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Final

WHITE SANDS MISSILE RANGE RANGE-WIDE ENVIRONMENTAL IMPACT STATEMENT

January 1998

White Sands Missile Range, New Mexico
Directorate of Environment and Safety
Environmental Services Division
WSMR, New Mexico 88002

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The proposed action is to continue and expand capabilities at White Sands Missile Range. This action would include testing of current systems and maintaining the current White Sands Missile Range infrastructure plus expanding mission capabilities into areas that would accommodate future needs. This document is a part of a larger system White Sands Missile Range will be using to manage its testing in relation to environmental stewardship. The White Sands Missile Range Environmental Impact Statement will be tiered for subsequent activities that are not covered in this document.

The Environmental Impact Statement addresses, to the extent possible, the potential impacts that would result from activities related to current and future testing at White Sands Missile Range. Environmental resource areas evaluated include air quality, transportation, biological resources, cultural resources, geology, hazardous wastes, noise, land use, socioeconomics, and water resources.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

White Sands Missile Range (WSMR), a Department of Defense major range and test facility located near Las Cruces, New Mexico, possesses unique characteristics required by the U.S. Army, U.S. Navy, U.S. Air Force, National Aeronautics and Space Administration (NASA), and other federal and commercial testing concerns to conduct safe, large-scale experiments on advanced weapons and space flight systems. The National Environmental Policy Act (NEPA) process is intended to help public officials make decisions based on an understanding of environmental consequences. The NEPA process also must ensure that the public and public officials are fully informed about the proposed action and have a meaningful opportunity to participate in the process before decisions are made and actions taken. In order to address these requirements, WSMR has prepared this range-wide Environmental Impact Statement (EIS).

This summary provides an overview of the entire EIS. It begins with a brief discussion of the organization of the EIS, then presents background data, followed by a synopsis of the proposed action. The environmental consequences of the proposed action are then briefly contrasted with the no action alternative as a basis for comparison. This summary concludes with a listing of basic mitigation measures in the proposed action to minimize potential environmental impacts.

Chapter 1 provides an overview of the proposed action and its benefits. Chapter 2 provides a more detailed description of the proposed action and its consequences, including mitigation measures, together with a description of the no action alternative and alternatives considered but not analyzed. Chapter 3 describes the affected environment at WSMR. Chapter 4 provides the analysis of consequences of the proposed action and the no action alternative. This analysis is the basis for the conclusions presented in Chapter 2. All mitigation measures in the proposed action are identified in Chapter 2 and are further developed in Chapter 5. Additional mitigation actions that developed through the public review process and measures that are proposed to supplement those in the EIS are also found in Chapter 5. The remaining chapters and the appendices provide information about preparers of this document, the cooperating agencies, references used to develop the analyses in this EIS, and other useful information.

BACKGROUND

Rapid changes in the character of advanced weapons and spaceflight systems present new challenges to WSMR in hosting research for and tests of these new systems. WSMR must be prepared to respond efficiently and flexibly to these variable conditions. This EIS is intended to assist WSMR in developing such responses while minimizing the environmental impacts of missions at WSMR. WSMR covers approximately 8,288 km^2 (3,200 mi^2) in south-central New Mexico (Bingham, pers. com. 1994). WSMR is the largest, all-overland test range in the United States. The range itself, together with adjacent extension and off-range use areas, is diverse with respect to environmental attributes such as geology and soils, weather patterns, and biological and cultural resources, as described in Chapter 3.

The primary mission of WSMR is the operation of a National Range in accordance with direction from the U.S. Army Test and Evaluation Command (TECOM). This mission includes the conduct of instrumentation research and development, and the development of U.S. Army, U.S. Navy, U.S. Air Force, NASA, and Defense Nuclear Agency systems.

The U.S. Army is the executive management agent for the facility, but both the U.S. Air Force and the U.S. Navy are afforded special status at the installation through the creation of service deputies. These deputies assist the WSMR Commander in maintaining a focus on the the-service nature of the facility. In 1995, the work force at WSMR totaled 7,713 and consisted of 3,640 civil service employees, 786 military personnel, and 3,287 contractor employees in support of these management responsibilities. WSMR operations include administrative and logistical support and technical support for more than 25 tenant organizations. WSMR collectively supports approximately 5,000 missions per year for these tenant organizations and other participating agencies.

PURPOSE AND NEED FOR THE PROPOSED ACTION

WSMR is the largest, all-overland test range in the United States. It is an extensive and complex range consisting of launch sites, target areas; instrumentation, buildings, equipment, and personnel. These unique characteristics are needed by the U.S. Army, U.S. Navy, U.S. Air Force, NASA, and other federal and commercial testing concerns to conduct safe, large-scale experiments on advanced weapons and space flight systems. Changes in the character of advanced weapons systems present new challenges to WSMR in hosting research and tests of these new systems. WSMR must be prepared to respond efficiently and flexibly to these variable conditions. The proposed action provides the testbed flexibility required to meet these challenges.

SUMMARY OF THE PROPOSED ACTION

The proposed action of this EIS is the long term operation of WSMR with the proposed adoption of specific mitigation measures for the continuation of existing programs and the future testing of scientific, military, and commercial systems. This proposed action includes two major components. The first component is the continuation of current project activities and existing operations and services including routine maintenance; modernization or removal of outdated facilities; and improvements in infrastructure, utilities, and services as necessary. The second component consists of changes in the number of projects and programs planned for the next 10-year period, with resulting changes in site usage and services. The proposed action includes adoption of mitigation measures to reduce the effect of White Sands Missile Range activities on the environment. These measures are further explained below and are identified throughout this document.

OTHER ALTERNATIVES

The no action alternative is the other primary alternative considered. This alternative represents the status quo. Under this alternative White Sands Missile Range would remain a viable National range which supports missile development and test programs for the Army, Navy, Air Force, National Aeronautics and Space Agency (NASA), other government and private organizations. Chapter 1 of the White Sands Missile Range Environmental Assessment (1985) describes the current activities at White Sands Missile range. The no action alternative is the continuation of existing missions and operations at approximately their current scope and rates, but without the adoption of specific mitigation measures identified in Section 2.4 and Chapter 5, except for the Geographic Information System (GIS) and the Decision Analysis System (DAS) which are being implemented as an environmental management system applicable to the proposed action and the no action alternative.

The alternative of closing WSMR is considered to be out of scope of this analysis. There are no Congressional or U.S. Army indications that this option is contemplated. A special NEPA process to address the shutdown and conversion of military bases has been established for such analyses.

The other preliminary alternative identified for consideration in the Notice of Intent (NOI), but not further analyzed in the EIS, focuses on testing of future systems and expansion of the mission into nuclear effects testing and launches into WSMR from off the range. Ongoing simulated nuclear effects testing is included in current operations and is analyzed accordingly in this EIS. (This research is more accurately referred to as nuclear effects simulation. It does not involve the testing of actual nuclear weapons.) A parallel NEPA process has been implemented with respect to current off-range launches into WSMR and is briefly discussed in Section 1.5.

GENERAL MITIGATION MEASURES

Project proponents will use the WSMR Decision Analysis System (DAS) and Geographic Information System (GIS) during the planning stage to assist in identifying the appropriate level of NEPA documentation, to plan projects so as to minimize environmental impacts, and to identify any additionally required mitigation measures. The DAS/GIS is an integrated, currently operable system which is modified as the need dictates. The WSMR master planning process will continue, including periodic review, updates, integration of the DAS/GIS, and adherence to the plan as a decision-making tool. WSMR historically and currently implements management practices for the conservation of sensitive natural resources, including wildlife, endangered species, and wetlands. These management practices will continue to be applied to all sensitive natural resources within WSMR. Best management practices and common erosion control techniques will be used in ground disturbing activities. These practices have general application: they minimize water contamination by overland flow, reduce soil loss by wind and water erosion, reduce the period of recovery in restoration efforts, reduce visual and aesthetic impacts, help minimize extent and duration of habitat loss, and in many other ways assist in environmental management.

These same mitigation measures will be integrated into the DAS/GIS components of the Environmental Analysis System (EAS) as explained in Chapter 1. This will provide future project proponents with environmental information, site location decision support, and regulatory approval at significant cost savings and with improved efficiency. As a result, WSMR will be better able to protect, restore, and enhance the range environment as it more effectively supports its operational mission.

MITIGATION MEASURES IN THE PROPOSED ACTION

The mitigation measures proposed as integral components of the proposed action are critical to its effective implementation. They are designed to minimize or eliminate the potential for adverse consequences, particularly but not exclusively the cumulative consequences, that arise from the ongoing operation of large testing activities at WSMR. A summary of general mitigation measures in the proposed action are found in Section 2.4. Resource- and issue-specific mitigation measures are presented in Chapter 5. Subsequent project-specific activities with potential impacts will still require separate environmental analysis which may entail additional, specific mitigation measures.

The following mitigation measures by resource are incorporated into the proposed action. The mitigation measures included in the proposed action are those that can be identified at the present time using available information. The WSMR Environmental Services Division may require future project proponents to adopt additional mitigation measures depending on project-specific data and on additional data that will be collected in relation to environmental resources at WSMR.

Geology and Soils

Once vegetation is removed from an area or a route into a recovery area, the same route will be used for subsequent entries, to the extent possible, to minimize the damage throughout the area and to minimize the need for repeated environmental surveys for entry routes into the same locale. Appropriate landscaping and building design techniques will be employed to prevent water/wind erosion caused or increased by permanent or long-term structures.

Hydrology/Water Resources

Best management practices and common erosion control techniques will be used in ground disturbing activities. Stormwater management strategies will be implemented as prescribed in the latest stormwater management plans for the various WSMR facilities, or per the Environmental Protection Agency (EPA) under National Pollutant Discharge Elimination System regulatory compliance guidelines. Specific monitoring requirements will be implemented for the Main Post and selected outlying impacted areas. All necessary equipment, personnel, and training will be maintained as necessary to ensure compliance with the Spill Prevention Control Plan. Engineering and planning programs will continue to anticipate future water and wastewater system improvements, and utility upgrades.

Air Quality

Notice of Intent (NOI) forms and permit applications will be filed with the New Mexico Air Quality Bureau for any emissions source requiring New Mexico Air Quality Bureau notification or permitting.

Dust suppressants will be used to suppress fugitive dust generation during maintenance of extensive exposed surfaces of soils known to generate nonpoint fugitive dust emissions. Additional mitigation measures to reduce the adverse air quality impacts of fugitive dust sources will include minimization of new roads and the reclamation, including revegetation, of old roads and cleared areas.

Ambient air monitoring will be maintained during and after laser testing at the High Energy Laser System Test facility.

As a part of documentation planned to supplement this EIS, WSMR will collect air quality data to assess the cumulative impact of the no action alternative and to analyze the cumulative impacts of the proposed action.

Biological Resources

A variety of lowland and mountain habitats occur within WSMR. The majority of these habitats are dominated by desert vegetation. Wetlands occur on WSMR, but they make up only a small portion of the total habitat (less than two percent – see Table 3-23). There is a notable absence of jurisdictional wetlands on WSMR. Information currently exists on a number of these wetland sites. In some cases, such as Salt Creek, water quality data is currently being gathered and a long-term monitoring program has been established. As activities on WSMR continue, additional data on wetland sites will be gathered. In any instance where there is a question of possible impacts to wetlands, WSMR will request review by the U.S. Army Corps of Engineers (COE) and EPA for Section 404 of the Clean Water Act permit applicability, and permit review and certification by NMED under Section 401 of the Clean Water Act. The location and type of any wetlands within proposed project areas will be determined. Potential impacts will be analyzed and verified with field investigations. Any activities potentially affecting jurisdictional wetlands will be reviewed for permit applicability by COE and EPA under Section 404, and by the NMED for state review and certification under Section 401. Wherever practicable, WSMR will avoid impacts to jurisdictional wetlands. If avoidance of wetlands is not practicable, then WSMR will implement measures to mitigate impacts to wetland sites. Mitigative measures will be site specific and developed on a case-by-case basis in coordination with the COE, U.S. Fish and Wildlife Service (USFWS), and EPA. The measures may include enhancement or enlargement of existing wetlands or potentially the creation of new wetlands.

Beginning with but not limited to a DAS/GIS data base review, surveys for threatened and endangered species will be undertaken in undocumented or inadequately surveyed areas where ground disturbing activities will occur and where suitable habitat exists. A qualified biologist will monitor all construction operations involving critical habitat disturbance. Examples of such activity include, but are not necessarily limited to, soil test borings, road construction, excavation of building foundations, support structure installation, and related construction activities. All facilities will be sited to avoid or minimize potential harm to protected, threatened, and endangered plant and animal species. Siting of new access roads and subsequent road construction will consider potential habitat disturbance or destruction which could result from diversion of water run-off from existing drainage patterns. Potential impacts on sensitive species identified during project-specific surveys will be evaluated in NEPA documents tiered to this EIS. Mitigation or avoidance measures to minimize any potentially significant impacts will be identified in this NEPA document. The USFWS and the New Mexico Department of Game and Fish (NMDGF) will be contacted if any proposed action is anticipated to impact listed species, species proposed for listing, or under review for listing as endangered or threatened under the Endangered Species Act. All data gathered on threatened, endangered, and candidate species will be reported to the USFWS and the NMDGF to assist in sustaining status records. Proactive management efforts for the protection and enhancement of federally listed species will be developed in coordination with the USFWS and the NMDGF.

The greatest likelihood of significant adverse consequences to biological resources to arise during recovery actions requiring entry to previously unsurveyed areas. Recovery procedures are generally foreseeable and rarely constitute emergencies for the purposes of exceptions under environmental regulation. In order to meet minimum environmental protection requirements under NEPA and the Endangered Species Act during any recovery action outside of the approved and surveyed area, proposed entry routes and project-related disturbance areas will be reviewed through the DAS/GIS data base. In the event that overriding project or other environmental requirements prohibit an adequate survey, a biologist or other qualified representative from the WSMR Environmental Services Division will accompany the recovery team, if required. This individual will assist in the selection of an entry path that will minimize the potential for adverse impacts. In addition, this individual will identify any activity with potential impacts on sensitive resources and assist in avoiding those impacts. Off-road travel required for other activities will be minimized and coordinated with the WSMR Environmental Services Division. The WSMR Environmental Services Division may prohibit off-road travel in sensitive areas.

Range personnel will be instructed concerning the prohibition against taking, collecting, harassing, or injuring protected species. Site personnel or members of the public caught violating federal and state laws intended to protect biological resources will be referred to the appropriate authorities for prosecution. To the extent practicable, signs will be posted near protected habitat and WSMR entrances, warning of penalties for unauthorized harm to protected biological resources.

Socioeconomics

No potentially adverse socioeconomic effects of the proposed action or the no action alternative have been identified to date. Any proposals for major changes in WSMR programs that could affect regional community planning will be analyzed in the appropriate level of NEPA documentation, tiered to this document. These impacts will be assessed and reviewed with municipal and state officials to assist them in responding to any need for increases or decreases in community services or employment.

Cultural Resources

Project proponents will incorporate cultural resources, DAS/GIS data base reviews, surveys in undocumented areas, and monitoring programs into proposed projects at the earliest possible planning stage. This includes cultural resource surveys of areas where no data exist and that exhibit a valid potential for cultural resources. Cultural resources will be avoided if practicable; if not, data recovery will be conducted as directed by the WSMR Archaeologist in consultation with the New Mexico State Historic Preservation Officer (SHPO) under the existing Programmatic Memorandum of Agreement (PMOA). Potential impacts on cultural resources identified during project-specific surveys will be evaluated in NEPA documents tiered to this EIS. Mitigation or avoidance measures to minimize any potential adverse effects will be identified in the appropriate NEPA document.

During any recovery action in an unsurveyed area, proposed entry routes and project-related disturbance areas will be reviewed through the DAS/GIS data base and surveyed in advance, when practicable. In the event that overriding project or other environmental requirements preclude an adequate survey, an archaeologist or other qualified representative from the WSMR Environmental Services Division will accompany the recovery team, if practicable. This individual will assist in the selection of the entry path that will minimize the potential for adverse effects and will identify and assist in avoiding or otherwise record any activity with potential impacts on cultural resources. The WSMR Environmental Services Division will require project proponents to implement additional mitigation measures beyond those stated in the project NEPA document if an adverse effect is identified.

Off-road travel required for recovery actions and other activities will be minimized and coordinated with the WSMR Environmental Services Division. The WSMR Environmental Services Division may prohibit off-road travel in areas of sensitive cultural resources.

Before construction, firebreaks will be surveyed for sensitive resources and rerouted to avoid any resources discovered. Projects that could produce fires will be reviewed in advance to protect identified cultural resources eligible for inclusion on the National Register of Historic Places. The WSMR Environmental Services Division will inform fire control personnel of site marking techniques.

Mitigation of any potential impacts of construction on cultural resources will be accomplished through relocation of the project to avoid the resource site; fencing of the site to exclude vehicles and trespassers; or, if no alternative is available, by data recovery or other approved treatment designed to protect values for which the site is considered significant. To the extent practicable, signs will be posted around historic structures and, in rare instances, at prehistoric sites. Signs will be posted at WSMR entrances warning of penalties for unauthorized removal of cultural resources.

As described in Section 4.6.3, the WSMR Environmental Services Division will be notified immediately if any historic or archaeological resources are discovered during construction or other ground disturbing activities. Construction must halt in the vicinity of cultural resources per Section 9.C of the PMOA with the SHPO. The WSMR Archaeologist will assess any potential adverse effects and consult with the SHPO to determine an appropriate course of action. The final determination as to the adequacy of proposed mitigation measures would be made through consultation between WSMR and the SHPO's office.

All potential visual impacts to culturally sensitive areas related to proposed new facilities will be assessed by the WSMR Archaeologist in consultation with the NMSHPO.

The following measures will be taken to minimize impacts to visual resources:

- Final siting decisions for roads and structures will consider an evaluation of the placement of these facilities to preclude significant visual impact on Trinity Site National Historic Landmark and other sensitive areas.
- Final construction design and facility siting recommendations will be coordinated with the WSMR staff Archaeologist for follow-on consultation with the SHPO.
- To minimize visual impact, building and road sizes will be restricted to the smallest size consistent with sound engineering practices.

Land Use

No potentially adverse effects of the proposed action or the no action alternative on land use have been identified. As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized. Mitigation measures will be required if such impacts are identified. Scheduling conflicts will be resolved by coordination with the WSMR National Range Directorate.

Utilities and Infrastructure

No potentially significant adverse effects of the proposed action or the no action alternative on utilities and infrastructure have been identified to date.

WSMR will establish design parameters and equipment operating procedures to assure that peak electric loading is minimized, and that electric machines and other apparatus are efficient in design and maintained for efficient operation. Electricity studies will consider load sharing, off-peak operations, and scheduling constraints to assure that Range users would have required levels of electricity to meet time-sensitive missions.

Traffic and Transportation

No potentially significant adverse effects of the proposed action or the no action alternative on traffic and transportation networks have been identified to date. Cumulative and indirect impacts will be comprehensively analyzed in documentation proposed to supplement this EIS. Mitigation measures will be required if such impacts are identified.

Recreation

No potentially adverse effects of the proposed action or the no action alternative on recreation have been identified. As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized. Mitigation measures will be required if such impacts are identified.

Aesthetics and Visual Resources

No potentially adverse effects of the proposed action or the no action alternative on aesthetic and visual resources have been identified to date, although the potential is deemed likely in the long term. Any construction projects that would have impacts on viewscapes from buildings included in or eligible for the National Register of Historic Places (NRHP) would be planned to minimize such impacts. As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized. Mitigation measures will be required if such impacts are identified.

Noise

The public will continue to be excluded from areas where they could be exposed to potentially harmful noise levels. WSMR personnel are required to use hearing protection devices in any environment where they may be exposed to harmful noise levels. Warning signs are posted in areas where high noise levels may occur. Personnel are administered periodic hearing tests in compliance with U.S. Army hearing conservation programs.

On-range operations are conducted in remote areas to the extent possible. Any potential impacts of project-specific noise on wildlife will be addressed in project-specific NEPA documentation. Potentially significant impacts will be avoided. Restricted areas (such as the San Andres National Wildlife Refuge) where sensitive wildlife exists will be avoided by maintaining aircraft at 610 m (2,000 ft) above ground level (AGL).

Radiation Sources

The existing restrictions to public access and the safety procedures and monitoring for WSMR personnel will continue in order to prevent any exposure to harmful radiation levels. No potentially adverse impacts of radiation on wildlife have been identified. Concerns expressed by the National Radio Astronomy Observatory related to significant spectral electromagnetic interference from WSMR have been considered in this EIS. Additional attention to these concerns will be applied in follow-on analysis documentation proposed to supplement the EIS.

As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized. Mitigation measures will be required if such impacts are identified.

Hazardous Materials/Hazardous Waste

Several mitigation measures have been incorporated to reduce potential impacts associated with hazardous materials/waste management. These measures include the following:

- coordination of inspections by WSMR Environmental Services Division;
- upgrading aboveground storage tanks, underground storage tanks (USTs), and associated piping to reduce the potential for releases of stored fuels;
- installation of leak detection systems in USTs;
- begin implementation of a hazardous materials tracking and hazardous waste minimization plan;
- increasing safety and fire department inspections of hazardous material/waste storage and use areas and review of emergency contingency plans;
- upgrading of existing impoundments and inspection of impoundments to determine if hazardous materials are being or have been released into soil and groundwater;
- increasing efforts to remove and abate lead paint;
- begin implementing hazardous material reuse/use reduction where replacement with hazard-free substitutes is not feasible; and
- implementing in situ remediation of contaminated sites wherever possible, environmentally protective, and cost efficient.

Health and Safety

Health and safety planning and implementation are inherently mitigation functions. At WSMR, these functions have been proactive and comprehensive historically, both on and off the site. All WSMR operations require thorough health and safety planning at the earliest stages of facility planning and operational design. These health and safety requirements are implemented during all phases of operation, from initial construction, through the life of the facility, to final disposition. Through this approach, the vast majority of potential health and safety hazards are avoided entirely or reduced to extremely low probabilities. Despite these successful range-wide risk minimization efforts, the possibilities for unforeseen or improbable emergencies are not discounted. Emergency response planning and implementation also are given the highest priority at WSMR. Responsive emergency management is not a process limited to on-site operations at WSMR. Regional cooperation with a wide range of federal, state, and community law enforcement and emergency agencies is fundamental to achieve the necessary level of coordination, communication, and emergency services in the sparsely populated areas surrounding and including WSMR. WSMR has been and will continue to be a major component in the integrated interagency regional emergency response capability in south central New Mexico. WSMR health and safety-related programs will continue to perform at the same top priority level of operation under both the proposed action and the no action alternative.

COMPARISON OF ENVIRONMENTAL CONSEQUENCES

In this EIS, potential impacts are described in general terms because specific impacts of projects cannot be determined until the locations and activities associated with those projects are defined. In general, the environmental consequences of activities are characterized as either not adverse or adverse but mitigable. The following paragraphs summarize and contrast the environmental consequences of the proposed action and the no action alternative, resource by resource, issue area by issue area prior to implementation of mitigation measures The mitigation measures identified for the adoption in the proposed action would reduce, mitigate, or eliminate the adverse impacts identified for the no action alternative as well as mitigate proportionally greater impacts contained within the proposed action. It is noted that in-depth analyses for many of these resources will be undertaken in follow-on documentation proposed to supplement the EIS.

Geologic Resources and Soils

Potential impacts on geologic resources and soils at WSMR are related to construction; off-road vehicle travel; and direct impacts of missiles, bombs, and other testing debris. Building and road construction associated with the proposed action could lead to soil compaction and loss of vegetation, leading in turn to wind and water erosion of soils. Construction on an existing disturbed area would not cause adverse changes unless the disturbed area were expanded. Missile impacts cause craters with effects similar in nature to construction — soil compaction and loss of vegetation. These impacts are characterized as potentially adverse but mitigable, with the significance proportional to the extent of disturbance. Earthquake or volcanic hazards are not considered a significant factor affecting range operations. The no action alternative would have proportionally fewer impacts on geology and soils, as project activities would not change and new construction would not occur. Other potential effects include run-off, non-construction related soil compaction and water/wind erosion as a result of soil crust disruption.

Hydrologic/Water Resources

Potential impacts on hydrologic and water resources at WSMR are related to concerns about water supply, wastewater treatment and disposal, and water quality. Although existing potable water resources at WSMR are more than adequate to meet demands of any increased activities under the proposed action, as are wastewater treatment and disposal facilities, WSMR is committed to wise water use. WSMR will design future operations and alter current operations to reduce water use and potential degradation of regional water resources. Potential impacts on water quality as a result of fuel spills and other possible contaminant releases are characterized as potentially adverse but mitigable. Potential impacts of the no action alternative would be proportionally fewer than potentially expanded operations under the proposed action.

Air Quality

Potential impacts on air quality are associated with possible exceedances of national ambient air quality standards, health guidelines for hazardous air pollutants, allowable emission rates for stationary sources, creation of offensive odors, and climate changes. Many of the project activities within the programs of the proposed action could result in potentially adverse but mitigable air quality impacts. Surface missile launches and the use of obscurants could elevate airborne concentrations of criteria and hazardous air pollutants above ambient air quality standards and applicable health guidelines in the vicinity of launches and field tests. Power generators that support WSMR projects in the field have potential emission rates that exceed New Mexico Air Quality Control Regulations for requiring source registration and permits.

These impacts are categorized as potentially adverse but mitigable, with the mitigation measure being compliance with the appropriate reporting and permitting requirements. At present, WSMR activities are not expected to alter local or mesoscale weather patterns. The potential impacts to air quality of the no action alternative would be substantively the same as those of the proposed action because, within limits, the number of times a given activity occurs is less important to air quality than the intensity of short-term effects of the discrete activity. No odor sources have been identified. WSMR will collect air quality data to assess the cumulative impact of WSMR activities. Additive effects on air quality from future projects will be factored in as a part of the ongoing analysis and reporting process. Cumulative impacts to air quality, including estimates of the total emissions from all existing WSMR and WSMR-related activities, are discussed in Section 4.16 of this document.

