212 provides guidance on BASH management techniques (U.S. Air Force 2004). The BASH hazards are managed to reduce the probability of a bird/aircraft impact. Most birds typically fly at altitudes below

2,500 feet AGL. Since most HPM system test aircraft will be operating above 3,000 feet AGL except during takeoff and landing, the potential for impacts on test and target aircraft are the same as for other non-HPM aircraft missions. Methods that have been used at Edwards AFB to control the bird air strike problem include the use of horned larks and use of a falconer. As such the likelihood of a BASH incident is considered low.

Mitigation Measures

To minimize potential HPM RF hazards, multiple controls will be used to reduce the potential for impacts on unsuspecting receptors. These controls would include shielding, barriers and backdrops, distance, and time as described in Section 4.7.4.

4.12.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Under Alternative B, surrogate HPM systems would be operated at power setting below maximum established SAR and immunity levels. The same number of A/A and A/G flight tests would occur under Alternative B. Safety and occupational health impacts created by test and target aircraft would be similar to those identified for Alternative A. While the potential for coupling RF energy to electronics equipment and the shock and burn hazard to personnel would be reduced because the power density of the surrogate would not create these effects, mitigation measures would still be implemented as described in Section 4.12.1.

4.12.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on safety and occupation health and no mitigation would be required.

4.13 SOCIOECONOMICS

4.13.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative

Implementation of the HPM system flight and ground testing under Alternative A would not create significant impacts on socioeconomics in the R-2515 or Edwards AFB areas. No mitigation would be required.

Most project personnel would be provided by current Air Force and contractor personnel from other bases. The small increase in the number of project personnel would have a positive impact on economic conditions in the area. Because test and evaluation programs at Edwards AFB routinely change, the number of support personnel in the area remains somewhat constant. The on-base housing would be able to absorb increases in military personnel due to normal vacancies and the transitioning of other military personnel and programs to other locations. The vacancy rate for on-base housing remains at a stable 10 percent (McCullough 2003). The added civilian/contractor and military personnel would have a short-term positive impact on the local economy of the Antelope Valley for the duration of the test and evaluation program. An increase in on- and off-base revenues would be expected to occur as a result of money spent for program materials, housing, and daily services. These increases would be a boost to the local economy. No new significant development for HPM testing would be required under Alternative A.

4.13.2 Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

Implementation of the HPM system flight and ground testing under Alternative B would not create significant impacts on socioeconomics in the R-2515 or Edwards AFB areas. Under Alternative B, surrogate HPM systems would be operated at power setting below maximum established SAR levels. The same number of A/A and A/G flight tests would occur under Alternative B. Socioeconomic impacts created by test and target aircraft would be similar to those identified for Alternative A.

4.13.3 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on socioeconomics, and no mitigation would be required.

4.13.4 Mitigation Measures

Since no significant impacts on socioeconomics would be anticipated under Alternative A, B, or C, no mitigation would be required.

4.14 WATER RESOURCES

4.14.1 Alternative A, HPM System Testing on Edwards AFB and Restricted Area R-2515, Proposed Action Alternative and Alternative B, Surrogate HPM Systems Testing at Reduced Power Levels

No adverse significant impacts on water resources would be expected from the proposed test and evaluation of HPM systems at Edwards AFB and within restricted area R-2515. All ground targets and firing points for the proposed G/G, A/G, and G/A modes under Alternatives A and B would be located at Edwards AFB; therefore, no impacts on water resources found within the R-2515 area would occur.

There are no perennial streams on-base and storm water runoff for the entire watershed is directed toward the three playa lakebeds: Rogers, Rosamond, and Buckhorn Dry Lakes. Use of the playa lakebeds would occur only when the water retained during the rainy season had evaporated.

The primary potential impact of HPM testing on the playa lakebeds would be one of increased temperature. The RF energy from the HPM system would heat the water, resulting in an elevated temperature. Since the RF energy pulses from the HPM testing would last for less than 10 seconds (usually from 1 to 5 seconds), this condition would be extremely temporary and no significant adverse impacts would be anticipated. Additionally, use of the playa lakebeds would occur only when the water retained during the rainy season had evaporated.

Test and evaluation programs would use existing facilities and modify buildings on an as-needed basis; however water usage would be well within the capabilities of the current water distribution system. Any increases in storm water runoff resulting from increases in paved areas would be handled by the current storm water drainage system. Major modifications to existing buildings that would use water resources may require a separate environmental analysis; however, no major modification or construction is anticipated, and no impacts to water resources are expected.

4.14.2 Alternative C (No-Action Alternative)

Under Alternative C, the No-Action Alternative, HPM flight and ground testing would not occur at Edwards AFB or within restricted area R-2515. Consequently, there would be no impacts on water resources and no mitigation would be required.

4.14.3 Mitigation Measures

Since no significant impacts on water resources would be anticipated under Alternative A, B, or C, no mitigation would be required.

4.15 CUMULATIVE IMPACTS

The CEQ Regulations define "cumulative impact" as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The ROI for cumulative impacts analysis includes Edwards AFB. The only areas with potential cumulative impacts include air quality, land use, and noise.

4.15.1 Past, Present, and Future Operations

Since 2000, the level of flight activity at AFFTC and Edwards AFB has remained fairly constant. Typically, when a flight test program is completed a new flight test program begins. The number of personnel, vehicles, aircraft, and basic infrastructure needed to support these flight activities is proportionate to the number of sorties flown. The number of sorties associated with operations at Edwards AFB (including NASA-related flights) from 2000 through 2004 have been approximately 10,400 per year (AFFTC 2005a). The numbers of sorties have varied from a 7.5 percent reduction from year 2000 to 2001 to a 2.7 percent increase from 2002 to 2003. Table 4-10 shows the aircraft type and sorties for those years. These aircraft regularly use the runways, restricted area R-2515, low-level routes, supersonic corridors, and targets on the PIRA to test aircraft integration and system capabilities. Overall, flight test operations at Edwards AFB have been analyzed in the *EA for Continued Use of Restricted Area R-2515*. The proposed action in this document included the operations summarized in Table 4-10 and concluded that these operations would not result in significant cumulative impacts.

Considering 128 annual flight missions as an addition to existing operations is probably the worst case assumption. The evaluations completed for the overall flight test activity at Edwards AFB cited above were done with consideration for the normal and continuous initiation and completion of flight test programs. The HPM system test and evaluation missions as addressed in this EA in all probability would not be additive to actions already analyzed, but rather would replace flight test programs recently completed. However, given the extensive flight operations at Edwards AFB, the addition of up to 128 missions per year for each of two aircraft would be an increase of less than 2 percent. In general, since the operations (airspeeds, altitudes, aircraft type) of these missions would be similar to those already evaluated, it would be expected these missions would have no measurable cumulative impact on most of the existing environment.

Potential cumulative impacts on natural resources would be minimal. Target areas for testing of HPM Systems and Directed Energy Systems Using Laser Technology would be essentially the same. Although there would be additional use of the dirt roads leading to the target areas and firing points, the total area disturbed would still be within the guidelines established by the *Biological Opinion for Continued Use of the PIRA*; therefore, a less than significant cumulative impact would be expected.

Table 4-10

Sortie Summary by Aircraft and Year at AFFTC

	Year				
Aircraft Type	**2000**	**2001**	**2002**	**2003**	**2004**
B-1	110	118	135	81	74
B-2	15	44	9	47	36
B-52	47	69	61	70	66
BE-20	0	3	53	28	5
BE-200	50	66	75	49	44
Boeing 737/747/757	14	12	14	46	13
C-5	0	0	3	34	67
C-12	451	483	494	600	602
C-130	106	163	92	84	145
C/KC-135	674	653	784	837	709
C-17	194	139	223	194	221
CH-46	275	266	326	346	76
CH-53	133	227	319	220	62
DC-8	12	19	44	34	16
ER-2	74	95	78	34	19
F-117	391	312	337	274	342
F-15	1,088	920	843	820	596
F-16	3,128	2,706	2,782	3,035	2,978
F-18	624	479	463	349	271
F-22	154	337	565	909	1,021
HH-60G	0	16	80	111	140
KC-10	24	55	65	67	180
T/AT-38	2,773	2,315	1,926	1,894	1,545
X-45/X-47	0	0	7	10	27
Other	915	910	672	522	474
Totals	11,252	10,407	10,450	10,695	9,729

Source: AFFTC 2005a

Programs recently evaluated in other environmental assessments which have been shown to have no significant impact include:

- *EA for the Orbital Reentry Corridor for Generic Unmanned Lifting Entry Vehicle (LEV) Landing;*
- *EA for Armed Munitions Integration Testing on the PIRA*; and
- *EA for the Testing and Evaluation of Directed Energy Systems Using Laser Technology.*

Collectively the sorties for these three programs and this program, could add up to 536 sorties annually (Table 4-11), less than a 6 percent increase in activity from 2004. Adding the projected sorties for the HPM system test flights would increase sorties by as much as 1.2 percent (in 2008, assuming all these program flights occur as projected), which is well within the support capacity of Edwards AFB and the AFFTC.

Table 4-11

Projected Sorties for New Programs

Year	Lifting Entry Vehicles	Armed Munitions Integration Testing on the PIRA	Test and Evaluation of Directed Energy Systems Using Laser Technology[1]	Integration and Developmental Testing of HPM Systems [1]
2006	2	100	120	0
2007	5	100	140	0
2008	5	100	280	128
2009	0	100	338	128
2010	0	100	340	128
2011	0	0	0	128
2012	0	0	0	128

Note: 1 – These totals include chase aircraft and ground missions.

Sources: AFFTC 2002b; Mattson 2005; Reinke 2005; Wilson 2005.

The total sorties for the chase and support aircraft are expected to be routine flights that are included as part of the normal operational commitment, and therefore would not create any additional cumulative impacts. These projects are all flight-related and have been identified individually as resulting in no significant impacts on the environment. Like this EA, each of these programs deals with airspace, noise, and land use concerns that also result in minimal individual impacts. Detailed information and analysis of these projects is available on the World Wide Web at http//:www.ealev.com and http://www.edwards.af.mil/penvmng/Documents/reviewdocs.htm.

Other future programs being evaluated include the next phase of the F-35 flight test program, the Unmanned Aerial Vehicle Flight Operations at Edwards AFB, and Hypersonic Corridors at Edwards AFB. Cumulative impacts of these programs will be addressed in separate EAs.

4.15.2 Areas with Potential Cumulative Impacts

This section addresses the potential additive effects of implementing the Proposed Action Alternative in combination with projects identified in Section 14.5. Although no significant impacts have been identified for the Proposed Action Alternative or the other alternatives presented in this EA, the effects of conducting HPM system test and evaluation missions could result in cumulative impacts in the following areas.

4.15.2.1 Air Quality

The projects identified in Section 14.5 would be implemented during the same time frame as this action. They are not expected to have any significant cumulative air quality impacts. Air quality impacts from these projects do not individually result in any significant, long-term impacts although they may result in localized impacts of short duration. Since these projects are primarily aircraft-related, the air quality impacts would occur as a result of aircraft launch and recovery operations and while the aircraft are operating below 3,000 feet AGL. However, these air emissions—when combined—are still below the *de minimis* thresholds for criteria pollutants.

4.15.2.2 Land Use

The impacts associated with this Proposed Action would occur within the base boundary of Edwards AFB; therefore, only cumulative effects occurring on Edwards AFB will be addressed. The land area is on a designated Air Force range and is designated for primary use as a bombing, targeting, and aircraft integration test activities. Past military test and evaluation activities do not present any further or additional environmental impacts when combined with this Proposed Action. Radio frequency energy from aircraft for electronic countermeasures missions against targets on the West Range, East Range, and within the facilities at the Birk Flight Test Facility occurs on a regular basis. Range management activities include routine inspection and cleanup of all range target sites. The cleanup of the ground target sites after the AEA missions would continue as range personnel maintain due diligence and maintenance activities, thus minimizing the opportunity for any environmental impacts. Any newly designated HPM target sites or controlled areas would be fully investigated with hazard assessments completed prior to a change in land use. Minor impacts on the land use would result during the short period of the actual test (i.e., horizontal and vertical buffer zones might prevent access to other target sites; however this is typical for land use on a test range).

4.15.2.3 Noise

Several sources of noise were evaluated to determine if, when considered comprehensively, they would result in a cumulative noise impacts. These include aircraft, transportation, construction, and detonation-related noise. The noise impacts of the detonations and sonic booms can result in a similar response. Both are measured in pounds per square foot (psf) and are impulsive. As such, there impacts are considered together.

The AFFTC aircraft that generate sonic booms under existing operations are the F-15, F-16, and F-22; these aircraft generate sonic booms during high-speed (Mach 1.0 to 1.5) flights (AFFTC 2001). Sonic boom experiments carried out in the R-2508 Complex, using the SR-71, were completed in 1995. The measurements show that at high altitudes (approximately 65,000 to 80,000 feet AGL), high-speed sonic boom overpressures propagated by the SR-71 are less than 1.0 psf at ground level. These experimental results generally fit into the established pattern of other available sonic boom data. In the *EA to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range* (AFFTC 2001) it was estimated that over 600 supersonic flights were conducted through this area annually. From 1997 through April 2001, only 56 noise complaints were received from persons within 50 miles of the corridors. Use of the local supersonic corridor by these aircraft does create additional noise impacts; however, analysis has shown these noise levels do not create a significant adverse impact (AFFTC 2001). The addition of up to 48 AEA missions and resulting detonations would also create additional noise impacts; however, based on past experience this would not create a significant adverse impact.

The noise created from other off-base transportation sources is expected to increase as the population in area increases. Other programs like Orbital Reentry Corridor for Generic Unmanned Lifting Entry Vehicles Landing; Armed Munition Integration Testing on the PIRA; and Testing and Evaluation of Directed Energy Systems Using Laser Technology would use existing vehicles and equipment. Noise created from these sources would not increase the on-base noise contours. Because construction activities are not anticipated in support of these new programs, additional construction-related noise would not result in a cumulative environmental impact.

The addition of noise generated from up to 128 flight missions and 48 ground missions per year would add to the noise in the region of interest; however, this increase would add to the noise in the on-base ROI only for very brief periods of time and would be less than significant. Noise contour values that would result from these flights would be lower than ambient noise created from other civilian noise sources. Therefore, less than significant cumulative noise impacts would be anticipated under the Integration and Developmental Testing of HPM Systems Program.

4.16 UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts include those impacts that are negative, occurring regardless of any identified minimization measures. The Proposed Action would likely prevent the re-growth of small areas of terrestrial plant communities and reintroduction of any wildlife habitat at the HPM target sites. The land that would be routinely graded for this project was previously disturbed, so the plant communities are of marginal quality for wildlife.

4.17 SHORT-TERM VERSUS LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

Examples of short-term uses of the environment include direct, construction-related disturbances and direct impacts associated with an increase in population and activity that occurs over a period typically less than 5 years. Long-term uses of the environment include impacts occurring over a period of more than 5 years, including permanent resource loss.

Since no new development would be required under the Integration and Developmental Testing of HPM Systems Program and current Air Force or contractor personnel from other bases would be used for the program, neither Alternative A, B, or C would involve any short- or long-term changes in population or productivity of the environment.

4.18 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable resource commitments are related to the use of nonrenewable natural resources and the effects that the use of those resources will have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of implementing an action (e.g., extinction of a rare or threatened species, or the disturbance of an important cultural resource site). In accordance with NEPA (40 CFR 1502.16), this section includes a discussion of any irreversible and irretrievable commitment of resources associated with the proposed project.

This programmatic EA only addresses the launch, flight operations, and use of HPM systems against controlled targets at selected sites and locations over Edwards AFB. Implementing any of these proposed actions would not require an irreversible or irretrievable commitment of resources. Irreversible or irretrievable commitment of resources that would be involved in other phases of the program (e.g., HPM system development, HPM system construction, or transportation to Edwards AFB) would be addressed in separate environmental documentation. Implementation of Alternative C (No-Action Alternative) would also not require an irreversible or irretrievable commitment of resources.

5.0 REFERENCES

95th Air Base Wing and Air Force Flight Test Center (95 ABW and AFFTC)

2005 *R-2508 Complex Environmental Baseline Study, Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA. August.

Adair, Eleanor R., and David R. Black

2003 Thermoregulatory Responses to RF Energy. *Bioelectromagnetics Supplement* 6:S17-S38. Wiley-Liss, Inc.

Air Force Center for Environmental Excellence

2003 *Final Supplemental Environmental Impact Statement Airborne Laser Program*. Document on file at www.afcee.brooks.af.mil/ ec/eiap/eis/abl/ABL_F-SEIS_Apr_03.pdf.