Biological Resources

Potential impacts on biological resources are primarily project-specific, but also include a variety of range-wide actions that are not related to specific activity sites. These range-wide actions can be intermittent or continuous. They include actions such as the impacts of feral and exotic animal species and exotic plants, hunting on WSMR, activity of routine maintenance vehicles and infrastructure support, and other actions that occur on WSMR but are not related to a specific project of activity site. Potential impact types include: physical destruction of vegetation; direct mortality of wildlife; habitat loss, fragmentation, and disruption of migration corridors; disruption of wildlife activities; and competition for resources. These impacts would be associated with construction; road building; and direct impacts of missiles, bombs, and other test debris. Habitat destruction could cause secondary impacts on wildlife. Impacts on threatened or endangered species, critical habitat, or wetlands could be adverse. Potential direct and indirect impacts of noise could result from sonic booms, low-flying aircraft, and other sources. If persistent, these sources of auditory stimuli could adversely affect the survival or reproduction of listed species, resulting in temporary or permanent hearing loss, abandonment of the nest or den site, disruption of breeding activity, or abnormally heightened levels of physiological stress. Most studies of free-ranging wildlife indicate, however, that a wide range of mammalian and avian species acclimate readily to infrequent aircraft noise (Lamp, 1989). The potential effects of these sources could include startling, temporary or permanent hearing loss, abandonment of nest or den sites, and mortality. Furthermore, potential adverse effects can be avoided or mitigated by limiting aircraft overflights in restricted areas such as the San Andres National Wildlife Refuge to 610 m (2,000 ft) above ground level. The potential impacts of the no action alternative could be proportionally fewer than those of the expanded mission component of the proposed action, depending on the specific nature of proposed future projects.

Socioeconomics

Concerns for potential socioeconomic impacts include changes in population, employment, and income in surrounding communities and demand for housing and public services. Additional economic impacts include the effects of range operations on the budget for the monument as well as on visitors of WSNM and San Andres National Wildlife Refuge. Current activities are judged to present no changes having adverse impacts on these variables. Modernization activities associated with the proposed action would lead to increased economic activity, which would have a positive impact on the surrounding area. Local communities would be readily able to accommodate increased demands for public services by the relatively small influx of outside workers that may be required to support the proposed action. Drastic changes such as the closure of WSMR or a major reduction in operations at WSMR are not addressed in either the proposed action or the no action alternative. The no action alternative, which presumes long-term stability at current operational levels, would have proportionally fewer impacts than those under the expanded mission component proposed action, but would not have the operational flexibility to meet changes in range-wide operations.

Cultural Resources

Cultural resources analysis is concerned with potential impacts on historic structures and archaeological resources on WSMR. Potential impacts on historic structures include physical destruction, isolating a property from its natural setting, creating elements in conflict with the character of a property or its setting, and neglect of the property leading to its deterioration or destruction. Potential impacts on archaeological resources include physical destruction, soil disturbances from off-road vehicles and missile impacts, creation of access to previously inaccessible areas, unauthorized removal of artifacts, and vandalism. Soil disturbances can cause compaction, which could damage surface or subsurface artifacts, and shock and vibration damage to artifacts and structures. In addition, construction of new roads may create access to previously inaccessible areas, leading to unauthorized removal of cultural properties or vandalism. These potentially adverse impacts are associated with both the proposed action and the no action alternative.

Land Use

Potential impacts of activities under the proposed action or the no action alternative would be largely project-specific. Use of the DAS/GIS, as described in this EIS and noted in Section 2.4, will enhance mitigation of any potentially adverse impacts by improving land use planning at WSMR. Potential impacts of the no action alternative may be fewer than those of the proposed action because the no action alternative would not include possible construction or testing of programs employing radically new technologies.

Utilities and Infrastructure

Utilities supporting missions at WSMR include electricity and telephone service, natural gas, transportation fuels, water, and sanitary and solid waste handling and treatment. Existing facilities, except the Main Post landfill, are considered sufficient to handle any increased demands for services under the proposed action or the no action alternative. The landfill has capacity only until the year 2000 when a new facility will need to be permitted and opened. Demands for utilities would be fewer under the no action alternative than under the expanded mission component of the proposed action. Any project making major new demands on utilities would be required to evaluate these impacts in a project-specific NEPA document.

Traffic and Transportation

The existing transportation network, including on-site roads, a rail spur, and access to nearby airports, is considered adequate to handle demands under either the proposed action or the no action alternative. General maintenance and minor improvements to both the roads and parking system are anticipated to be required to meet future needs. Impacts under either alternative are therefore judged to be not adverse.

Recreation

The recreation potential on the range and in the surrounding vicinity is widely varied; however, recreational opportunities are limited by safety and security requirements. Recreation areas include WSMR's significant historic and geologic features and off-range national and state forests and parks. On-range uses include hunting, golfing, and athletics. Off-range opportunities exist for skiing, camping, and nature viewing. Current recreation opportunities are sufficient to meet the present demands of both the proposed action and the no action alternative. Recreation activities on WSMR are analyzed and planned to ensure that no adverse environmental impacts will result.

Aesthetics and Visual Resources

Potential impacts of the proposed action on aesthetics at WSMR and the surrounding area include degradation of the visual panorama at WSMR by increases in vehicle traffic, missile launches, and numbers of support buildings. Increased activity at WSMR also could lead to increased visitation at sites with aesthetic value in the area, degrading their visual quality; increases in smoke at sites; short-term degradation of the serenity of scenic vistas by flight patterns; and effects on air clarity from combustion emissions. Potential impacts of the no action alternative are qualitatively similar, but would be proportionally fewer than those under the expanded mission component of the proposed action. Neither course of action is deemed to present adverse impacts.

Noise

Major change in noise levels is unlikely in the proposed action. Potential impacts of noise on human health and wildlife are associated with several sources at WSMR: missiles and rockets, space vehicles, low-level aircraft, helicopters, drones, troop training exercises, the discharge of large-bore guns (such as the Navy gun), high explosives, highway transport, and various routine noises associated with residential living in the community area. Potential impacts of both the proposed action and the no action alternative are characterized as potentially adverse but mitigable.

Radiation Sources

Potential impacts of radiation at WSMR include exposure of humans and wildlife to ionizing and nonionizing radiation and potential electromagnetic interference with communications. Devices containing ionizing radiation sources are sealed and inspected by the WSMR Radiation Protection Officer. Self-luminous devices containing radium-226 are collected by the Radiation Protection Officer for proper disposal. Most of the radioactive trinitite (fused sand) that resulted from the first atomic bomb, exploded at Trinity site, has been evaluated at Los Alamos National Laboratory and found to be of little hazard to personnel. Potential sources of nonionizing radiation at WSMR include ultraviolet and visible energy; microwaves; radio waves; lasers; and the electromagnetic pulse facility, designed to simulate the radio waves produced by a nuclear detonation in the atmosphere. Potential impacts of these sources are considered minimal because the public is excluded from any area producing potential hazards, and WSMR personnel are required to follow appropriate safety procedures. The potential radiation impacts of the proposed action and of the no action alternative cannot be distinguished with current data. WSMR will collect data to establish a radiation source baseline and to analyze the potential for cumulative impacts.

Hazardous Materials/Hazardous Waste

Potential impacts from hazardous materials management activities at WSMR that are associated with the proposed action include potential fuel releases, potential releases of hazardous liquids from impoundments into soils and groundwater, and asbestos and lead abatement releases. These impacts are considered potentially adverse but mitigable by devoting sufficient resources to address these issues in accordance with operational requirements. With few exceptions, the proposed action would not increase the hazardous waste generated at WSMR. The potential exceptions would be projects generating larger quantities of hazardous waste, such as high-energy laser tests, propulsion and materials tests by NASA, and facilities upgrade activities. Existing facilities are capable of managing these potential problems, but may require increased personnel and training programs to manage, test, and monitor wastes. The no action alternative would have similar impacts except that eliminating demolition for new construction would decrease the requirement for asbestos and lead abatement efforts.

Health and Safety

Because of the extent of existing WSMR health and safety and emergency preparedness programs, and because there would not be significant differences between the proposed action and the no action alternative with respect to health and safety issues, no adverse health and safety consequences distinguish these alternatives. The most visible potential emergency arising from WSMR-related projects is an errant missile impact, on or off the site. This and other potentially adverse accidents have been addressed to reduce the probabilities of such occurrences to extremely low levels. For example, missile tests are closely scrutinized before and during flight with a command organization, the Missile Flight Safety Office, observing at all times. The Missile Flight Safety Office has the authority and the mandate to cancel a mission or destroy a missile in flight if the safety of any person, on or off the site, is threatened. Recognizing that full emergency response capabilities must still be maintained as high-priority programs despite extensive risk reduction efforts, WSMR health and safety and emergency response programs are extensive and compose a major element of emergency response expertise and capability supporting the entire region. This status will be maintained regardless of the alternative selected under this EIS process. Therefore, there are no significant differences with regard to health and safety programs or operational consequences between the proposed action and the no action alternative

ENVIRONMENTAL ANALYSIS SYSTEM CONCEPT

In the past, WSMR has applied the NEPA process in planning and evaluating new actions on a case-by-case basis. However, the large number of projects and the complexity and size of WSMR make it difficult for decision makers and planners to determine information requirements for specific actions. The location and quality of existing information is difficult to determine in many cases. This has led to the uncoordinated preparation of a large number of project-specific EAs and Records of Environmental Consideration (RECs). This lack of coordination has resulted in substantial expense, unpredictable project approval processes and schedules, potential project delays, and a high likelihood of duplication of previous efforts. Additionally, a related risk exists that cumulative and indirect impacts are not adequately investigated. All of these issues are further complicated by the changes in national defense planning and direction emerging from the changing geopolitical situation.

To meet the legal mandates of NEPA and increase planning efficiency, WSMR has determined that a coordinated environmental planning and integration approach is necessary to achieve several goals: unify and streamline the decision making process, assemble all the reasonably available environmental knowledge about WSMR into one system, and continue to gather such information through efficient research and analysis methods designed to validate and feed all new information back into the decision making system. This process would result in a continual increase in system efficiency.

This integrated planning approach constitutes a system referred to as an Environmental Analysis System (EAS). Through this system, the proposed action can be implemented, project planning and scheduling can be improved efficiently to meet the needs of the tenant agencies, and the requirements of NEPA and other environmental laws can be more easily met. The EAS is composed of three major tools: this range-wide EIS, a computer-based GIS, and a computer supported Decision Analysis System (DAS). The GIS can be viewed as a series of data bases for the evaluation of potential environmental impacts of future projects at WSMR. It contains both spatial information and attribute data. The DAS is an interactive software system designed to assist project proponents in identifying the level of NEPA documentation required, determining the need for associated field surveys, determining the need for environmental permits and agency reviews, and designing and locating projects to minimize environmental impacts. Design, testing and updating of the DAS will be closely coordinated with regulatory agencies to ensure the incorporation of all environmental management attributes.

This EIS does not constitute final NEPA documentation for specific future projects or for other currently unknown direct, indirect, or cumulative adverse consequences of specific future projects. This EIS will provide a broad environmental planning baseline for other NEPA processes and documents. Specific projects and the associated potential environmental impacts will need to be addressed in subsequent analyses specific to the project location and associated activities. The need for appropriate NEPA documentation will be determined for each project. All proposed action elements will comply with federal, state, local, and U.S. Army environmental regulations, health and safety regulations, and permit requirements. This EIS will be a source of information, but not a substitute, for any required project-specific NEPA documentation. The DAS/GIS prepared in parallel with this EIS will provide additional assistance to project proponents in complying with NEPA and other legal requirements.

SUPPLEMENTAL ANALYSES AND COMMITMENT SUMMARY

To remedy deficiencies in the baseline for specific resource areas and to augment impacts analyses, a number of follow-on analyses are proposed to supplement this EIS. These analyses will include, but not be limited to:

- comprehensive cumulative impacts analysis for WSMR and contiguous activities;
- water resources analysis;
- air quality analysis;
- updated and comprehensive Integrated Natural Resources Management Plan;
- noise/radiation analysis; and
- hazardous materials/waste management analysis.

These analyses and their resulting reports are described in the Commitment Management Summary found in Appendix D.

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Chapter One
Introduction

CHAPTER 1
INTRODUCTION

This chapter introduces the range-wide environmental issues of concern at White Sands Missile Range (WSMR) and discusses how the proposed action incorporates measures to address these issues. In order to achieve this objective, the chapter begins with background information, and then presents an overview of the proposed action.

1.1 BACKGROUND

WSMR is a Department of Defense major range and test facility located near Las Cruces, New Mexico. The range possesses unique characteristics necessary for the U.S. Army, U.S. Navy, U.S. Air Force, National Aeronautics and Space Administration (NASA), and other federal and commercial testing concerns to conduct safe, large-scale experiments on advanced weapons and space flight systems. The U.S. Army recognizes that, under these requirements, the comprehensive management of WSMR presents difficult and unpredictable challenges.

The National Environmental Policy Act (NEPA) process is intended to help public officials make decisions that are based on an understanding of environmental consequences. The NEPA process also must ensure that the public and public officials are fully informed about the proposed action and have a meaningful opportunity to participate in the process before decisions are made and actions taken. To meet these goals, this range-wide Environmental Impact Statement (EIS) has been prepared to address these concerns in accordance with the Council on Environmental Quality regulations implementing NEPA (Code of Federal Regulations 40 CFR 1500 to 1508, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act) and U.S. Army Regulation AR 200-2 (Environmental Effects of Army Actions) (U.S. Army 1988a).

WSMR covers approximately 8,288 km^2 (3,200 mi^2) (Bingham, pers. com. 1994) in south-central New Mexico (Figure 1-1). WSMR is the largest, all-overland test range in the western hemisphere. The range itself, together with adjacent call-up and off-range use areas, is diverse with respect to environmental attributes such as geology and soils, weather patterns, and biological and cultural resources. The primary mission of WSMR is the operation of a National Range in accordance with direction from the U.S. Army Test and Evaluation Command (TECOM). This mission includes the conduct of range instrumentation research and development; development tests of U.S. Army, U.S. Navy, and U.S. Air Force air-to-air/surface, surface-to-air, and surface-to-surface weapons systems; dispenser and bomb drop programs; gun system testing; target systems; meteorological and upper atmospheric probes; equipment, component, and subsystem programs; high-energy laser programs; and special

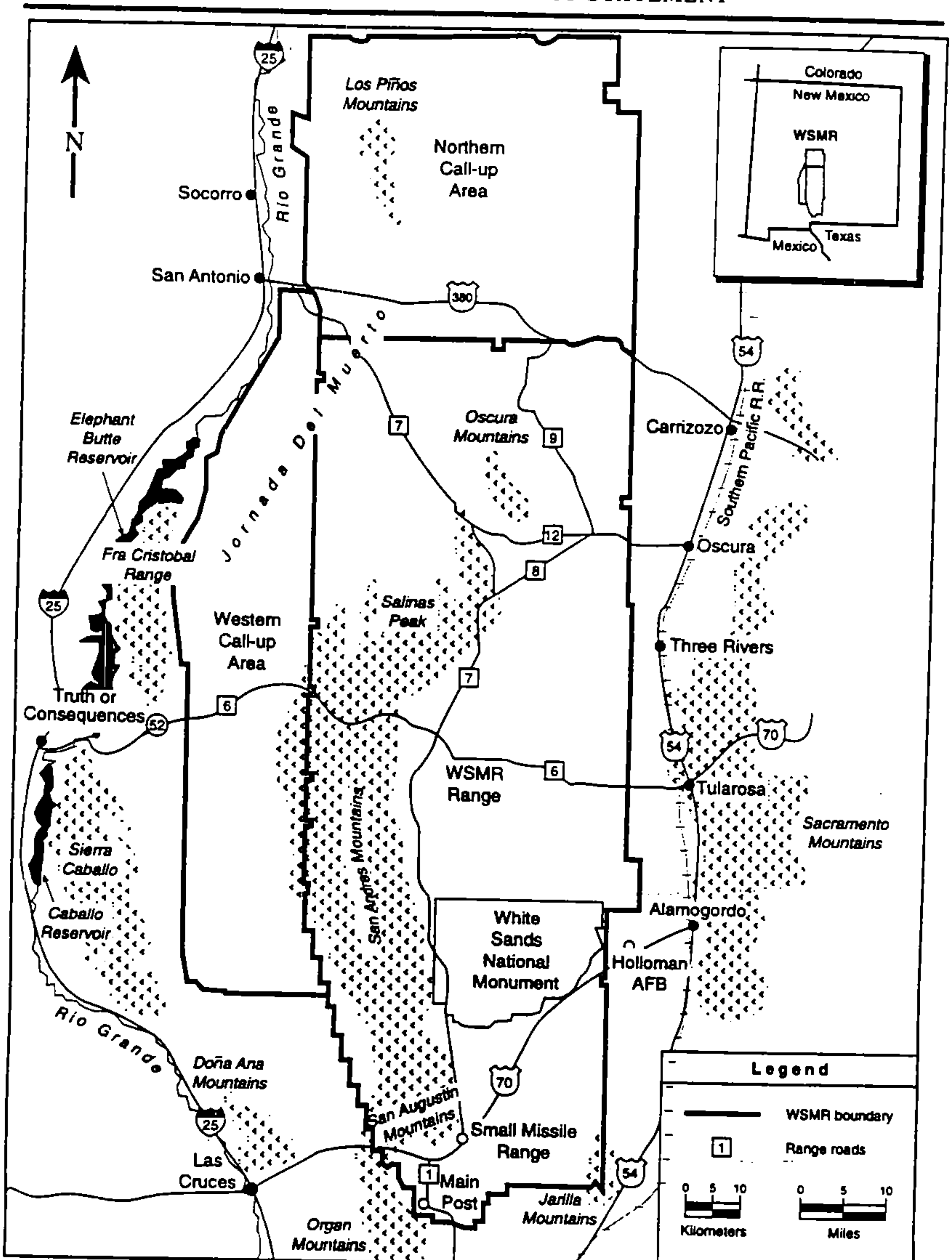

Figure 1-1. WSMR location map

tasks. NASA's Lyndon B. Johnson White Sands Test Facility (WSTF) provides expertise and infrastructure to test and evaluate spacecraft materials, components, and propulsion systems.

WSMR provides scientific expertise for the support of weapons systems and provides administrative and logistical support to tenants such as NASA, the U.S. Army, the U.S. Air Force, and the U.S. Navy (U.S. Army 1985a). In this role, the range supports research, development, test, and evaluation of weapon and space systems, subsystems, and components. For these purposes, it includes an extensive complex of ranges, launch sites, impact and target areas, instrumentation, buildings, equipment, and personnel. The range provides internal and external data during testing by telemetry, radar, laser tracking, interferometer, optical, and other sensing systems. Both to protect the public and national security, and to ensure the best possible research environment, all airspace and electromagnetic interference are controlled on and adjacent to the range. NASA, at WSTF, maintains a separate environmental office which coordinates the WSTF compliance activities and provides integration with the overall WSMR environmental program.

WSMR has other capabilities, such as experimental payload and missile component recovery, target support, air and ground multiple target control, photography and film processing, calibration and standards, and ordnance and propellants storage. Facilities are available for environmental experiments, warhead and explosive tests, microwave tests, and directed-energy weapon tests. In addition to testing U.S. Army, U.S. Navy, and U.S. Air Force systems, WSMR develops and tests target drones and manned flight vehicles; develops and tests propulsion, guidance, support, and instrumentation systems; and evaluates the effects of environmental conditions (e.g., weather) on system performance. Various U.S. Army laboratories and test facilities, including the Temperature Test facility, Army Research Laboratories, and Nuclear Effects Directorate, are located at WSMR.

WSMR resources are available to support all U.S. military department and government agency programs, and authorized non-government agencies and foreign governments (U.S. Army 1985a). In addition, WSMR operations include administrative assistance, logistical support, and technical advice for more than 25 tenant organizations. The work force at WSMR in 1995 totaled 7,713, and consisted of 3,640 civil service employees, 786 military personnel, and 3,287 contractor employees. WSMR provides personnel with community services such as a commissary and a chapel; administrative services in the areas of personnel, finance, and accounting; safety and security services, and controlled-access gates; fire protection and emergency response capabilities; civil, electrical, and mechanical engineering services; master planning; and industrial hygiene services.

The U.S. Army is the executive management agent for the facility, and the U.S. Air Force and the U.S. Navy are afforded special status at the installation through the creation of service deputies. These deputies assist the WSMR Commander in maintaining a focus on the the tri-service nature of the facility. WSMR has been designated the lead command to support the following major test and instrumentation development programs:

- directed energy weapons (e.g., lasers),
- hypervelocity weapons and munitions,
- Ballistic Missile Defense Organization components (and as one of only two sites allowing antiballistic missile testing),
- missile-launched smart munitions and mobile smart munitions testing,
- gun system testing.

- air defense and fire support (including technology required to test air defense systems),
- laser sensor and signature technology (air defense and fire support sensor and signal processing test technology), and
- target control.

1.2 PROPOSED ACTION

This section summarizes the proposed action.

1.2.1 Purpose and Need for the Proposed Action

WSMR is the largest, all-overland test range in the United States. It is an extensive and complex range consisting of launch sites, target areas, instrumentation, buildings, equipment, and personnel. These unique characteristics are needed by the U.S. Army, U.S. Navy, U.S. Air Force, NASA, and other federal and commercial testing concerns to conduct safe, large-scale experiments on advanced weapons and space flight systems. Changes in the character of advanced weapons systems present new challenges to WSMR in hosting research and tests of these new systems. WSMR must be prepared to respond efficiently and flexibly to these variable conditions. The proposed action provides the flexibility required to meet these challenges.

1.2.2 Proposed Action

The proposed action is the continuation of existing programs and the future testing of scientific, military, and commercial systems at WSMR with the proposed adoption of specific identified mitigation measures applicable to these existing and future programs. The proposed mitigation measures are applicable to two major components of the proposed action. The first component is the continuation of current project activities and existing operations and services, including routine maintenance, modernization or removal of outdated facilities; and improvement in infrastructure, utilities, and services as necessary. The second component consists of changes in the number of projects and programs planned for the next ten year period, with resulting changes in site usage and services. The projected increase is estimated to be ten to fifteen percent across all programs. The program changes may include both expansions and reductions in the scope of existing activities, with consequent requirements for either increases or decreases in utilities and services (since changes in the scope of operations at WSMR cannot be predicted, follow-on environmental documentation and planning will be required should these changes be potentially significant; see Section 1.4.1 Tiering).

WSMR will anticipate and plan for potential changes in the nature and type of impact of future operations based on projections of tenant agencies. WSMR takes this approach not as a proponent or opponent of such changes, but in order to be prepared for the consequences of potential changes.

The mitigation measures to be adopted by the proposed action are described in Section 2.4, both generically and with respect to specific resources and issues. A more indepth specification of mitigation measures to be adopted are part of the proposed action is found in Chapter 5. These same mitigation measures and strategies will be integrated into the Geographic information System (GIS) and Decision Analysis System (DAS) components of the Environmental Analysis System (EAS). This will provide future project proponents with environmental information, site location decision support, and regulatory information and project approval at significant cost savings and improved efficiency. As a consequence, WSMR will be increasingly enabled to protect, restore, and enhance the range environment as it more effectively supports its operational mission.

1.3 OTHER ALTERNATIVES CONSIDERED

The no action alternative is the continuation of existing missions and operation at approximately their current scope and rates, but without the adoption of specific mitigation measures identified in Section 2.4 and Chapter 5, except for the Geographic Imformation System (GIS) and Decision Analysis System (DAS), which are being implemented as an environmental management system applicable to both the proposed action and the no action alternative.

The alternative of closing WSMR is considered to be out of the scope of this analysis. There are no Congressional or U.S. Army indications that this option is contemplated. A special NEPA process to address the shutdown and conversion of military bases has been established for such analyses.

The other preliminary alternative identified in the Notice of Intent (NOI), but not further analyzed in the EIS, focused on testing of future systems and expansion of the mission into Nuclear Effects Testing and off-range launches into WSMR. These alternative components were reconsidered in the course of the scoping process and dismissed as a specific alternative best relegated to separate analysis. Ongoing simulated nuclear effects testing is included in current operations and is analyzed accordingly in this EIS. (This research is more accurately referred to as nuclear effects simulation. It does not involve the testing of actual nuclear weapons.) A parallel NEPA process has been implemented with respect to off-range launches into WSMR and is discussed in Section 1.5.

1.4 SCOPE OF THIS EIS

This EIS does not constitute comprehensive NEPA documentation for potential future projects or for other currently unknown direct, indirect, or cumulative adverse consequences of specific projects under the proposed action. Rather, it provides an environmental planning baseline from which other NEPA processes and documents may tier.

1.4.1 Tiering

The Council on Environmental Quality NEPA regulations encourage agencies to tier environmental documents to eliminate repetitive discussions and to focus the decision-making process on the pertinent issues at each level of review (40 CFR 1502.20, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act). Tiering refers to the coverage of general matters in broad-scope documents, with subsequent narrower scope documents incorporating, by reference, the general discussions and concentrating primarily on the specific issues. In order to better evaluate potential cumulative effects of unrelated actions on the range, this EIS addresses potential impacts of ongoing and planned programs at WSMR on a range-wide basis. Both potential cumulative impacts and appropriate mitigation measures are discussed. This EIS is broad in scope and is intended to serve as a baseline document for subsequent project-specific analyses. As future actions arise, the appropriate NEPA document — Categorical Exclusion, Record of Environmental Consideration (REC), Environmental Assessment (EA), or EIS — may incorporate this EIS by reference. In addition, new information obtained in support of future actions will be incorporated as part of the WSMR environmental decision-making process. This range-wide documentation will therefore not substitute for project-specific NEPA documents, but will serve as a resource in their preparation.

In the past, WSMR has applied the NEPA process in planning and evaluating new actions on a case-by-case basis. However, the large number of projects and the complexity and size of WSMR make it difficult for decision makers and planners to determine information requirements for specific actions. The location and quality of existing information is difficult to determine in many cases. This has led to the preparation of a large number of project-specific EAs and RECs in an uncoordinated fashion, resulting in substantial expense, unpredictable project approval processes and schedules, potential project delays, and a high likelihood of duplication of previous efforts. Additionally, a related risk exists that cumulative and indirect impacts are not adequately investigated. All of these issues are further complicated by the changes in national defense planning and direction emerging from the changing geopolitical situation.

To meet the legal mandates of NEPA and increase planning efficiency, WSMR has determined that a coordinated environmental planning approach is necessary to achieve several goals: unify and streamline the decision-making process, assemble all the reasonably available environmental knowledge about WSMR into one system (including both the EIS and EAS), and continue to gather such information through efficient research methods designed to validate and feed all new information back into the decision-making system. This process would result in a continual increase in system efficiency.

This integrated planning approach drives the EAS. Through this system, the proposed action can be implemented, project planning and scheduling can be improved efficiently to meet the needs of the tenant agencies, and the requirements of NEPA and other environmental laws can be more easily met. The EAS is composed of three major tools: this range-wide EIS, a computer-based graphic GIS, and a computer-supported DAS. The GIS can be viewed as a series of data bases for the evaluation of potential environmental impacts of future projects at WSMR. It contains both spatial information and point attribute data. The DAS is an interactive software system designed to assist project proponents in identifying the level of NEPA documentation required, determining the need for associated field surveys, determining the need for environmental permits and agency reviews, and designing and locating projects to minimize environmental impacts.

This EIS does not constitute final NEPA documentation for specific future projects or for other currently unknown direct, indirect, or cumulative adverse consequences of specific future projects. This EIS will provide a broad environmental planning baseline for other NEPA processes and documents. Specific projects and the associated potential environmental impacts will need to be addressed in subsequent analyses specific to the project location and associated activities. The need for appropriate NEPA documentation will be determined for each project. All proposed action elements will comply with federal, state, local, and U.S. Army environmental regulations, health and safety regulations, and permit requirements. This EIS will be a source of information, but not a substitute, for any required project-specific NEPA documentation. The GIS and DAS prepared in parallel with this EIS will provide additional assistance to project proponents in complying with NEPA and other legal requirements. The EAS will also be the repository of data gathered from the design, implementation, and update of plans related to the operations at WSMR. These plans include but are not limited to the Integrated Natural Resources Management Plan, the Pollution Prevention Plan, the Installation Spill Plan, the Spill Prevention Control and Countermeasures Plan, Endangered Species

Recovery Plans, and the Historic Preservation Plan. Close coordination with regulatory agencies will delineate other required plans as well as their content. In addition to incorporation of data from the formation and execution of these plans, all NEPA documentation produced in their support will be tiered to this EIS. These plans are then an integral part of WSMR actions acting as an aid in sound environmental planning.

1.5 SUMMARY OF ISSUES DEVELOPED FROM THE SCOPING PROCESS

Scoping refers to the process under NEPA by which, at the earliest stages of the development of an EIS, the general public and public officials are given the opportunity to identify issues of concern for consideration in the preparation of the EIS. A Notice of Intent for Preparation of an EIS for Projects and Activities Associated with Future Programs at WSMR (U.S. Army 1993a) was published in the Federal Register on April 15, 1993. The NOI invited public comments on issues, activities, and alternatives to be considered in the EIS. Public scoping meetings were held in Las Cruces (May 27, 1993), Alamogordo (May 25, 1993), Socorro (May 26, 1993), and Albuquerque (June 1, 1993), New Mexico; and El Paso, Texas (May 24, 1993). In response to public interest, an additional scoping meeting was held in Monticello, Utah, on June 3, 1993. The scoping period closed on June 18, 1993. All public comments received were categorized according to the issues raised, summarized, and incorporated into this EIS as described in Section 1.6.

At the initiation of the EIS process, forty-two people attended the six scoping meetings, and 28 people submitted comments either at the meetings, by mail, or by telephone. Comments were submitted on 13 topic areas, as summarized below. Thirty-one reviewers of the June 1994 Draft EIS provided written comments. An additional fifteen members of the public provided verbal comments on the WSMR EIS program at four public hearings held in November, 1994. The comments and responses are found in the WSMR EIS Comment Response Document (CRD). The CRD is available to interested reviewers upon written request.

1.5.1 Alternatives

One commentor stated that launch alternatives, including overland testing at locations other than WSMR, should be considered. This commentor also stated that rather than expanding testing to include off-post launches from Green River to WSMR, the range should include its client and funding bases to assure survival of the range. The commentor preferred the no action alternative. The off-range launch concerns were addressed in the TMD Extended Range EIS, as described in Section 1.5, and are therefore not included in this EIS.

1.5.2 Biological Resources

One commentor stated that the EIS should examine the impact of feral horses on riparian zones and should consider the potential removal of the horses. Another commentor stated that the EIS should consider impacts of low-flying aircraft on breeding desert bighorn sheep in the Green River area, as well as impacts of aircraft on threatened, endangered, and sensitive species in the flight corridor inside and outside parks. This commentor also said that, under Executive Order 11990, protection of wetlands must be addressed and ensured when evaluating impacts of potential releases of hazardous materials during transportation.

Biological resources studies at WSMR are described in Section 3.4, and general potential impacts of WSMR activities on these resources are addressed in Section 4.4. Impacts of projects potentially affecting biological resources, including bighorn sheep, in the Green River area will be discussed in project-specific environmental documentation where necessary. Potential impacts on wetlands at WSMR are discussed in Section 4.4 and will be further addressed in project specific environmental documentation where necessary.

1.5.3 Cultural Resources

One commentor stated that the EIS should focus on not compromising the irreplaceable archaeological resources of southeast Utah, which include evidence of prehistoric, Anasazi, and Fremont occupation, and historic Ute occupation.

Archaeological resources in southeast Utah are outside the scope of this WSMR range-wide EIS, but will be addressed in documents for projects potentially affecting them, for example, the TMD Extended Range EIS, which includes possible launches from Green River, Utah.

1.5.4 EIS Process

One commentor stated the independent WSMR and TMD EISs should be combined to avoid segmentation and to take into account all aspects of launch and testing activities.

The U.S. Army felt it was impractical to combine the WSMR and TMD EISs because the proposed actions in the two documents are different in scope and extent. However, information used in these documents is being shared to the extent practicable. Potential impacts of all launch and testing activities conducted by the U.S. Army will be described in appropriate environmental documentation.

1.5.5 Electromagnetic Emissions

One commentor stated that the EIS should address the impact of electromagnetic emissions beyond WSMR, including radio astronomy observatories. Potential impacts of electromagnetic emissions on observatories are described in Section 4.13.

1.5.6 Geology

One commentor stated that the EIS should study soil erosion, which has occurred at WSMR. Potential impacts of WSMR activities on soil erosion are described in Section 4.1.

1.5.7 Hazardous Materials and Waste Transportation

One commentor stated that the EIS should examine cleanup of existing debris and debris resulting from future programs. Another commentor stated that the use of the range road that passes Malpais Springs should be studied for impacts of potential spills from vehicles, and that alternatives should be considered that prohibit tankers from carrying fuel. Two additional commentors stated that the EIS should identify mitigation measures to reduce impacts on river systems and the watershed from potential spills during transport of hazardous materials, particularly with respect to the Green River and its water supply.

Hazardous materials and management issues at WSMR are discussed in Sections 3.14 and 4.14, and transportation concerns are discussed in Sections 3.9 and 4.9. Alternatives that prohibit tankers from carrying fuel on WSMR are incompatible with the site mission. Mitigation measures to reduce potential impacts of spills on water resources at WSMR, including a Spill Contingency Plan, are described in Section 2.4.2. Impacts at Green River, Utah, are outside the scope of this EIS but are addressed in the TMD Extended Range EIS where appropriate.

1.5.8 Health and Safety

One commentor stated that the EIS should examine impacts on residences adjacent to WSMR, such as masonry cracking due to vibrations resulting from WSMR missions. Two commentors suggested evaluating the continuing need for evacuation of safety areas on the north and west sides of WSMR, including who should be evacuated, how to inform people of evacuations, and how to alert foreign visitors of evacuations in their native language. One commentor stated that decision criteria should be based on past safety records, low population density in the safety areas, and the ability to save tax money.

One commentor stated that, in evaluating all factors, the EIS should conclude that launching missiles from the Green River area is too risky. Another commentor stated that the EIS should consider the risk of a booster launched from Green River falling outside the projected drop zone or fragments falling from an aborted launch inside or adjacent to Utah parks. This commentor expressed concern that there would be no time to warn park visitors or others along the flight path.

One commentor stated that the EIS should consider continuing concerns that past tests at WSMR have caused cancer and other health effects on humans and cattle. Another commentor said the EIS should identify mitigation measures to reduce the likelihood or impact of any hazardous substance release during transport or launch, or from unspent fuel. If a release occurs, impacts on people, property, wildlife, and other resources should be identified.

Health and safety plans and procedures at WSMR and in the surrounding region are described in Section 3.15. Potential impacts of WSMR programs on health and safety are described in Section 4.15. Mitigation measures concerning the hazardous substance releases are described in Section 2.4. Information on potential impacts on structures adjacent to WSMR was not available at the time of preparation of this EIS. Impacts of launches from Green River, Utah, are outside the scope of this EIS but are addressed in the TMD Extended Test Range EIS.

1.5.9 Land Use and Recreation

Fifteen commentors focused on the need to reopen State Highway 52 between Tularosa and Engle, New Mexico, to establish an avenue for east-west commercial and tourist traffic. Two commentors stated that the EIS should evaluate how military land can be returned to ranchers for their stewardship. One commentor stated that economic impacts of military evacuations on park areas should be examined in considering potential missile launch sites.

The reopening of State Highway 52 would affect the WSMR mission adversely. There are many security and safety concerns associated with allowing the public to drive through WSMR. The New Mexico State Highway Department Planning Division (1978) conducted a comprehensive study on this subject. Based on the results of this study, the reopening of State Highway 52 is not considered to be viable.

1.5.10 Noise

One commentor stated that the EIS should consider impacts of low-flying aircraft on back country hikers seeking solitude in Utah parks. Impacts of low-flying aircraft in Utah are outside the scope of this EIS but are addressed in the TMD Extended Test Range EIS where appropriate.

1.5.11 Operational and Technical Issues

One commentor stated that commitments to mitigation and monitoring should be very clearly and comprehensively stated in the Record of Decision. Three commentors expressed concerns about identification of missile drop zones. A particular concern was that population statistics may not represent actual numbers in booster drop zones because transient populations could be missed. One commentor suggested that the EIS consider firing missiles from the Black Mesa area in San Juan County, New Mexico, which would avoid flying over 5,000 people in two communities.

Commitments to mitigation are stated in Section 2.4 of this EIS and will be reiterated in the Record of Decision where necessary. The proposed action and alternatives in this EIS do not include booster drops outside of WSMR or the possibility of firing missiles from the Black Mesa area.

1.5.12 Policy and Socioeconomics

One commentor stated that the EIS should evaluate ways to expand civilian jobs and laboratory work instead of looking at ways to expand the range for military purposes. Another commentor noted launches from Black Mesa would have the necessary infrastructure (e.g., roads, motels) and would have an economic benefit for San Juan County.

Efforts to expand civilian jobs and laboratory work are outside the scope of this EIS, whose purpose is to examine potential impacts of current and planned future testing activities. The proposed action and alternatives in this EIS do not include the possibility of firing missiles from the Black Mesa area.

1.5.13 Water Quality

One commentor stated that impacts on surface and groundwater from construction and other activities should be examined, and that the agreement with Fort Bliss regarding the Soledad Aquifer should be considered for implementation. Potential impacts of WSMR activities on surface and groundwater are described in Section 4.2.

1.6 ADDITIONAL RELEVANT ENVIRONMENTAL DOCUMENTATION

The Draft WSMR EIS was prepared during the same period as the Theater Missile Defense (TMD) Extended Test Range EIS, which evaluates the environmental impacts that result from testing missile defense systems. Tests will be conducted at four national test ranges, including WSMR. The scope of the WSMR analysis in the TMD Extended Test Range EIS includes potential launches of missiles from Fort Wingate, New Mexico, and Green River, Utah. This analysis is referenced but not repeated in this range-wide EIS. The previous range-wide EA for WSMR (U.S. Army 1985a), which also addressed continuing operations, is cited herein as a source of background information. In addition, a number of project-specific NEPA documents recently have been or soon will be completed for WSMR. These documents have been used as sources of project information in this EIS and are referenced appropriately.

To remedy insufficiencies in the baseline for specific resources and to augment impacts analysis, a number of follow-on analyses are proposed to supplement this EIS. These analyses are described in Appendix D, Commitment Management Summary. For a comprehensive list of available environmental documentation contained in the WSMR Environmental Services Division, see Appendix A.

CHAPTER TWO
DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

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DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

This chapter describes the alternatives considered, including the proposed action, and summarizes their environmental consequences based on the information presented in Chapters 3 and 4. This chapter compares the alternatives in detail to assist decision makers and to facilitate understanding of the issues by government officials and the public.

The clearest points for comparison between the proposed action and the no action alternative are not decisive differences between easily defined environmental consequences. The primary difference between the proposed action and the no action alternative is the amount of increase in existing activities, proposed new programs and operations, and the introduction of presently-undefined, emerging technology testing activities. The projected increase over the next ten years is estimated to be ten to fifteen percent across all programs. The proposed action offers a greater latitude for the advance preparation for long-term, flexible management at uncertain levels of operational demand, including both significant increases and decreases in operations and their accompanying effects. The incorporation of comprehensive mitigation and increased operational planning efficiency is enhanced in the proposed action. The no action alternative does not promote an increased degree of flexibility or efficiency in long-term management.

Often, in this chapter of an Environmental Impact Statement (EIS), the differences in environmental consequences are the issues detailed and emphasized because they represent the primary basis for distinguishing between alternatives. In this EIS, the other factors discussed above are emphasized. These factors are the primary points of comparison between the proposed action and the no action alternative, rather than specific environmental consequences. The affected environment and environmental consequences sections (Chapters 3 and 4, respectively) provide detailed analyses designed both to meet the immediate need in this National Environmental Policy Act (NEPA) process to inform the decision makers and the public, and to provide the scope of NEPA documentation to allow subsequent NEPA documents to tier from this EIS, as discussed in Chapter 1.

2.1 PROPOSED ACTION

The proposed action includes activities that are in addition to the no action alternative. These activities consist of changes in project programs that are planned for the next 10-year period, with resulting changes in site usage and services. Additionally, the program changes may include both expansions and reductions in the scope of existing activities, and requirements for consequent increases or decreases in utilities and services. Mitigation measures are incorporated into the definition of the proposed action, as discussed in more detail below.

Under the proposed action, White Sands Missile Range (WSMR) would preserve the flexibility to provide efficient services, maintain and upgrade facilities and infrastructure, and provide for the safety and well-being of personnel at varying levels of potential future activity. Such activity could include testing of future missile systems and other defense systems employing radically new technology, with numbers of missions similar to, lower than, or higher than those at present. The need to preserve this flexibility requires that this range-wide analysis describe many of the elements of the proposed action in generic terms. These generic descriptions are provided below.

Although the precise numbers and details of future testing programs cannot be anticipated in the face of changing defense needs, general descriptions of the types of testing currently conducted at WSMR are provided as a guide to the general nature of the WSMR mission. As part of the proposed action, WSMR would implement mitigation measures to comply with relevant environmental regulations. All potential activities are expected to occur within the boundaries of WSMR and the off-range call-up areas. Exceptions to this are aircraft involved in testing at WSMR that would be based off range and some target vehicles air-launched off range. Missiles may be launched from McGregor Range and Fort Wingate, New Mexico, and from Green River, Utah, as described in Section 2.2.3.2 and in the Theater Missile Defense (TMD) Extended Test Range EIS.

As stated in Chapter 1, specific projects and the associated potential environmental impacts will need to be addressed in subsequent analyses specific to the project location and the associated activities. The need for appropriate NEPA documentation will be determined for each project. All elements of the proposed action would comply with federal, state, local, and U.S. Army environmental regulations, health and safety regulations, and permit requirements. This EIS will be a source of information for any required project-specific NEPA documentation. The Geographic Information System (GIS) and Decision Analysis System (DAS) prepared in parallel with this EIS will provide additional assistance to project proponents in complying with NEPA and other environmental regulatory requirements.

2.2 PRIMARY COMPONENTS OF THE PROPOSED ACTION AND THE NO ACTION ALTERNATIVE

This section describes the general activities associated with the proposed action, including construction and typical test programs conducted at WSMR. General operational, program, and land use areas are shown in Figure 2-1.

2.2.1 Administration and Community Services

WSMR conducts routine activities in association with the day-to-day operations of the range, its tenants, and directorates. Examples of mission area support activities at WSMR include management, engineering, planning, installation, operations, and maintenance for all communications, automation, printing and publishing, and records management.

Examples of services and facilities provided to the community include the commissary, post exchange, bank/credit union, health clinic, dental clinic, post office, child development services

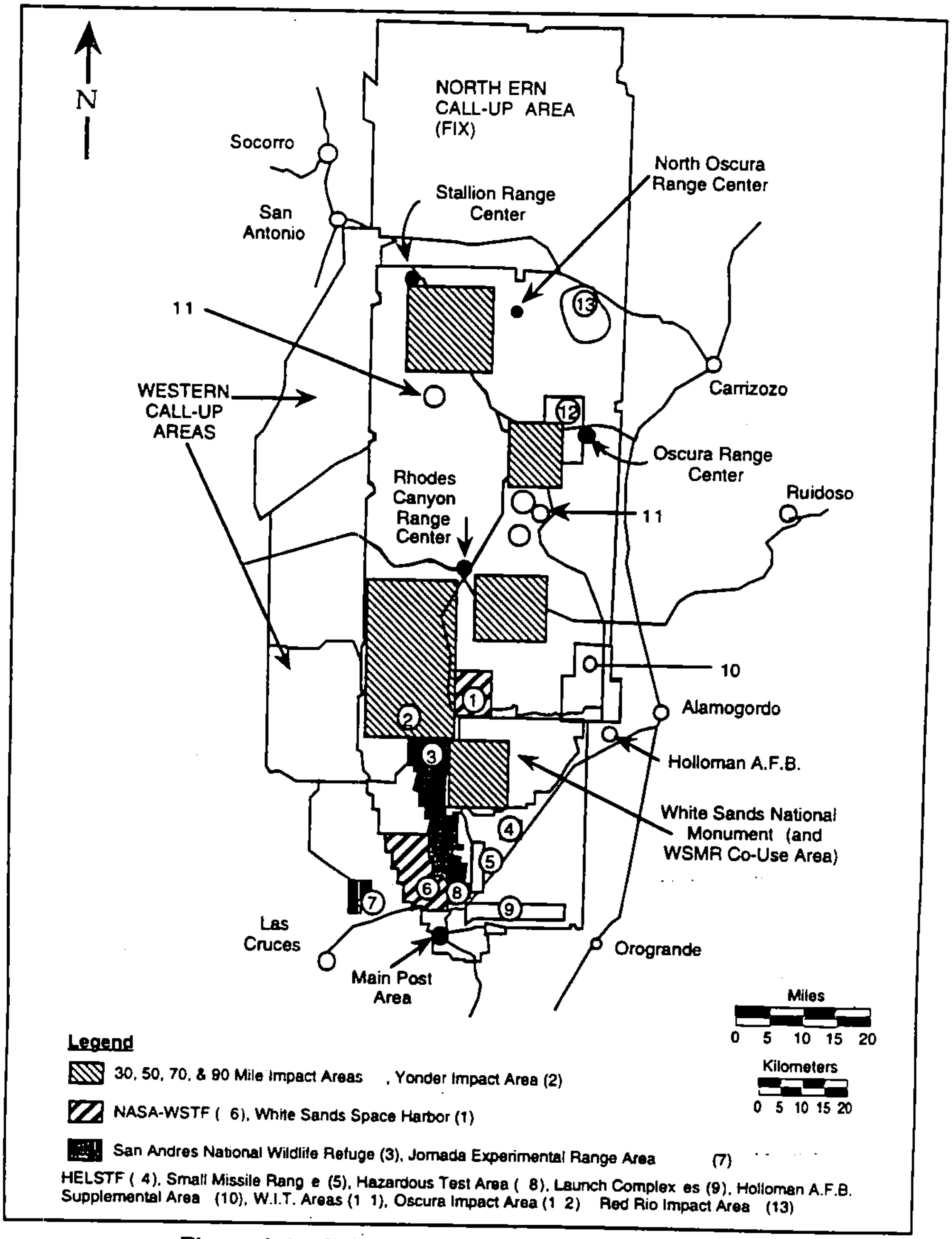

Figure 2-1. WSMR operations and land use area

center, chapel services, public affairs, legal services, shipping, Army Education Center, thrift shop, arts and crafts center, bowling and sports centers, auto craft shop, community club, golf club, youth services, post library, and public schools (WSMR 1994a).

2.2.2 Construction

The proposed action would require a variety of construction projects to support ongoing and new projects. In addition, outdated facilities that are economically feasible to maintain would be modernized. Examples of typical modernization programs at WSMR include upgrading the communication capabilities of a building, refurbishing structures, improving the plumbing, refurbishing interiors, rewiring, and painting. Buildings that are no longer economically feasible to maintain, or that present a health hazard, would be removed from the range.

WSMR would continue to make improvements to the utilities and infrastructure on the installation. Maintaining sewage and water systems is necessary for the day-to-day operations of the range. Constant monitoring of the sewage treatment plant would ensure compliance with applicable state and federal regulations. The drinking water system would be tested periodically and monitored to ensure continued compliance with the Safe Drinking Water Act.

All roads and bridges on WSMR would be inspected and maintained. Roads would be paved and graded as needed, and drainage ditches and water systems would be inspected and regularly maintained. WSMR would continue to routinely maintain the range. These activities include heating and cooling system upgrades, roofing repairs, landscaping, post beautification, curb repairs, grounds maintenance, erosion control measures, and general maintenance to keep facilities in proper working condition.

2.2.3 Typical Testing Programs

Existing programs at WSMR include a number of specific projects that can be grouped into broad categories. Most future projects are likely to fall into these categories, with the exception of radical new technologies, the nature of which cannot be anticipated. During the five-year period from 1989 to 1993, WSMR completed an average of 4,366 scheduled missions per year. Future numbers may be lower or higher depending on demand for the services provided by the facility. A number of existing projects have been analyzed in existing or draft Environmental Assessments (EAs), which are cited appropriately in this text as examples.

2.2.3.1 Air-to-Air/Surface Missile Programs. This category includes projects that test missiles launched from aircraft against targets in the air and on the ground. On average, 200 air-to-air/surface missions have been conducted per year from 1989 to 1993. Examples of launch and impact sites for these programs include the northern, southern, and mid portions of the range; 50-mile area; and Air Force Special Weapons Center (AFSWC), Northeast Center Impact (NECI) area, TS-513, and SALT sites. Examples of projects included in this category are described below.

Advanced Medium Range Air-to-Air Missile

The AMRAAM program provides for the acquisition of the next generation all-weather, all environment, medium range air-to-air missile system in response to U.S. Air Force, U.S. Navy, and North Atlantic Treaty Organization (NATO) operational requirements over the next 12 years (1993 to 2005). The design of the AMRAAM system permits missile employment within and beyond visual range, with or without an operational aircraft radar, and is compatible with F-14, F-15, F-16, F/A-18, F-22, German F-4F, and British Sea Harrier aircraft. The

AMRAAM is designed primarily to replace the AIM-7 Sparrow missile, and provides increased firepower and combat effectiveness while reducing aircraft and aircrew vulnerability. AMRAAM includes state-of-the-art technology to achieve improvements over existing radar-guided missile systems.

Typical tests of the AMRAAM at WSMR include captive carry tests during which the missile is attached to a carrier aircraft that flies around the test airspace but does not launch the missile; dress-rehearsal flights during which the carrier aircraft, safety chase aircraft, and target drone all fly their assigned routes, but the missile is not launched; and hot firings during which the carrier aircraft and the safety chase aircraft fly their assigned routes and then fire the missile at the target drone. Further details of the AMRAAM program are provided in the AMRAAM EA (U.S. Air Force 1992).

Brilliant Anti-Armor Submunition

BAT is a self-guided submunition that can autonomously locate, attack, and destroy moving tanks and other armored vehicles using acoustic and infrared (IR) sensors. The submunition is air launched or delivered by the Army Tactical Missile System (ATACMS), or another delivery vehicle and launched from current Multiple Launch Rocket System (MLRS) firing sites at WSMR. The project includes several types of tests divided into three main phases: (1) developmental test and evaluation; (2) system operational tests; and (3) production and verification test and evaluation, stockpile to target sequence, and production testing of the delivery vehicle. Further details of the BAT project are provided in the BAT (U.S. Army 1994) and ATACMS (U.S. Army 1993j) EAs.

2.2.3.2 Surface-to-Air Missile Programs. On average, 700 surface-to-air missile missions have been conducted per year from 1989 to 1993. Common examples of launch and impact sites for these programs include Launch Complex (LC)-32, LC-34, LC-35, LC-37, RAS site, NOP, LC-50, WC-50 Marietta site, FAADS Valley, Pony site, Sulf site, and southern and middle portions of the range. Examples of projects included in this category are described below.

Extended Range Interceptor Technology

The ERINT project develops and flight tests the ERINT interceptor missile and the ERINT target system missile. A tactical ballistic missile target and a maneuvering tactical missile target are being developed. Both target missile types carry a non-hazardous simulated chemical payload. The project also requires construction of three concrete pads measuring several hundred square meters (m^2) each, 30 m (100 ft) of rail, 20 retaining walls each 6 m (20 ft) long, and renovation of one building. Further details of the ERINT project are provided in the EA for ERINT (U.S. Army Strategic Defense Command [USASDC] 1991a).

Forward Area Air Defense System

The FAADS program includes several defensive weapons to be used in the future against threats from fixed- and rotary-wing aircraft and ground targets. Although the entire test program for these weapons systems is being conducted at a number of U.S. Army installations nationwide, WSMR is host to a large number of FAADS tests. Elements of the FAADS include the following:

- Stinger Manpad (a shoulder-mounted missile operated by a two-man team driving a wheeled vehicle);

- Air-to-Air Stinger (a Stinger missile mounted on a helicopter);
- Avenger (a Stinger missile mounted on a pedestal on an High Mobility Multipurpose Wheeled Vehicle [HMMWV]);
- surrogate for Line of Sight Forward-Heavy (LOS F-H) (a missile mounted on an M3-tracked vehicle – also known as a Bradley Infantry Fighting Vehicle – or other vehicle);
- Non Line of Sight (NLOS) (a fiber-optic guided missile mounted on an HMMWV);
- a variety of electromagnetic, IR, and acoustical sensors placed at stationary sites or mounted on wheeled vehicles or aircraft; and
- command, control, and intelligence (communications systems located at stationary sites or mounted on wheeled vehicles).

A typical test includes setup of equipment and facilities, transportation of personnel and observers to the site, firing of a missile at a drone or vehicle target or tracking of targets without firing, use of pyrotechnic flares dropped from aircraft, use of obscurants, and disassembly and removal of equipment. Further details on FAADS is provided in the Draft EIS for FAADS (U.S. Army 1993b).

PATRIOT

The Phased-array Tracking to Intercept of Target (PATRIOT) project is a surface-to-air guided missile system used against high-performance, air-breathing targets and tactical ballistic missiles. Testing includes both live firings against drones and tracking missions. Approximately 250 live firings and 500 tracking missions are proposed for the period fiscal year 1993 to 2003. Further detail on PATRIOT is provided in the EA for the Patriot Missile System (U.S. Army 1995) and in the U.S. Army (1982a) document titled *PATRIOT Final Safety Statement, PATRIOT Missile System.*

The U.S. Navy Standard Missile Program involves ongoing RDT&E and follow-on testing and evaluation through its life cycle at the Naval Air Weapons Center-Weapons-White Sands (NAWCWPNS WS) Desert Ship Facility (LC-35). The Standard Missile is a supersonic, solid-rocket propelled, tail-controlled missile with all-electric guidance and control equipment. All trajectories and intercepts are scheduled within approved WSMR air space and over approved impact areas (e.g., 30, 50, and 70 mile impact areas). WSMR-approved targets are used for intercepts and include subsonic and supersonic aircraft and missiles. Approximately 8-12 tests per year are proposed for the period of fiscal year 1993-2003. Further information concerning this missile program is provided in EA for Standard Missile and Finding of No Significant Impact (U.S. Navy 1991).