Air Force Flight Test Center (AFFTC)

1992 *Study of Freshwater Shrimp at Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA. December.

Air Force Flight Test Center (AFFTC)

1993 *Edwards Air Force Base Flood Study*. Document on file at 95 ABW/CEV, Edwards AFB, CA. December.

Air Force Flight Test Center (AFFTC)

1994 *Edwards Air Force Base Comprehensive Plan*. Document on file at Environmental Management (95 ABW/CEV), Edwards AFB, CA. June.

Air Force Flight Test Center (AFFTC)

1995a *Bird Aircraft Strike Hazard Investigation at Edwards Air Force Base and Air Force Plant 42*, 9 April. Document on file at Environmental Management (95ABW/CEV), Edwards AFB, CA.

Air Force Flight Test Center (AFFTC)

1995b *Edwards Air Force Base Energy Plan*. Document on file at 95 ABW/CEV, Edwards AFB, CA. March.

Air Force Flight Test Center (AFFTC)

1996 *Final Environmental Assessment for the Continued Use of the Precision Impact Range Area (PIRA), Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA. February.

Air Force Flight Test Center (AFFTC)

1997a *Edwards Air Force Base Utility System Study*. Document on file at 95 ABW/CEV, Edwards AFB, CA. July.

Air Force Flight Test Center (AFFTC)

1997b *Edwards Air Force Base Comprehensive Plan,* Chapter 20, *Design Standards,* published under separate cover. Document on file at 95 ABW/CEV, Edwards AFB, CA. March.

Air Force Flight Test Center (AFFTC)

1997c *Programmatic Environmental Assessment for the Basewide Removal, Replacement, and Installation of Oil/Water Separators, Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA. January.

Air Force Flight Test Center (AFFTC)

1997d *Programmatic Environmental Assessment for Routine Flightline Activities, Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA. March.

Air Force Flight Test Center (AFFTC)

1998a *Stormwater Pollution Prevention Plan (SWPPP), Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA.

Air Force Flight Test Center (AFFTC)

1998b *Environmental Assessment of R-2515, Edwards AFB, California*. On file at 95 ABW/CEV.

Air Force Flight Test Center (AFFTC)

1999 *Environmental Assessment of the Water Pipeline to the Air Force Research Laboratory Edwards AFB, California*. On file at 95 ABW/CEV. February.

Air Force Flight Test Center (AFFTC)

2001 *Environmental Assessment to Extend the Supersonic Speed Waiver for Continued Operations in the Black Mountain Supersonic Corridor and Alpha Corridor/Precision Impact Range Area.* Document on file at 95 ABW/CEV, Edwards, AFB, CA. April.

Air Force Flight Test Center (AFFTC)

2002a Draft *Integrated Natural Resources Management Plan for Edwards AFB, CA*. May.

Air Force Flight Test Center (AFFTC)

2002b *Environmental Assessment for Orbital Reentry Corridors for Generic Unmanned Lifting Entry Vehicle Landing at Edwards AFB*. On file at 95 ABW/CEV, Edwards AFB, CA. December.

Air Force Flight Test Center

2005a Air Force Flight Test Center AFTO 781 Database-Annual Sorties Flown. August.

Air Force Flight Test Center

2005b "R-2508 Complex," Edwards AFB, CA. http://r2508.edwards.af.mil/. Accessed 16 March.

Air Force Flight Test Center

2005c *Environmental Assessment for Armed Munitions Integration Testing on the Precision Impact Range Area*. Document on file at 95 ABW/CEV. May.

Air Force Institute for Environment, Safety and Occupational Health Risk Analysis (AFIERA)

2002 Aircraft Engine Emissions Estimator.

Alfred Gobar Associates

1997 *Antelope Valley Labor Market Study*. Prepared for Lancaster Economic Development Corporation. October.

Barlow, Doug

2005 Personal communications regarding emergency services and emergency response at U.S. Borax Mine. April.

Bates, Michelle

2005 Personal communication. May.

Bedke, Curtis M.

2005 Mission Statement for Air Force Flight Test Center by Brigadier General Bedke, U.S. Air Force, AFFTC Commander, Microsoft PowerPoint presentation on file at 95 ABW/CEVX office.

Bureau of Land Management

2006 *Environmental Impact Report for the West Mojave Plan*. U.S. Department of Interior, BLM California Desert District Office, Moreno Valley, California. Accessed online at http://www.blm.gov/ca/cdd/wemo.html.

Burrell, James

2003 Disruptive Effects of Electromagnetic Interference on Communications and Electronic Systems, School of Information Technology and Engineering, George Mason University. April.

California Air Resources Board (CARB)

2003a "Ambient Air Quality Standards" available at http://www.arb.ca.gov/aqs/aaqs2.pdf. July 9. (Accessed January 18, 2005).

California Air Resources Board (CARB)

2003b "State Area Designations" available at http://www.arb.ca.gov/desig/adm/adm.htm. December 5. (Accessed January 18, 2005).

California Department of Fish and Game (CDFG)

2005 *Draft Range-wide Monitoring of the Desert Tortoise: 2001 – 2005 Summary Report*. On file at California Fish and Game Office, Bishop, California.

California Environmental Protection Agency (Cal/EPA)

2005 "California Almanac of Emissions and Air Quality" website at http://www.arb.ca.gov/ aqd/ almanac/ almanac01/ almanac01.htm. (Accessed January 18, 2005).

Camp, M., H. Garbe, and D. Nitsch

n.d. *UWB and EMP Susceptibility of Modern Electronics*. Institute of Basic Electronic Engineering and Measurement Science, University of Hanover, Hanover, GE.

Central Utah Water Conservation District (CUWCD)

2005 *Utah Lake System Environmental Impact Statement.* Section 3.8.6.1 at www.cuwcd.com.

City Locator

2005 Demographic Data on local cities. www.hometownlocator.com. March.

Code of Federal Regulations

2003 *Determining Conformity of Federal Actions to State or Federal Implementation Plans.* Environmental Protection Agency, 40 CFR 93, 2003 ed. Office of the Federal Register, National

Archives and Records Service, General Services Administration, U.S. Government Printing Office, Washington DC.

Colorado Department of Transportation

2004 "Colorado DOT Tire/Pavement Noise Study". Report No. CDOT-DTD-R-2004-5. Accessed online at http://tools.ecn.purdue.edu/~sqdh/noiselit.pdf.

Committee on Hearing, Bioacoustics and Biomechanics, Assembly of Behavioral and Social Sciences (CHABA)

1981 *Assessment of Community Noise Response to High-Energy Impulsive Sounds*. National Research Council, National Academy of Sciences, Washington, D.C.

Crosby

2005 Update of cultural resource site at Edwards AFB. June.

Cultural Systems Research, Inc.

1987 *California Low-Level Radioactive Waste Disposal Project: Cultural Resources Surveying: Ethnographic Resources Candidate Site Selection Phase*. Menlo Park, California.

Department of Defense

1997 DoD Pest Management Training and Certification, DoD Pest Management Program 4150.7M. April.

Department of Defense (DoD)

2003 *DoD Dictionary of Military and Related Terms*. Joint Pub 1-02.

Directed Energy Professional Society

2004 *High Power Microwave Technologies—Introduction to HPM Systems*. 7th Annual Directed Energy Conference, Washington, D.C. August.

Earle, D.D., B. Boyer, R.A. Bryson, R.U. Bryson, M.M. Campbell, J.J. Johannesmeyer, K.A. Lark, C.J. Elder, J.A., and C.K. Chou

2003 *Auditory Response to Pulsed Radiofrequency Energy*. Bioelectromagnetics Supplement 6:S162-S173. Motorola Florida Research Laboratories, Ft. Lauderdale, FL., Wiley-Liss, Inc.

Earle, D.D., B. Boyer, R.A. Bryson, R.U. Bryson, M.M. Campbell, J.J. Johannesmeyer, K.A. Lark, C.J. Parker, M.D. Pittman, L.M. Ramirez, M.R. Ronning, and J. Underwood

1997 *Cultural Resources Overview and Management Plan for Edwards AFB, California*. Volume 1, *Overview of Prehistoric Cultural Resources*. Computer Sciences Corporation, Edwards Air Force Base, California. Submitted to AFFTC, Base Historic Preservation Office, Edwards Air Force Base, California.

Earle, D. D., K. A. Lark, C. J. Parker, M. R. Ronning, and J. Underwood

1998 Cultural Resources Overview and Management Plan for Edwards AFB, California, Volume 2: *Overview of Historic Cultural Resources*. Computer Sciences Corporation, Edwards Air Force Base, California. Submitted to AFFTC, Base Historic Preservation Office, Edwards Air Force Base, California.

Edwards Air Force Base (Edwards AFB)

1996 *Edwards Air Force Base Joint Land Use Study*. Document on file at 95ABW/CEV technical library.

Edwards Air Force Base (Edwards AFB)

2002a Edwards AFB Website. Hppt://www.edwards.af.mil/index-static.html.

Edwards Air Force Base (Edwards AFB)

2002b Personal communications with Public Affairs Office. May.

Edwards Air Force Base (Edwards AFB)

2004 *Integrated Natural Resources Management Plan*. Document on file at 95ABW/CEV technical library.

Elder, J.A.

2003 Ocular Effects of Radiofrequency Energy. *Bioelectromagnetics Supplement* 6:S148-S161. Wiley-Liss, Inc.

Elder, J.A., and C.K. Chou

2003 Auditory Response to Pulsed Radiofrequency Energy. *Bioelectromagnetics Supplement* 6:S162-S173. Wiley-Liss, Inc.

EMIGuru

2005 "Useful Bits of Information." Kimmel Gerke Associates, LTD. http://www.emiguru.com.

Federal Communication Commission

1999 *Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields*, Office of Engineering and Technology Bulletin 56, Fourth Edition. August.

Federal Interagency Committee on Noise

1992 *Federal Agency Review of Selected Airport Noise Analysis Issues*. August.

Federal Interagency Committee on Urban Noise (FICUN)

1980 *Guidelines for Considering Noise in Land-Use Planning and Control*. June.

Federal Register

2004 *Approval and Promulgation of Implementation Plans, Finding of Attainment, and Designation of Areas for Air Quality Planning Purposes; 1-Hour Ozone Standard, East Kern County, CA*. Volume 69, No. 78, Rules and Regulations. April 22.

Greene, Julie and Sanders, Andrew C.

n.d. *Alkali Mariposa Lily*. Herbarium Department of Botany and Plant Sciences, University of California, Riverside, California.

Gregorac, Leopold

2005 "ADT Weapon of the 21st Century." http://www2.arnes.si/lgrego7/ (Accessed March 2005).

Guy, A. W., Chou, C. K.

1975 *Microwave Induced Acoustic Effects in Mammalian Auditory Systems*, AGARD Radiation Hazards - Page: 17 p. August.

Hagenauer, Larry

2005 Personal communications. Tybrin Corporation. March/April.

Holland, V.L.

1986 *Preliminary Descriptions of Terrestrial Natural Communities of California*. California Department of Fish and Game.

Houchin Aerospace

2005 Technical specifications on Cummins QSB5.9. Ground Powered Units, Model 790.

Illman, P.E.

1993 *The Pilot's Air Traffic Control Handbook*, 2nd Edition. TAB books, New York.

Jasik, H., and R.C. Johnson

1984 *Antenna Engineering Handbook*. McGraw-Hill.

Jauchem, James R., Melvin R. Frei, Kathy L. Ryan, James H. Merritt, and Michael R. Murphy

1999 Lack of Effects on Heart Rate and Blood Pressure in Ketamine-Anesthetized Rats Briefly Exposed to Ultra-WideBand Electromagnetic Pulses. *IEEE Transactions on Biomedical Engineering*, Vol. 46, No. 1. January.

Levell, Peggy

1999 Electronic communication with Jocelyn Swain (Computer Sciences Corporation) regarding the amount of money Edwards AFB spent on education in fiscal year 1998. August 25.

Lucas, M.J., and P.T. Calamia

1996 *Military Operations Area and Range Noise Model: NRNMAP User's Manual*. Final. Wright-Patterson AFB, Ohio: AAMRL. A1/OE-MN-1996-0001.

MacMahon, James A.

1992 *The Audubon Society Nature Guides, Deserts*. Alfred A. Knopf, Inc. From the Final R-2508 Complex Environmental Baseline Study.

Mardiguian, Michel

2002 Feedback Letters to the Editor, Part 15 Devices: Attributing Interference. NARTE EMC Engineer. St Remy les Chevreuse, France.

MARCOA Publishing, Inc.

1998 *Into the Future Edwards Air Force Base.* Document on file at Environmental Management AFFTC/EM, Edwards AFB, CA.

Martinov, Marcus

2005 Personal communications on emergency services provided by California City Fire Department. April.

Mattson, Paul

2005 Personal communications regarding the proposed flights of laser equipped aircraft at Edwards AFB, CA. March.

McCullough, Irmina

2003 Personal communications with Allen Tamura (Jt3/CH2MHill) regarding military family housing vacancy rates. February 27.

Microwave 101

2005 “Basic Concepts of Microwave Engineering”. http://microwaves101.com.

Microwave News

2004 “What’s New, A Report on Non-ionizing Radiation.” www.microwavenews.com/ jan04.html. January.

Mitchell, D. R., D.E. Buescher, J.R. Eckert, D.M. Laabs, M.L. Allaback, S.J. Montgomery, and R.C. Arnold, Jr.

n.d. Biological Resources Technical Report, Basewide Vegetation and Wildlife Surveys and Habitat Quality Analysis. From the *Final R-2508 Complex Environmental Baseline Study*.

Mitchell, D. R., D.E. Buescher, J.R. Eckert, D.M. Laabs, M.L. Allaback, S.J. Montgomery, and R.C. Arnold, Jr.

1993 *Biological Resources environmental Planning Technical Report*. Prepared in support of the Programmatic Environmental Assessment for Basewide Implementation of the Installation Restoration Program at Edwards AFB, California. Tetra Tech, San Bernardino, California.

Montoya, Kevin

2005 Personal communications. Director of Directed Energy at Edwards AFB, CA. March.

Morgan, M.G.

1988 *Electric and Magnetic Fields from 60 Hertz Electric Power*. Pittsburgh, Carnegie Melon University.

National Aeronautical Charting Office

2004a *H-3/H-4 IFR Enroute High Altitude—U.S.*, Washington, D.C.: National Aeronautical Charting Office, Federal Aviation Administration, U.S. Department of Transportation. April 15.

National Aeronautical Charting Office

2004b *IFR/VFR Low Altitude Planning Chart.* Washington, D.C.: National Aeronautical Charting Office, Federal Aviation Administration, U.S. Department of Transportation. April 15.

National Aeronautical Charting Office

2004c *L-3/L-4 IFR En Route Low Altitude –U.S.* Washington, D.C.: National Aeronautical Charting Office, Federal Aviation Administration, U.S. Department of Transportation. April 15.

National Aeronautics and Space Administration (NASA)

1997 *Environmental Assessment of Aircraft Consolidation at NASA at Dryden Flight Research Center* (DFRC). Department of the Air Force, Edwards, CA.

National Geospatial-Intelligence Agency

2004 *DOD Area Planning AP/IB Chart, Military Training Routes—Western U.S.*, St. Louis, MO: National Imagery and Mapping Agency. April 15.

National Oceanic and Atmospheric Administration

2001 U.S. Department of Commerce, Western Regional Climate Center website at http://www.wrcc.dri.edu. (Accessed January 18, 2005.)

Norwood, Richard

2003 Quarterly Report to MAJCOM on the status of the Edwards Air Force Base Cultural Resource Program. Summary spreadsheet prepared by Richard Norwood, Base Historic Preservation Officer, Edwards Air Force Base, California. December.

Pater, Larry

1976 "Noise Abatement Programs for Explosive Operations at NSWC/DL", presented at the 17th Explosive Safety Seminar of the DoD Explosives Safety Board.

Powell, J.A., and C.L. Hogue

1979 *California Insects.*

Pratt, J.A., and C.L. Pierce

1995 *Butterflies of the Mojave Desert Military Bases: China Lake Naval Air Weapons Center, Fort Irwin Military Reservation, and Edwards Air Force Base*. Report from the University of California, Riverside Entomology Department.

Reinke, Dan, Ph.D.