2.2.3.3 Surface-to-Surface Programs. On average, 250 surface to-surface missile and other weapon systems missions have been conducted per year from 1989 to 1993. Examples of launch and impact sites for these programs include LC-33, Deer Horn, Fort Wingate, McGregor Range, Brillo, Tula, Gate, Chili, Dead Horse, Dust, Rhodes Warhead Impact Target (WIT), Denver WIT, Stallion WIT, ABC-1, 649, G-10, G-16, G-20, G-25, and PUP. Examples of projects included in this category are described below.

Army Tactical Missile System

The ATACMS is an inertially guided, solid-propellant missile launched from a Multiple Launch Rocket System (MLRS) launcher. The mission for this missile is to destroy high-value targets from ranges beyond that of MLRS rockets and conventional artillery. The missile will be capable of delivering a wide variety of warheads. The first warhead to be developed is the anti-personnel, anti-materiel warhead containing M74 submunitions. A typical test will consist of a single missile launched from a launch complex into an established WIT area. The warhead will consist of up to 1,000 M74 bomblets containing live fuses with live high explosives. Live high explosives are only dispensed into impact areas approved for this type of munition.

Line of Sight Anti-Tank

The LOSAT system consists of an armored vehicle with missiles used to engage threats. The missile is a hypervelocity, solid-propellant, tube-launched missile that uses a non explosive, kinetic energy penetrator with no warhead. The LOSAT program is conducted at the Small Missile Range and includes flight tests, when missiles are launched, and fire control tests, which locate and track target vehicles but no missiles are launched. The tests use stacked armor plates, tanks, a bunker, special instrumented targets, and a helicopter on poles as targets. The fire control tests will focus on both moving and stationary vehicles. Further information is provided in the *Draft Addendum 2 Kinetic Energy Missile Site Specific Environmental Assessment for White Sands Missile Range, New Mexico* (U.S. Army n.d.a).

Navy Gun

The Navy Gun program involves testing of new propulsion systems for 13- and 20-cm (5- through 8-inch) guns. The purpose is to develop gun systems with a range greater than 36,576 m (40,000 yards), improving both the range and effectiveness of current systems. Steel shells filled with an inert material are fired from LC-35, LC-37, and TS-601 (at the Small Missile Range). Approximately 100 rounds per year are fired into as many as five impact areas on WSMR. Further details are provided in the *Draft Environmental Assessment for Advanced Gun Weapon System Technology Programs for Naval Air Warfare Center Weapons Division at White Sands Missile Range, New Mexico* (U.S. Navy 1993).

2.2.3.4 Aircraft Dispenser and Bomb Drop Programs. On average, 900 dispenser and bomb drop missions have been conducted per year from 1989 to 1993. Examples of impact sites for these programs include Oscura and Red Rio ranges and other environmentally approved areas. Training operations include most fighter and bomber aircraft in the U.S. Department of Defense inventory and from some foreign countries. Other U.S. Air Force programs at WSMR include training for aerial combat maneuvers, and air-to-ground and air-to-air gun firing.

2.2.3.5 Target Systems. On average, 400 target system missions have been conducted per year from 1989 to 1993. Examples of launch and impact sites for these programs include LC-32, LC-36, ROWL, GAM83, Army 5, Pony site, Ron site, and Sulf site. Target systems include full-scale aircraft (e.g., QF-100, QF-U, QF-86), ground vehicles, and subscale aircraft (e.g., MQM-107, AQM-37).

A typical target system is the XQUH-1B, a full-scale UH-1 helicopter outfitted with a drone kit. The drone kit allows the helicopter to take off, fly, and land without a human pilot. The XQUH-1B is used as a target for the Stinger, Chaparral, and Homing All the Way to Kill (HAWK) missile programs. Typical missions include test, maintenance, and target flights.

Drones are controlled using the Drone Formation Control System, a series of antennas and relays on and adjacent to WSMR. This system is scheduled to be replaced by the Next Generation Target Control System, which will be mobile and use the satellite-based Global Positioning System in the year 2000.

2.2.3.6 Meteorological and Upper Atmospheric Probes. On average, 15 meteorological and upper atmospheric probe missions have been conducted per year from 1989 to 1993. Examples of launch and impact sites for these programs include Holloman AFB, Northrup Strip, and off-range sites. Typical missions include small rockets and balloons carrying a variety of instruments designed to collect data on atmospheric physics, chemistry, and meteorology.

2.2.3.7 NASA and Space Program Support. On average, 400 National Aeronautics and Space Administration (NASA) and space program support missions have been conducted per year from 1989 to 1993. The launch site for these programs is White Sands Space Harbor (WSSH). Three major NASA missions at WSMR are the Space Shuttle program and the shuttle training aircraft, the Single Stage Rocket Test (SSRT) program, and the proposed X-33 reusable launch vehicle program.

White Sands Test Facility (WSTF) is located on a 24,605-hectare (60,800-acre) tract on WSMR (NASA 1994). WSTF operates as a field test installation under the NASA Johnson Space Center (JSC), Houston, Texas. The facility exists within WSMR through an Interagency Agreement, as an autonomous entity in terms of operations and environmental management. Its primary purpose is to provide testing services to JSC for the United States space program. However, it also has provided test services and support for Department of Defense, Department of Energy, private industry, and foreign government agencies, as well as other NASA divisions. The primary WSTF mission is to develop, qualify, and test the limits of spacecraft propulsion systems and subsystems. The facility also tests materials, components, and machinery, which involves hazardous environments, remote sites, sizable deployment areas, or other unique capabilities. Special cleaning and decontamination facilities are used to support the Space Shuttle program and other space and planetary missions. The experience and resources developed during these testing activities provide WSTF with the flexibility and potential for fulfilling, a variety of research, development, and testing assignments in support of new programs.

Laboratories at WSTF are engaged in extensive testing efforts to evaluate the compatibility of materials being considered for use in aerospace applications. Flammability, off-gassing, thermal stability, out-gassing, toxicity, susceptibility to ignition and other such evaluations are performed regularly. The laboratories also perform spacecraft component qualification testing, precision cleaning, failure analysis, and a variety of other activities for NASA, other government agencies, and, in special situations, industry.

The Tracking and Data Relay Satellite System (TDRSS) ground station adjacent to WSTF became operational in 1983 following the insertion of the first shuttle-launched TDRS satellite into geosynchronous orbit. The system includes three satellites and two ground stations to provide tracking and data relay services for spacecraft, including the shuttle, in low orbit.

WSTF has its own environmental resource document (NASA 1980, 1992), which provides a description of all environmental aspects of the operations at the facility. The document provides a summary of the environmental background within which WSTF was established, as well as a description of the environmental aspects of current WSTF operations. As is the case for all previous site data, all future activities at WSTF will be incorporated into the WSMR Environmental Analysis System.

Space Shuttle Program

WSSH provides runways and all landing aids necessary for a shuttle landing. Crash and rescue emergency personnel are provided when needed for shuttle training aircraft practice sessions and for any landings by aircraft from Holloman AFB. Major activities at WSSH consist of maintenance and upkeep of the landing strips. Approximately eight times per year, during shuttle flights, WSSH provides NASA with climatic data and other services.

Shuttle Training Aircraft

The shuttle training aircraft is a Gulfstream II, which mimics the flight characteristics and instrumentation on board the shuttle. The shuttle training aircraft provides a realistic simulation of the shuttle landing from an altitude of approximately 10,668 m (35,000 ft) through touchdown.

Single Stage Rocket Test Program

The purpose of the SSRT is to provide the Ballistic Missile Defense Organization and commercial users with a vertical launch of a sub-orbital recoverable rocket capable of lifting up to 1,361 kg (3,000 lb) of payload to an altitude of 457 km (284 mi), returning to the launch site for a precise soft vertical landing, with the capability to launch another mission within three to seven days. The specific program being conducted at NASA/WSTF, called the DC-X program, is described in Environmental Assessment Single Stage Rocket Technology DC-X Test Program (Strategic Defense Initiative Organization 1992). This program involves preflight static test firing followed by a flight test series consisting of hover flight, expanded hover flight, and rotation flight at WSSH.

2.2.3.8 Equipment, Component, or Subsystem Programs. On average, 300 equipment, component, or subsystem program missions have been conducted per year from 1989 to 1993. Examples of launch and impact sites for these programs include Brillo site, Kirtland AFB, Holloman AFB, 50-mile Area, and midrange areas of WSMR. This testing includes standard communications, air frames, countermeasures, and telemetry. Examples of these programs are described below.

JSE Optical Guided Weapon

This program tests optically guided weapons and sensors. It is a laser warning system used for designating targets and range finding. The primary objective of the sensors is detection. A typical mission scenario includes a static test with a system mounted on a helicopter on the ground, a flight test lasting one to two hours, and then further static tests. Tests are conducted in daylight and after dark, and approximately one-third of all tests involve some kind of countermeasure including flares, smoke grenades, and flame throwers.

Low On-Range Active Inertial Navigation System

LORAINS is an on-board guidance system for aircraft, usually C-12s; however, F-111s and B-1s also are used for testing. Testing consists of flying over the range while using the system to communicate with solar-powered transponders set up throughout the range.

2.2.3.9 High-energy Laser Programs. On average, 100 high-energy laser missions have been conducted per year from 1989 to 1993. These programs occur in various locations on WSMR. These locations are examined in advance for any potential impacts of the proposed program.

2.2.3.10 Research and Development Programs. On average, 100 research and development programs have been conducted per year from 1989 to 1993. These programs occur in various locations on WSMR. These locations are examined in advance for any potential impacts of the proposed program. Examples of research and development programs include Nuclear Effects Directorate (NED) testing, Defense Nuclear Agency activities, and the Research Rockets program.

Nuclear Effects Directorate

NED began operation at WSMR in 1957. In 1964, it became an arm of the U.S. Army Test and Evaluation Command (TECOM) for nuclear weapon effects testing, evaluation, and assessment. The mandate for NED was fostered by the 1959 cessation of aboveground nuclear testing and the subsequent ban on all atmospheric nuclear testing in 1963, which dictated a greater emphasis on simulators for development and characterization of nuclear-hardened military systems. The NED mission is to perform complete nuclear weapon effects test, evaluation, and assessment programs on military systems, providing the necessary nuclear environments, support instrumentation, and technical expertise.

NED staff includes scientists, engineers, technicians, and programmers. Specific areas of expertise include nuclear effects test, evaluation, and assessment; life cycle nuclear survivability assessment; transient radiation effects on electronics testing; and maintenance of a comprehensive nuclear survivability data base.

NED operations are managed from two primary sites. Most of the major test facilities are housed in a complex located just south of the main WSMR Post area. NED offices and laboratories are located in a new 5,574m^2 (60,000 ft^2) complex located 32 km (20 mi) northeast of the Main Post. Examples of major nuclear weapon effects test facilities operated by NED include the Fast Burst Reactor (FBR), Linear Electron Accelerator (LINAC), Relativistic Electron Beam Accelerator (REBA), Gamma Radiation facility, Solar Furnace, electromagnetic pulse and radiation facilities, and Large Blast Thermal Simulator (LBTS).

Research Rockets

Research Rockets is the branch through which the Naval Air Warfare Center Weapons Division WSMR supports agency requirements to launch various sounding/research rockets. This branch has supported the launching of over 1,131 sounding rockets at WSMR. Originally conceived during the research and testing of captured German V-2 rockets, the unit and scope of the program in which it was involved developed rapidly and became involved primarily in launching rocket for atmospheric and near-space research programs.

The prime customers of this unique program are NASA, Naval Research Laboratory, Phillips Laboratory East, the Defense Nuclear Agency, the Ballistic Missile Defense Organization, and various domestic and foreign universities. From May 1962 through March 1994, 1,129 research rockets have been launched from WSMR.

2.2.3.11 Special Tasks. On average, 2,190 special task missions have been conducted per year from 1989 to 1993. These programs occur in various locations on WSMR. These locations are examined in advance for any potential impacts of the proposed program. The Special Task programs consist of small-scale training exercises, indoor testing, recovery, and Explosive Ordnance Disposal. The activities involved vary greatly by mission, but some common ones include:

- fuel bladder drops (1,893 L [500 gal]) from helicopters (bladders must be empty or contain water, they will not contain fuel);
- parachute drops of either equipment or personnel;
- mountaineering and rappelling, with as many as 150 personnel per mission;
- use of either live or blank ammunition (usually all materials are recovered after the mission). The Richardson Ranch Training Complex is used on a regular basis for special operations training using live and blank ammunition; and
- joint military training exercises such as Roving Sands.

2.3 ALTERNATIVES TO THE PROPOSED ACTION

The no action alternative and alternatives considered but not further analyzed are described in Section 1.3. As discussed there, the no action alternative is the primary alternative considered and presumes that operations would continue at approximately their current rates into the indefinite future.

2.4 MITIGATION MEASURES IN THE PROPOSED ACTION

General or universal mitigation measures identified in the impact analyses (Chapter 4) are summarized below as a part of both components of the proposed action. Following these general mitigation measures, resource and issue-specific mitigation measures are listed by area using the same numbering system found in Chapters 3 and 4, for ease of location between chapters. A more in-depth specification of mitigation measures is found in Chapter 5.

- Although these measures are part of both components of the proposed action, subsequent project-specific activities with potential impacts will require separate NEPA documentation, which may entail additional, specific mitigation measures.
- Project proponents will use the WSMR DAS/GIS at the earliest point in the planning stage to assist in identifying the appropriate level of NEPA documentation, to plan projects so as to minimize environmental impacts, and to identify any additional required mitigation measures.
- The Master Planning process will continue, including periodic review, updating, integration of the DAS/GIS, and adherence to the plan as a decision making tool.
- Best management practices and common erosion-control techniques will be used in ground-disturbing activities. These practices have general application: they minimize water contamination by overland flow, reduce soil loss by wind and water erosion, reduce the period of recovery in restoration efforts, reduce visual and aesthetic impacts, help to minimize extent and duration of habitat loss, and in many ways otherwise assist in environmental management.

- All construction activity plans and designs, including maintenance, repair, and demolition, will be routed through the WSMR Environmental Services Division for review. WSMR Environmental Services Division will ensure that best management practices are in compliance with NEPA and other legislation specific to individual resources contained within WSMR. These construction activities include but are not limited to ground-disturbing activities (i.e., roads, trenches, reclamation activities, fences, power lines), activities that may cause harm to personnel or wildlife (i.e., harmful radiation from radars or lasers, loud noises), and routine maintenance activities (e.g., painting, fence mending, roofing).

- If road shoulders are necessary, they will be kept to a minimum width and water bars will be used to reduce erosion where necessary. Road construction, maintenance, and closing plans will be provided to WSMR Environmental Services Division during the design phases to ensure compliance with environmental standards.

- Exterior lighting will be avoided where possible, particularly where it could significantly impact wildlife or other natural resources, and where safety and security world not be impeded.

2.4.1 Geologic Resources and Soils

Once an initial route has been established into a recovery area, this route will be used for subsequent entries, to the extent possible, to minimize the damage to soils and potentially to geologic formations throughout the area and to minimize the need for repeated environmental surveys for entry routes into the same locale. Appropriate landscaping and building design techniques will be employed to prevent water and wind erosion caused or increased by permanent or long-term structures.

Other soils impacts mitigation includes the application of dust suppressants on permanently cleared areas (e.g., WITs).

2.4.2 Hydrologic Resources

Best management practices will be used to limit impacts on water resources and erosion-control techniques will be used in ground disturbing activities.

- Storm water management strategies will be implemented as prescribed in the latest storm water management plans for the various WSMR facilities, or per Environmental Protection Agency (EPA) guidance under National Pollutant Discharge Elimination System regulatory compliance guidance.

- Specific monitoring requirements will be implemented for the Main Post and selected outlying areas based on the water resources management study to be completed as a supplement to this EIS.

- All necessary equipment, personnel, and training will be maintained as necessary to ensure compliance with the Spill Contingency Plan (U.S. Army 1993b), to be activated in the event of any spills of hazardous substances, and to minimize impacts on surface and groundwater.

- Engineering and planning programs will continue to anticipate future water and wastewater system improvements, utility upgrades, and expansion of waste management capacities.
- All requirements for permitting of wastewater treatment and discharge facilities will be met and maintained in accordance with EPA and New Mexico State requirements under Sections 401 and 402 of the Clean Water Act.
- All requirements will be met for timely compliance with U.S. Army Corps of Engineers (COE) permits associated with the disturbance of jurisdictional wetlands under Section 404 of the Clean Water Act, and for State of New Mexico Environment Department (NMED) permit review and certification review of such permits.

2.4.3 Air Quality

Notice of Intent (NOI) forms and permit applications will be filed with the New Mexico Air Quality Bureau for any emissions source requiring New Mexico Air Quality Bureau notification or permitting. Such sources include, but are not limited to, power generators rated above 54 kW (NOI) or 136 kW (permit).

The public is excluded from the vicinity of launches, tests, and activities involving the release of hazardous air pollutants, to a distance and for a duration that assures an ample margin of safety to avoid potential exposure to criteria or hazardous air pollutant concentrations exceeding ambient air quality standards or applicable health guidelines.

Ample water or chemical dust suppressants will be used to suppress fugitive dust generation during maintenance of extensive exposed surfaces of soils known to generate substantial nonpoint fugitive dust emissions. Additional mitigation measures to reduce the adverse air quality impacts of fugitive dust sources will include minimization of new roads and the reclamation, including revegetation, of old roads and cleared areas.

Ambient air monitoring will be maintained during and after laser testing at the High Energy Laser System Test facility.

To date, no cumulative air quality impacts have been identified. However, such impacts may exist or may develop unless overlapping missions are evaluated for similar impacts. WSMR will collect air quality data to assess the cumulative impact of WSMR activities (Appendix D). Cumulative impacts on air quality are discussed in Section 4.16.2.3 of this document. As noted at the beginning of Section 4.3, air quality is determined by two variables: sources and meteorology. Neither is a constricting factor to air quality at WSMR. Although the pollution sources with the proposed action and the no action alternative are many and varied, WSMR is expected to be large enough to accommodate these activities without long-term or localized cumulative impacts on air quality. Numerous permanent launch complexes and other facilities allow tests to be scheduled and spaced so that air pollutants would not accumulate for any appreciable time beyond the test activity.

2.4.4 Biological Resources

A variety of lowland and mountain habitats occur within WSMR. The majority of these habitats are dominated by desert vegetation. Wetlands occur on WSMR, but they make up only a small portion of the total habitat (less than two percent - see Table 3-23). There is a notable absence of jurisdictional wetlands on WSMR. Information currently exists on a number of these wetland sites. In some cases, such as Salt Creek, water quality data is currently being gathered and a long-term monitoring program has been established. As activities on WSMR continue, additional data on wetland sites will be gathered. In any instance where there is a question of possible impacts to wetlands, WSMR will request review by COE and EPA for Section 404 permit applicability, and permit review and certification by NMED under Section 401 of the Clean Water Act. The location and type of any wetlands within proposed project areas will be determined. Potential impacts will be analyzed and verified with field investigations. Any activities potentially affecting jurisdictional wetlands will be reviewed for permit applicability by COE and EPA under Section 404 of the Clean Water Act, and by the NMED for state review and certification under Section 401 of the Clean Water Act. Wherever possible, WSMR will avoid impacts to jurisdictional wetlands. If avoidance of wetlands is not possible, then WSMR will implement measures to mitigate impacts to wetland sites. Mitigative measures will be site specific and developed on a case-by-case basis in coordination with the COE, USFWS, and EPA. The measures may include enhancement or enlargement of existing wetlands or potentially the creation of new wetlands.

The presence of jurisdictional wetlands does not preclude activities at a site. The COE currently maintains approximately 40 nation-wide permits that cover limited construction activities (such as roads, bridges, utility lines, and bank stabilization) within Waters of the United States. Several of these nation-wide permits allow limited construction within jurisdictional wetlands. In some cases, one or more of these permits may apply to a proposed activity. If the proposed impact is not covered by a nation-wide permit, then the applicant can request from the COE, under Section 404 of the Clean Water Act, an individual permit. The COE may issue an individual permit for certain types of activities within wetlands. The implementation of a nation-wide permit or the acquisition of an individual permit for disturbance of jurisdictional wetlands would be in coordination with the COE and EPA.

Beginning with but not limited to DAS/GIS data base review, surveys for threatened and endangered species may need to be undertaken in undocumented or inadequately surveyed areas. Monitoring/survey programs will be implemented at the earliest possible planning stage of all proposed projects, including but not limited to infrastructure and utilities (road construction) and research projects. Proponents will use DAS/GIS data bases to assist in selecting preferred and alternative operations sites that minimize adverse consequences to sensitive resources. WSMR Environmental Services Division will prepare a WSMR threatened and endangered species survey handbook to provide guidance for survey requirements and documentation, which will be required of all project proponents. Potential impacts on sensitive species identified during project-specific surveys will be evaluated in NEPA documents tiered to this EIS. Mitigation or avoidance measures to minimize any potentially significant impacts will be identified in the appropriate NEPA document. USFWS will be contacted if any proposed action is anticipated to impact listed species, species proposed for listing, or under review for listing as endangered or threatened under the Endangered Species Act. Existing data on the locations of threatened, endangered, and candidate species will be incorporated into the Integrated Natural Resources Management Plan and will be reviewed by the WSMR Environmental Division. All data gathered on threatened, endangered, and candidate species will be reported to the USFWS to assist in sustaining status records. Proactive management efforts for the protection and enhancement of federally listed species will be developed in coordination with the USFWS.

Previous surveys for threatened and endangered species have contributed significant information on the occurrence, range, and distribution of these species on WSMR (see Section 3.4.3.1 and Tables 3-25 and 3-26). These data have been incorporated into the WSMR GIS database and will serve as an initial review source when activites are proposed on WSMR. The information from this database will facilitate on-the-ground surveys which will be undertaken at all activity sites for threatened and endangered species. Monitoring/survey programs will be implemented at the earliest possible planning stage of all proposed projects, including but not limited to infrastructure (utility/road construction) and research projects.

The situation presenting the greatest likelihood of adverse consequences to biological resources was determined to arise during recovery actions requiring entry to previously unsurveyed areas. Recovery procedures are generally foreseeable and rarely constitute emergencies for the purposes of exceptions under the environmental regulations. Therefore, in order to meet minimum environmental protection requirements under NEPA and the Endangered Species Act during any recovery action outside of the approved and surveyed area, proposed entry routes and project-related disturbance areas will be reviewed through the GIS data base and will be surveyed in advance, if practicable. In the event that overriding project or other environmental requirements prohibit an adequate survey, a biologist or other qualified representative of the WSMR Environmental Services Division will accompany the recovery team, if required. This individual will assist in the selection of an entry path that will minimize the potential for adverse impacts. In addition, this individual will identify any activity with potential impacts on sensitive resources and assist in avoiding or otherwise record such activity.

Off-road travel required for recovery actions and other activities will be minimized and coordinated with the WSMR Environmental Services Division. The WSMR Environmental Services Division may prohibit off-road travel in sensitive areas.

All above ground power lines modified or constructed on WSMR will be constructed in accordance with *Suggested Practices for Raptor Protection on Power Lines, the State of the Art in 1981* (Olendorff et al. 1981) or more current guidance, in accordance with direction from the WSMR Environmental Services Division. These guidelines describe the proper spacing of phase conductor lines and ground lines on poles, as well as positioning of poles. Above ground power lines no longer needed have been removed from WSMR (Morrow, pers. com. 1993a). Poles containing raptor nests and every 20th pole in obvious perch locations are retained to provide proper perches and nesting sites (U.S. Army n.d.b).

WSMR also is committed to completion of the Sike's Act agreement and Installation Natural Resources Plan for the Conservation of Fish and Wildlife Resources on WSMR; phased production of Endangered Species Management Plans for federally listed species known to occur on WSMR; and revision of the WSMR Spill Prevention, Control, and Countermeasures Plan and other plans that do not currently include provisions for interagency consultation or for addressing actions that may have impacts on threatened or endangered species or their habitats. WSMR recently entered into a cooperative agreement for the protection of the White Sands pupfish. This agreement (between the U.S. Army, U.S. Air Force, White Sands National Monument, USFWS, and NMDGF) commits to the creation of limited-use areas around the White Sands pupfish habitat as well as a variety of other measures to avoid harm to this species. In addition to the cooperative agreement, a White Sands pupfish management and recovery plan is being developed by WSMR. This plan will futher define specific management prescriptions for the protection and enhancement of this species.

The WSMR Environmental Services Division will require project proponents to implement additional mitigation measures beyond those stated in the project NEPA document if additional impacts are identified. The appropriate level of supplemental environmental documentation will be prepared, verifying the impacts and the need for any mitigation as a result of the recovery action. All data generated in the course of these efforts shall be entered into the GIS data bases.

Range personnel will be instructed concerning the prohibition against taking, collecting, harassing, or otherwise injuring protected species on WSMR, and appropriate disciplinary measures will be imposed on those found to be violating site policy. Site personnel or members of the public caught violating federal and state laws that protect biological resources will be referred to the appropriate authorities for prosecution. To the extent possible, signs will be posted near protected habitat and WSMR entrances, warning of penalties for unauthorized harm to protected biological resources.

Routes for trenches and other ground-disturbing activities will be mapped and provided to WSMR Environmental Services Division prior to disturbance to ensure compliance with mitigation requirements, including those of the Endangered Species Act. Trenches will not be left open overnight unless escape ramps are installed every 274 m (300 yds). Escape ramps can be short lateral trenches sloping to the surface or wooden planks extending to the surface. Ramp slopes will be less than 45 degrees (100 percent). Trenches left open overnight will be inspected and animals found will be reported to the WSMR Environmental Services Division.

Only native grasses, forbs, and shrubs indigenous to WSMR and suitable to replace extant vegetation within the habitat will be used during revegetation unless otherwise directed by the WSMR Environmental Services Division. Wherever possible, species beneficial to wildlife will be used. Seeding and transplanting plans will be prepared by the proponent and submitted to the WSMR Environmental Services Division for approval prior to revegetation. Revegetated areas that have not become established by the end of the growing season will be treated to prevent erosion and site degradation (e.g., mulched, contoured). Vegetation will not be cleared within 0.5 km (0.3 mi) of sensitive habitat features unless prior approval is given by the WSMR Environmental Services Division.

A screen of undisturbed, natural vegetation will be left between sensitive habitat features and any new, permanent roads or facilities where practicable. Where natural vegetation must be destroyed or does not provide a screen, seeding, reseeding, or transplanting of vegetation will be conducted to establish or enhance the screen.

Any animal carcasses discovered during routine maintenance and repair of existing electrical transmission and distribution lines will be reported to the WSMR Environmental Services Division within 24 hours of observation regardless of age or degree of decomposition. Records of carcass locations will be maintained in order to facilitate the identification of specific problem areas and to prioritize methods to prevent electrocution. Reports will include the pole number and location. All modifications to and construction of above ground power on WSMR will be performed in accordance with *Suggested Practices for Raptor Protection on Power Lines, the State of the Art in 1981* (Olendorff, et al. 1981) or more recent standards.

2.4.5 Socioeconomics

No adverse socioeconomic effects of the proposed action or the no action alternative have been identified to date. Any proposals for major changes in WSMR programs that could affect regional community planning will be analyzed in the appropriate level of NEPA documentation, tiered to this document. These impacts will be assessed and reviewed with appropriate municipal and state officials to assist them in responding to any need for increases or decreases in community services or employment.

2.4.6 Cultural Resources

Consistent with current procedures, project proponents will incorporate cultural resources, GIS data base reviews, mitigation, and monitoring programs into proposed projects at the earliest practicable planning stage, including cultural resource surveys of impact areas where no data exist and that exhibit a valid potential for cultural resources. Cultural resources will be avoided if practicable; if not, data recovery will be conducted as directed by the WSMR Archaeologist in consultation with the State Historic Preservation Officer (SHPO) under the existing Programmatic Memorandum of Agreement.

Project proponents will be informed, directly and through use of the DAS/GIS, of areas that have been surveyed for cultural and biological resources and released for impacts of drones, tow targets, vehicles, and activities that may impact the surface. Proponents will use these areas for such releases whenever practicable. The WSMR Environmental Services Division has standards and specifications which provide guidance for survey requirements and documentation and are required of all project proponents. Potential impacts on cultural resources identified during project-specific surveys will be evaluated in NEPA documents tiered to this EIS. Mitigation or avoidance measures to minimize any potentially adverse impacts will be identified in the appropriate NEPA document.

During any recovery action in an unsurveyed area, proposed entry routes and project-related disturbance areas will be reviewed through the GIS data base and surveyed in advance, when practicable. In the event that overriding project or other environmental requirements preclude an adequate survey, an archaeologist or other qualified representative of the WSMR Environmental Services Division will accompany the recovery team, if required. This individual will assist in the selection of the entry path that will minimize the potential for adverse impacts and will identify and assist in avoiding or otherwise record any activity with potential impacts on cultural resources.

The WSMR Environmental Services Division will require project proponents to implement additional mitigation measures beyond those stated in the project NEPA document if additional adverse impacts are identified. The appropriate level of supplemental environmental documentation will be prepared, verifying the impacts and the need for any mitigation as a result of the recovery action. All data generated in the course of these efforts shall be entered into the GIS data bases. The project proponent for each recovery action that requires unsurveyed entry shall document the basis upon which the determination was made that overriding requirements prohibited survey prior to entry.

- Off-road travel required for recovery actions and other activities will be minimized and coordinated with the WSMR Environmental Services Division. The WSMR Environmental Services Division may prohibit off-road travel in sensitive areas.
- Preplanned firebreaks will be surveyed for sensitive resources and rerouted to avoid any resources discovered. Projects that could produce fires will be reviewed in advance to protect identified cultural resources eligible for inclusion on the National Register of Historic Places. The WSMR Environmental Services Division will inform fire control personnel of site marking techniques. To the extent possible, the WSMR Environmental Services Division will monitor firebreak construction during fire fights.
- Mitigation of any potential impacts of construction on cultural resources will be accomplished through relocation of the project to avoid the property; fencing of the property to exclude vehicles and trespassers; or, if no alternative is available, by data recovery or other approved treatment designed to protect values for which the property is considered significant. Target sites at training ranges will be reviewed for archaeological and

biological resources and sensitive sites will be avoided. National Register criteria will be used by the WSMR Archaeologist to determine if structures are potentially significant. These criteria will be used regardless of structure age.

- Range personnel are and will be instructed concerning the prohibition against collecting cultural materials from WSMR. The appropriate disciplinary measure will be imposed on those violating site policy. Site personnel or members of the public caught violating federal and state laws protecting cultural resources will be referred to the appropriate authorities for prosecution. To the extent practicable, signs will be posted around historic structures and, in rare instances, at prehistoric sites. Signs will be posted at WSMR entrances warning of penalties for unauthorized removal of cultural resources.

As described in Section 4.6.3, the WSMR Environmental Services Division will be notified immediately if any historic or archaeological resources are discovered during construction or other ground disturbing activities. Construction must halt in the vicinity of cultural resources per PMOA Section 9.C. The WSMR Archaeologist will assess any potential adverse effects and consult with the SHPO to determine an appropriate course of action. The final determination as to the adequacy of proposed mitigation measures would be made through consultation between WSMR and the office of the state SHPO.

Adverse or potentially adverse cumulative impacts on cultural resources may occur by various uses of the range. These cumulative impacts on cultural resources may occur as a result of helicopter and other aircraft vibrations damaging standing cultural resources; compaction and surface pressure damaging subsurface archaeological resources such as pottery and architecture; and vandalism resulting in the removal, defacement, or destruction of artifacts and properties. Cumulative impacts on cultural resources also may occur in secured training ranges, which are subject to repeated impacts of ordnance. Cumulative impacts to targets and heavy-use areas should be reviewed periodically by the WSMR Archaeologist, or designated substitute, to ensure that disturbances to archaeological sites are not occurring. Comparison of target locations against archaeological surveys could mitigate these impacts by establishing target locations away from sensitive sites.

GIS technology is creating a new and more cost-effective management potential for large tracts of land such as WSMR by correlating important environmental parameters to the presence of cultural resources. Based on previously compiled archaeological and environmental relationship data, it will be possible to estimate the probability of site density in a given region. This will be invaluable in selecting possible alternate activity sites, or in cost estimation of proposed sites based on projected survey and mitigation needs. The model also will assist in identifying potential costs or delays associated with legal status such as National Historic Landmarks and Districts.

The model provides a tool for land management and project administration within WSMR. It may be used to judge the cost effectiveness of test-site selection, theoretically being able to identify the area least costly to survey and mitigate for cultural resources based on expectation of site density. As more data become available from archaeological survey work within WSMR, the information can be added to the model data base. This will result in an evolving analytical tool as the data base increases. Expectations for landscape use should be different from north to south across WSMR, reflecting the long history of land use in the region, as well as the variation in cultural traditions from east to west and from north to south.

2.4.7 Land Use

No potentially adverse effects of the proposed action or the no action alternative on land use have been identified to date. As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized. Mitigation measures will be required if such impacts are identified.

2.4.8 Utilities and Infrastructure

No potentially adverse effects of the proposed action or the no action alternative on utilities and infrastructure have been identified to date. As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized carefully. Mitigation measures will be required if such impacts are identified.

2.4.9 Traffic and Transportation

No potentially adverse effects of the proposed action or the no action alternative on traffic and transportation networks have been identified to date. As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized carefully. Mitigation measures will be required if such impacts are identified.

2.4.10 Aesthetics and Visual Resources

No potentially adverse effects of the proposed action or the no action alternative on aesthetic and visual resources have been identified to date, although the potential is deemed likely in the long term. Any construction projects that would have impacts on viewscapes from buildings included in or eligible for the National Register of Historic Places would be planned to minimize such impacts. Yellow sodium vapor lights or glare shields will be used on outdoor lights wherever possible to reduce potential impacts on astronomical observatories. As the DAS/GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, direct, indirect, and cumulative impacts will be scrutinized carefully. Mitigation measures will be required if such impacts are identified.

2.4.11 Recreation

No potentially adverse effects of the proposed action or the no action alternative on recreation have been identified to date. Mitigation measures will be required if such impacts are identified. Memoranda of Agreement (MOA) exist between WSMR and both the National Park Service for White Sands National Monument and the U.S. Fish and Wildlife Service for the San Andres National Wildlife Refuge. These MOA address conflicts between recreational use of these areas and restricted access for purposes of safety and security.

2.4.12 Noise

The public will continue to be excluded from areas where they could be exposed to potentially harmful noise levels. WSMR personnel are required to use hearing protection devices in any environment where they may be exposed to harmful noise levels. Warning signs are posted in areas where high noise levels may occur. Test personnel are administered periodic hearing tests in compliance with U.S. Army hearing conservation programs.

WSMR programs generally are not conducted close to off-range population centers. Range operations are conducted in remote areas to the extent possible. Any potentially adverse impacts of project-specific noise on wildlife will be addressed in project-specific NEPA documentation. Potentially adverse impacts will be mitigated or avoided. Restricted areas (such as the San Andres National Wildlife Refuge) where sensitive wildlife exists will be avoided by maintaining aircraft at 610 m (2,000 ft) above ground level (AGL). No cumulative noise impacts are anticipated because the limitations of range scheduling prevent major increases in the number of noise sources at WSMR. A follow-on analysis of noise and cumulative impacts is proposed to supplement this EIS (Appendix D, Commitment Management Summary).

2.4.13 Radiation Sources

Existing restrictions on public access and enforcement of safety procedures and monitoring for WSMR personnel will continue in order to prevent any exposure to harmful radiation levels. WSMR is required to provide a Radiation Protection Committee as part of the WSMR Radiation Protection Program. This program is applicable to all organization elements on WSMR using, processing, and/or handling potentially hazardous radiation producing devices or radioactive materials. This program applies to all activities on WSMR, and the specifics of such actions are delineated on a case-by-case basis regarding wildlife resources. No impacts of radiation on wildlife have been identified to date.

The impact of WSMR electromagnetic radiation on the Very Large Array (VLA) and Very Long Baseline Antenna (VLBA) radio telescopes can be mitigated by avoiding emissions above the Harmful Effective Isotropic Radiated Power (HEIRP) as discussed in Section 4.13.2.3. Coordination between the National Radio Astronomy Observatory (NRAO) and WSMR's Frequency Coordinator Office will continue to assist with mitigation of radio frequency interference. The WSMR Frequency Coordinator will forward schedules of potentially impactive emissions to NRAO for use in avoiding interference with the radio telescope's observing schedules. A follow-on analysis for noise (to include electromagnetic interference) is proposed to supplement this EIS (Appendix D).

2.4.14 Hazardous Materials/Hazardous Waste

Where necessary to meet regulatory requirements or other concerns, the mitigation measures below would be implemented to reduce potential impacts associated with hazardous materials and waste management.

- Coordination of inspections by the WSMR Environmental Services Division.
- Upgrading above-ground storage tanks, under ground storage tanks (UST), and associated piping to reduce the potential for releases of stored fuels.
- Upgrading above-ground storage tanks and associated piping to reduce the potential for release of stored fuels.
- Installing leak detection systems in USTs.
- Implementing a plan to track hazardous materials and minimize hazardous waste.
- Increasing safety and fire department inspections of hazardous materials and waste storage and use areas, plus review of emergency contingency plans.

- Upgrading existing impoundments and inspection of impoundments to determine if hazardous materials are being or have been released into soil and groundwater.
- Increasing efforts to remove and abate the use of lead paint in conjunction with monitoring federal and state lead abatement regulations.
- Continuing surveys for, and remediation of asbestos-containing materials (ACM).
- Test uncertified electrical transformers and capacitors for oils containing polychlorinated biphenyls (PCB) adjacent to buildings used in remote areas of WSMR. Currently, only the transformers at the Main Post, range centers, and NASA/WSTF have been tested.
- Implementing, where possible, hazardous material reuse rather than hazardous waste generation, treatment, storage, and disposal where replacement with hazard-free substitutes is demonstrably impossible.
- Performing in-situ remediation of contaminated sites wherever possible, environmentally protective, and cost efficient.
- A follow-on hazardous materials/waste management analysis is proposed to supplement this EIS (Appendix D).

2.4.15 Health and Safety

Comprehensive health and safety programs and emergency response systems have been established at WSMR and jointly between WSMR and the network of federal, state, and local emergency response agencies in the region. These will not change significantly regardless of the alternative selected under this EIS. Therefore, no significant differences exist between the proposed action and the no action alternative.

Health and safety planning and implementation are by nature mitigation measures. At WSMR, these functions have been historically very proactive and comprehensive, both on and off the site. WSMR operations all require thorough health and safety planning at the earliest stages of facility planning and operational design. These health and safety requirements are implemented during all phases of operation, from initial construction, through the life of the facility, to final disposition. Through this approach, the vast majority of potential health and safety hazards are avoided entirely or reduced to extremely low probabilities. Despite these successful range-wide risks minimization efforts, the possibilities for unforeseen or improbable emergencies are not discounted. Emergency response planning and implementation also are given the highest priority at WSMR. Responsive emergency management is not a process limited to on-site operations at WSMR; regional cooperation with a range of federal, state, and community law enforcement and emergency agencies is fundamental to achieve the necessary level of coordination, communication, and emergency services delivery in the sparsely populated areas surrounding and including WSMR. WSMR has been and will continue to be a major component in the integrated interagency regional emergency response capability in south central New Mexico. WSMR health and safety-related programs will continue to perform at the same top priority level of operation under both the proposed action and the no action alternative.

2.5 COMPARISON OF ENVIRONMENTAL CONSEQUENCES

This section compares the potential environmental consequences of the proposed action (worst case-expanded mission) and the no action alternative, based on the analyses in Chapter 4 prior to the implementation of mitigation measures. Potential impacts are described in general terms because specific impacts of possible future projects cannot be determined until the locations and activities associated with those projects are defined. Specific impacts would be identified in project-specific NEPA documents tiered to this EIS (see Section 1.4.1).

In general, the environmental consequences of the proposed action and the no action alternative are characterized as either not adverse or adverse but mitigable. Implementation of the mitigation measures have been identified for the proposed action would reduce, mitigate, or eliminate the adverse impacts identified for the no action alternative as well as mitigate the proportionally greater impacts associated with the expanded mission component of the proposed action. The WSMR Environmental Services Division may require proponents of future projects to adopt additional mitigation measures depending on both project-specific and additional data that would be collected with regard to environmental resources.

2.5.1 Geologic Resources and Soils

Potential impacts on geologic resources and soils are related to construction, off-road vehicle travel, and direct impacts of missiles, bombs, and other testing debris. Building and road construction associated with the proposed action could lead to soil compaction and loss of vegetation, leading to wind and water erosion of soils. Construction on existing disturbed areas would not cause adverse changes unless a disturbed area was expanded (e.g., additions to an existing building). Missile impacts cause depressions with effects similar to those from construction soil compaction and loss of vegetation. These impacts are characterized as potentially adverse but mitigable, with significance proportional to the extent of disturbance. Earthquake hazards are not considered a significant factor affecting range operations. The no action alternative would have proportionally fewer impacts on geologic resources and soils, as project activities would not change and new construction would not occur.

2.5.2 Hydrologic Resources

Potential impacts on hydrologic resources are related to water supply, water quality, and wastewater treatment and disposal. Existing water supplies at WSMR are more than adequate to meet demands of any increased activities under the proposed action, as are wastewater treatment and disposal facilities. Potential impacts on water quality as a result of fuel spills and other possible contaminant releases are characterized as potentially adverse but mitigable, as described in Section 4.2. Potential impacts of the no action alternative would be proportionally fewer, as demands for water supply/treatment facilities would be less than the proposed action.

2.5.3 Air Quality

Potential impacts on air quality are associated with possible exceedances of national ambient air quality standards, health guidelines for hazardous air pollutants, allowable emission rates for stationary sources, creation of offensive odors, and climate changes. Many of the project activities included in the proposed action may result in potentially adverse but mitigable air quality impacts. Surface missile launches and the use of obscurants could elevate airborne concentrations of criteria and hazardous air pollutants above ambient air quality standards and applicable health guidelines in the vicinity of launches and field tests. These impacts are mitigated by excluding the public from access to the test areas.

Power generators that support WSMR projects in the field have potential emission rates that exceed New Mexico Air Quality Control Regulations for requiring source registration and permits. These impacts are categorized as potentially adverse but mitigable, with the preventive mitigation measure being compliance with the appropriate reporting and permitting requirements. Aircraft, missiles, and mobile ground sources would not significantly affect air quality on either local or regional scales. No odor sources have been identified. Mitigation of fugitive dust from nonpoint sources includes timely application of ample water or chemical dust suppressants; minimization of new roads; and the reclamation, including revegetation, of old roads and cleared areas. At present, WSMR activities are not expected to alter local or mesoscale weather patterns. The potential impacts to air quality of the no action alternative would be substantively the same as those of the proposed action, because, within limits, the number of times a given activity occurs is less important to air quality than the intensity of short-term effects of the discrete activity. WSMR will collect air quality data to assess the cumulative impact of WSMR activities. Cumulative impacts to air quality are discussed in Section 4.16.2.3 of this document.

2.5.4 Biological Resources

Potential impacts on biological resources are largely project-specific because they depend largely on the precise location and extent of project activities. Therefore, these impacts would be addressed in project-specific NEPA documents tiered to this EIS. Potential impacts include physical destruction of vegetation, direct mortality of wildlife, habitat loss and fragmentation, and disruption of migration corridors. Such impacts are associated with construction, the building of roads, and the direct impacts of missiles, bombs, and other test debris. Habitat destruction could cause secondary impacts on wildlife.

Past activities for WSMR have implemented best management techniques to avoid impacts to wetlands and endangered species. This management commitment has included surveys for threatened and endangered species, monitoring of wetlands and water quality, studies on the impacts of feral and non-native species, activity restrictions to avoid impacts to sensitive habitats and cooperation with resource management agencies (which includes the development of a number of Memoranda of Understanding or Agreement for the protection of specific resources). The data from these surveys and studies is currently being incorporated into the DAS/GIS system that will be expanded to eventually provide all of the baseline biological data for WSMR. An Integrated Natural Resources Management Plan is being prepared that will incorporate all of the historic and current data on natural resources into a coordinated management effort. The Integrated Natural Resources Management Plan will reference existing data and incorporate the relational database.

Impacts on threatened or endangered species, as defined in the Endangered Species Act, must be avoided or mitigated. Potential impacts of noise would result from sonic booms, low-flying aircraft, and other noise sources, as described below. The effects of these sources include startling, temporary or permanent hearing loss, and abandonment of nest or den sites of sensitive wildlife species. WSMR will restrict airflights to 610 m (2,000 ft) AGL over the San Andres National Wildlife Range where sensitive wildlife occurs and will, wherever possible, avoid direct or indirect impacts to this sensitive area. If impacts cannot be avoided, WSMR will contact the appropriate management agencies and, in cooperation with these agencies, develop mitigative measures to avoid irreparable harm to the resource. Potential impacts of the no action alternative would be proportionally fewer than those of the proposed action, depending on the number and nature of proposed future projects.

2.5.5 Socioeconomics

Potential concerns for socioeconomic impacts include changes to population, employment, and income in surrounding communities and demand for housing and public services. Additional economic impacts include the effects of range operations on the budget for the monument as well as on visitors of White Sands National Monument and San Andres National Wildlife Refuge. Incremental changes in current activities are judged to have no measurable impacts on the regional socioeconomic setting or on the Monument and Refuge. Modernization activities associated with the proposed action would lead to increased economic activity, which would have a generally positive impact on the surrounding area. Local communities would be readily able to accommodate increased demands for public services by the relatively small influx of outside workers that may be required to support the proposed action. Decreases in project activities would lead to proportional decreases in economic activity, but drastic changes such as the closure of WSMR are not contemplated in either the proposed action or the no action alternative. The no action alternative would have proportionally fewer impacts than the proposed action. The proposed action would not result in a sizeable positive or negative impact on the regional socioeconomic setting at WSMR.

2.5.6 Cultural Resources

The cultural resources analysis is concerned with adverse impacts on historic structures and archaeological resources. Adverse impacts on historic structures include physical destruction, isolation of a property from its natural setting, creation of elements in conflict with the character of a property or its setting, distribution or intrusion into the historic or cultural landscape, and neglect of the property leading to its deterioration or destruction. Adverse impacts on archaeological resources include physical destruction, soil disturbances from off-road vehicles and missile impacts, creation of access to previously inaccessible areas, unauthorized removal of artifacts, and vandalism. Soil disturbances cause compaction, damage to surface or subsurface artifacts, and shock and vibration damage to artifacts and structures. Erosion/channel cutting by in-wash flow through road culverts can also impact cultural resources. In addition, construction of new roads may create access to previously inaccessible areas, possibly leading to unauthorized removal of cultural properties or vandalism. These potential impacts are associated with both the proposed action and the no action alternative. However, the lower level of activity under the no action alternative, particularly construction-related ground disturbance, would lead to proportionally lower impacts. To the degree that the loss of any cultural property may be important, these impacts may be potentially adverse.

2.5.7 Land Use

Potential impacts of activities under the proposed action or the no action alternative would be largely project-specific and cannot be characterized as to significance from the data available. Potential impacts of the no action alternative would be fewer than those of the proposed action because the no action alternative would not include construction or replacement of WSMR facilities.

2.5.8 Utilities and Infrastructure

WSMR missions are supported by several utilities including electricity and telephone service, natural gas, transportation fuels, water, and sanitary and solid waste handling and treatment. With the exception of the Main Post landfill, existing facilities in conjunction with current and planned improvements are considered sufficient to handle any increased demands for services under the proposed action or the no action alternative. Specific upgrades to WSMR utilities are discussed in Section 3.8 of this document.

Demands for utilities would be lower under the no action alternative than under the proposed action because fewer personnel would be required and new construction would not take place. The landfill has an adequate capacity until the year 2000 (Battelle Environmental Management Operations 1990). Then a new facility will need to be permitted and opened. Any project making major new demands on utilities would be required to evaluate these impacts in a project-specific NEPA document.

2.5.9 Traffic and Transportation

The existing transportation network at WSMR, including on-site roads, a rail spur, and access to nearby airports, is considered adequate to handle demands under either the proposed action or the no action alternative. Impacts under either alternative are therefore judged to be not of any measurable consequence.

2.5.10 Recreation

Current recreation opportunities are sufficient to meet demand under either the proposed action or the no action alternative. Any increased demand for on-range recreation would be met by following the requirements of Army Regulation AR 215-2.

2.5.11 Aesthetics and Visual Resources

Potential impacts of the proposed action on aesthetics at WSMR and the surrounding area include degradation of the visual panorama by increases in vehicle traffic, missile launches, and numbers of support buildings or other facilities. Increased activity at WSMR also could lead to degradation of the range's visual quality. These effects are mostly related to smoke and dust at the site and effects on air clarity from combustion emissions. Construction related to the proposed action may result in structures visible from the White Sands National Monument. Impacts to the viewshed could be reduced by integrating natural colors and contours in the structure's design. Potential impacts on the Trinity Site National Historic Landmark viewshed would be of particular concern, due to its historic importance. Increased demands for outdoor lighting could have adverse impacts on astronomical observatories in the WSMR area. Potential impacts of the no action alternative are qualitatively similar, but would be proportionally fewer than those under the proposed action.

2.5.12 Noise

Potential impacts of noise on human health and wildlife are associated with nine sources at WSMR: missiles and rockets, high explosives, space vehicles, low-level aircraft, helicopters, drones, troop training exercises, highway transport, and various routine noises associated with residential living. Potential impacts of both the proposed action and the no action alternative are characterized as potentially adverse but will be mitigated under both components of the proposed action.

A mandatory Hearing Conservation program, which provides for regular hearing tests and hearing protection in potentially hazardous areas, is in effect for WSMR personnel. The public generally is protected from noise by restricting tests involving high noise levels to remote areas and by excluding the public from these areas. Sonic booms rarely occur over populated areas as a result of off-range launches into WSMR. Wildlife impacts are avoidable by limiting source activities to areas where sensitive wildlife or nesting birds do not occur and restricting aircraft overflights in these areas to 610 m (2,000 ft) AGL. The potential noise impacts of the no action alternative would be proportionally fewer than those of the proposed action, given the lower level of activity, but would be qualitatively the same.

2.5.13 Radiation Sources

Potential impacts of radiation at WSMR include exposure of humans and wildlife to ionizing and nonionizing radiation and potential electromagnetic interference with communications. There have been no radiation releases hazardous to human health or wildlife from the FBR, the LINAC, the Gamma Radiation facility, or the REBA. Small quantities of depleted uranium have been deposited at a number of locations on WSMR during previous tests but is in solid metallic form, which is unlikely to be mobile in the range's arid environment. Other devices containing ionizing radiation sources, including some research rockets, have been sealed and inspected by the WSMR Radiation Protection Officer. Self-luminous devices containing radium-226 are collected by the Radiation Protection Officer for proper disposal. The remaining radioactive trinitite (fused sand) that resulted from the first atomic bomb exploded at Trinity site has been evaluated at Los Alamos National Laboratory and found to be of little hazard to personnel.

Potential sources of nonionizing radiation at WSMR include ultraviolet and visible energy, microwaves, radio waves, lasers, and the electromagnetic pulse facility designed to simulate the radio waves produced by a nuclear detonation in the atmosphere. Potential impacts of these sources are not considered adverse because the public is excluded from any area producing potential hazards, and WSMR personnel are required to follow appropriate safety procedures.

The potential radiation impacts of the proposed action and of the no action alternative would be similar, to the extent that no major changes in the use of radiation sources at WSMR are contemplated under the proposed action. Any future project involving such changes would discuss potential environmental impacts in an appropriate-level NEPA document tiered to this EIS.

2.5.14 Hazardous Materials/Hazardous Waste

Potential consequences to hazardous materials management activities at WSMR associated with the proposed action include potential fuel releases; the need to more accurately track hazardous materials use in compliance with Executive Order 12856, which directs federal agencies to comply with the Emergency Planning and Community Right-to-Know Act of 1994; the need for increased inspection of hazardous materials storage and use areas; potential releases of hazardous liquids from impoundments into soils and groundwater; requirements for increased asbestos and lead abatement during construction; increased testing of transformers and capacitors that contain PCBs; and increased levels of training for WSMR staff and contractors. A heightened potential for adverse human health effects will result from increased occupational exposure to hazardous materials and waste during management activities. These impacts are considered to be potentially adverse but mitigable by devoting sufficient resources to address these issues in accordance with operational requirements.

With a few exceptions, the proposed action is not anticipated to increase the hazardous waste generated at WSMR. The potential exceptions would be projects generating large quantities of hazardous waste (e.g., high-energy laser tests, propulsion system and materials tests by NASA, facilities upgrade activities). Existing facilities are capable of managing these potential problems, but they may require increased personnel to manage, test, and monitor wastes. The no action alternative would have similar impacts except that eliminating new construction would decrease the requirement for asbestos and lead abatement efforts.

2.5.15 Health and Safety

Because of the superlative WSMR health and safety, and emergency preparedness programs, and because there would be no significant differences between the proposed action and the no action alternative with respect to health and safety issues, no significant distinguishing consequences may be identified for either alternative. The most visible and potentially drastic emergency events involving WSMR activities such as aberrant missile impacts on or off the range, explosions, or releases of hazardous materials, have been addressed through intensive planning and operational design so as to reduce the probabilities of such events to extremely low levels, while still maintaining full emergency response capabilities. These events are deemed to be of low significance due to minimized probabilities and due to the comprehensive mitigation measures in place through the health and safety and emergency response programs. Therefore, there are no significant differences with regard to health and safety consequences between these two alternatives.