2005 Personal communications regarding the proposed flights of armed munitions equipped aircraft at Edwards AFB, CA. March.

Ronning, M.R., M.D. Pittman, and J. Underwood

2000 *Cultural Resources Overview and Management Plan for Edwards AFB, California*, Volume 3: *Cultural Resources Management Plan*. Computer Sciences Corporation, Edwards Air Force Base, California. Submitted to AFFTC, Base Historic Preservation Office, Edwards Air Force Base, California.

Scutellaria Group Web Site

2005 "Propagation of Alpine Plants, Seed Germination and Planting". Accessed at http://sphosting.com/cactus/page3.html.

Stanford Alumni

2005 Home Page. "How Fast and High Do Birds Fly?" Accessed at http://www.stanfordalumni.org/birdsite/text/essays/How_Fast.html

United States Fauna

2005 "Mojave ground squirrel". http://www.unitedstatesfauna.com/mohavegroundsquirrel.php (Accessed May).

U.S. Air Force

1978. *Environmental Protection: Planning in the Noise Environment.* AFM-19-10. Washington, D.C.: U.S. Government Printing Office.

U.S. Air Force

1984. *Assessing Noise Impact of Air Force Flying Operations: Guidelines*. Washington, D.C.: HQ/USAF.

U.S. Air Force

1995a *Draft Environmental Assessment for the Continued Supersonic Operations in the Panamint Valley Military Operating Area (MOA)*. Prepared by Air Force Flight Test Center, Edwards Air Force Base, CA.

U.S. Air Force

1995b *Environmental Compliance Assessment and Management Program (ECAMP), Preliminary Environmental Findings for Edwards AFB, California*. Prepared by AFFTC/EMC Environmental Compliance Division, April. Document on file at 95 ABW/CEV, Edwards AFB, CA.

U.S. Air Force

1997a *Final Environmental Impact Statement for the Program Definition and Risk Reduction Phase of the Airborne Laser Program: Volume 1*. Kirtland Air Force Base, New Mexico. April.

U.S. Air Force

1997b Radio Frequency Radiation (RFR) Safety Program. Air Force Occupational Safety and Health Standard 48-9. http://afpubs.hq.af.mil. August.

U.S. Air Force

2002 *Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations.* Institute for Environment, Safety, and Occupational Health Risk Analysis. January.

U.S. Air Force

2003a Information from the annual Air Emissions Inventory for Edwards Air Force Base.

U.S. Air Force

2003b *Air Force Transformational Flight Plan (Directed Energy Master Plan)*. November.

U.S. Air Force

2003c Consultative Letter, AFRL-HE-BR-CL-2003-0017, Precision Impact Range Area (PIRA) Laser Safety Survey. Edwards AFB, CA. 29 October 2003.

U.S. Air Force

2004 *Bird/Wildlife Aircraft Strike Hazard (BASH) Management Techniques*. Air Force Pamphlet 91-212. http://www.e-publishing.af.mil. February.

U.S. Air Force

2005a *Annual 2004 Air Emissions Inventory for Edwards Air Force Base*. On file with 95ABW/CEVX.

U.S. Air Force

2005b Flyover Noise Calculator. Air Force Research Laboratory, Wright Patterson Air Force Base. Available by contacting robert.mckinley@wpafb.af.mil.

U.S. Army

2001 *Environmental Noise Management, An Orientation Handbook for Army Facilities*. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). May.

U.S. Army

2003 *Aircraft Noise Estimates, Stryker Brigade Combat Team Draft Environmental Impact Statement*. Appendix H-4. July.

U.S. Army

2004a Noise Levels for Common Army Equipment. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). Accessed online at http://chppm-www.apgea.army.mil/hcp/NoiseLevelsPrint.htm.

U.S. Army

2004b *Supplemental Draft Environmental Impact Statement National Training Center, Ft. Irwin, CA.* Ft. Irwin, CA. p. 4-67. January.

U.S. Army Corps of Engineers

1996 *Delineation and Characterization of "Waters of the United States" at Edwards Air Force Base, California*. Waterways Experiment Station. pp. 1–81.

U.S. Army Corps of Engineers and Air Force Flight Test Center

1994 *Programmatic Environmental Assessment for the Comprehensive Plan of Edwards Air Force Base*, July. Document on file at 95 ABW/CEV, Edwards AFB, CA.

U.S. Census Bureau

2000 *Profiles of General Demographics Characteristics, 2000 Census of Population and Housing*. U.S. Department of Commerce.

U.S. Department of Agriculture, Soil Conservation Service

1998 *Interim, Soil Survey of Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA.

U.S. Department of Housing and Urban Development (HUD)

1978 Environmental Criteria and Standards, Section 51.101.9.

U.S. Department of Housing and Urban Development (HUD)

1985 *The Noise Guidebook*. HUD-953-CPD. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Interior, Bureau of Land Management

1980 *Final Environmental Impact Statement and Proposed Plan, California Desert Conservation Area*. Prepared by Bureau of Land Management: Riverside and Bakersfield Offices.

U.S. Department of Transportation

1980 *Highway Traffic Noise, The Price of Progress*. HEV-21/8-80 (20M), Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. September.

U.S. Environmental Protection Agency (U.S. EPA)

1974 *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. (Levels Document). EPA-550/9-47-004. U.S. Government Printing Office.

U.S. Environmental Protection Agency (U.S. EPA)

1982 *Guidelines for Noise Impact Analysis*. EPA-550/9-82-001. Washington, D.C.: U.S. Government Printing Office.

U.S. Environmental Protection Agency (U.S. EPA)

1991 *Compilation of Air Pollutant Emission Factors*, *AP-42*, Volume II, Part I, Appendix N, *Diesel Powered*, *Transit Buses*. March.

U.S. Environmental Protection Agency (U.S. EPA)

1999 *AP-42: Compilation of Emission Air Pollutant Factors* Volume II: *Mobile Sources*. Updated November 24, 2000.

U.S. Fish and Wildlife Service (USFWS)

1991 *Biological Opinion for Routine Operations and Facility Construction within the Cantonment Areas of Main and South Bases, Edwards AFB, California (1-6-91-28)*. On file at 95 ABW/EM, Edwards AFB, CA.

U.S. Fish and Wildlife Service (USFWS)

1994a *Biological Opinion for the Precision Impact Range Area, Edwards Air Force Base, California*, March. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Fish and Wildlife Service (USFWS)

1994b *Guidelines for Handling Desert Tortoises During Construction Projects*. Document on file at 95 ABW/EM, Edwards AFB, CA.

U.S. Fish and Wildlife Service (USFWS)

1996 *Request for Amendment of the Biological Opinion (1-8-94-F-6) for the Precision Impact Range Area, Edwards Air Force Base, California*. February. Document on file at AFFTC/EM, Edwards AFB, CA.

U.S. Forest Service

2004 http://www.fs.fed.us. Accessed December 2004.

U.S. Geological Survey (USGS)

1998 *Topography, Surface Features, and Flooding of Rogers Lake Playa, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA.

U.S. Natural Resources Conservation Service

1997 *The Grazing and Cropland Management Plan for Edwards Air Force Base, California*. Document on file at 95 ABW/CEV, Edwards AFB, CA.

Van Andel, Jeff

2005 Personal communications regarding emergency services and response for the city of Boron, CA. Fire Captain, Station 17, Boron, CA. April.

Vitale, Louis S.

1997 *Electromagnetic Field (EMF) Assessment and Site Impact Report.* Vita Tech Engineering, LLC, Springfield VA. May.

Wade, Paul

1998 Antenna Fundamentals, Chapter 1

Wilson, Sonja

2005 Personal communications regarding the proposed flights lifting entry vehicles at Edwards AFB, CA. March.

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6.0 PERSONS AND AGENCIES CONTACTED

Bransfield, Ray

2006 Personal communication. Conference call to discuss recommendations for environmental effects on Natural Resources. U.S. Fish and Wildlife Service Office, Ventura, California. March.

Congo, William

2005 Personal communication. U.S. Army Space and Missile Defense Command Public Affairs Office, Huntsville, Alabama. January.

D’Andrea, John

2004 Personal communication. Naval Health Research Center Detachment-Microwave Department, Brooks City Base, Texas. November/December.

Hagenauer, Larry

2005 Personal and electronic communication. March/April.

Jones, Rebecca

2006 Personal and electronic communication. Conference call to discuss comments of Draft EA and proposed response to comments. California Department opf Fish and Game, Palmdale, CA. July/August.

Mattson, Paul

2005 Personal communication on HPM systems. Tybrin Corporation. Edwards AFB. February/March/April.

Montoya, Kevin

2005 Personal communication on HPM testing and integration requirements. 412 TW/EWA, Edwards, AFB. February/March/April.

Morgan, Dan

2005 Personal communication on Unmanned Aerial Vehicles. January.

Mork, Brian Ph.D.

2005 Personal communication on HPM technology. Tybrin Corporation, Edwards AFB. January/February/March.

Schwedland, Ron

2005 Personal communication regarding the FJ44-2 engine used in the Proteus. Director of Business Development, Williams International, LLC. January/February.

Wilson, Sonja

2004 Tybrin Corporation, Edwards AFB. May.

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8.0 ACRONYMS AND ABBREVIATIONS

412 TW	412th Test Wing
412 TW/CC	Commander 412th Test Wing
412 TW/ENROR	412th Test Wing/Range Safety Office
95 ABW	95th Air Base Wing
95 ABW/CC	Commander 95th Air Base Wing
95 ABW/CEV	95th Air Base Wing Civil Engineering Flight
95 AMDS/SGPB	Bioenvironmental Flight Office
A/A	air-to-air
A/G	air-to-ground
A/S	air-to-space
ACEC	area of critical concern
ADS	Active Denial System
ADT	active denial technology
AEA	airborne electronic attack
AFB	Air Force Base
AFFTC	Air Force Flight Test Center
AFFTCI	Air Force Flight Test Center Instruction
AFIERA	Air Force Institute for Environment, Safety and Occupational Health Risk Analysis
AFOSH	Air Force Occupational Safety and Health
AFRL	Air Force Research Lab
AGE	aerospace ground equipment
AGL	above ground level
ANSI	American National Standards Institute
AVAQMD	Antelope Valley Air Quality Management District
AVEK	Antelope Valley East Kern
BASH	bird/aircraft strike hazard
BLM	Bureau of Land Management
CAA	Clean Air Act

CAAQS	California Ambient Air Quality Standards
CARB	California Air Resources Board
CCR	California Code of Regulations
CDNL	C-weighted day-night level
CDP	census designated place
CEQ	Council on environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHABA	Committee on Hearing, Bioacoustics and Biomechanics
CNEL	Community Noise Equivalent Level
CO	carbon monoxide
CSEL	C-weighted sound exposure level
CUWCD	Central Utah Water Conservation District

dB	decibels
dBA	A-weighted decibels
dBC	C-weighted decibels
dBP	peak sound level
DE	directed energy
DNL	day-night average noise level (also L_{dn})
DoD	Department of Defense
DTSC	Department of Toxic Substances Control
DWMA	Desert Wildlife Management Area

E	electric field strength
EA	environmental assessment
EIAP	Environmental Impact Analysis Process
EMR	electromagnetic radiation
EO	Executive Order
EPCRA	Emergency Planning-and-Community-Right-to-Know Act
ESA	Endangered Species Act

°F	degrees Fahrenheit

FAA	Federal Aviation Administration
FICUN	Federal Interagency Committee on Urban Noise
FP	firing point
FR	*Federal Register*
G/A	ground-to-air
G/G	ground-to-ground
GHz	gigahertz
GPU	ground power unit
GSE	ground support equipment
GVS	ground vehicle stopper
H	magnetic field strength
HERF	hazards of electromagnetic radiation to fuel
HERO	hazards of electromagnetic radiation to ordnance
HERP	hazards of electromagnetic radiation to personnel
HMMWV	high mobility multi-wheeled vehicle (Hummer)
HPM	high power microwave
HUD	Department of Housing and Urban Development
Hz	hertz
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
KCAPCD	Kern County Air Pollution Control District
kV	kilovolt
kV/m	kilovolts/meter
kW	kilowatt
λ	wavelength
L_{dnmr}	onset rate adjusted monthly day-night average A-weighted sound level
L_{eq}	long-term equivalent A-weighted sound level
L_{max}	A-weighted single event sound level

LTO	landing and takeoff
MBTA	Migratory Bird Treaty Act
MDAB	Mojave Desert Air Basin
MDAQMD	Mojave Desert Air Quality Management District
MHz	megahertz
MOA	Military Operation Area
MPE	maximum permissible exposure
MSL	mean sea level
MW	megawatt
mW/cm^2	milliwatt per square centimeter
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NAWS	Naval Air Weapons Station
NEPA	National Environmental Policy Act
NEW	net explosive weight
NO_2	nitrogen dioxide
NOTAM	Notice to Airmen
NRHP	National Register of Historic Places
OG/CC	Commander Operations Group
OU	Operable Unit
PEL	permissible exposure limit
PIRA	Precision Impact Range Area
P.L.	Public Law
$PM_{2.5}$	particulate matter 2.5 microns or less in diameter
PM_{10}	particulate matter 10 microns or less in diameter
POL	petroleum, oil, and lubricant
PSD	Prevention of Significant Deterioration
psf	pounds per square foot
RADHAZ	radiation hazards

RCRA	Resource Conservation and Recovery Act
RF	radio frequency
RFR	radio frequency radiation
ROI	Region of Influence
RPV	remotely piloted vehicle
S/G	space-to-ground
SAR	specific absorption rate
SDZ	surface danger zone
SEA	Significant Ecological Area
SEGS	Solar Electric Generating System
SEL	sound exposure level
SIP	State Implementation Plan
SO_2	sulfur dioxide
SPL	sound pressure level
SUA	special use airspace
TCP	traditional cultural property
TRACON	terminal radar approach
TRI	toxic release inventory
UAV	unmanned aerial vehicle
U.S.C.	United States Code
U.S. EPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWB	ultrawideband
V/m	volts per meter
VFR	visual flight rules
VOC	volatile organic compound
W/cm	watts per centimeter

W/m^2 watts per square meter

A AIR EMISSIONS ANALYSIS

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Table A-1
C-17 Aircraft Flight Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
C-17	F117-PW- 100 turbofan engines	4	LTO	Takeoff (Mil)	232.93	0.03	34.30	0.40	0.10	2.31
				Climb Out (Int)	181.98	1.21	30.02	0.36	0.10	2.31
				Approach	71.32	0.30	13.03	1.25	0.10	5.52
				Idle (Taxi-in)	18.40	2.15	3.96	23.86	0.10	10.54
				Idle (Taxi-out)	18.40	2.15	3.96	23.86	0.10	10.54

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.03	31.96	0.37	0.09	2.15
		1.50	1.32	32.78	0.39	0.10	2.52
		5.00	0.43	18.59	1.78	0.14	7.87
		15.00	2.37	4.37	26.34	0.11	11.64
		30.00	4.75	8.74	52.68	0.21	23.27
Total Emissions Per Mission (lbs)			**8.90**	**96.44**	**81.57**	**0.65**	**47.46**

Notes:
CO -carbon monoxide
LTO - landing and takeoff
NOx - nitrogen oxides
PM10 - particulate matter 10 microns or less in diameter
ROG - reactive organic gas
SOx - sulfur oxides

Source: All data were extracted from the ***Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations,*** published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002

Table A-2
AC-130 Aircraft Flight Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
C-130	T-56-A-15	4	LTO	Takeoff (Mil)	40.93	0.28	11.42	1.77	0.10	1.22
				Climb Out (Int)	36.33	0.42	9.69	1.65	0.10	1.46
				Approach	20.67	0.58	8.31	2.82	0.10	3.85
				Idle (Taxi-in)	15.00	1.97	7.49	3.84	0.10	3.64
				Idle (Taxi-out)	15.00	1.97	7.49	3.84	0.10	3.64

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.05	1.87	0.29	0.02	0.20
		1.50	0.09	2.11	0.36	0.02	0.32
		5.00	0.24	3.44	1.17	0.04	1.59
		15.00	1.77	6.74	3.46	0.09	3.28
		30.00	3.55	13.48	6.91	0.17	6.55
Total Emissions Per Mission (lbs)			**5.70**	**27.64**	**12.18**	**0.34**	**11.94**

Notes:
CO -carbon monoxide
LTO - landing and takeoff
NOx - nitrogen oxides
PM10 - particulate matter 10 microns or less in diameter
ROG - reactive organic gas
SOx - sulfur oxides

Source: All data were extracted from the ***Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations,*** published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002.

Table A-3
C-135 Aircraft Flight Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
C-135	TF-33-P-5&9	4	LTO	Takeoff (Mil)	160.50	0.55	12.08	-	0.10	3.67
				Climb Out (Int)	149.33	1.50	7.88	2.11	0.10	3.15
				Approach	69.00	1.37	6.37	5.24	0.10	3.55
				Idle (Taxi-in)	18.67	90.91	1.39	95.06	0.10	4.98
				Idle (Taxi-out)	18.67	90.91	1.39	95.06	0.10	4.98

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.35	7.76	-	0.06	2.36
		1.50	1.34	7.06	1.89	0.09	2.82
		5.00	1.89	8.79	7.23	0.13	4.90
		15.00	101.82	1.56	106.47	0.11	5.58
		30.00	203.64	3.11	212.93	0.22	11.16
Total Emissions Per Mission (lbs)			**309.05**	**28.28**	**328.52**	**0.60**	**26.81**

Notes: CO -carbon monoxide
LTO - landing and takeoff
NOx - nitrogen oxides
PM10 - particulate matter 10 microns or less in diameter
ROG - reactive organic gas
SOx - sulfur oxides

Source: All data were extracted from the ***Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations,*** published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002

Table A-4
X-45 Aircraft Flight Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
X-45	F404-GE-102D	1	LTO	Takeoff (Mil)	126.95	0.24	22.27	1.33	0.10	1.61
				Climb Out (Int)	108.38	0.27	15.92	1.32	0.10	1.57
				Approach	51.83	0.85	7.14	3.17	0.10	1.46
				Idle (Taxi-in)	10.90	54.82	1.43	123.75	0.10	4.48
				Idle (Taxi-out)	10.90	54.82	1.43	123.75	0.10	4.48

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.03	2.83	0.17	0.01	0.20
		1.00	0.03	1.73	0.14	0.01	0.17
		2.00	0.09	0.74	0.33	0.01	0.15
		10.00	5.98	0.16	13.49	0.01	0.49
		10.00	5.98	0.16	13.49	0.01	0.49
Total Emissions Per Mission (lbs)			**12.10**	**5.60**	**27.62**	**0.05**	**1.50**

Source: All data were extracted from the ***Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations,*** published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002

Notes: Fuel flow and emissions are based on the engine model F404-GE-400/FID2
CO -carbon monoxide
LTO - landing and takeoff
NOx - nitrogen oxides
PM10 - particulate matter 10 microns or less in diameter
ROG - reactive organic gas
SOx - sulfur oxides

Table A-5
Proteus Aircraft Flight Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Operation Cycle	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
						ROGs	NOx	CO	SOx	PM_{10}
Proteus	FJ44-2	2	LTO	Takeoff (Mil)	27.17	0.48	17.95	2.87	0.10	2.52
				Climb Out (Int)	22.65	0.49	15.48	2.48	0.10	3.15
				Approach	8.27	0.97	6.10	6.28	0.10	3.55
				Idle (Taxi-in)	3.68	2.28	2.42	32.08	0.10	4.98
				Idle (Taxi-out)	3.68	2.28	2.42	32.08	0.10	4.98

Operation Cycle	Number of Operations	Time in Mode (minutes)	Emissions (lbs)				
			ROGs	NOx	CO	SOx	PM_{10}
LTO	1	1.00	0.03	0.98	0.16	0.01	0.14
		1.00	0.02	0.70	0.11	0.00	0.14
		2.00	0.03	0.20	0.21	0.00	0.12
		10.00	0.17	0.18	2.36	0.01	0.37
		10.00	0.17	0.18	2.36	0.01	0.37
Total Emissions Per Mission (lbs)			**0.42**	**2.23**	**5.20**	**0.03**	**1.13**

Notes:
CO -carbon monoxide
LTO - landing and takeoff
NOx - nitrogen oxides
PM10 - particulate matter 10 microns or less in diameter
ROG - reactive organic gas
SOx - sulfur oxides

Source: "Time in Mode" and "Fuel Flowrate" data were extracted from AP-42, Compilation of Air Pollutant Emissions Factors, Volume II: Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, Michigan, September 1985. Because "Fuel Flowrate" information for the FJ44-2 engine was not available, data for the JT15D-5B engine was substituted as a conservative estimate as these engines are similar in size and thrust. Emission Factors were provided by Mr. Ron Schwedland, Director of Business Development with Williams International, LLC, the manufacturer of the FJ44-2 engine. No particulate information was provided; therefore, particulate emission factors for the JT15D-5B were used.

Table A-6
Aircraft Ground Test Activity and Emissions for Edwards AFB

Aircraft Type	Engine Type	Number of Engines	Mode of Operation	Fuel Flow (lbs/min)	Emission Factors (lbs/1,000 lbs of fuel)				
					ROGs	NOx	CO	SOx	PM_{10}
C-17	F117-PW-100	4	Idle	18.40	2.15	3.96	23.86	0.10	10.54
C-130	T-56-A-15	4	Idle	15.00	1.97	7.49	3.84	0.10	3.64
C-135	TF-33-P-5&9	4	Idle	18.67	90.91	1.39	95.06	0.10	4.98
X-45	F404-GE-102D	1	Idle	10.90	54.82	1.43	123.75	0.10	4.48

	Time in Mode per Test (minutes)	Emissions (lbs)				
		ROGs	NOx	CO	SOx	PM_{10}
C-17	360.00	56.97	104.92	632.19	2.54	279.27
C-130	360.00	42.55	161.78	82.94	2.07	78.62
C-135	360.00	2,444.10	37.37	2,555.67	2.58	133.89
X-45	360.00	215.11	5.61	485.60	0.38	17.58
Total Emissions Per Year (lbs)		**2,758.73**	**309.69**	**3,756.40**	**7.57**	**509.36**

Notes: Fuel flow and emissions for the X-45 are based on the engine model F404-GE-400/FID2
CO -carbon monoxide
LTO - landing and takeoff
NOx - nitrogen oxides
PM10 - particulate matter 10 microns or less in diameter
ROG - reactive organic gas
SOx - sulfur oxides

Source: All data were extracted from the ***Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations,*** published by the United States Air Force, Institute for Environment, Safety, and Occupational Health Risk Analysis, in January 2002

Table A-7
Total Expected Aircraft Emissions

		Emissions (tons/yr)				
Year		**NO_2**	**VOCs**	**PM_{10}**	**SO_2**	**CO**
2008 through 2012 (each year)						
T&E Aircraft	Tests					
Air Tests						
C-17	32	1.543	0.142	0.759	0.010	1.305
C-130	32	0.442	0.091	0.191	0.005	0.195
C-135	32	0.452	4.945	0.429	0.010	5.256
X-45	32	0.090	0.194	0.024	0.001	0.442
Total	128	2.527	5.372	1.403	0.026	7.198
Ground Tests						
C-17	12	0.630	0.342	1.676	0.015	3.793
C-130	12	0.971	0.255	0.472	0.012	0.498
C-135	12	0.224	14.665	0.803	0.015	15.334
X-45	12	0.034	1.291	0.105	0.002	2.914
Total	48	1.858	16.552	3.056	0.045	22.538
Target Aircraft/Tow Platform						
X-45	26	0.073	0.157	0.020	0.001	0.359
Proteus	26	0.029	0.005	0.015	0.000	0.068
Total	52	0.102	0.163	0.034	0.001	0.427
Total		**4.487**	**22.087**	**4.494**	**0.073**	**30.163**

Notes:
CO -carbon monoxide
LTO - landing and takeoff
NOx - nitrogen oxides
PM10 - particulate matter 10 microns or less in diameter
ROG - reactive organic gas
SOx - sulfur oxides

Table A-8

Mobile Source Emissions

Equipment or Vehicle Type	Number of Vehicles	HP	Vehicle Miles Traveled	Number of Missions	Year	NO_2 Emission Factor (g/mi)	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor (g/mi)	Total SO_2 Emissions (tons/yr)	CO Emission Factor (g/mi)	Total CO Emissions (tons/yr)	VOC Emission Factor (g/mi)	Total VOC Emissions (tons/yr)	PM_{10} Exhaust Emission Factor (g/mi)	Total PM_{10} Exhaust Emissions (tons/yr)	PM_{10} Fugitive Emission Factor (g/mi)	Total PM_{10} Fugitive Emissions (tons/yr)	Total PM_{10} Emissions (tons/yr)
ZEUS-HLONS (hybrid diesel/electric HMMWV, LDDT[a])	1	150 at 3,600 RPM	50	12	2006	1.0	0.0007	0.157	0.0001	1.3	0.0009	0.4	0.000	0.109	0.0001	1.48	0.0010	0.0011
				48	2007	1.0	0.0026	0.157	0.0004	1.3	0.0034	0.4	0.001	0.109	0.0003	1.48	0.0039	0.0042
					2008	1.0	0.0026	0.157	0.0004	1.3	0.0034	0.4	0.001	0.109	0.0003	1.48	0.0039	0.0042
					2009	1.0	0.0026	0.157	0.0004	1.3	0.0034	0.4	0.001	0.109	0.0003	1.48	0.0039	0.0042
					2010	1.0	0.0026	0.157	0.0004	1.3	0.0034	0.4	0.001	0.109	0.0003	1.48	0.0039	0.0042
					2011	1.0	0.0026	0.157	0.0004	1.3	0.0034	0.4	0.001	0.109	0.0003	1.48	0.0039	0.0042
					2012	1.0	0.0026	0.157	0.0004	1.3	0.0034	0.4	0.001	0.109	0.0003	1.48	0.0039	0.0042
Semi-Trailer	1	410	50	12	2006	13.7	0.0091	-	-	6.7	0.0045	1.6	0.001	2.630	0.0017	6.54	0.0043	0.0061
				48	2007	13.7	0.0362	-	-	6.7	0.0178	1.6	0.004	2.630	0.0070	6.54	0.0173	0.0243
					2008	13.7	0.0362	-	-	6.7	0.0178	1.6	0.004	2.630	0.0070	6.54	0.0173	0.0243
					2009	13.7	0.0362	-	-	6.7	0.0178	1.6	0.004	2.630	0.0070	6.54	0.0173	0.0243
					2010	13.7	0.0362	-	-	6.7	0.0178	1.6	0.004	2.630	0.0070	6.54	0.0173	0.0243
					2011	13.7	0.0362	-	-	6.7	0.0178	1.6	0.004	2.630	0.0070	6.54	0.0173	0.0243
					2012	13.7	0.0362	-	-	6.7	0.0178	1.6	0.004	2.630	0.0070	6.54	0.0173	0.0243

Notes:
CO - carbon monoxide
HMMWV - high mobility multi-purpose wheeled vehicle
LDDT - light-duty diesel truck
NO_2 - nitrogen dioxide
PM_{10} - particulate matter 10 microns or less in diameter
SO_2 - sulfur dioxide
VOC - volatile organic compound

Table A-9

Related Stationary Source Emissions (on ground)

Year - 2006

Process Description	Fuel Type	Power Rating (BTU/hr)	Operation (hrs)	NO_2 (lb/MMBtu)	NO_2 Emission Rate (tons/year)	CO Emission Rate (ton/year)	SO_2 Emission Rate (ton/year)	PM_{10} Emission Rate (ton/year)	VOC Emission Rate (ton/year)
Generator (A/M32A-60B)	JP-8	3,543,300	50	0.698	0.062	0.004	0.005	0.005	0.002
Generator (MDG4)	Diesel	8,034,000	50	0.698	0.140	0.010	0.010	0.012	0.003
Total			**100**		**0.202**	**0.014**	**0.015**	**0.018**	**0.005**

Year - 2007

Process Description	Fuel Type	Power Rating (BTU/hr)	Operation (hrs)	NO_2 (lb/MMBtu)	NO_2 Emission Rate (tons/year)	CO Emission Rate (ton/year)	SO_2 Emission Rate (ton/year)	PM_{10} Emission Rate (ton/year)	VOC Emission Rate (ton/year)
Generator (A/M32A-60B)	JP-8	3,543,300	300	0.698	0.371	0.026	0.027	0.032	0.009
Generator (MDG4)	Diesel	8,034,000	300	0.698	0.841	0.058	0.061	0.074	0.020
Total			**600**		**1.212**	**0.083**	**0.089**	**0.106**	**0.030**

Year - 2008 through 2012 (each year)

Process Description	Fuel Type	Power Rating (BTU/hr)	Operation (hrs)	NO_2 (lb/MMBtu)	NO_2 Emission Rate (tons/year)	CO Emission Rate (ton/year)	SO_2 Emission Rate (ton/year)	PM_{10} Emission Rate (ton/year)	VOC Emission Rate (ton/year)
Generator (A/M32A-60B)	JP-8	3,543,300	300	0.698	0.371	0.026	0.027	0.032	0.009
Generator (MDG4)	Diesel	8,034,000	300	0.698	0.841	0.058	0.061	0.074	0.020
Total			**600**		**1.212**	**0.083**	**0.089**	**0.106**	**0.030**

Notes: 1 - It was assumed that the A/M32A-60B generator would be used for 2 hours per test and that the Proteus and the X-45 would not require generators for sta

BTU - British thermal units

CO - carbon monoxide

lb/s - pound/s

NO_2 - nitrogen dioxide

PM_{10} - particulate matter equal to or below 10 microns

SO_2 - sulfur dioxide

VOC - volatile organic compounds

Source: Mr. Darrell Stiff, Chief, Powered Aircraft Ground Equipment, 412 Equipment Maintenance Squadron, Edwards AFB, CA. Personal correspondence with Mr. Larry Hagenauer, EAFB Environmental Contractor, 18 Aug 2004.

Table A-10

Related Mobile Source Emissions (on ground)

Year - 2006

Equipment or Vehicle Type	Rate of Emissions	Number of Vehicles	HP	Vehicle Miles Traveled		Number of Trips	Hours per Day	Emission Type	NO_2 Emission Factor[a]	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor[a]	Total SO_2 Emissions (tons/yr)	CO Emission Factor[a]	Total CO Emissions (tons/yr)	VOC Emission Factor[a]	Total VOC Emissions (tons/yr)	PM_{10} Emission Factor[a]	Total PM_{10} Emissions (tons/yr)	Entrained PM_{10} Emission Factor[b] (lbs/VMT)		Total Entrained PM_{10} Emissions (tons/yr)
				Paved	Unpaved														Paved	Unpaved	
LDGV, LDGT, &HDGT	g/VMT	3	N/A	40	10	16	N/A	Travel	0.90	0.00	-	-	8.87	0.02	0.91	0.00	0.11	0.00	0.02	0.78	0.20
	g/VMT							Cold Start	2.77	0.01	-	-	93.49	0.25	5.21	0.01	-	-	-	-	-
	g/VMT							Hot Start	1.76	0.00	-	-	12.74	0.03	1.38	0.00	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	2.11	0.01	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	5.01	0.01	-	-	-	-	-
LDDT	g/VMT	1	N/A	40	10	16	N/A	Travel	12.01	0.01	-	-	11.03	0.01	2.78	0.00	2.63	0.00	0.02	0.78	0.07
	g/VMT							Cold Start	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	-	-	-	-	-	-	-
				TOTAL Emissions in tons/year						**0.025**		**-**		**0.314**		**0.041**		**0.003**			**0.270**

Year - 2007 through 2012 (each year)

Equipment or Vehicle Type	Rate of Emissions	Number of Vehicles	HP	Vehicle Miles Traveled		Number of Trips	Hours per Day	Emission Type	NO_2 Emission Factor[a]	Total NO_2 Emissions (tons/yr)	SO_2 Emission Factor[a]	Total SO_2 Emissions (tons/yr)	CO Emission Factor[a]	Total CO Emissions (tons/yr)	VOC Emission Factor[a]	Total VOC Emissions (tons/yr)	PM_{10} Emission Factor[a]	Total PM_{10} Emissions (tons/yr)	Entrained PM_{10} Emission Factor[b] (lbs/VMT)		Total Entrained PM_{10} Emissions (tons/yr)
				Paved	Unpaved														Paved	Unpaved	
LDGV, LDGT, &HDGT	g/VMT	3	N/A	40	10	276	N/A	Travel	0.90	0.04	-	-	8.87	0.40	0.91	0.04	0.11	0.01	0.02	0.78	3.50
	g/VMT							Cold Start	2.77	0.13	-	-	93.49	4.27	5.21	0.24	-	-	-	-	-
	g/VMT							Hot Start	1.76	0.08	-	-	12.74	0.58	1.38	0.06	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	2.11	0.10	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	5.01	0.23	-	-	-	-	-
LDDT	g/VMT	1	N/A	40	10	276	N/A	Travel	12.01	0.18	-	-	11.03	0.17	2.78	0.04	2.63	0.04	0.02	0.78	1.17
	g/VMT							Cold Start	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Hot Soak	-	-	-	-	-	-	-	-	-	-	-	-	-
	g/VMT							Diurnal	-	-	-	-	-	-	-	-	-	-	-	-	-
				TOTAL Emissions in tons/year						**0.430**		**-**		**5.420**		**0.709**		**0.045**			**4.664**