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CHAPTER THREE
AFFECTED ENVIRONMENT

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AFFECTED ENVIRONMENT

This chapter describes the environment potentially affected by the proposed action at White Sands Missile Range (WSMR). These descriptions are based on existing information and are intended to indicate baseline conditions against which generic impacts of activities in general program categories can be evaluated in Chapter 4. Additional and updated information will be required to evaluate potential impacts of specific future projects in National Environmental Policy Act (NEPA) documents tiered to this Environmental impact Statement (EIS). The nature of this additional information is described in the consequence analyses of Chapter 4.

3.1 GEOLOGY AND SOILS

This section describes the geologic setting, soils, geology, and seismicity of the potentially affected environment. The discussion focuses on the environment within the boundaries of WSMR and the northern and western range Call-Up Areas.

3.1.1 Geologic Setting

WSMR is located within the Mexican Highland section of the Basin and Range Province. The area is characterized by alternating north-south aligned depressions and uplifted structural blocks (fault blocks). The eastern two-thirds of WSMR are located in the Tularosa Basin. The Sacramento Mountains and the Jarilla Mountains are located just east of the WSMR boundary (Figure 3-1). The western one-third of the base is occupied predominantly by the San Andres Mountains, with the western slopes defining the western boundary. The Organ Mountains, a southern extension of the San Andres Range, abut the southwest corner of WSMR.

The northwest corner of the Range and the western range Call-Up Area lie within the Jornada del Muerto, a broad valley defined by the Oscura, San Andres, and Organ mountains on the east and the Fra Cristobal Range and Sierra Caballo on the west. The northern WSMR boundary is marked by the northern-most extent of the Oscura Mountains, which extend southward into the range (Figure 3-1). The northern Call-Up Area extends onto the Chupadera Mesa and is defined by the Manzano Mountains to the northwest and Gallinas Peak to the northeast. The topography of the northern Call-Up Area is relatively flat with the exception of the Los Piños Mountains.

Additional geologic features associated with the WSMR area include the Doña Ana Mountains, located approximately 16 km (10 mi) southwest of the range boundary, and the Jarilla Mountains at the southeast corner of the range (Figure 3-1).

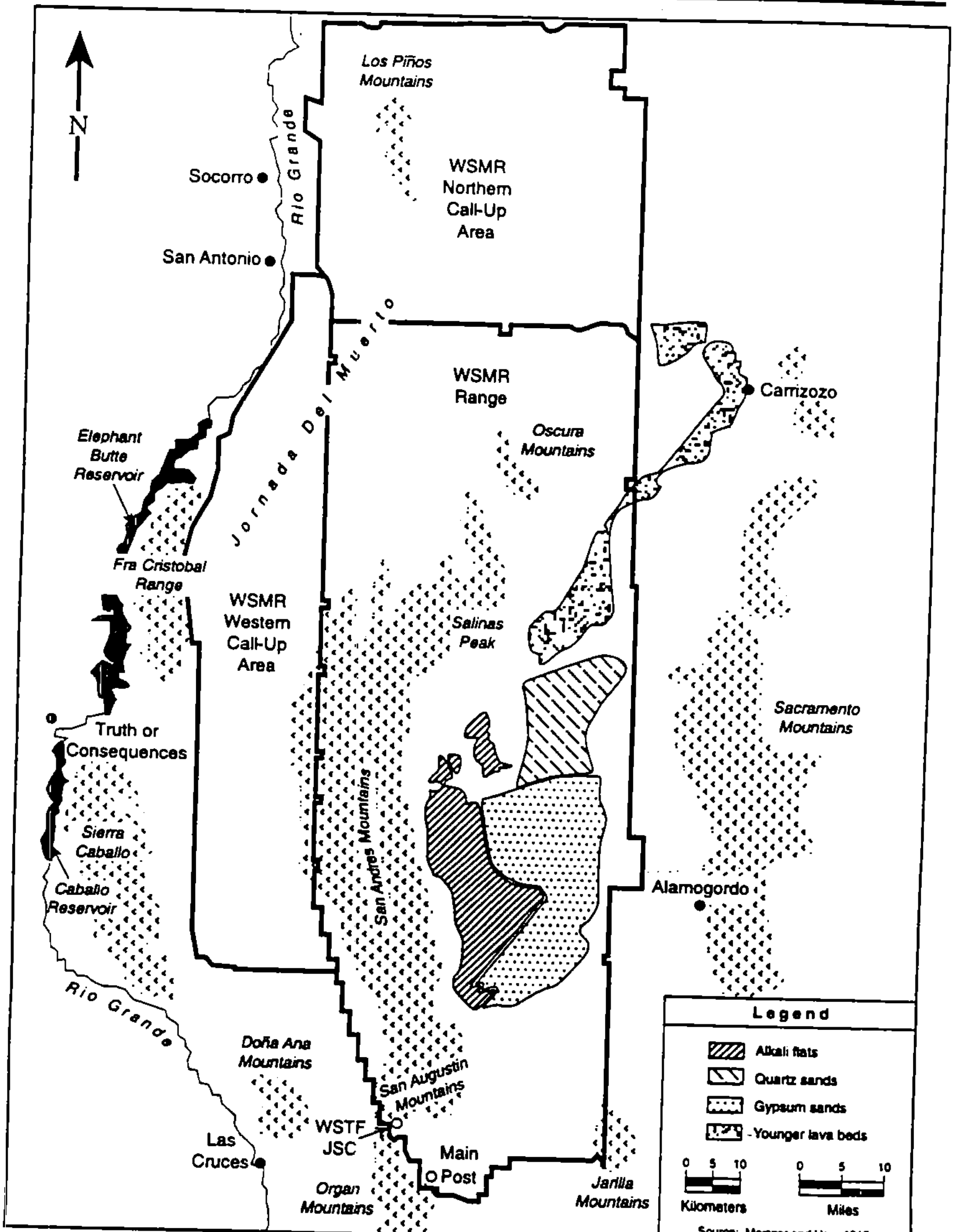

Figure 3-1. Missile range and surrounding geologic features

3.1.2 Geology

WSMR is located within the southeastern-most portion of the Basin and Range province - an area defined by alternating uplifted fault blocks forming mountains and mesas, and downthrown blocks forming drainage basins. Erosion of the uplifted fault blocks and subsequent depositional processes have resulted in thick sequences of alluvial material within the basins. The faulting in this area is mainly characterized by normal faulting due to extension of the crust. The time of faulting can only be approximated and characterized by pre- Tertiary and Tertiary Period faulting. It is difficult to determine the exact age of the pre-Tertiary faulting, due to massive deformity of bedding, the amount of faulting, the large amount of erosion that has taken place, Tertiary intrusions, volcanic activity, and concealment by sands and gravels.

The pre-Tertiary faulting is characterized by dip-slip normal fault movement with displacements ranging from 305 to 915 m (1,000 to 3,000 ft). The late Tertiary faulting is characteristic of normal faulting with displacements of at least 3,700 to 4,600 m (12,000 to 15,000 ft) (Seager 1981).

The main late Tertiary faults are referred to as the Organ Mountain fault and the Artillery Range fault. The Organ and Artillery fault zone are part of the zone of faulting that extends from El Paso to Mockingbird Gap. Movement on these faults raised the modern fault block, which forms the Organ and San Andres mountains and down-dropped the western part of the Tularosa Basin. These faults truncated the older, pre-Tertiary faults and are a result of continuing extension of the Rio Grande Rift system. Movement of faults in the area is through to have occurred as recently as 1100 years ago (Seager 1981).

The mountain ranges within WSMR and the extension areas vary from 6 to 48 km (4 to 30 mi) wide and up to 97 km (60 mi) in length, with crests ranging from 1,980 to 2,740 m (6,500 to 9,000 ft) (U.S. Army 1985a). Prominent geologic features are described in the following sections (Figure 3-1).

3.1.2.1 San Andres Range. The San Andres range, which follows the same northeast trend as the Sacramento Range across the Tularosa Basin, is approximately 137 km (85 mi) long and 9.7 to 27 km (6 to 17 mi) wide. Mockingbird Gap separates the San Andres Mountains from the Oscura Mountains to the north and San Augustin Pass separates the San Andres Mountains from the Organ Mountains in the south. Three peaks within the range rise to elevations greater than 2,400 m (8,000 ft), with the highest, Salinas Peak, almost 2,740 m (9,000 ft) above mean sea level (MSL) (Kottlowski et al. [1956] 1984).

San Andres Mountains

As the most prominent geologic feature on WSMR, these mountains occupy the western third of the range. The San Andres Mountains form the westward dipping limb of a broad anticlinal structure whose axial plane follows the Tularosa Valley and converges on Mockingbird Gap (Kottlowski et al. [1956] 1984). The sedimentary rocks of the San Andres Mountains dip westward on the west limb of the anticline. Mockingbird Gap is interpreted as the collapsed crest of the anticlinal structure between two major fault zones, which remain active as evidenced by recent fault scarps in alluvium (Kottlowski et al. [1956] 1984). The Organ Mountains fault and Artillery Range fault zones extend from El Paso to Mockingbird Gap along the eastern base of the San Andres Mountain chain (Seager 1981). These faults promoted uplift of the fault-block ranges above the western Tularosa Basin and are the most recent faults to form in this area in response to continued extension of the Rio Grande Rift (Seager 1981).

The morphology of the Sacramento Range is similar to that of the San Andres Mountains. The range is an asymmetrical ridge defined by a steep escarpment on the east and a broad alluvial apron sloping to the Jornada del Muerto, on the west. The escarpment marks a major fault zone along the eastern edge of the range overlooking the downthrown Tularosa Valley. The range contains a series of strike valleys that cut into a well-exposed series of rocks ranging from Precambrian-age (before 570 million years ago) granites to sedimentary deposits of the Paleozoic era (570 to 225 million years ago) through the Tertiary period (65 to 2 million years ago) (Kottlowski et al. [1956] 1984).

San Augustin Mountains

The San Augustin Mountains are located north of San Augustin Pass and extend to the Lohman Canyon area (Seager 1981). Structurally the San Augustin Mountains represent a transition from the Organ Mountains, dominated by the batholith, to the San Andres Mountains, composed mostly of tilted and faulted Paleozoic rocks (Seager 1981). The majority of the San Augustin Mountains comprise the north-plunging northern end of the Organ batholith (Seager 1981). The roof of the batholith is composed of metamorphosed Paleozoic rocks.

Oscura Mountains

The 32-km (20-mi), north-south range reaches its maximum elevation of 2,650 m (8,700 ft) at Oscura Peak and then drops gradually to Chupadera Mesa (Kottlowski et al. [1956] 1984). Sedimentary rocks of the Oscura Mountains dip east on the eastern limb of the faulted artificial structure whose axis passes through Mockingbird Gap (Kottlowski et al. [1956] 1984). As a result, the morphology of strata exposed along their western escarpment mirrors that observed in the eastern escarpment of the San Andres Mountains (U.S. Army 1985a).

Organ Mountains

U.S. Highway 70 traverses San Augustin Pass, linking WSMR with Las Cruces, New Mexico. This north-south-aligned range is one of the most picturesque in the state, and takes its name from a series of distinctive pinnacles that run along its backbone. The Organ Mountains comprise the southern portion of the uplifted structural block overlooking the Tularosa Basin, approximately 1,525 m (5,000 ft) below. The Paleozoic- and Mesozoic-era (225 to 65 million years ago) deposits that make up the bulk of the San Andres Mountains have been affected significantly by a mid-Tertiary period of igneous intrusion and deformation in the Organ Range. Subsequent erosion has produced the coalescing alluvial plains that extend outward from the margins of the Organ Mountains to the Tularosa Basin and the Jornada del Muerto (Seager 1981).

Jarilla Mountains

The Jarilla Mountains, located at the extreme southeast corner of WSMR, are a small uplift (6 by 5 km [4 by 3 mi]) rising from the floor of the Tularosa Basin. Morphologically similar to the nearby Organ Mountains, they represent a less impressive result of the same history of mid-Tertiary intrusion, deformation, and erosion (Seager et al. 1987).

3.1.2.2 Tularosa Basin. The Tularosa Basin is a northeast-trending structural block defined by the upthrown Sacramento Mountain Range to the east and the Organ, San Andres, and Oscura mountains to the west. The basin is approximately 193 km (120 mi) long and averages 56 km (35 mi) in width, with elevations ranging from 1,190 to 1,310 m (3,900 to 4,300 ft) above MSL. It is separated from a basin to the south (the Hueco Bolson) by a low topographic divide just north of the Texas-New Mexico border. WSMR occupies approximately 75 percent of the valley.

The basin is covered with varying thicknesses of alluvial fill deposited subsequent to basin formation in the late Tertiary period. Test well T-14, drilled at WSMR in 1967, identified basin fill sediments ranging from sand and gravel to clay with interbedded sand and evaporites to the maximum logged depth of 1,833 m (6,015 ft) (Orr and Myers 1986).

Orr and Myers (1986) divide the fill deposits in the southern portion of the Tularosa Basin into five distinct mappable units.

- Coarse to fine-grained deposits occur in gently sloping alluvial fans along the basin margin. These alluvial fans spread outward from the surrounding mountain slopes and coalesce into flat alluvial plains toward the basin interior. These fan deposits interfinger with lacustrine and alluvial deposits of the central basin.

- Fine-grained sediments formed from lacustrine deposition in the closed Tularosa Basin extend throughout most of the basin. These deposits of primarily clay and evaporites with minor sand beds are identified at the surface in the northern portion of the basin and at depth in the south basin.

- A third depositional unit is identified in the southern portion of WSMR, in the vicinity of Fort Bliss. This unit is described as fluvial-eolian sand, gravel, and clay deposits that extend from the Organ and Franklin mountains to the central portion of the valley and south to the Hueco Mountains.

- The gypsiferous evaporate deposits of the Lake Lucero-White Sands area constitute the fourth depositional unit identified by Orr and Myers (1986) in the Tularosa Basin. These deposits occupy White Sands National Monument (WSNM), and areas administered by WSMR, including the Lake Lucero area and the alkali flats north of Lake Lucero. The deposits occur as dense recrystallized gypsum, gypsum dunes, and alluvial deposits. Hard caliche (sediments cemented with recrystallized gypsum) has formed at or near the surface in many of the dry lake gypsum deposits in the central portion of the valley.

- The fifth depositional unit is composed of coarse-grained deposits. These deposits are saturated with saline water in the central Tularosa Basin.

Meinzer and Hare (1915) and Talmadge and Wooten (1937) described the most likely scenario of gypsum sand formation at WSNM and the alkali flats. Gypsum occurring in the Paleozoic outcrops of the neighboring mountains dissolved in the groundwater and surface waters and was transported in solution to the basin interior. The gypsum was then deposited on the basin floor as lake waters evaporated and spring waters surfaced. The deposits are further transported and reworked by wind and erosional processes.

Volcanic deposits occur in the northern portion of the Tularosa Valley in the form of the Malpais. The basalt lava beds are located northwest of Carrizozo and extend southwest into the northern portion of the range. The rugged, hilly area rises up to 61 m (200 ft) above the valley floor and measures approximately 48 km (30 mi) long and 0.8 to 8 km (0.5 to 5 mi) wide. An older portion of the flows is located just east of the boundary between WSMR and the northern Call-Up Area and measures approximately 65 km^2 (25 mi^2). Three volcanic cones (located at the eastern edge of the Chupadera Mesa and at Little Black Peak) constitute the source of the flows (U.S. Army 1985a).

3.1.2.3 Sacramento Range. The Sacramento Mountains are a fault-block range curving gently to the east. The mountains rise gradually in the east, then descend abruptly to the plains of the Tularosa Basin east of WSMR. The range is approximately 64 km (40 mi) long and 11 to 21 km (7 to 13 mi) wide (Pray 1961). To the north, the headwaters of Tularosa Canyon separate the Sacramento Mountains from the Sierra Blanca, their northern extension. To the south, the Sacramento Mountains end with an abrupt descent to the tablelands of Otero Mesa. The highest peak rises approximately 2,950 m (9,700 ft) with local relief in the steep-walled, west-draining canyons reaching 610 to 914 m (2,000 to 3,000 ft) in many places (Pray 1961).

The rugged western escarpment is dissected every few miles by deep canyons with typical exposures of 1,524 m (5,000 ft) or more. The exposed strata are almost entirely Paleozoic rocks, capped in a few places by remnants of the Mesozoic strata, which probably were once continuous over the entire region (Pray 1961). Beneath the Paleozoic deposits are Precambrian rocks of sedimentary origin. These are largely shale, siltstone, and free-grained quartz sandstone that have been slightly metamorphosed (Pray 1961). Numerous igneous intrusions crosscut the northern and central portions of the escarpment. Quaternary period (3 million years ago to present) deposits consisting of differing levels of terrace and piedmont sediments and undifferentiated recent alluvium extend onto the Tularosa Basin (Pray 1961).

Several mountain masses extend the Sacramento Range northward for a total length of 129 km (80 mi). The most prominent of the mountain masses is the Sierra Blanca, which tops 3,658 m (12,000 ft). Unlike the orderly series of sedimentary strata that form the Sacramento exposures, these mountains are defined by a central igneous intrusion of similar age and composition to the intrusive elements of the central Sacramento Range. Flanking this central mass of igneous rock are strata of Paleozoic limestone uplifted during a period of volcanism (Pray 1961).

3.1.2.4 Jornada del Muerto. The Jornada del Muerto is a broad valley defined by the Oscura, San Andres, and Organ mountains on the east and the Fra Cristobal Range and Sierra Caballo on the west. The valley measures 193 km (120 mi) long and from 24 to 48 km (15 to 30 mi) in width. Elevations within the basin range from 1,433 to 1,554 m (4,700 to 5,100 ft) above MSL (U.S. Army 1985a). The higher elevation of the Jornada Plains as compared to the Tularosa Basin is a result of the main drainage from the western portion of the San Andres Mountains (Kottlowski et al. [1956] 1984). Gently sloping alluvial fans extend westward from the San Andres Mountains, covering the eastern portion of the basin with a thick sequence of Quaternary sediments.

The eastern edge of the basin marks the western boundary of WSMR, while the WSMR western Call-Up Area spans the basin to the Fra Cristobal Range. The northeast-trending nature of the Jornada del Muerto places the northern portion of the valley within the north boundary of WSMR and the northern range Call-Up Area. The valley is located just east of the central rift of the Rio Grande. The valley is a structural syncline, defined by slightly western-tilting San Andres Mountains and the greater eastern-tilting strata of the Sierra Caballo (Kottlowski et al. [1956] 1984).

The Jornada del Muerto is covered predominantly with Tertiary to Quaternary alluvium derived from erosion of the San Andres and Organ mountain formations. The gently dipping sedimentary geologic sequence comprising the San Andres Mountains extends beneath the valley fill of the Jornada del Muerto.

Bolson deposits of Quaternary age range from 0 to 122 m (0 to 400 ft) thick in the basin (Kottlowski et al. [1956] 1984). Data collected from the drilling of Sun Oil Co., Victoria Land and Cattle Co. Well No. 1, located in the western Call-up Area of WSMR and approximately 16 km (10 mi) east of the Fra Cristobal Range, indicated 30 m (100 ft) of valley fill material over a thick sequence of Upper Cretaceous, Triassic period (225 to 190 million years ago), and Paleozoic era sedimentary deposits. The well was drilled to a depth of 1,845 m (6,053 ft), encountering Precambrian granite at a depth of approximately 1,829 m (6,000 ft). The valley fill is medium to coarse-grained gypsiferous sandstone containing pebbles of gray limestone and light-brown shale (Kottlowski et al. [1956] 1984).

The Jornada Malpais is located in the northern portion of the Jornada del Muerto and occupies approximately 259 km^2 (100 mi^2) of the WSMR Western Call-up area. The jagged terrain of the basalt flows rise to heights of approximately 122 m (400 ft) above the valley floor.

3.1.3 Seismicity

WSMR is located in the Rio Grande Rift, a region characterized by recent volcanism and active faulting. Rifting in this region has resulted in continued movement along faults located at the boundaries of the Tularosa Basin and the Jornada del Muerto. Three major fault zones, occurring partly within the boundaries of WSMR, are identified by Krinitzsky and Dunbar (1988). The western Tularosa zone occurs along the eastern base of the San Andres, Organ, and Franklin mountains. Faults in this zone have moved during the late Pleistocene epoch (2 million to 8,000 years ago) and/or early Holocene epoch (within the last 8,000 years) (Machette 1987). The eastern Tularosa fault zone is identified by the Alamogordo fault located along the base of the Sacramento Mountains. Studies along this fault identify movement during the Pleistocene and possibly the Holocene (Machette 1987). The third fault zone primarily comprises surface faults occurring within the Tularosa Basin east of the Organ Mountains. Movement along these faults has occurred within the last 2 million years and may be in response to activity along the major Tularosa fault zones (Seager 1981).

No major earthquake (greater than IV on the Modified Mercalli Intensity Scale) has occurred within the boundaries of WSMR since historic record-keeping began in 1849. Effects of a major earthquake as measured on the modified Mercalli scale are defined as ranging from felt by all persons with slight damage; to waves identified along the ground surface, resulting in total damage to all structures. Based on the young age of the faults within WSMR and the geologic record, the possibility of a significant earthquake at WSMR exists (Krinitzsky and Dunbar 1988). Krinitzsky and Dunbar (1988) further estimate that the largest earthquake that reasonably can be expected to occur at WSMR may result in displacements of 3 to 4 m (10 to 13 ft) along a fault length of 35 to 50 km (22 to 31 mi).

The Rio Grande Rift system is still active, and there is evidence of faulting occurring as recently as 5,000 years ago. Due to the large expanse of WSMR, site specific seismic risk models will be required for each project. The seismic risk for projects not involving construction would be minimal. A specific seismic risk evaluation should be carried out for projects that include the permanent placement of structures. The required evaluation should include but not be limited to the type of construction for facilities, the proximity to active faults, the depth of sediment to bedrock, and historic earthquake occurrences.

3.1.4 Geologic Resources

Potential geologic resources at WSMR include gypsum, hydrocarbons, and minor amounts of a variety of minerals. Mining operations are not conducted within WSMR at present. However, previous mining activity in the White Sands area and the neighboring mountains has been documented. As of 1978, there were 138,160 hectares (341,388 acres) of state mineral rights within WSMR (Foster 1978). The U.S. Congress has previously set aside funds to purchase mining claims within WSMR. All but approximately nine claims have been purchased, and three are under lease.

Mineral deposits were first discovered in the Organ district in 1846. This discovery, the Stevenson ore body (Seager 1981), ushered in mining of the Organ Mountain area. Mining activity peaked in the district in the late 1800s and early 1900s, particularly 1900 to 1909, and then gradually dwindled until about 1935 when mining essentially ceased (Seager 1981). A second flurry of mining occurred during the first two to three years of World War II. This mining did not last past the end of the war (Seager 1981).

In 1945, large areas of the northeast Organ Mountains and adjacent San Andres Range were acquired by the federal government to create the White Sands Proving Ground (WSPG), the predecessor of WSMR. These areas included several gold, silver, zinc, copper, and lead prospects or mines. Most of these deposits were mined from veins associated with large igneous intrusions in the San Andres and Organ mountains and from replacement deposits in younger volcanic rocks. Mines in the Organ district produced $2.5 million worth (at 1935 prices) of various ores over a 125-year period. As of 1979, none of the mines or prospects in the Organ district were in operation (Seager 1981).

Millions of tons of potentially commercial grade gypsum occur within WSMR and the surrounding area in the form of Quaternary gypsum dunes and as gypsum rock in the San Andres Mountains (U.S. Army 1985a). The federally protected gypsum dunes of White Sands National Monument and those which extend into lands administered by WSMR are recognized as the largest continuous deposit of gypsum sand in the world. Other widespread gypsum deposits, occurring as both dune sand and as continuous beds, are available for mining elsewhere in New Mexico.

Sand and gravel are abundant in the basin alluvial deposits occupied by the range and extension areas. These types of deposits are widespread in the Basin and Range province.

The Tularosa Basin and the Jornada del Muerto have been assigned Class 2 ratings for hydrocarbon potential (Foster and Grant 1974). Class 1 is the most favorable and Class 4 is the least favorable ranking for oil and gas production (Foster and Grant 1974). The geologic framework of the more structurally complex Tularosa Basin is favorable for the accumulation of hydrocarbons (Foster 1978). The presence of potential source and reservoir rocks, the limited degree of metamorphism within the sedimentary strata, and the favorable geothermal gradient contribute to the potential. A thorough evaluation of the oil and gas potential within the boundaries of WSMR has not been completed due to the limited amount of exploration performed to date (except around the Tularosa Basin). The number of test wells drilled in the area has been limited because of the difficulty identifying favorable structures beneath the thick basin alluvium; the remoteness of the area; and, more significantly, the restrictions on oil and gas exploration within WSMR (Foster 1978).

The Engle Field of subbituminous coal extends southeastward from Truth or Consequences, New Mexico, through the western Call-Up Area of WSMR near the Sierra-Doña Ana county line. The potential economic need for this field, as well as other small fields within WSMR, is negated by the abundance of such deposits elsewhere in the state (U.S. Congress).

3.1.5 Soils

The *Soil Survey of White Sands Missile Range* (U.S. Department of Agriculture [USDA] 1976) identifies and maps 30 Soil Conservation Service (SCS) soil series, or soil units, covering the range area. Each soil series is characterized by differing composition, slope, texture of the surface layer, and source material. A map of soil unit distribution and a table of soil unit descriptions are presented in a condensed soil survey report for WSMR. This report includes a table addressing the use of range soils as structural material and soil properties to consider during construction and engineering design.

The diversity of soil units represented at WSMR is a function of the varying topography and soil formation processes in the region. Soil genesis is influenced by many factors ranging from chemical precipitation from lake waters, wind-driven processes, erosion of highlands, alluvial deposition, and basalt lava flow deposition. Soils identified at WSMR include the gypsum dunes and lake bed deposits of WSNM and the Lake Lucero area, the rocky soils associated with the rough foothills and slopes of the neighboring mountains, and the sandy loams of the Tularosa Basin and the Jornada del Muerto. Table 3-1 indicates the approximate area and extent of soil types at WSMR. Sections 3.1.2.1 through 3.1.2.3 summarize the predominant soil units identified in each region of the range.

3.1.5.1 Mountains and Mesas. This region, which is characteristic of the uplands of the Rio Grande Rift valley, contains slopes ranging from 5 to greater than 75 percent and includes rock outcrops, mesas, mountain slopes, and ridges. Soil descriptions vary from stony loams to bedrock outcrops. Soils in these zones are characterized by medium to rapid runoff with moderate permeability. Predominant SCS units include Deama-Rock, Gilland-Rock, and Lozier-Rock outcrop complexes, and variable rock land.