Notes:

a - Emission factors were obtained using EMFAC 7G.
b - Emission factors for the LDGV, LDGT, HDGT, and LDDT were obtained from AP-42 Emission Factors, December 2003.
CO - carbon monoxide
HDGT - heavy-duty gasoline truck
LDDT - light-duty diesel truck
LDGT - light-duty gasoline truck
LDGV - light-duty gasoline vehicle
NO2 - nitrogen dioxide
PM10 - particulate matter equal 10 microns or less in diameter
SO2 - sulfur dioxide
VOC - volatile organic compounds

2006						
	SOURCE	**NOx**	**VOC**	**PM10**	**SO2**	**CO**
	Generators	0.202	0.005	0.018	0.015	0.014
	HMMV	0.001	0.000	0.001	0.000	0.001
	Semi	0.009	0.001	0.006	0.000	0.005
	Subtotals	**0.212**	**0.006**	**0.025**	**0.015**	**0.019**
	LDVs	0.025	0.041	0.273	0.000	0.314
	Totals	**0.237**	**0.047**	**0.298**	**0.015**	**0.333**
2007						
	Generators	1.212	0.030	0.106	0.089	0.083
	HMMV	0.003	0.001	0.004	0.000	0.003
	Semi	0.036	0.004	0.024	0.000	0.018
	Subtotals	**1.251**	**0.035**	**0.134**	**0.089**	**0.105**
	LDVs	0.430	0.709	4.709	0.000	5.420
	Totals	**1.681**	**0.744**	**4.844**	**0.089**	**5.525**
2008 through 2012						
	Generators	1.212	0.030	0.106	0.089	0.083
	HMMV	0.003	0.001	0.004	0.000	0.003
	Semi	0.036	0.004	0.024	0.000	0.018
	Subtotals	**1.251**	**0.035**	**0.134**	**0.089**	**0.105**
	LDVs	0.430	0.709	4.709	0.000	5.420
	Subtotals	**0.430**	**0.709**	**4.709**	**0.000**	**5.420**
	T&E Aircrafts	2.527	5.372	1.403	0.026	7.198
	Ground Tests	1.858	16.552	3.056	0.045	22.538
	Target Aircraft/Tow Platform	0.102	0.163	0.034	0.001	0.427
	Subtotals	**4.487**	**22.087**	**4.494**	**0.073**	**30.163**
	Totals	**6.169**	**22.831**	**9.338**	**0.162**	**35.688**

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B DISTRIBUTION LIST

APPENDIX B
DISTRIBUTION LIST

AFFTC Technical Library
412 TW/TSDL
Edwards AFB, CA 93524

Antelope Valley Air Quality Management District
43301 Division St., Ste. 206
Lancaster, CA 93639-4409
Attn: Charles L. Fryxell. APCO
(Or) Bret Banks, Operations Manager

Bureau of Land Management
Barstow Area Office
2601 Barstow Road
Barstow, CA 92311-3221

Bureau of Land Management
Ridgecrest Area Office
300 S. Richmond Road
Ridgecrest, CA 93555-4436

California Department of Fish and Game
1416 Ninth Street
Sacramento, CA 95814

California Department of Parks and Recreation
P.O. Box 942896
Sacramento, CA 94296

CALTRANS
Department of Transportation
District 6
1352 W. Olive Avenue
Fresno, CA 93728

CALTRANS
Department of Transportation
District 8
464 West 4th Street
San Bernardino, CA 92401-1400

CALTRANS
Department of Transportation
District 9
500 South Main Street
Bishop, CA 93514

City of Lancaster
Planning Department
44933 N. Fern Ave.
Lancaster, CA 93534

Congressman McKeon
Antelope Valley Field Office
1008 W. Avenue M-14 #E-1
Palmdale, CA 93551

Congressman Thomas
4100 Empire Dr.
Bakersfield, CA 93309

Edwards AFB Base Library
95 SPTG/SVMG
5 West Yeager Blvd.
Building 2665
Edwards AFB, CA 93524-1295

Federal Aviation Administration
Western Pacific Region
Attn: Charles Lieber
Airspace Management Branch
15000 Aviation Boulevard
Lawndale, CA 90261

Jerry Schwartz
Environnemental Lead
Surveillance Systems Engineering Group
FAA, AND-402
800 Independence Avenue SW, Room 511
Washington, DC 20591

John O'gara
Head of Environmental Planning
Environmental Office
Code 8G0000D
#1 Administration Circle
Naval Air Weapons Station
China Lake, CA 93555

Kern County APCD
Attn: Thomas Paxson, P.E.
2700 M Street, Suite 302
Bakersfield, CA 93301-2370

Kern County Department of Planning
and Development Services
2700 M Street, Suite 100
Bakersfield, CA 93301-2323

Kern County Library
Boron Branch
26967 20 Mule Team road
Boron, CA 93516

Kern County Library
California City Branch
9507 California City Boulevard
California City, CA 93505

Kern County Library
Mojave Branch
16916-1/2 Highway 14
Mojave, CA 93501

Kern County Library
Ridgecrest Branch
131 East Las Flores Ave
Ridgecrest, CA 93555

Kern County Library
Wanda Kirk Branch (Rosamond)
3611 Rosamond Boulevard
Rosamond, CA 93560

Los Angeles County Library
Lancaster Branch
601 W. Lancaster Boulevard
Lancaster, CA 93534

Mojave Desert AQMD
14306 Park Ave.
Victorville, CA 92392-2310
Attn: Charles L. Fryxell, APCO

US Senator Barbara Boxer
501 I Street, Suite 7-600
Sacramento CA 95814

US Senator Diane Feinstein
United States Senate
331 Hart Senate Office Building
Washington, DC 20510

Muhammad Bari
Director of Public Works
HQ NTC Ft. Irwin
Attn: AFZJ-PW-EV
PO Box 105097
Building 285
Fort Irwin, CA 92310-5097

Native American Heritage Commission
915 Capital Mall, Room 364
Sacramento, CA 95814

Office of Historic Preservation
State Historic Preservation Officer
PO Box 942896
Sacramento, CA 94296-0001

Office of Planning and Research
California State Clearinghouse
PO Box 3044
Sacramento, CA 95812-3044

San Bernardino County
Land Use Services Department
Planning Division
385 N. Arrowhead Ave., 1st Floor
San Bernardino, CA 92415-0182

Sierra Club
Antelope Valley Group
P.O. Box 901875
Palmdale, CA 93590

U.S. Department of the Interior
Fish and Wildlife Service
Ventura Field Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726

U.S. Environmental Protection Agency
Region IX
EIS Review Section
75 Hawthorne Street
San Francisco, CA 94105

C EXAMPLES OF PROPOSED TARGET AREAS

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Example of Existing Target Board at Downfall Complex

Target Area at Mt. Grinnel

Target Area at Haystack Butte

Target Area at Mt. Mesa

PB-13 Target Area

Target Area at Jackrabbit Hill

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D RESPONSE TO COMMENTS

<table>
<tr><th colspan="3">Draft Environmental Assessment for High Power Microwave at Edwards AFB</th></tr>
<tr><th>Comment #</th><th>Commenter</th><th>Comment</th></tr>
<tr><th colspan="3">Response</th></tr>
<tr><td>1</td><td>DTSC</td><td>The Department of Toxic Substances Control (DTSC) has completed our review of the above referenced document, received by the Office of Military Facilities on June 24, 2006. DTSC has no comments on this document.</td></tr>
<tr><td colspan="3">Noted. Thank you for your response.</td></tr>
<tr><td>2</td><td>Department of Fish and Game, Region 6 Bishop, CA</td><td>(July 14, 2006) In the Executive Summary, on page 5, under Natural Resources, it states that the effects from HPM testing are expected to primarily affect birds; however, the size and duration of the HPM activity is expected to be so small/brief as to mathematically have almost no effect. There is no means provided in the EA to determine if there will be impacts to birds and no mitigation measures if there are impacts, except to remove nests from target sites. To evaluate potential for this impact, the Department recommends short and long terms studies to determine if there are any impacts to birds.

(August 10, 2006) The current monitoring descriptions for wildlife did not appear to be listed in the original document; a description of these would be beneficial. Our main concern in these areas, if fenced, would be impacts to burrowing owl, which ground nest in open areas.</td></tr>
<tr><td colspan="3">(July 14, 2006) Thank you for your response. The 95ABW/CEV (Environmental Management office) and the Range (412th Test Wing) will continue to routinely assess potential impacts before tests and actual impacts after tests at test sites on the PIRA and at Edwards AFB. Consequently, if any tests resulted in a significant impact on any natural resource subsequent tests would be stopped until additional mitigation measures were implemented. Reports of these routine assessments are available to the CDFG on request. Many different types of test and evaluation of different systems occur at the Edwards AFB range on routine basis. The mitigation measures proposed would limit the potential for exposure to birds by limiting the target areas used to those areas generally devoid of vegetation and ground cover. Mathematically, a 10 second exposure to a limited area (5 acres maximum) that would not include habitat that typically supports birds would create a limited potential for effects. Although the 5 acres is the size of the target area, the target where the beam would be focused would be similar in size to a car, truck, tank, or airplane.
(August 10, 2006) The Air Force will include the monitoring procedures as an Appendix to the Environmental Assessment. A reference to following the monitoring procedures listed in Appendix E will be added to Chapter 4.9.4. “Prior to initiating a HPM test on targets within one of the selected sites or other areas on the PIRA, the monitoring procedures outlined in Appendix E will be implemented.”</td></tr>
<tr><td>3</td><td>Department of Fish and Game, Region 6 Bishop, CA</td><td>In Section 3.9.1 a good job was done in listing sensitive plant species at both Edwards and in the R-2515 area, but only listed animal species in the area were listed in Section 3.9.2. There are many BLM, FWS and CDFG sensitive animal species that may occur in both areas that could be impacted by the project. Most of those are birds including burrowing owl, which is protected under Fish and Game Code Section 3503.5 and is known to occur on Edwards within the PIRA area. Section 3.9.2 needs to be update to include additional sensitive species.</td></tr>
<tr><td colspan="3">Noted. Thank you for your response. Per your suggestion, the Air Force will review and update the lists of sensitive animal species in Section 3.9.2 to</td></tr>
</table>

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<tr><td>4</td><td>Department of Fish and Game, Region 6 Bishop, CA</td><td>(July 14, 2006) Section 4.9.1.2, page 4-30, says tortoise population densities were found to be low to very low throughout Edwards AFB, and approximately 80 percent of the base has densities at or below 20 tortoises per square mile. Due to the catastrophic declines of tortoise populations in the West Mojave area, this would be considered a fairly high density area.
(August 10, 2006) There is current information from the desert tortoise study plots and line distance sampling which show approximate numbers of tortoises per square mile in the West Mojave, so the data is there and available.</td></tr>
<tr><td colspan="3">(August 10, 2006) Thank you for your responses. The Air Force will remove the reference to low to very low densities and change to paragraph to read: “The most recent studies at Edwards AFB show that the tortoise populations for approximately 80 percent of the Base are estimated to be below 20 tortoises per square mile (AFFTC 2002a) and based on transects summarized in the Range-wide Monitoring of the Desert Tortoise:2001-2005 populations of the desert tortoise in the Western Mojave range from 7.81 tortoises per square kilometer in 2001 to 5.4 in 2004 (CDFG 2005).” Data on the desert tortoise populations in the West Mohave cannot be directly compared with densities at Edwards AFB, however, based on population trends for the species as summarized in the Range-wide Monitoring of the Desert Tortoise: 2001 – 2005 it could reasonably be concluded that the tortoise population at Edwards AFB would have also declined.</td></tr>
<tr><td>5</td><td>Department of Fish and Game, Region 6 Bishop, CA</td><td>In the same section, it states that prior to conducting HPM test activities, visual inspection of the target area would be accomplished, or tortoise fences would be installed around the target area to verify natural resources, particularly the desert tortoise, are not located there. If the area is fenced, it should be inspected after fencing to ensure no tortoise are within the fenced area.</td></tr>
<tr><td colspan="3">Thank you for your response. The Air Force will include a statement requiring the area enclosed by new tortoise fences be inspected after the fences are installed (if this mitigation measure is implemented). The Air Force will add the following sentence to Section 4.9.1.2 - Desert Tortoise and Mohave Ground Squirrel. “If the tortoise fences are installed, the newly enclosed area would be inspected to ensure that tortoises are not located within the 5 acre target area.”</td></tr>
<tr><td>6</td><td>Department of Fish and Game, Region 6 Bishop, CA</td><td>On the bottom of the same page and going onto the follow page it discusses studies that have been conducted which show ocular effects on laboratory animals after localized exposure of the eye to both continuous and pulsed RF energy exposure, but inconsistencies in these results are reasons why ocular effects are not useful in defining adverse effect level for RF exposure. Were all of the studies done on ocular effects inconsistent with each other? Were the studies peer reviewed? Has it been only one person who determined that ocular effects are not useful in defining adverse effect levels for RF exposure?</td></tr>
<tr><td colspan="3">Thank you for your response. As noted in comment 2 above, 95ABW/CEV (Environmental Management office) will continue to assess potential impacts on natural resources in the target areas to ensure potential and actual effects do not cause any significant impacts. All the studies reviewed were inconsistent according to Joe A Elder 2003 (Bioelectromagnetic Supplement 6:S148-S161; Wiley-Liss, Inc.) who reviewed other studies. These studies were published in scientific journals, the internet, and a copy of his report was obtained from U.S. Navy and Air Force sources at Brook City Base San Antonio, Texas where research into the effects of RF energy on humans has been their focus. Unfortunately these studies do not cover all scenarios. However, the main</td></tr>
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<tr><td>7</td><td>Department of Fish and Game, Region 6 Bishop, CA</td><td>Another study was done on exposure to UWB pulse on rats for 2 seconds on and 2 seconds off which resulted in no significant changes in hear rate or mean arterial blood flow. The EA states that the beams will be for 10 seconds. Has any research be done with this length of time? Was this study conducted under different temperatures?</td></tr>
<tr><td colspan="3">Thank you for your response. As noted in comment 2 above, 95ABW/CEV (Environmental Management office) will continue to assess actual effects after each test to ensure that the potential effects of subsequent tests would not create any significant impacts. No known research or information was found that specifically addressed 10 seconds of radiated HPM beam. However, based on the best information available there is no reason to believe that a 10 second pulse would create any significant effect or significant impact on animal species within the Region of interest.</td></tr>
<tr><td>8</td><td>Department of Fish and Game, Region 6 Bishop, CA</td><td>(July 14, 2006) The EA goes on to say that effects on wildlife would result from thermal heating of the water molecules in tissue; that the energy would penetrate just below the skin surface and heat the body; and change in body temperature of animals in the desert area may not result in an impact on these species if they can regulate their body temperature. Since tortoises are know to be out in 100 degree temperatures, it would seem there could be some significant impacts. In addition, it appears that Mohave ground squirrels are not good at thermal regulation, which is why they spend so much time underground. Prior to initiating the testing, trials should be conducted on desert tortoise at the Nevada Desert Tortoise Conservation Center to determine what the impacts to tortoises will be at different temperatures.
(August 10, 2006) At the Clark County Desert Tortoise Conservation Center, in Nevada, many of the tortoises brought in have Upper Respiratory Tract disease; these tortoises are euthanized. In making the recommendation that trails be done on tortoises, it was these tortoises in mind that would be euthanized anyway.</td></tr>
<tr><td colspan="3">(July 14, 2006) Thank you for your response. The Air Force will remove desert tortoises from the target areas to ensure the potential for exposure on this endangered species is extremely limited. The target areas would be monitored for evidence of active Mohave ground squirrels and test plans would be written to ensure the HPM beam was not radiated at that target area if this species was found to be active at the target site. If the wildlife were in the target areas and above ground they could be exposed to the thermal effects of heating. However, since the desert tortoises would be removed from the target areas and/or tortoise fences installed, the potential for their exposure would be extremely limited. The Mohave ground squirrel spends most of its time underground (generally 8 months of the year). The HPM beam would not penetrate into the burrows. Because there are a limited number of tests, and the Mohave ground squirrel is generally underground their potential for exposure would also be limited. The Air Force would not recommend that trials on desert tortoises be conducted to determine the impacts on them at different temperatures. Because they will be removed from the target area this should not present a problem for the species.
(August 10, 2006) Thanks again for the clarification to your previous comment. The Air Force would support this testing if arrangements could be made such that any tortoise scheduled to be euthanized and brought to the test site were segregated from other tortoises. Coordination with the 95thABW/CEV would be required. Additionally, the procedure must be approved by the Air Force (Directed Energy Bioeffects Division, Human Effectiveness Directorate,</td></tr>
</table>

Draft Environmental Assessment for High Power Microwave at Edwards AFB		
Comment #	**Commenter**	**Comment**
		Response
Air Force Research Laboratory, Brooks City Base, San Antonio, TX, USA), USFWS, and CDFG and written into the test plan.		
9	Department of Fish and Game, Region 6 Bishop, CA	Page 4-34 of the same section states that tortoises are most active in California during the spring and early summer, with additional activity occurring during warmer fall months and occasionally after summer rainstorms. From several recent projects that have taken place in similar habitat near Edwards, we now know that tortoise can be active throughout the year and also just prior to and after winter rainfall. This should be included in the document.
Thank you for your response. The Air Force will update the sentence to read: "The tortoises are most active during the spring and early summer when annual plants are most common and can be active throughout the year and also just prior to and after winter rainfalls."		
10	Department of Fish and Game, Region 6 Bishop, CA	(July 14, 2006) Section 4.9.4 on page 4-35, on mitigation says tortoises found within the project area will be removed from target areas and firing points and placed in outdoor desert tortoise pens located in a natural environment for up to 7 consecutive days. The other option given is to tortoise fence around the target areas and firing points. The Department recommends the second option. If the first option is used and more than one tortoise is found will each have its own pen? Will a burrow be constructed in the pen? Will blood work be done to determine if tortoises are ill prior to placing two in the same pen? (August 10,2006) It should be noted in the document that there would only be one tortoise per pen.
(July 14, 2006) Thank you for your response. The Air Force will continue to follow established procedures. Consultation with the USFWS office in Ventura recommended the use of tortoise pens or tortoise fencing. While the Air Force also considers the use of tortoise fences as the best solution, it may not be feasible due to the nature of the test plan. Established procedures at Edwards AFB, agreed upon by USFWS, would limit pens to one tortoise per pen. Whether a burrow is constructed would depend on time of year and duration of test, with the main objective that a minimum amount of contact and interference with the tortoises occurs. Since only one tortoise would be in a pen, blood work would not be required. (August 10, 2006) Thank you for the clarification to your previous comment. The Air Force will include the following sentence in Section 4.9.4: "Tortoise pens will be limited to one tortoise per pen."		
11	Department of Fish and Game, Region 6 Bishop, CA	(July 14, 2006) For examples of mitigation measures the following should be included: 1) Measure 1 also address Mohave ground squirrel in the awareness briefing; and 2) a measure should be included that stationary target boards will be designed to prevent ravens from nesting. (August 10, 2006) Thank you for including Mohave ground squirrel as part of the awareness briefing.
(July 14, 2006) Thank you for your response. The Air Force will add the mitigation measures requested. A Mohave ground squirrel awareness briefing is already part of the awareness briefing provided to anyone who works in any field areas on Base; consequently, Measure 1 has already been implemented. Target designs would be reviewed in accordance with the Air Force EIAP process on a case-by-case basis to minimize where possible, perches or other parts of the target that may support nesting by ravens or other bird species. (August 10, 2006) Noted. Thank you for your response.		

Department of Toxic Substances Control

Maureen F. Gorsen, Director
8800 Cal Center Drive
Sacramento, California 95826-3200

Linda S. Adams
Secretary for
Environmental Protection

Arnold Schwarzenegger
Governor

June 29, 2006

Mr. Gary Hatch
95 ABW/CEVX
5 East Popson, Building 2650A
Edwards Air Force Base, California 93524-1130

COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE INTEGRATION AND DEVELOPMENTAL TESTING OF HIGH POWER MICROWAVE SYSTEMS (STATE CLEARINGHOUSE #2006064001), EDWARDS AIR FORCE BASE, CALIFORNIA (May 2006)

Dear Mr. Hatch:

The Department of Toxic Substances Control (DTSC) has completed our review of the above referenced document, received by the Office of Military Facilities on June 24, 2006. DTSC has no comments on this document.

Should you have any questions, please contact me at (916) 255-3683.

Sincerely,

John Harris

John Harris
Project Manager
Hazardous Substances Scientist
Office of Military Facilities

STATE OF CALIFORNIA
Governor's Office of Planning and Research
State Clearinghouse and Planning Unit

Arnold Schwarzenegger
Governor

Sean Walsh
Director

July 25, 2006

Gary Hatch
U.S. Air Force Flight Test Center/ 95th ABW
95ABW/CEVX, 5 E. Popson Ave
Building 2650A
Edwards AFB, CA 93524-1130

Subject: EA for the Integration and Developmental Testing of HPM Systemps at Edwards Air Force Base, California
SCH#: 2006064001

Dear Gary Hatch:

The enclosed comment (s) on your Joint Document was (were) received by the State Clearinghouse after the end of the state review period, which closed on July 15, 2006. We are forwarding these comments to you because they provide information or raise issues that should be addressed in your final environmental document.

The California Environmental Quality Act does not require Lead Agencies to respond to late comments. However, we encourage you to incorporate these additional comments into your final environmental document and to consider them prior to taking final action on the proposed project.

Please contact the State Clearinghouse at (916) 445-0613 if you have any questions concerning the environmental review process. If you have a question regarding the above-named project, please refer to the ten-digit State Clearinghouse number (2006064001) when contacting this office.

Sincerely,

Terry Roberts

Terry Roberts
Director, State Clearinghouse

Enclosures
cc: Resources Agency

1400 TENTH STREET P.O. BOX 3044 SACRAMENTO, CALIFORNIA 95812-3044
TEL (916) 445-0613 FAX (916) 323-3018 www.opr.ca.gov

State of California - The Resources Agency Arnold Schwarzenegger, Governor
DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov
Eastern Sierra-Inland Deserts Region (Region 6)
407 W. Line Street
Bishop, CA 93514
(760) 872-1171
(760) 872-1284 -FAX

Clear 7-15-06 Late

July 14, 2006

RECEIVED
JUL 25 2006
STATE CLEARING HOUSE

Mr. Gary Hatch
U.S. Air Force Flight Test Cebter/95th ABW
95ABW/CEVX, 5 E. Popson Ave., Bldg. 2650 A
Edwards Air Force Base, CA 93524

Dear Mr. Hatch:

The Department of Fish and Game (Department) has reviewed the Environmental Assessment for the Integration and Developmental testing of High Power Microwave (HPM) Systems at Edwards Air Force Base (EA), SCH #2006064001. The proposed action is to conduct open-air integration and developmental testing of high power microwave systems at Edwards AFB while operating within restricted area R-2515 against ground-to-ground, ground-to-air, air-to-ground, and air-to-air targets. All targets will be physically located on or above Edwards AFB, inside restricted area R-2515. Up to 100 acres could be designated for target areas: however each target area would be limited to 5 acres.

The Department is providing comments on this EA as the state agency which has the statutory and common law responsibilities with regard to fish and wildlife resources and habitats. California's fish and wildlife resources, including their habitats, are held in trust for the people of the State by the Department (Fish & Game Code section 711.7). The Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitats necessary for biologically sustainable populations of those species (Fish & Game Code section 1802). The Department's fish and wildlife management functions are implemented through its administration and enforcement of the Fish and Game Code (Fish & Game Code Section 702). The Army is requesting comments as provided for in the Sikes Act (Title 16, U.S. Code Section 670), Public Law 99-561. The Department is providing these comments in furtherance of these statutory responsibilities, as well as its common law role as trustee for the public's fish and wildlife.

In the Executive Summary, on page 5, under Natural Resources, it states that the effects from HPM testing are expected to primarily affect birds; however, the size and duration of the HPM activity is expected to be so small/brief as to mathematically have almost no effect. There is no means provided in the EA to determine if there will be impacts to birds and no mitigation measures if there are impacts, except to remove nests from target sites. To evaluate potential for this impact, the Department recommends short and long terms studies to determine if there are any impacts to birds.

In Section 3.9.1 a good job was done in listing sensitive plant species at both Edwards and in the R-2515 area, but only listed animal species in the area were listed in Section 3.9.2. There are many BLM, FWS and CDFG sensitive animal species that may occur in both areas that could be impacted by the project. Most of these are birds including burrowing owl, which is protected under Fish and Game Code Section 3503.5 and is know to occur on Edwards within the PIRA area. Section 3.9.2 needs to be update to include additional sensitive species.

Section 4.9.1.2, page 4-30, says tortoise population densities were found to be low to very low throughout Edwards AFB, and approximately 80 percent of the base has densities at or below 20 tortoises per square mile. Due to the catastrophic declines of tortoise populations in the West Mojave, this would be considered a fairly high density area.

In the same section, it states that prior to conducting HPM test activities, visual inspection of the target area would be accomplished, or tortoise fences would be installed around the target area to verify natural resources, particularly the desert tortoise, are not located there. If the area is fenced, it should be inspected after fencing to ensure no tortoise are within the fenced area.

On the bottom of the same page and going onto the follow page it discusses studies that have been conducted which show ocular effects on laboratory animals after localized exposure of the eye to both continuous and pulsed RF energy exposure, but inconsistencies in these results are reasons why ocular effects are not useful in defining adverse effect level for RF exposure. Were all of the studies done on ocular effects inconsistent with each other? Were the studies peer reviewed? Has it been only one person who determined that ocular effects are not useful in defining adverse effect levels for RF exposure?

Another study was done on exposure to UWB pulse on rats for 2 seconds on and 2 seconds off which resulted in no significant changes in hear rate or mean arterial blood flow. The EA states that the beams will be for 10 seconds. Has any research be done with this length of time? Was this study conducted under different temperatures?

The EA goes on to say that effects on wildlife would result from thermal heating of the water molecules in tissue; that the energy would penetrate just below the skin surface and heat the body; and change in body temperature of animals in the desert area may not result in an impact on these species if they can regulate their body temperature. Since tortoises are known to be out in 100 degree temperatures, it would seem there could be some significant impacts. In addition, it appears that Mohave ground squirrels are not good at thermal regulation, which is why they spend so much time underground. Prior to initiating the testing, trials should be conducted on desert tortoise at the Nevada Desert Tortoise Conservation Center to determine what the impacts to tortoises will be at different temperatures.

Page 4-34 of the same section states that tortoises are most active in California during the spring and early summer, with additional activity occurring during warmer fall months and occasionally after summer rainstorms. From several recent projects that have taken place in similar habitat near Edwards, we now know that tortoise can be active throughout the year and also just prior to and after winter rainfall. This information should be included in the document.

Section 4.9.4 on page 4-35, on mitigation says tortoises found within the project area will be removed from target areas and firing points and placed in outdoor desert tortoise pens located in a natural environment for up to 7 consecutive days. The other option given is to tortoise fence around the target areas and firing points. The Department recommends the second option. If the first option is used and more than one tortoise is found will each have its own pen? Will a burrow be constructed in the pen? Will blood work be done to determine if tortoises are ill prior to placing two in the same pen?

For examples of mitigation measures the following should be included: 1) Measure 1 also address Mohave ground squirrel in the awareness briefing; and 2) a measure should be included that stationary target boards will be designed to prevent ravens from nesting.

Thank you for this opportunity to comment. Please submit any biological studies to the Department for review. Questions regarding this letter and further coordination on these issues should be directed to Ms. Rebecca Jones, Environmental Scientist, (661) 285-5867.

Sincerely,

Steve Parmenter

for Denyse Racine, Senior Environmental Scientist
Habitat Conservation Program

cc: Ms. Rebecca Jones
State Clearinghouse
Chron

Knight, Jim -- Tetra Tech

From: Mattson Paul D Contr 95 ABW/CEV [Paul.Mattson.ctr@edwards.af.mil]
Sent: Thursday, August 10, 2006 3:10 PM
To: Knight, Jim -- Tetra Tech
Subject: FW: Response to Comments for HPM

From: Becky Jones [mailto:dfgpalm@mindspring.com]
Sent: Thursday, August 10, 2006 3:07 PM
To: Mattson Paul D Contr 95 ABW/CEV
Cc: dfg.palm@mindspring.com; Dyas Keith Civ 95 ABW/CEV; Wilson Sonja Contr 95 ABW/CEV
Subject: Re: Response to Comments for HPM

Mr. Mattson,

I have review the responses to comments for HPM. Follow are my comments;

Comment 2 - The current monitoring descriptions for wildlife did not appear to be listed in the the original document, a description of these would be beneficial. Our main concern in these areas, if fenced, would be impacts to burrowing owl, which ground nest in open areas.

Comment 4 response - There is current information from desert tortoise study plots and line distance sampling which show approximate numbers of tortoise per square mile in the West Mojave, so the data is there and available.

Comment 8 response - At the Clark County Desert Tortoise Conservation Center, in Nevada, many of the tortoises brought in have Upper Respiratory Tract Disease, these tortoise are euthanized. In making the recommendation that trials be done on tortoises, it was with these tortoises in mind that would be euthanized anyway.

Comment 10 response- It should noted in the document that there would only be one tortoise per pen.

Comment 11 response - Thank you for including Mohave ground squirrel as part of the awareness briefing.

Thank you for letting me comment on your responds,
Becky Jones
Department of Fish and Game
Eastern Sierra/Inland Deserts Region
(661) 285-5867

E WILDLIFE SURVEY AND MONITORING PROCEDURES

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APPENDIX E.1

WILDLIFE SURVEY AND MONITORING PROCEDURES

Desert tortoise is the only federally listed species (federally threatened) on Edwards Air Force Base. Desert tortoise survey protocol is based on federal desert tortoise survey methodology with minor modifications. Survey and monitoring requirements are also based on the location of the project and the relevant biological opinion for that particular area and habitat. Preconstruction surveys consist of a presence/absence survey by qualified biologists following desert tortoise survey protocol (Appendix E.2). Desert tortoise awareness training, survey, and monitoring of construction areas and activities, is conducted by 95 ABW/CEV qualified biologists in compliance with biological opinion requirements. Some areas subject to continuous long-term use may be fenced to exclude desert tortoise.

During desert tortoise surveys, observations of other wildlife and plant species, including sensitive species, are documented in the field notes. The presence of other sensitive species observed at the site, or during travel to and from a site, is noted using GPS units. The location data are added to the GIS database.

Edwards AFB also has protocols for Mohave ground squirrel (California listed as threatened) and burrowing owl surveys (California species of special concern). The Mohave ground squirrel protocol is based on the California Fish and Game requirements with minor modifications. Mohave ground squirrel trapping protocol emphasizes assuring the safety of the trapped animals. The inventories conducted on Edwards AFB provide information on where this species occurs on the base, which vegetation types it prefers, and they assist land managers in making decisions regarding the management of Mohave ground squirrels. The burrowing owl protocols are based on the protocols and guidelines of the California Burrowing Owl Consortium[1].

The protocol for burrowing owl determines when surveys may be conducted and when construction is allowed near burrows. The burrowing owl surveys also focus on determining the presence or absence of burrows, and documenting the distribution and abundance of the species on base.

Edwards is conducting on-going long-term monitoring surveys within each of the 60 habitat quality assessment plots first established on base in 1992. Mohave ground squirrel is one of the species being surveyed on the long-term monitoring plots.

Qualified contractors and specialized small mammal experts are conducting these surveys and other site specific Mohave ground squirrel surveys. Staff and subcontractors have recently conducted burrowing owls surveys to determine abundance and population boundaries at known locations.

[1] California Burrowing Owl Consortium, 1993 Burrowing Owl Survey Protocol and Mitigation Guidelines. Tech. Rep. Burrowing Owl Consortium, Alviso, California.