3.1.5.2 Slopes/Alluvial Plains. Soils on the slopes and alluvial plains of WSMR include sandy to stony loams associated with alluvial fans, arroyos, and gentle slopes. Runoff for these soils ranges from slow to rapid, and permeability is characterized as slow to moderately rapid. SCS soil units occupying these zones include Berino-Doña Ana, Lozier-Rock, and Nickel-Tencee.

3.1.5.3 Valley/Basin Floors. Valleys and basin floors at WSMR are characterized by slopes ranging from 0 to 15 percent. Soils are described as sands to loams and are characterized by slow runoff and permeabilities ranging from slow to very rapid. SCS soil units occupying this terrain include dune land, gypsum land, lava flows, Marcial-Ubar, Mimbres-Glendale, Onite-Bluepoint-Wink, and Yesum associations.

3.2 HYDROLOGY/WATER RESOURCES

This section provides an overview of the hydrology and water resources of the WSMR area (U.S. Army 1992a). It includes a description of the physical setting, surface water resources, ground water resources, and water supply and wastewater treatment for a number of locations on WSMR where recent mission activities have occurred or where projected mission activities are planned. This section is abstracted from the *Hydrology/Water Resources Data Report* (U.S. Army 1993c), which was revised from the *Phase I Data Collection Plan* (U.S. Army 1992b) for the WSMR rangewide EIS. The report (U.S. Army 1993c) is a stand-alone technical document that provides detailed information on water resources and hydrologic conditions within the WSMR area. A comprehensive bibliographic profile of sources describing both historical and ambient hydrologic conditions at WSMR is included.

Table 3-1
Approximate area and proportionate extent of soils

Soil	Area Hectares	(Acres)	Extent*
Active Dune Land, Gypsum	38,770	(95,800)	4.4
Aladdin Association	2,145	(5,300)	0.3
Berino-Doña Ana Association	23,756	(58,700)	2.8
Deama-Rock Outcrop Complex	23,877	(59,000)	2.7
Doña Ana-Pajarito-Bluepoint Association	5,544	(13,700)	0.6
Dune Land-Dune Ana Complex	66,168	(163,500)	7.5
Dune Land-Yesum Association	26,508	(65,500)	3.0
Gilland-Rock Outcrop Complex	32,052	(79,200)	3.7
Gypsum Land, Hummocky	9,065	(22,400)	1.0
Gypsum Land, Level	31,607	(78,100)	3.6
Gypsum Rock Land	1,943	(4,800)	0.2
La Fonda Association	2,954	(7,300)	0.3
Lava Flows	16,471	(40,700)	1.9
Lozier-Rock Outcrop Crop Complex	65,642	(162,200)	7.5
Marcial-Ubar Association	46,621	(115,200)	5.3
Mead Silt Loam	10,522	(26,000)	1.2
Mimbres-Glendale Association	30,069	(74,300)	3.4
Nickel-Tencee Association	88,913	(219,700)	10.1
Onite-Bluepoint-Wink Association	51,559	(127,400)	5.9
Oscura Silty Clay	1,457	(3,600)	0.2
Rock Land, Cool	85,108	(210,300)	9.6
Shale Rock Land	6,718	(16,600)	0.8
Sonoita-Pinaleno-Alladin Association	18,657	(46,100)	2.1
Sotim-Russier Association	13,153	(32,600)	1.5
Tencee-Nickel Association, Gently Sloping	7,001	(17,300)	0.8
Tencee-Nickel Association, Steep	13,153	(32,500)	1.5
Yesum-Holloman Association	101,145	(249,927)	11.6
Yesum Very Fine Sandy Loam	16,512	(40,800)	1.9
Intermittent Lakes	7,689	(19,000)	0.9
Total	877,684	(2,168,727)	100.0

* Reported in percent rounded to the nearest 0.1.

A primary role of hydrologic monitoring at WSMR includes obtaining data and relevant information regarding the protection of WSMR site and regional water resources. Regulatory guidelines generally have been promulgated by the state of New Mexico; however, certain aspects are directed by the Environmental Protection Agency (EPA). Applicable to this hydrologic assessment are EPA secondary drinking water standards (Table 3-2), water quality standards for the state of New Mexico (Table 3-3), and the protection of receiving water bodies from wastewater effluent discharges (Table 3-4). These standards and guidelines serve to

Table 3-2
Secondary drinking water standards[a]

Chemical Constituent	Maximum Concentration (mg/L)[b]
Chloride	250
Color (color units)	15
Copper	1
Corrosivity	noncorrosive
Total Dissolved Solids (TDS)	500
Fluoride	2.0
Foaming Agent	0.5
Iron	0.3
Manganese	0.5
Odor (threshold odor number)	#3
pH (standard units)	6.5 to 8.5
Sulfate	250
Zinc	5

[a] According to Code of Federal Regulations 40 CFR 143.
[b] Reported in mg/L, unless otherwise indicated.
Note: mg/L = milligram per liter

protect certain water resources and provide the basis for comparison of appropriate monitoring data.

3.2.1 Physiographic Setting

The geologic setting of WSMR is described in Section 3.1. The bulk of WSMR lies within the Tularosa Basin, which can be described geologically as a faulted depression situated between mountains in south-central New Mexico (Orr and Myers 1986). The basin extends north-south for approximately 240 km (150 mi), has a maximum width of approximately 97 km (60 mi), and covers an area of approximately 15,540 km^2 (6,000 mi^2). The interior of the basin contains an extensive area of alkali flats and gypsum sands, which lie 1,219 m (4,000 ft) above MSL. The south part of this basin interior, which forms the center of WSMR, is characterized by slight relief and lack of definite drainage (Meinzer and Hare 1915).

3.2.2 Climate, Precipitation, and Surface Water Resources

The climate of the Tularosa Basin is typical of the arid southwestern United States. The days are generally warm and the nights cool (Meinzer and Hare 1915). This basin is less affected, especially in summer, by the great cyclonic storms that pass periodically across the continent farther to the north. Most rainfall is produced by condensation from localized ascending air currents and falls during infrequent, heavy midsummer storms. Little precipitation occurs in late autumn, early winter, or spring. Due to the relatively scarce rainfall (averaging 25 cm [10

Table 3-3
New Mexico water quality standards

Chemical Constituent	Allowable Concentration (mg/L)*
Section A - Human Health Standards for Groundwater	
Arsenic (As)	0.1
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Chromium (Cr)	0.05
Cyanide (CN)	0.2
Fluoride (F)	1.6
Lead (Pb)	0.05
Total Mercury (Hg)	0.002
Nitrate (NO_3 as N)	10.0
Selenium (Se)	0.05
Silver (Ag)	0.05
Uranium (U)	5.0
Radioactivity: Radium-226 & Radium-228 Combined (picoCurie per liter)	30.0
Benzene	0.01
Polychlorinated Biphenyls (PCBs)	0.001
Toluene	0.75
Carbon Tetrachloride	0.01
1,2-Dichloroethane (EDC)	0.01
1,1-Dichloroethylene (1,1-DCE)	0.005
1,1,2,2-Tetrachloroethylene (PCE)	0.02
1,1,2-Trichloroethylene (TCE)	0.1
Ethylbenzene	0.75
Total Xylene	0.62
Methylene Chloride	0.1
Chloroform	0.1
1,1-Dichloroethane	0.025
Ethylene Dibromide (EDB)	0.0001
1,1,1-Trichloroethane	0.06
1,1,2-Trichloroethane	0.01
1,1,2,2-Tetrachoroethane	0.01
Vinyl Chloride	0.001
PAHs (total naphthalene plus monomethylnaphthalenes)	0.03
Benzo-a-pyrene	0.0007
Section B - Other Standards for Domestic Water Supply	
Chloride (Cl)	250
Copper (Cu)	1.0
Iron (Fe)	1.0
Manganese (Mn)	0.2
Phenols	0.005
Sulfate (SO_4)	600
Total Dissolved Solids (TDS)	1,000
Zinc (Zn)	10.0
pH (standard units)	6.0 to 9.0

Source: NMWQCC 1993.
* Reported in mg/L, unless otherwise indicated.
Note: mg/L = milligram per liter

Table 3-4
New Mexico wastewater discharge guidelines

Potential Pollutant	Allowable Concentrations (mg/L)*
Biochemical Oxygen Demand	< 30
Chemical Oxygen Demand	< 125
Settleable Solids	< 0.5
Fecal Coliform Bacteria	< 500 organisms per 100 milliliters
pH (standard units)	6.6 to 8.6

* Reported in mg/L, unless otherwise indicated.
Note: mg/L = milligram per liter
Source: NMWQCC 1993

inches] or less in the lowland plains), the vegetation and physiographic features have a distinctly desert aspect (Figure 3-2). In contrast, the nearby high mountains surrounding the basin receive more precipitation (from 30 to 50 cm [12 to 20 inches]) (Meinzer and Hare 1915).

As expected, air temperatures are inversely related to surface elevation, ranging from an average of less than 7 °C (44 °F) in Cloudcroft to 16 °C (61 °F) in Alamogordo. Section 3.3 provides more detailed descriptions of the climate in the WSMR area.

Streamflows are generated from the high mountainous areas along the flanks of the Tularosa Basin. The west side of the Sacramento Mountains covers 1,360 km^2 (525 mi^2). The average annual precipitation for this drainage area generally exceeds 46 cm (18 inches) per year (Meinzer and Hare 1915). Resultant streamflows are less than 5 percent of the precipitation (estimated to total 617 million m^3 [500,000 ac-ft] per year). Springs contribute the bulk of this flow. The Three Rivers drainage area comprises approximately 259 km^2 (100 mi^2) and exhibits more diversity of physical conditions than those drainage areas of the Sacramento Mountains previously described. The estimated volume of surface water flowing from the Three Rivers drainage area exceeds 123 million m^3 (100,000 ac-ft), which drains into the Tularosa Basin (Meinzer and Hare 1915). The total area of other mountain ranges draining into the Tularosa Basin, although nearly as great as those areas already described, probably contributes less water to the basin (estimated to be several thousand acre-feet per year), due to relatively lower precipitation.

Floods have occurred infrequently, for which the greatest concern has involved the Main Post area. U.S. Army Corps of Engineers (COE) has completed reports for floods that occurred on August 19, 1978 (COE 1978), and for a subsequent flood study (COE 1979a).

Several runoff-recovery studies have evaluated the feasibility of augmenting water supplies of the Main Post area. Flow-capture alternatives included construction of on-channel dams and reservoirs, the use of infiltration ditches or pits to recharge subsurface units artificially, and downstream shallow wells to pump water seeping from any upstream reservoir(s). Proposed

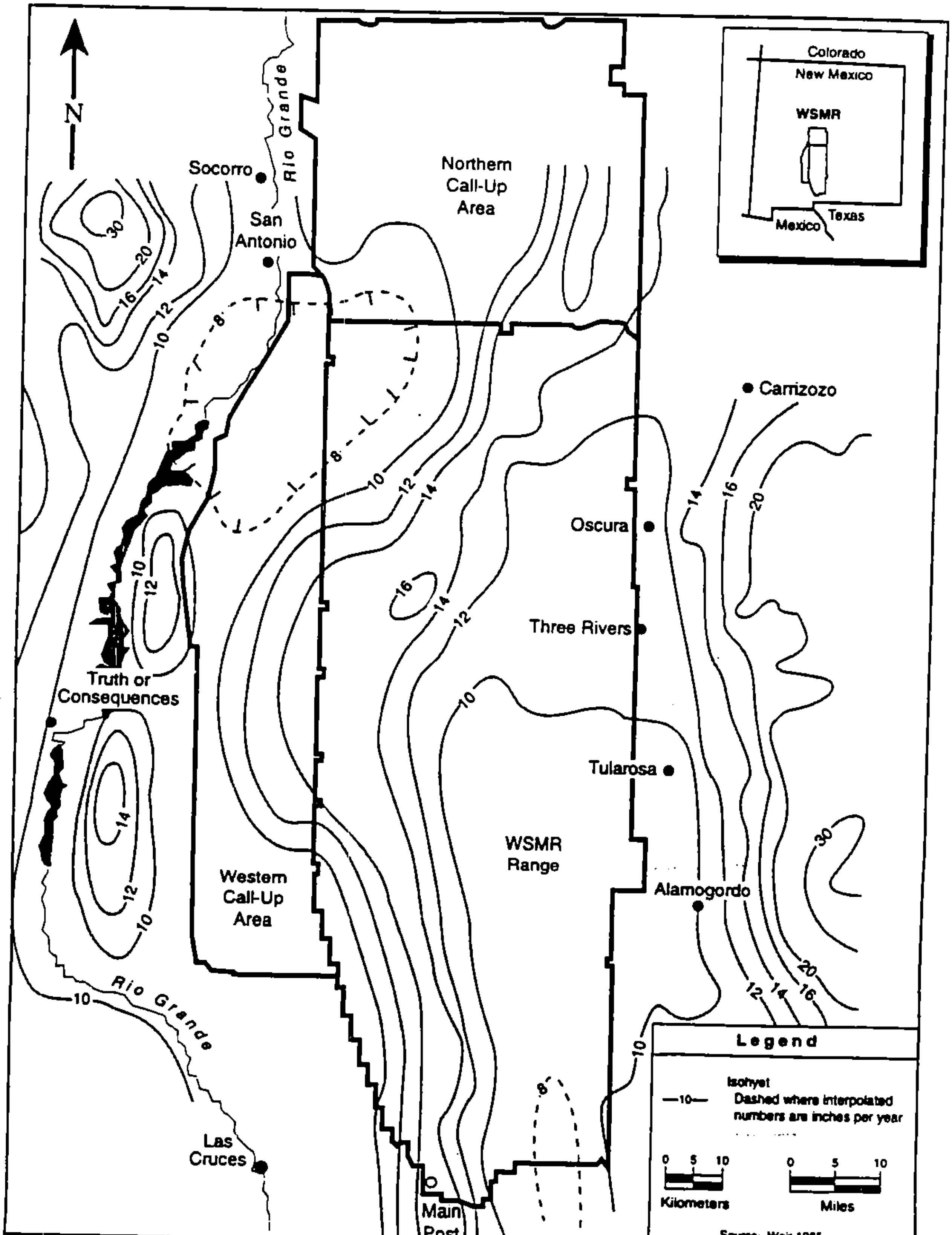

Figure 3-2. Average annual precipitation in south-central New Mexico

and alternative dam sites northwest of the Main Post area were identified. Study references are given in U.S. Army (1993c, Section 6).

3.2.3 Groundwater Resources

This section discusses ground water resources on WSMR. Ground water pumpage, water levels, and well rehabilitation also are discussed briefly. Additional details are provided in U.S. Army (1993c, Section 3.3).

3.2.3.1 Range-wide Summary. Water supply sources are a critical concern at many WSMR installations. On-site sources of potable water are distributed randomly and principally involve localized groundwater sources, although investigations for capturing surface runoff from selected arroyos have been conducted.

Ground Water Resources Drilling/Testing Investigations

Between June 1952 and July 1960, several hydrologic studies were conducted by the United States Geological Survey (USGS) on behalf of the U.S. Army Post Engineer. These studies primarily dealt with water development and well rehabilitation technical services to the U.S. Army (Hood 1963). Beginning in July 1960, USGS field services included the following (Hood 1963):

- seasonal water-level measurements in WSMR wells;
- drilling observation, well rehabilitation, groundwater reconnaissance, and supply feasibility surveys at several WSMR areas; and
- preparation of a water supply master plan for the Main Post area, including experimental use of floodwaters to augment natural groundwater recharge to that area.

Regarding reconnaissance and supply feasibility surveys, WSMR areas of interest from July 1960 through June 1962 included the Stallion Range Center (SRC), the Salinas Peak area, the Rhodes Canyon Range Center (RCRC), the Hazardous Test Area (HTA), and the Small Missile Range area (Figure 3-1) (Hood 1963). An overview of various site hydrologic investigations is provided in the following sections. More details of specific investigations are given in U.S. Army (1993c).

During the period from June 1962 through January 1965, a replacement supply well (10A) and a combined test/observation well (T-7) were drilled at the Main Post, a test well (B-1) was drilled just outside the WSMR boundaries on the Bosque del Apache Wildlife Refuge, and two test wells (RC-1 and RC-2) were drilled northwest of the RCRC (Doty 1968a). Cooper (1973) compiled data on well drilling, construction, testing, water sampling, and water level measurements of test and production (supply) wells in numerous areas on WSMR.

Groundwater Pumpage

Table 3-5 lists the documented WSMR annual groundwater pumpage rates since 1967. The volume of groundwater pumpage has decreased from an average of nearly 3.18 million m^3 (839 million gal) annually during the 1967 to 1976 period to an average of slightly over 2.54 million m^3 (670 million gal) annually during the 1979 to 1988 period, which is a reduction of approximately 20 percent. Short-term (year-to-year) variations generally reflect Main Post

Table 3-5
Annual WSMR groundwater pumpage (1967 to 1992)

Year	Pumpage in m^3 (gal)	Year	Pumpage in m^3 (gal)
1967	3,502,739 (925,323,800)	1980	2,744,630 (725,053,000)
1968	3,029,920 (800,418,500)	1981	2,520,881 (665,945,000)
1969	3,295,759 (870,645,500)	1982	2,773,038 (732,171,600)
1970	3,494,166 (923,059,000)	1983	2,701,115 (713,557,500)
1971	3,619,203 (956,090,300)	1984	2,594,054 (685,275,000)
1972	3,324,642 (878,275,600)	1985	2,560,583 (676,433,000)
1973	3,335,185 (881,060,700)	1986	2,140,513 (565,462,500)
1974	2,909,381 (768,575,400)	1987	2,348,164 (620,492,000)
1975	2,743,236 (724,684,800)	1988	2,378,448 (628,318,000)
1976	2,532,122 (668,914,400)	1989	2,875,351 (759,585,650)
1977	2,647,122 (699,294,000)	1990	2,467,919 (651,953,900)
1978	2,619,684 (692,045,700)	1991	2,106,892 (556,580,800)
1979	2,621,676 (692,572,000)	1992	2,322,071 (613,425,000)

Source: Adapted from U.S. Army 1993c (Table 4).

Notes: m^3 = cubic meter
gal = gallon

water use through pumpage (U.S. Army 1993c, Sections 3.3.1.2 and 3.3.2.2), principally for lawn irrigation to supplement naturally occurring precipitation (see pumpage results for 1991 in particular). Water use for areas other than the Main Post fluctuates according to the WSMR missions in operation, ranging between nearly 235,000 m^3 (62 million gal) of groundwater withdrawals in 1989 and less than 110,000 m^3 (29 million gal) of withdrawals in 1990.

3.2.3.2 Main Post. Herrick (1955) gave a comprehensive assessment of the groundwater resources for the approximately 518-km^2 (200-mi^2) Main Post area. This area is within a reentrant in the mountains bordering the Tularosa Basin on the west. The reentrant is bounded on the south and southwest by the Organ Mountains, on the northwest by the San Augustin Mountains, and on the north by the San Andres Mountains (Figure 3-1).

The total relief of the area is nearly 1,524 m (5,000 ft). Several small springs occur in the mountains, but there are no perennial streams in the area. The annual precipitation in the area averages 33 cm (13 inches). Playas in the basin east of this area occasionally contain water following heavy summer thunderstorms.

The principal source of groundwater in the bolson deposits in the Main Post is the precipitation that falls within the reentrant and the nearby mountains, which is an area of approximately 104 km^2 (40 mi^2). The average annual recharge to the area groundwater is estimated at 1.23

million m^3 (320 million gal) per year (Cave, pers. com. 1993). Water table contours indicate that groundwater moves eastward out of the reentrant to the lower part of the basin east of the area. From there, it moves southeast towards the Hueco Bolson in Texas.

Historical chemical analyses of 44 samples from wells and test holes in the Main Post area indicate that the groundwater within the reentrant, at least to a depth of 305 m (1,000 ft) below ground surface, contains fresh water (Herrick 1955). However, shallow groundwater in the basin a few miles east of this area is highly saline. Although an estimated 1.23 billion m^3 (324 million gal) of fresh water is stored in the bolson deposits underlying the Main Post area (west of the access road), not all of this volume is available to wells (Figure 3-3). Water levels of some of the Main Post production wells declined more than 3 m (10 ft) in the four years since their completion. Recent water level conditions are documented by Myers and Sharp (1992). It is concluded that pumping from the Main Post area over the long term will continue to remove ground water from storage.

More recent studies of groundwater development impacts in the Main Post area were made by Kelly and Hearne (1976) and by Risser (1988). Risser's modeling analysis estimated that the freshwater bolson aquifer thickness beneath the Main Post well field was 457 to 610 m (1,500 to 2,000 ft). Both water level and water quality impacts on existing and projected water demands were evaluated in these studies. Risser (1988) estimated that concentrations of dissolved solids could increase by at least 500 mg/L during the pumping period (1983 to 2017) considered in this project impact assessment if pumping rates are accurate and individual sand lenses are hydraulically connected to saline water in the eastern part of the modeled area. Time series plots of water levels and specific conductance in the Main Post wells are available in U.S. Army (1993c).

Groundwater Resources Drilling/Testing Investigations

Water is pumped principally from groundwater storage in the Main Post area (Hood 1963). A replacement water supply well field (with production wells 10, 11, and 13 through 17) has been in production since the early 1950s when production from the old well field 3 km (2 mi) southeast of the Main Post became inadequate.

Cooper (1970) made a useful compilation of data collected on well drilling, construction, testing, water sampling, and water level measurements of test and production (supply) wells in the Main Post area. Law and RASCo (COE 1992a) compiled an updated well service record. Construction and lithology diagrams of wells in addition to hydrographs (where applicable) are available. Water quality data from this reference are summarized in Table 3-6 (Cooper 1970). For selected wells, recent water level and indicator water quality data are available (Myers and Sharp 1989, 1992).

In 1967, a strati-graphic test well (T-14) was drilled to a depth of 1,833 m (6,015 ft) approximately 6 km (4 mi) northeast of the Main Post area. Pertinent aspects of the summary record for test well T-14 are given in Doty and Cooper (1970). Analyses of samples collected from six intervals in this well indicated water below 789 m (2,590 ft) to be highly saline and only the shallowest interval (64 to 110 m [210 to 360 ft] below ground level) to contain potable water (U.S. Army 1993c, Appendix Table A-2).

Between November 1968 and June 1969, test wells T-15 through T-18 (Figure 3-3) were drilled to depths ranging from 229 to 762 m (750 to 2,500 ft) as part of a continuing program to locate and evaluate potable water supplies in the Main Post area (Lyford 1970). No pumping test was conducted on well T-15. Wells T-16 and T-17 are located on Fort Bliss property.

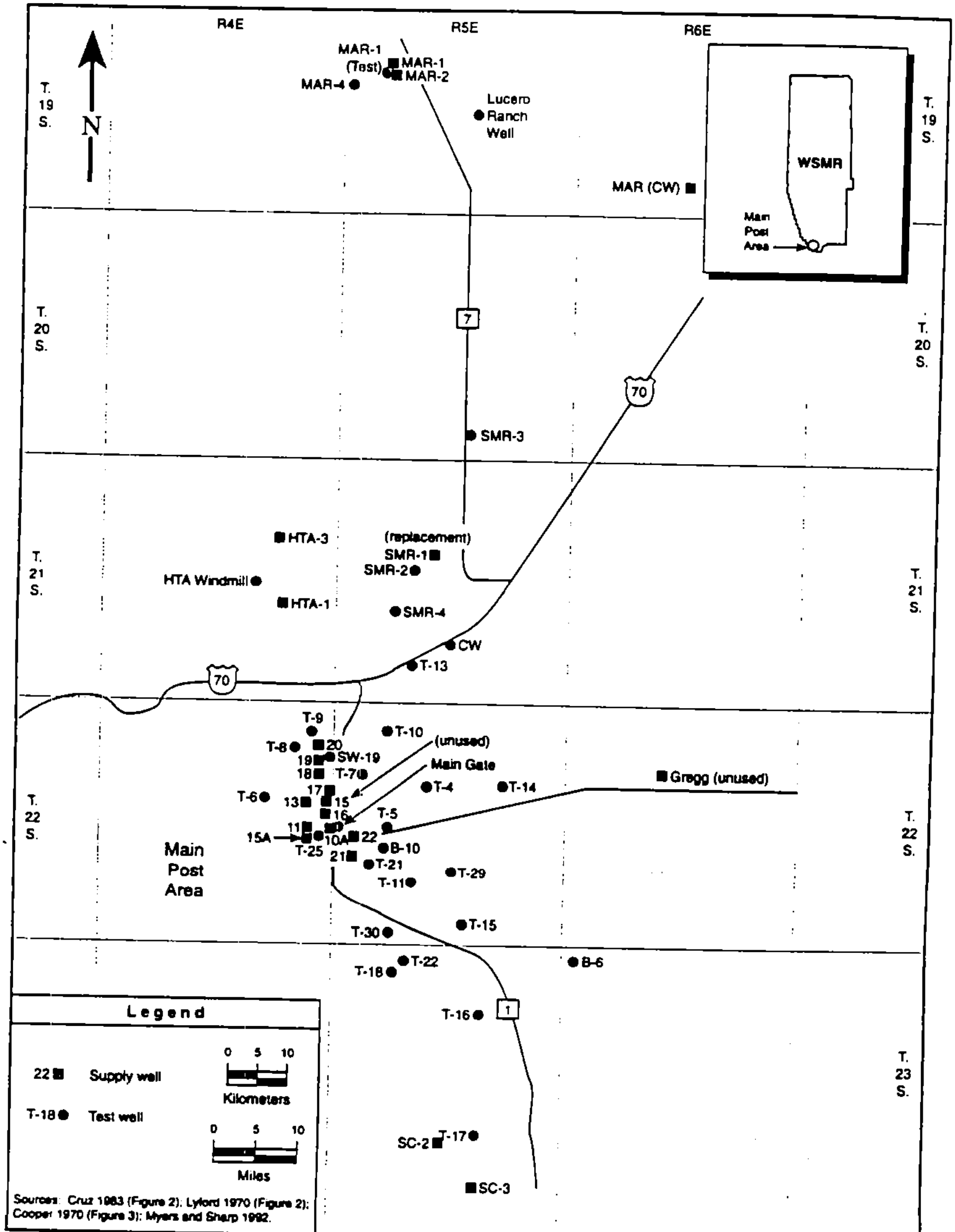

Figure 3-3. Locations of wells in the Main Post and adjacent areas

Table 3-6
Water quality summary for the Main Post area[a]

Supply Well Location[b]:		4	5	6	7	9	10	10A[c]	11
Number of Samples:		2	2	2	2	2	10	3	10
Chemical Constituent	New Mexico Standard[d] (mg/L)	Mean Concentrations (mg/L)[e]							
Silica (SiO_2)	—	52	45	53	56	48	43	44	44
Iron (Fe, dissolved)	1.0	.02	0.2	.02	.05	.03	.16	.04	.01
Iron (Fe, total)	1.0	—[f]	—	—	—	—	1.2	.08	.10
Calcium (Ca)	—	28	28	27	27	24	36	35	35
Magnesium (Mg)	—	7.4	7.7	7.3	6.6	6.1	8.3	7.2	8.5
Sodium (Na) + Potassium (K)	—	21	19	21	19	18	23	26	22
Bicarbonate (HCO_3)	—	108	99	105	106	98	131	127	122
Carbonate (CO_3)	—	0	0	0	0	0	0	0	0
Sulfate (SO_4)	600	39	39	37	34	28	48	53	47
Chloride (Cl)	250	10	13	11	8.8	9.0	9.4	10	10
Fluoride (F)	1.6	0.4	0.5	0.3	0.4	0.6	0.3	0.4	0.4
Nitrate (NO_3-N)	10.0	2.0	3.1	1.6	1.9	1.2	2.3	2.7	5.9
Dissolved Solids (calculated)	1,000	212	204	210	205	182	235	235	232
Dissolved Solids (residue on evaporation)	1,000	—	—	—	—	—	243	248	243
Hardness (as $CaCO_3$)	—	100	102	96	95	84	123	116	123
Noncarbonate Hardness (as $CaCO_3$)	—	12	21	11	8	9	15	13	23
Specific Conductance[g]	—	291	279	284	270	242	336	329	335
pH (standard units)	6.0 to 9.0	7.2	7.1	7.2	7.4	7.1	7.3	7.4	7.2
Color (units)	—	—	—	—	—	—	6	3	2
Temperature (°C)	—	—	—	—	—	—	25	26	24

(table continues)

Table 3-6 (continued).