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APPENDIX E.2

FIELD SURVEY PROTOCOL FOR ANY FEDERAL ACTION THAT MAY OCCUR WITHIN THE RANGE OF THE DESERT TORTOISE

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January 1992

FIELD SURVEY PROTOCOL FOR ANY FEDERAL ACTION THAT MAY OCCUR WITHIN THE RANGE OF THE DESERT TORTOISE

The Mojave population of the desert tortoise was listed as a federally endangered species on August 4, 1989 by emergency rule and as a threatened species by final rule on April 2, 1990. Section 7(a) regulations of the Endangered Species Act (Federal Register Vol. 51, No. 106, pp. 19957-19963) require each federal agency to review its actions at the earliest possible time to determine whether any action may affect listed species (Mojave population of the desert tortoise) or critical habitat. If such a determination is made, formal consultation is required with the Fish and Wildlife Service. The Service may request a federal agency to enter into consultation if it identifies any action of that agency that may affect the desert tortoise and for which there has been no consultation. Through completion of the formal Section 7 process, that is issuance of a "no jeopardy" biological opinion, the federal agency receives authorization from the Fish and Wildlife Service to incidentally take a specified number of federally threatened desert tortoises and tortoise habitat through the implementation of a proposed project. Without this authorization from the Fish and Wildlife Service, the federal agency would be in violation of Section 9 of the Endangered Species Act if the proposed project were implemented and resulted in the "take" of a desert tortoise or its habitat.

Section 9 of the Endangered Species Act prohibits the "taking" of any federally listed threatened or endangered species without first obtaining necessary authority from the Fish and Wildlife Service. "Take" includes "harming, harassing, pursuing, hunting, shooting, wounding, killing, capturing, collecting, or attempting to engage in any such conduct"(Section 3(19), Endangered Species Act 1973, as amended). Harm includes "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or shelter"(50 CFR 17.3(c)). "Take" also includes modification of habitat that would result in harm to the desert tortoise.

In response to a demand for information and/or guidance on compliance with Section 7 of the Endangered Species Act, the Fish and Wildlife Service has developed a protocol for surveys within the range of the federally threatened desert tortoise. The purpose of this protocol is to provide technical assistance to federal agencies to determine 1) if a proposed action "may adversely affect" the desert tortoise and thus initiate formal consultation with the Fish and Wildlife Service and 2) the incidental take of desert tortoises and tortoise habitat. Survey information would also enable the federal agency to modify the proposed project or develop an alternative project that would minimize or avoid incidental take of desert tortoises or their habitat. This latter point is relevant under Section 7(a)(1) of the Endangered Species Act which requires all federal agencies to consult with the Fish and Wildlife Service and utilize their authorities to carry out programs for the conservation of endangered and threatened species.

We also recommend that you obtain a copy of "Procedures for Endangered Species Act Compliance for the Mojave Desert Tortoise" before you begin planning your project. This document is available from any of the five Fish and Wildlife Service offices listed below and provides more information on sections 7, 9, and 10 of the Endangered Species Act.

This survey protocol is subject to revision as new information becomes available. Before initiating the survey protocol described below, we recommend checking with the Fish and Wildlife Service to verify that you are implementing up-to-date survey methods.

In Arizona:

Fish and Wildlife Service
Phoenix Field Office
2321 W. Royal Palm Road
Phoenix, Arizona 85021
(602) 640-2720

In California, for Inyo, Kern, Los Angeles, and San Bernardino Counties:

Ventura Fish & Wildlife Office
2493 Portola Road, Suite B
Ventura, California 93003
(805) 644-1766

In California, for Imperial and Riverside Counties:

Carlsbad Fish & Wildlife Office
2730 Loker Avenue West
Carlsbad, California 92008
(760) 431-9440

In Nevada:

Nevada Fish & Wildlife Office
1340 Financial Blvd. Suite 234
Reno, Nevada 89502
(775) 861-6300

In Utah:

Utah Ecological Services Field
Office
1300 South Lincoln Plaza,
Suite 404
Salt Lake City, Utah 84105-2316
(801) 524-5001

Survey protocol includes five parts: 1) survey need, 2) survey types, 3) survey quality, 4) survey time period, and 5) qualifications of the surveyor.

Survey Need: The desert tortoise may occupy numerous habitat types within its range in the Mojave and Colorado deserts and below an elevation of 5000 feet. In these areas there is a likelihood of encountering desert tortoises or tortoise sign. If the federal agency does not know if the proposed project occurs within the range of the desert tortoise, please request a species list from the Fish and Wildlife Service office listed above that has jurisdiction over the project area. If the Fish and Wildlife Service species list includes the Mojave population of the desert tortoise, this means the desert tortoise may be present within or near the project area.

The following criteria have been developed by the Fish and Wildlife Service to assist federal agencies in their determination of "may affect" for the desert tortoise: 1) desert tortoise habitat on the project site, 2) desert tortoise habitat adjacent to the project site such that the project area may overlap the home range of a desert tortoise, or 3) project would introduce direct or indirect disturbance to desert tortoise habitat (e.g., roads). Desert tortoise habitat is defined as areas with presence of tortoises or tortoise sign within areas likely to be home range, dispersal corridors, or habitat identified in the recovery plan. If the project area and adjacent areas meet one of these three criteria or if any tortoise sign (e.g., live tortoises, shells, bones, scutes, limbs, scats, burrows, pallets, tracks, egg shell fragments, courtship rings, drinking sites, mineral licks, etc.) is known to occur in the project area or adjacent areas, then the proposed project "may affect" the desert tortoise and consultation with the Fish and Wildlife Service should be initiated.

Please note that all free-roaming desert tortoises located north and west of the Colorado River are protected under the Endangered Species Act. For example, the desert tortoise that on occasion occurs above 5000 feet or in pinyon-juniper woodland would be protected under the Endangered Species Act.

The next step is for the federal agency to determine the likelihood of an adverse effect to the desert tortoise from implementation of the proposed project. If the proposed action may adversely affect the desert tortoise, formal consultation is required unless, as a result of the preparation of a biological assessment or as a result of informal consultation with the Fish and Wildlife Service, the federal agency determines, with the written concurrence of the Fish and Wildlife Service, that the proposed action is not likely to adversely affect the desert tortoise or critical habitat.

As mentioned above, the presence of a desert tortoise within the project boundary is not necessary for the project to result in the take of the desert tortoise. For example, a desert tortoise may be present in the Zone of Influence and may use the project site for feeding, breeding, or shelter. The Zone of Influence is defined as the area where tortoises on adjacent lands may be directly or indirectly affected by project exploration, construction, maintenance, operation, monitoring, dismantlement, enhancement, and project abandonment. Destruction of tortoise habitat used for feeding, breeding, or shelter is considered take under the Endangered Species Act.

For formal consultation, that is, projects that may adversely affect the desert tortoise, the Fish and Wildlife Service recommends the following protocols:

> For a surface disturbance project that would result in the clearing or crushing of vegetation (e.g., roads, buildings, excavation or fill sites, utility towers, water improvements, driving overland for land surveying and other activities, etc.) the federal agency should conduct a Presence-or-Absence Survey (100 percent survey) for desert tortoises and tortoise sign over the entire project area and the Zone of Influence adjacent to the project area. (See Survey Types below.) The

survey information would be used to develop a reliable incidental take statement as required in the biological opinion. Depending on the type of project, a Clearance Survey (see below) in occupied tortoise habitat may be necessary. The Fish and Wildlife Service requests that survey results (i.e., copies of the completed transect forms) be submitted to the appropriate Service office within 30 days of completion or with the request for formal consultation. If not included in the biological assessment or biological evaluation this information may be requested in the biological opinion.

For a management project that would result in modification of very large areas of desert tortoise habitat (e.g., grazing), the federal agency should coordinate with the Fish and Wildlife Service to develop an alternative method for surveying for desert tortoises and their sign. This method should consider variations in habitat quality within the project area, the natural history of the desert tortoise, and be statistically acceptable. The survey information would be necessary to develop a reliable incidental take statement as required in the biological opinion. Depending on the type of project, a Clearance Survey (see below) in occupied tortoise habitat may be necessary. The Fish and Wildlife Service requests that survey results be submitted to the appropriate Service office within 30 days unless the federal agency initiates formal consultation. If not included in the biological assessment or biological evaluation this information may be requested in the biological opinion.

If (1) the federal agency has determined that the proposed project is not likely to adversely affect the desert tortoise because the project area is not considered tortoise habitat, and (2) a desert tortoise or tortoise sign (shells, bones, scutes, limbs, burrows, pallets, scats, egg shell fragments, tracks, courtship rings, drinking sites, mineral licks, etc.) are found in the project area during implementation of the proposed action, the proposed action should immediately stop and the federal agency determine whether formal consultation is necessary to comply with the Endangered Species Act. The Fish and Wildlife Service recommends that the federal agency notify us in writing within three (3) days of the discovery. This short notification period will help ensure a prompt response by the Fish and Wildlife Service to facilitate compliance with the Endangered Species Act.

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Fish and Wildlife Service Survey Protocol for Desert Tortoises and Bureau of Land Management Categories of Desert Tortoise Habitat: The Bureau of Land Management has developed category maps for desert tortoises to assist the Bureau in managing public lands for the tortoise within the Bureau's multiple use mandate. Bureau maps were not developed to provide information on how to avoid take of the desert tortoise or comply with the federal Endangered Species Act. The Bureau has assigned three categories to their maps on desert tortoise habitat. These categories reflect the quality of tortoise habitat, quantity of tortoises present, and the Bureau's ability to manage these areas for the desert tortoise while minimizing resource conflicts. For example, Category 1 is considered better for tortoises than category 2. However, category 3 areas may contain high quality tortoise habitat and high density of tortoises, but because of resource conflicts the Bureau has assigned the area to category 3.

If an area is not classified on the Bureau's maps as category 1, 2, or 3, this does not mean that this area does not contain desert tortoises or is not considered desert tortoise habitat. The Bureau did not categorize lands that it does not manage such as military reservations or private lands. Also, the Bureau did not categorize lands in many areas that have densities of desert tortoises less than 20 per square mile. Thus, if a proposed project is not located in an area categorized as category 1, 2, or 3 by the Bureau, the project may still be located in desert tortoise habitat if it is in the desert and below 5000 feet.

Survey Types: Two types of surveys are recommended: 1) Presence-or-Absence and 2) Clearance. Neither survey utilizes the 1.5-mile triangular transect survey method developed by the Bureau of Land Management. This triangular transect method has not provided reliable information on the number of desert tortoises that would be incidentally taken as a result of implementation of the proposed project and thus is not adequate for meeting the requirements of the Endangered Species Act.

Presence-or-Absence: This survey type is recommended for all potential desert tortoise habitats. A Presence-or-Absence Survey equivalent to that described below would be requested for habitats thought to be outside suitable habitat for the desert tortoise if tortoise sign is found within these habitats located within the project area.

The purpose of this survey is to determine impacts of potential land disturbance activities or land management activities to the local tortoise population. This includes identifying the number and location of all tortoises and tortoise sign that occur within a given project area or selected area and if any tortoises occur in adjacent areas whose home range may overlap into the project area and thus be lost or harassed by the proposed action.

The project area is defined as any area that will be cleared or partially cleared, with vehicles on or adjacent to it, temporarily or permanently used for equipment or materials storage, loading or unloading, or sites where soils/vegetation is damaged, fragmented, or disturbed (e.g., driving overland).

The entire project area is surveyed using belt transects 10 yards or 30 feet wide (100 percent coverage). In some locations, belt transects less than 30 feet wide may be appropriate (see below). In addition, the Zone of Influence is surveyed. The Zone of Influence is defined as the area where tortoises on adjacent lands may be directly or indirectly affected by project exploration, construction, maintenance, operation, monitoring, dismantlement, enhancement, and project abandonment. As a minimum, the belt transects in the Zone of Influence are located at 100, 300, 600, 1200, and 2400-foot intervals from and parallel to the edge of the project boundaries. (See Figures 1 and 2.) All tortoise sign (live tortoises, shells, bones, scutes, limbs, scats, burrows, pallets, tracks, egg shell fragments, courtship rings, drinking sites, mineral licks, etc.) within the project area and sign located on transects within the Zone of Influence should be mapped.

The extent of the Zone of Influence is dependent on the type of habitat alteration/development and its proximity to other developments. The extent of the Zone of Influence increases as the probability of increased use by domestic predators, potential human use in the Zone, road creation and use, littering, waste disposal, etc. These uses result in increased take of desert tortoises through predation, collection as pets, vandalism, road kills, and attracting predators such as ravens, coyotes, and feral dogs to the area.

Figure 1. Example of a proposed transmission line including areas with full (100 percent) survey coverage for desert tortoises (construction area) and locations of transects within the Zone of Influence.

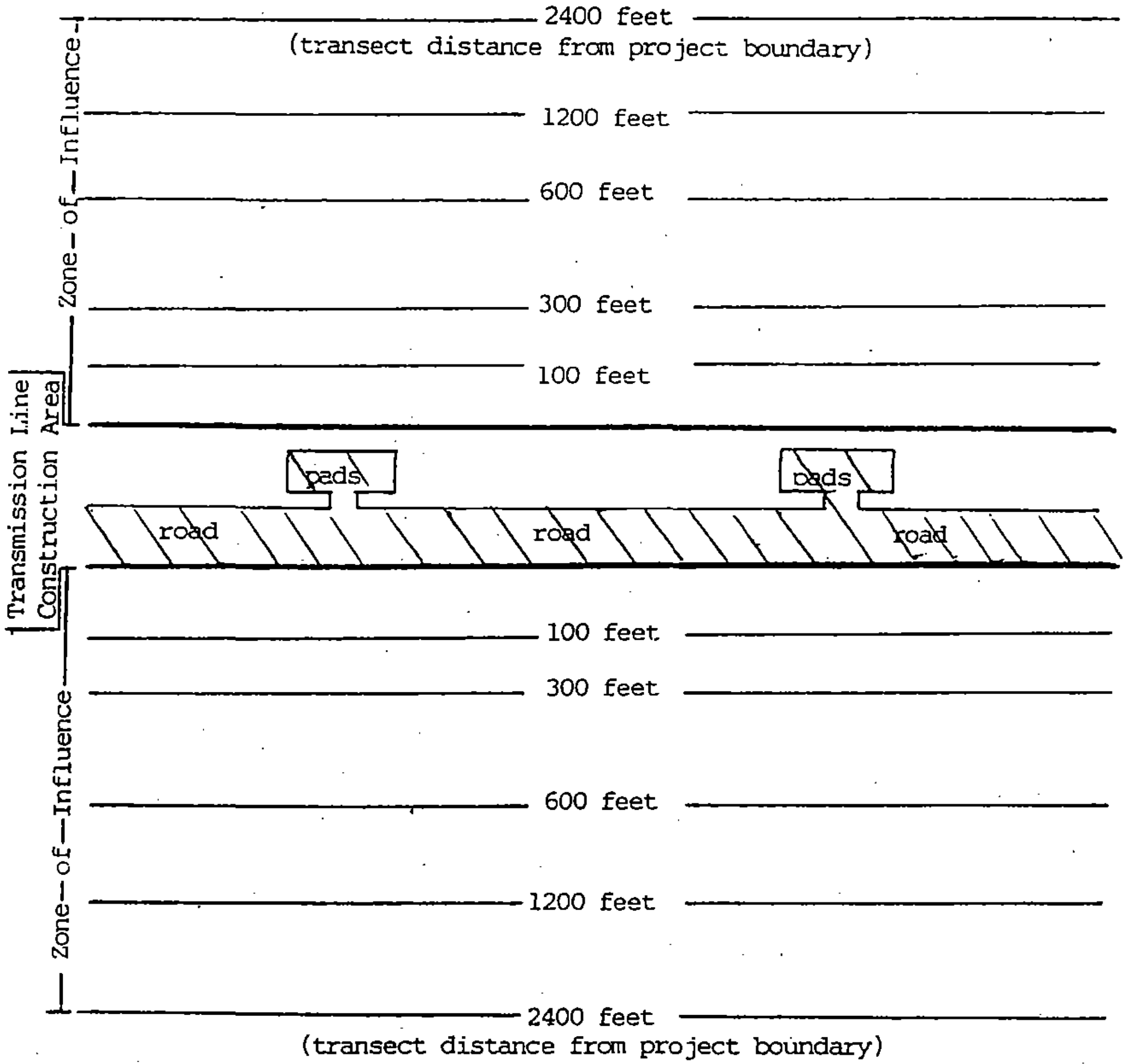
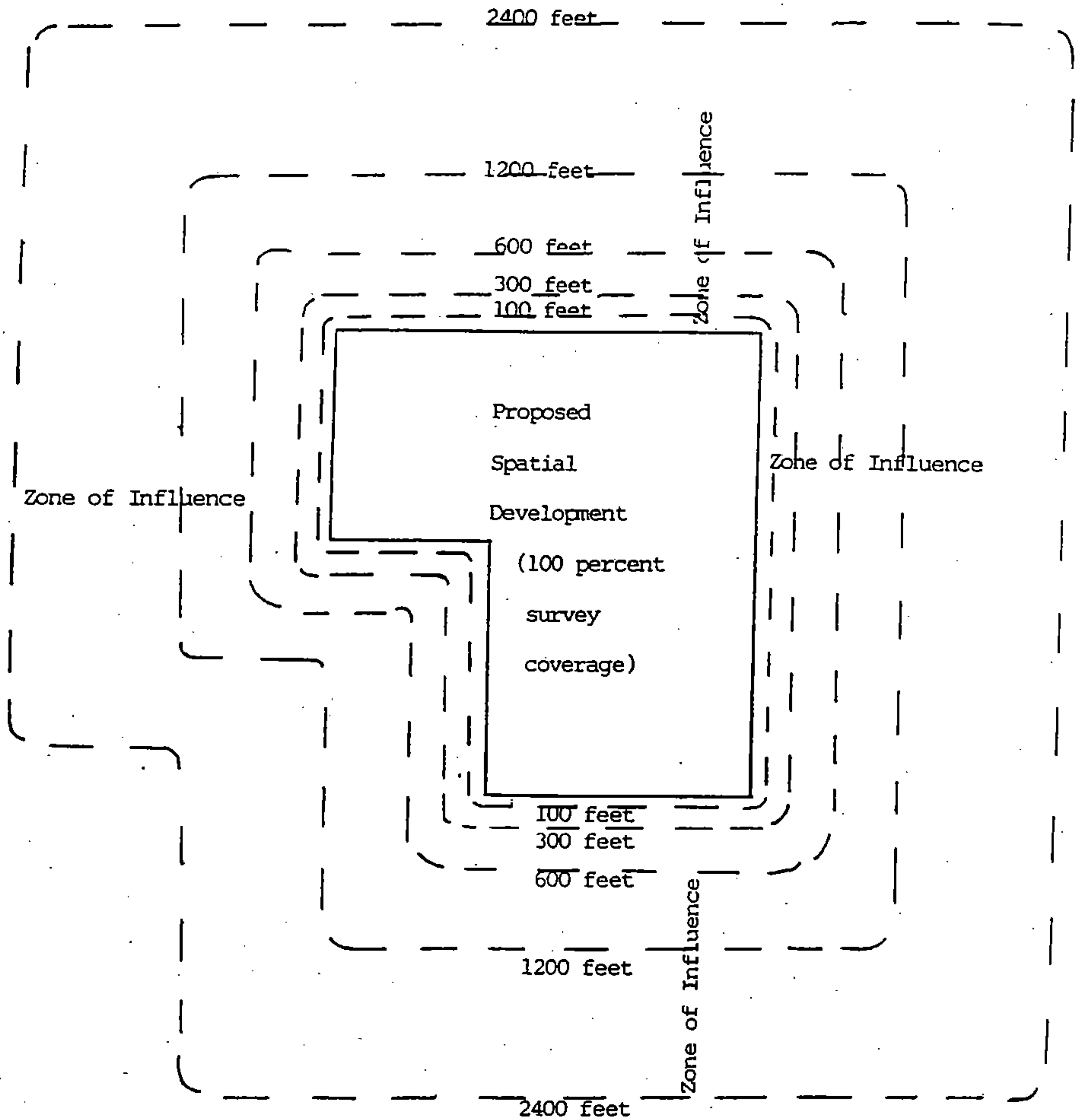


Figure 2. Example of a proposed spatial development (e.g., residential development, commercial development) with full (100 percent) survey coverage for desert tortoises and locations of transects within the Zone of Influence.



Additional transects may be recommended at 3600- and 4800-foot intervals from the perimeter of the project area for developments 1) located in or within one mile of categories 1 or 2 habitats as defined by the Bureau of Land Management or 2) associated with residential development, new or increased road use, landfills, or projects that would result in increases in human use or litter.

For example, if a project area is 640 acres or one square mile, 176 parallel transects each one mile long and 30 feet wide would be necessary to provide 100 percent coverage of the project area. Additional transects would be necessary to survey the adjacent areas or Zone of Influence.

If the project area contains locations with vegetation or topography that obscures or reduces that surveyor's ability to see tortoise sign at distances of up to 15 feet on the ground, the width of the survey should be reduced to 10 feet, that is, 5 feet on either side of the surveyor. Some examples of situations where a 10-foot wide transect should be conducted instead of a 30-foot wide transect would be: 1) foothills and slopes of mountains which contain rocks, boulders, and/or vegetation that obstruct the surveyor's view of the ground at distances greater than 5 feet, and 2) areas in which the vegetation density is greater than that of typical creosote or creosote/bursage flats or bajadas in the Mojave Desert such as desert wash scrub or woodlands and ecotones between habitat types. In these areas the surveyor's view of the ground and tortoise sign, if present, would be obstructed and a 30-foot wide transect would not be acceptable.

When mapping tortoise sign, the recommended map scale is 1 inch=100 feet for plans involving ground disturbance and 1 inch=1000 feet for preliminary planning (master planning or specific planning). These map scales are based on those frequently required by city or county planning departments. The map should include locations and specific types of all tortoise sign found on the project area and Zone of Influence including the number live tortoises, reference to the corresponding transect form with additional information on tortoise sign found, significant landmarks, legal description of the project area, survey dates, and the range of elevation within the project boundaries. Please note that a federal Fish and Wildlife License/Permit is required before a surveyor can capture, touch, or "harass" a live desert tortoise even for the purposes of taking measurements or determining its sex. A permit may also be required from the appropriate state wildlife resource agency (e.g., Arizona Game and Fish

Department, California Department of Fish and Game, Nevada Department of Wildlife, Utah Division of Wildlife Resources). **The Fish and Wildlife Service emphasizes that the surveyor should only estimate the size of all live desert tortoises encountered.**

If the surveyor wishes to use a fiber-optic scope or video camera that is placed inside a tortoise burrow instead of or in addition to a hand-held mirror to investigate desert tortoise shelter sites, you should contact the Fish and Wildlife Service at one of the offices listed above. We will need information on the type of equipment you will be using and your qualifications to use it. Improper use of such equipment may disturb or injure tortoises, damage the shelter site, and may promote the spread of disease. These actions may be considered take under the Endangered Species Act. You should refer to the Desert Tortoise Handling Protocols for information on when and how to utilize these scopes to avoid the possible transmission of disease between tortoises.

The following format is recommended for recording transect data. (See Figure 3.) This format has been modified from the Bureau of Land Management's Interim Techniques Handbook for Collecting and Analyzing Data on Desert Tortoise Populations and Habitats. One form is used for each transect where tortoise sign occurs. Pages 1, 2, and 3 of the form would be completed for each transect in the project site and the Zone of Influence where tortoise sign occurs. If additional space is needed, more forms may be used for each transect and stapled together.

If no tortoise sign is located during Presence-or-Absence Surveys, we recommend that the surveyor complete and submit summary form(s) (Figure 4) to the appropriate Fish and Wildlife Service office listed above.

Please do not collect any desert tortoise sign. Tortoise scats may be used by tortoises to mark or identify travel areas and shelter sites. Tortoise shells may be an important source of minerals for reptiles and mammals.

Figure 3. Desert tortoise survey form for Presence-or-Absence and Clearance Surveys (4 pages).

January 1992

M/D/Y

Date__________
Transect No.__________
State__________
County__________
City__________
Recorder__________
Project Name__________
____
Parcel No.__________

INFORMATION ON SHELTER SITES

(Please indicate why you believe a shelter site is active or inactive[1])

Sign No.	Type	Location	Width	Estimated Length	Other Sign

Condition of Shelter Site[1]/Comments

CONDITION OF SCATS[2] - COMMENTS (See below)

CONDITION OF SHELL REMAINS[3] - COMMENTS (See below)

SIGNS OF HUMAN DISTURBANCE-COMMENTS

Show locations of types of tortoise sign on transect line below:

Drawing: Scale 1 in = ______ft Drawing or Map Reference No.___________ Transect No. ________
Recorder____________ Date______ Parcel No._________ Location_______________________

INFORMATION INDEX FOR DESERT TORTOISE SIGN
Burrows and Dens, Scats, and Shell Remains

[1]Burrows and Dens:
1. currently active, with tortoise or recent tortoise sign
2. good condition, definitely tortoise; no evidence of recent use
3. deteriorated condition (please describe); definitely tortoise
4. deteriorated condition; possibly tortoise (please describe)
5. good condition; possibly tortoise (please describe)

[2]Scats:
1. wet (not from rain or dew) or freshly dried; obvious odor
2. dried with glaze; some odor; dark brown
3. dried; no glaze or odor; signs of bleaching (light brown), tightly packed material
4. dried; light light brown to pale yellow, loose material; scaly appearance
5. bleached, or consisting only of plant fiber

[3]Shell Remains:
1. fresh or putrid
2. normal color; scutes adhere to bone
3. scutes peeling off bone
4. shell bone is falling apart;growth rings on scutes are peeling
5. disarticulated and scattered

Figure 4. Desert tortoise summary form for Presence-or-Absence and Clearance Surveys (3 pages).

January 1992

(place a 4 X 6 photograph showing the area where the transect was conducted)

M/D/Y
Date ________
Transect No. ________
State ________
County ________
City ________
Recorder ________
Address ________
Project Name ________
Type of Project ________
____
Quad Name ________
Scale ________
Site Name ________
T____ R____ Sec____
¼ Sec____ ¼¼ Sec____
UTM Zone ________
Northing ________
Easting ________
Parcel No. ________

This form should be completed for those transects that contain one or more desert tortoise sign. After the project site and Zone of Influence have been surveyed for tortoise sign, the results from the transect forms should be compiled on a summary form.

If no tortoise sign occurs on the project site or Zone of Influence, the summary form should be completed. Please fill in all sections on the top 2/3 of the page of the summary form.

DESERT TORTOISE HANDBOOK 1992: FORM FOR PRESENCE-OR-ABSENCE AND CLEARANCE SURVEYS

Project Site | | Zone of Influence | | _____ft from Project Site
Transect Length: _____ft Width: 30 ft Other _____ft Time ________
Weather: Airtemp at: 5 cm____°C Surface____°C Cloud cover_____%
Rainfall_____in Wind speed_____ Rainfall in last 30 days_____in
Land Form (e.g., mesa, bajada, wash)________________
% Slope: high______ low______ Aspect______ Elevation________ft
Soils________________
Vegetation: dominant perennials________________
____
dominant annuals________________
____
Adjacent Land Use: up to 1 mi________________
Soils________________
Vegetation________________

TOTAL NUMBER OF

Corrected Sign	Live Tortoises Adult/Juv.	Shelter Sites Pallet/Burrow/Den Active/Inactive [1]	Scats [2]	Shell Remains [3]
	A= J=			A= J= Unk= M= F= Unk=

Tracks	Eggshell Fragments	Drinking Sites	Courtship Rings	Other	Neotoma Middens w/sign :w/o sign
					:

SIGNS OF HUMAN DISTURBANCE - NUMBER AND TYPES SEEN

Tire Tracks	Human Footprints	Dog Sign	Trash	Dump Sites	Shotgun/ Rifle Shells	Blading	Ravens	Other

SUMMARY FORM (continued) FOR PRESENCE-OR-ABSENCE AND CLEARANCE SURVEYS FOR DESERT TORTOISE SIGN

Comments/Drawings

INFORMATION INDEX FOR DESERT TORTOISE SIGN
Burrows and Dens, Scats, and Shell Remains

[1]Burrows and Dens:
1. currently active, with tortoise or recent tortoise sign
2. good condition, definitely tortoise; no evidence of recent use
3. deteriorated condition (please describe); definitely tortoise
4. deteriorated condition; possibly tortoise (please describe)
5. good condition; possibly tortoise (please describe)

[2]Scats:
1. wet (not from rain or dew) or freshly dried; obvious odor
2. dried with glaze; some odor; dark brown
3. dried; no glaze or odor; signs of bleaching (light brown), tightly packed material
4. dried; light light brown to pale yellow, loose material; scaly appearance.
5. bleached, or consisting only of plant fiber

[3]Shell Remains:
1. fresh or putrid
2. normal color; scutes adhere to bone
3. scutes peeling off bone
4. shell bone is falling apart;growth rings on scutes are peeling
5. disarticulated and scattered

Clearance Survey: For projects located in areas with habitat used by desert tortoises, especially those projects with a linear band of disturbance (e.g. pipelines, roads, transmission lines), a Clearance Survey may be required as part of the Terms and Conditions of a biological opinion to reduce incidental take of the desert tortoise. The purpose of the survey would be to temporarily relocate or salvage tortoises from the area of construction and any other area deemed necessary to avoid or minimize the death of desert tortoises that may be caused by the project. A Clearance Survey would require full coverage of the project area, and would focus on locating all desert tortoises above and below ground within the project area. This survey would be conducted immediately prior to surface disturbance at each site within the project area. The survey period may be stipulated in the Terms and Conditions of the biological opinion to reduce the incidental take of desert tortoises.

Survey Quality: To determine the accuracy of the surveyor in locating desert tortoise sign during Presence-or-Absence Surveys for each project area, the Fish and Wildlife Service recommends that the surveyor conduct an intensive survey in a portion of the project area following completion of the 100 percent survey. The size of the intensive survey area is 5 percent of the size of the project area. The intensive survey area would also receive 100 percent coverage using transects 10 feet wide rather than 30 feet or 5 feet wide rather than 10 feet wide. The location of the intensive survey would be plotted on the map and a comparison made between the sign recorded in this area during the 100 percent survey effort and the intensive survey effort. The quality or accuracy of the survey for the project area will be determined by comparing these two data sets for this area.

If the surveyor does not meet the minimal qualifications stated below or if there is a major difference in number of sign recorded between the intensive survey effort and the 100 percent survey effort, the survey may not be deemed adequate by the Fish and Wildlife Service.

If the survey results do not include the Zone of Influence, the Fish and Wildlife Service may not concur with the survey results.

__Qualifications of Surveyor__: The Fish and Wildlife Service does not endorse any individual or company with respect to their abilities to conduct satisfactory surveys. We recommend the following criteria for selecting someone to conduct surveys to determine presence or absence of desert tortoises in a given area or recent use of the area by the desert tortoise.

As a general rule, a qualified desert tortoise surveyor is a biologist with a bachelors degree or graduate degree in biology, ecology, wildlife biology, herpetology, or related fields. He/she must have demonstrated prior field experience using accepted resource agency techniques to survey for desert tortoises. Field experience may mean a minimum of 60 days field experience searching for desert tortoises and tortoise sign.

The surveyor should have the following qualifications for the survey results to be accepted by the Fish and Wildlife Service: 1) ability to recognize and accurately identify __all__ types of desert tortoise sign listed above, and 2) ability to carefully, legibly, and completely record all sign including size of shelter sites, shells, and estimated size of live tortoises.

__Survey Time Period__: Survey time for determination of "may affect" is not limited. Survey time for Presence-or-Absence Surveys is limited to the following approximate activity period of the desert tortoise, March 25 to May 31. This survey time may be extended by the Fish and Wildlife Service if tortoises on or near the project area have been observed above ground prior to March 25 or after May 31.

This survey window is based on the activity period for the desert tortoise throughout its range during a typical year and equates to the period of time when a tortoise is not brumating or aestivating. During dry years this activity period may be shorter and in wet years it may be longer. Desert tortoises may also become active during and after summer rains.

Surveys conducted outside this window will be subject to close scrutiny by the Fish and Wildlife Service. The Service may consider the results of these surveys as under-representing the number of tortoises on and use of the project site by desert tortoises.

Presence-or-Absence or Clearance surveys should only be conducted during daylight hours.

The Fish and Wildlife Service considers the results of a Presence-or-Absence Survey, including the Zone of Influence, to be valid for no more than one year. This time period of survey data reliability may be significantly reduced depending on project size, location, or proximity to other land disturbance.