Supply Well Location[b]: Number of Samples:		T-1 1	T-2 1	T-3 1	T-4[c] 6	T-5 7	T-6 2	T-7 11	T-9 2	T-10[c] 6
Chemical Constituent	New Mexico Standard[d] (mg/L)	Mean Concentrations (mg/L)[e]								
Silica (SiO_2)	—	24	36	33	20	27	43	28	30	33
Iron (Fe, dissolved)	1.0	.03	—	—	—	—	—	0.4	.24	.01
Iron (Fe, total)	1.0	—	—	—	—	—	—	—	—	—
Calcium (Ca)	—	44	60	60	15	32	50	28	86	37
Magnesium (Mg)	—	9.5	8.4	12	2.4	6.5	9.5	2.9	17	7.5
Sodium (Na) + Potassium (K)	—	32	39	56	26	30	27	52	62	27
Bicarbonate (HCO_3)	—	188	138	300	58	101	182	125	148	143
Carbonate (CO_3)	—	0	31	0	0	0	0	0	0	0
Sulfate (SO_4)	600	41	64	50	40	58	51	67	188	44
Chloride (Cl)	250	14	26	15	11	16	16	20	54	11
Fluoride (F)	1.6	0.4	0.5	0.5	0.4	0.4	1.2	0.7	2.7	0.4
Nitrate (NO_3-N)	10.0	0.5	0.1	0.1	0.8	6.3	4.9	4.2	21	1.7
Dissolved Solids (calculated)	1,000	257	333	375	144	226	290	258	536	231
Dissolved Solids (residue on evaporation)	1,000	—	—	—	—	—	298	258	564	246
Hardness (as $CaCO_3$)	—	149	184	199	49	105	165	81	286	123
Noncarbonate Hardness (as $CaCO_3$)	—	0	18	0	5	24	16	3	164	8
Specific Conductance[g]	—	409	505	610	216	356	449	414	825	349
pH (standard units)	6.0 to 9.0	7.4	8.7	7.6	7.2	7.5	7.8	7.7	7.4	7.3
Color (units)	—	—	—	—	—	—	—	—	25	5
Percent Sodium		31	32	38	46	38	26	67	—	36
Temperature (°C)	—	—	—	—	—	—	—	27	27	26

(table continues)

Table 3-6 (continued).

Supply Well Location[b]:		T-11	T-12	T-13[c]	T-14[c]	T-15[c]	T-16[c]	T-17[c]	T-18
Number of Samples:		6	4	6	3	1	2	2	2
Chemical Constituent	New Mexico Standard[d] (mg/L)	Mean Concentrations (mg/L)[e]							
Silica (SiO_2)	—	28	35	36	0.42	26	33	28	30
Iron (Fe, dissolved)	1.0	.12	.25	.02	.94	.09	—	—	.08
Iron (Fe, total)	1.0	—	—	—	—	—	2.3	.19	—
Calcium (Ca)	—	32	34	49	32	47	31	26	42
Magnesium (Mg)	—	5.7	6.3	13	1.9	4.7	3.7	0.8	3.5
Sodium (Na) + Potassium (K)	—	25	39	34	146	63	40	56	101
Bicarbonate (HCO_3)	—	114	126	148	133	93	116	127	177
Carbonate (CO_3)	—	0	0	0	9	0	0	0	0
Sulfate (SO_4)	600	45	79	80	133	112	54	54	224
Chloride (Cl)	250	8.8	17	26	55	54	18	19	39
Fluoride (F)	1.6	0.5	0.5	1.0	0.5	0.4	0.5	0.9	3.5
Nitrate (NO_3-N)	10.0	2.5	0.3	6.3	2.7	4.2	3.2	2.1	0.1
Dissolved Solids (calculated)	1,000	204	272	318	543	357	240	249	427
Dissolved Solids (residue on evaporation)	1,000	232	260	329	593	354	255	249	463
Hardness (as $CaCO_3$)	—	102	111	176	88	137	92	69	120
Noncarbonate Hardness (as $CaCO_3$)	—	9	8	54	0	61	2	0	0
Specific Conductance[g]	—	310	422	492	717	567	355	376	670
pH (standard units)	6.0 to 9.0	7.3	7.4	7.5	8.6	7.7	8.2	7.8	7.6
Color (units)	—	5	5	15	200	0	53	18	8
Percent Sodium		33	—	—	—	—	—	—	—
Temperature (°C)	—	25	25	30	24	27	26	29	32

(table continues)

Table 3-6 (continued).

[a] See U.S. Army 1993c (Appendix Table A-2) for complete set of water quality analyses. Data for wells T-15 through T-18 were extracted from Wilson and Myers 1981.

[b] See Figure 3-3.

[c] Analyses for relatively saline sampled intervals were omitted.

[d] Dash indicates no standard has been established.

[e] Reported in mg/L, unless otherwise indicated.

[f] Dash indicates no data available.

[g] Reported in micromilliohms per centimeter at 25 °C.

Notes: mg/L = milligram per liter

Transmissivities were calculated as follows for the other three test wells: well T-16, 455 m^2/d (4,900 ft^2/d); well T-17, 205 m^2/d (2,200 ft^2/d); and well T-18, 14 m^2/d (153 ft^2/d) (Lyford 1970). Water quality analyses were made on samples collected at selected intervals (U.S. Army 1993c, Appendix Table A-2); selected results are summarized in Table 3-6. It was judged that supply wells completed near test wells T-15, T-16, and T-17 should have yields in excess of 0.012 m^3/s (200 gpm). In contrast, the relatively low transmissivity in test well T-18 indicated that wells completed near the mountain front in unconsolidated materials would have lower yields than wells completed in more permeable fan deposits farther out in the basin.

The USGS published annual WSMR water resources review data summary reports beginning in 1968 and continuing through 1988 (U.S. Army 1993c, Section 6). Kelly (1973) compiled geohydrologic data for more than 100 wells and test holes drilled in the Main Post and adjacent areas. Observation well data documented the extent of water level declines caused by pumpage of approximately 49.3 million m^3 (13 billion gal) of groundwater from the underlying aquifer through 1972 (Figure 3-4). Selected water level and specific conductance time-series plots are available in U.S. Army (1992a). Generalized basin-wide geologic cross sections of the Main Post and Holloman Air Force Base (AFB) are provided in Figure 3-5. WSMR continues to drill additional wells for test and supply as needed, in accordance with technical specifications in U.S. Army (1980a). Details of this program are supplied in U.S. Army (1993c). In addition, a recent expansion of the Soledad Canyon well field has taken place (see Section 3.2.5.12).

Groundwater Pumpage

Groundwater pumpage has been documented for Main Post water supply wells since 1948 (Table 3-7). The Main Post well field pumpage increased steadily from 1948 to 1967 when it stabilized, until the early 1970s (Table 3-7). Since then, a varying but generally decreasing trend in pumpage rates has been observed (Table 3-7). Over the past 10 years of available records, an average of 94.5 percent of the WSMR groundwater pumping has occurred in the Main Post area. This compares to an average of 98.5 percent of sitewide pumpage by Main Post wells during the 1967 to 1976 period. Pumpage by Main Post area wells has averaged approximately 95 percent of sitewide pumpage during the last three years of unpublished record keeping (1990 to 1992). Hence, groundwater pumpage for sites outside of the Main Post area has been increasing as a percentage of total WSMR sitewide pumpage.

In contrast, the volume of Main Post well field pumpage has been decreasing from an average of 3.13 million m^3 (827 million gal) annually during the 1967 to 1976 period to an average of 2.43 million m^3 (641 million gal) annually during the 1979 to 1988 period. This is a reduction of 23 percent. In recent years, annual pumpage has varied from this average, reflecting the dominant water use for lawn irrigation to complement natural precipitation (Harris, pers. com. 1992). Specifically, 1989 had below-normal precipitation, resulting in above average groundwater pumpage in the Main Post area; conversely, 1991 had above normal precipitation, resulting in groundwater pumpage in the Main Post area substantially below average (Table 3-7).

Water Levels

Since 1953, water levels in the Main Post well field area have been monitored in test wells to evaluate the impacts of pumping groundwater resources in this area. Of the original five test wells, only two were still serviceable in 1963 (Hood 1963). Well T-6 and the new main gate well were drilled to continue water level monitoring: in addition to the test-well monitoring, water levels in production well 12 have been recorded continuously (Hood 1963). The average

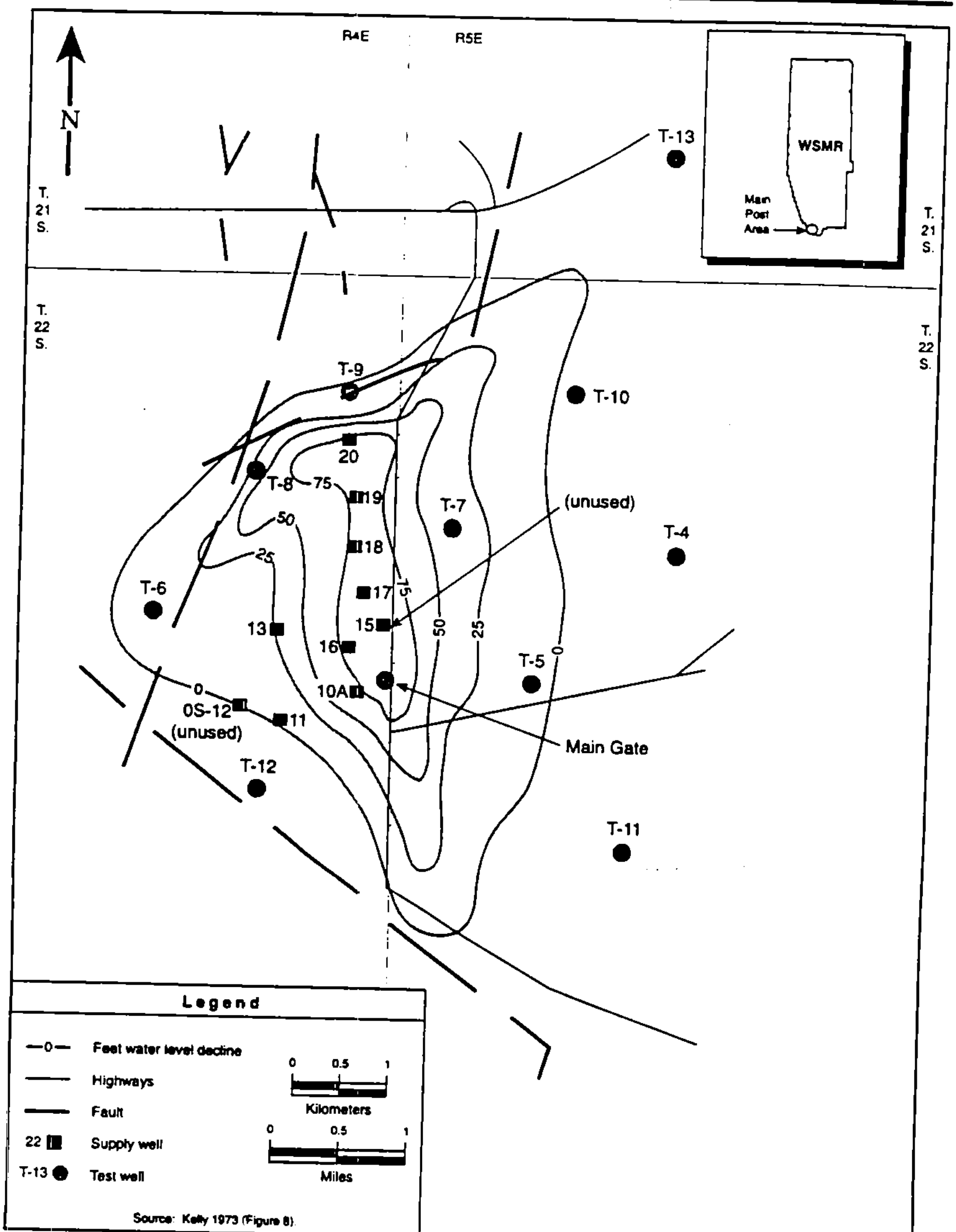

Figure 3-4. Water level declines for the Main Post area, 1949 to 1972

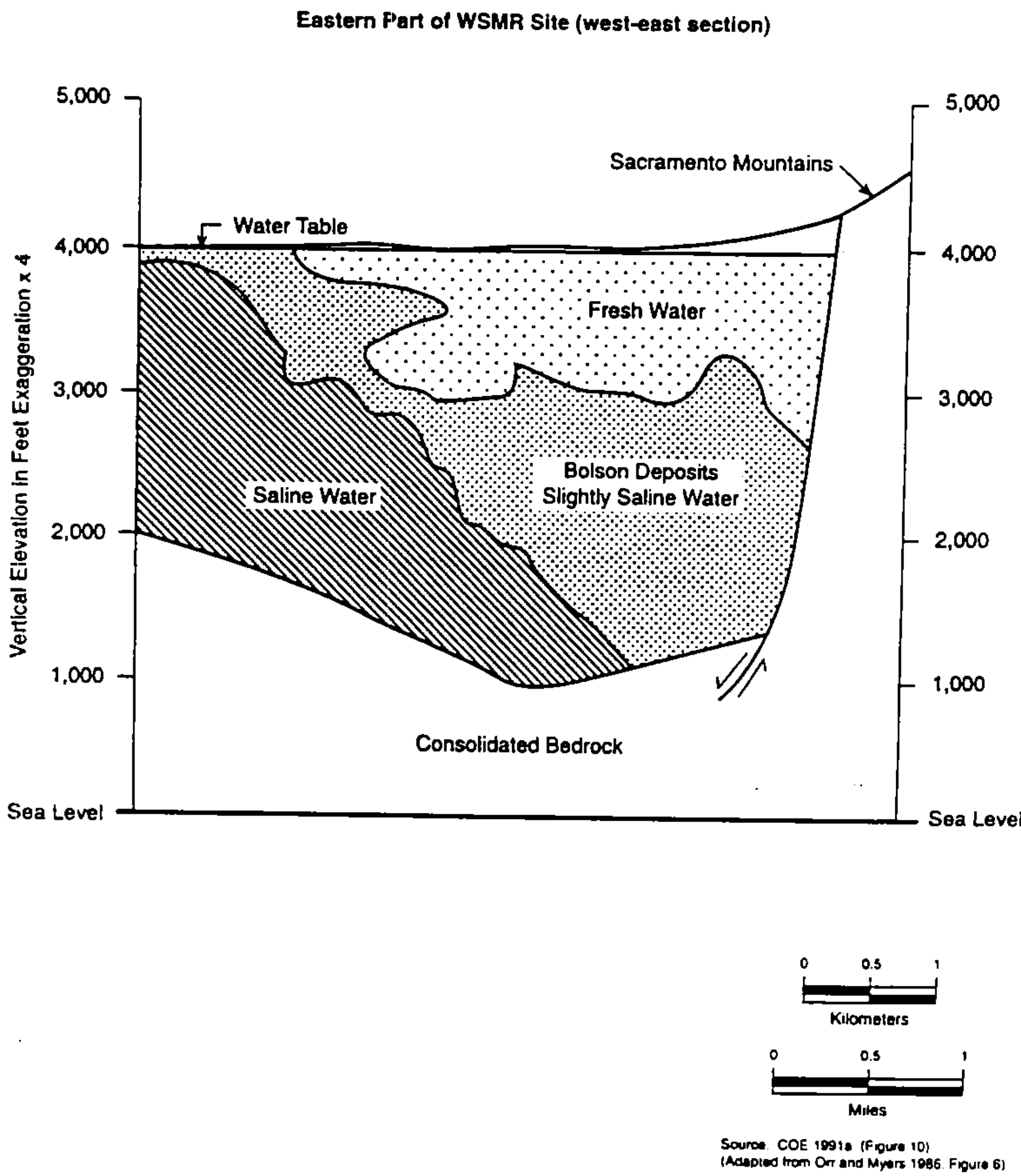

Figure 3-5. Hydrogeologic cross sections for eastern and western parts of the Tularosa Basin (figure continues on next page)

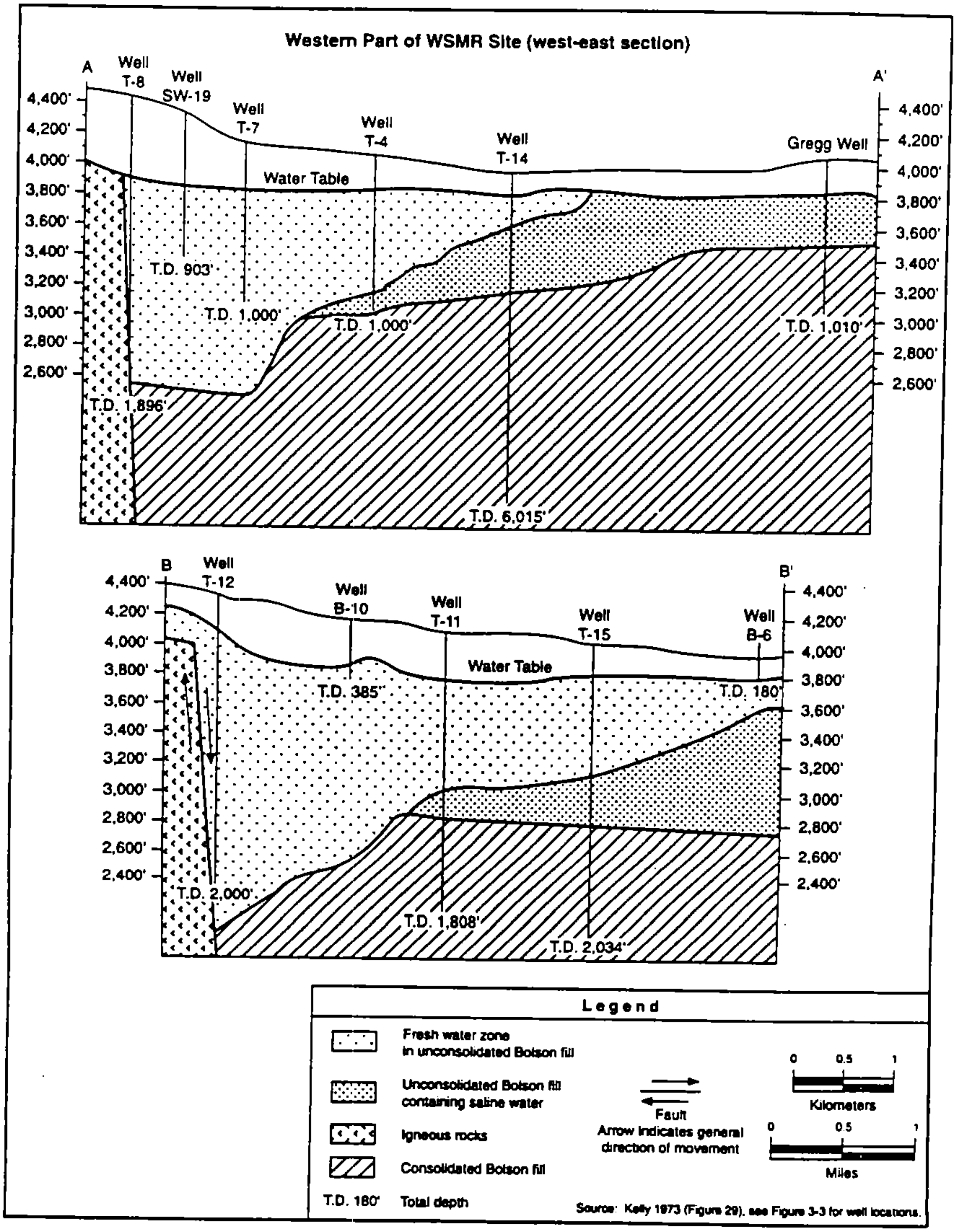

Figure 3-5. (figure continued)

Table 3-7
Annual groundwater pumpage for the Main Post area (1948 to 1992)

Year	Pumpage in m^3	(gal)	%*	Year	Pumpage in m^3	(gal)	%*
1948	311,540	(82,300,000)	—	1971	3,554,578	(939,018,000)	98
1949	395,576	(104,500,000)	—	1972	3,267,877	(863,280,000)	98
1950	578,034	(152,700,000)	—	1973	3,296,579	(870,862,000)	99
1951	781,689	(206,500,000)	—	1974	2,866,570	(757,266,000)	99
1952	761,627	(201,200,000)	—	1975	2,704,985	(714,580,000)	99
1953	895,630	(236,600,000)	—	1976	2,489,500	(657,655,000)	98
1954	1,160,610	(306,600,000)	—	1977	2,604,517	(688,039,000)	98
1955	1,279,094	(337,900,000)	—	1978	2,575,653	(680,414,000)	98
1956	1,402,120	(370,400,000)	—	1979	2,580,884	(681,796,000)	98
1957	1,501,298	(396,600,000)	—	1980	2,698,660	(712,909,000)	98
1958	1,602,747	(423,400,000)	—	1981	2,418,736	(638,961,000)	96
1959	2,123,621	(561,000,000)	—	1982	2,674,978	(706,652,800)	97
1960	2,464,687	(651,100,000)	—	1983	2,598,688	(686,499,200)	96
1961	2,469,987	(652,500,000)	—	1984	2,463,631	(650,821,000)	95
1962	2,501,406	(660,800,000)	—	1985	2,453,052	(642,056,000)	98
1963	2,646,387	(699,100,000)	—	1986	2,021,513	(534,026,000)	94
1964	3,092,310	(816,900,000)	—	1987	2,174,107	(574,337,000)	93
1965	3,157,040	(834,000,000)	—	1988	2,205,586	(582,653,000)	93
1966	2,934,458	(775,200,000)	—	1989	2,641,103	(697,704,000)	92
1967	3,455,695	(912,896,000)	99	1990	2,359,331	(623,268,000)	96
1968	3,004,435	(793,686,000)	99	1991	1,980,558	(523,207,000)	94
1969	3,267,389	(863,151,000)	99	1992	2,177,972	(575,358,000)	94
1970	3,406,382	(899,869,000)	97				

Source: U.S. Army 1993c.

* Percent of total WSMR site-wide pumpage (see Table 3-5).

Notes: m^3 = cubic meter
gal = gallon

water level decline from 1954 to 1962 was 15 m (50 ft) (Hood 1963). This compares to the more than 23-m (75-ft) decline given by Kelly (1973) for the longer period between 1949 and 1972 (Figure 3-4). This water level decline undoubtedly has included some local pumping effects and inefficiencies of individual wells; nonetheless, it represented a considerable added pumping lift. Water level declines in a particular well may vary from year to year as a result of the staggered schedule of pumping established to minimize excessive drawdown in a single well (Hood 1963).

Well Rehabilitation

Production well yields in the Main Post area have diminished over time, caused principally by gravel entering the well along with water. Decreased well yields also have been caused by water level declines in the well field, including pump deterioration, well screen plugging by chemical precipitates, partial plugging of the gravel pack by silt, and partial filling of well screens with material passing through the screens but not pumped out (Hood 1963). As a consequence, a production well rehabilitation program was developed for three wells during 1961 and 1962. The results indicated the need for certain replacement wells (Hood 1963). More details are provided in U.S. Army (1993c, Section 3.3.2.4).

3.2.4 Water Supply and Wastewater Treatment

Several technical documents detail the regional aspects of the WSMR water supply or wastewater treatment (U.S. Army 1993c, Section 3.5). These and other related studies discuss both historical as well as future needs for water development and wastewater treatment at various locations at the WSMR site. Primary water- and wastewater-related impacts are associated with activities around the Main Post area and, to a lesser extent, at the White Sands Test Facility (WSTF) and SRC sites. Extracts of these studies are provided in the following subsections. Report testing accomplished at WSMR in December 1993 indicated no problems with lead (Pb) or copper (Cu) in the drinking water supply (Cave, pers. com. 1994).

3.2.4.1 WSMR Water Supply Use and Projections. Groundwater pumpage production totals on an annual basis at the Main Post wells were summarized previously (Table 3-7). COE (1991 a) provides annual pumpage by individual wells supplying the Main Post. As of 1989, nine production wells were on line for this supply (wells 13 and 15A were not operational due to equipment malfunctions).

The COE (1991a) study included results of a regional water requirement analysis. The bulk of projected growth in water demand was derived from WSMR rather than Holloman AFB or Ft. Bliss which were included in this projected 40-year regional analysis.

Based upon Higginbotham & Associates, P.C. (U.S. Army 1986a), four watersheds adjacent to the Main Post area can provide a water supply. Natural recharge to the underlying freshwater aquifer is estimated at 1.02 million m^3 (825 ac-ft) per year, which represents approximately 38 percent of current annual withdrawals. Eleven production wells serve the Main Post area (Figure 3-6 excluding well 15, which has not been used). These wells are capable of supplying water to an effective population in excess of 14,400 (U.S. Army 1986a). Based upon a 16-hour pumping period, the pumping capacity totals 0.46 m^3/s (7,306 gpm) for the 11 production wells. However, two wells normally are held in reserve for repairs or maintenance so that the practical pumping capacity is 0.37 m^3/s (5,885 gpm) and varies depending upon which wells are in service. Recently, wells 10A, 15, and 16 have been unused (Cave, pers. com. 1993).

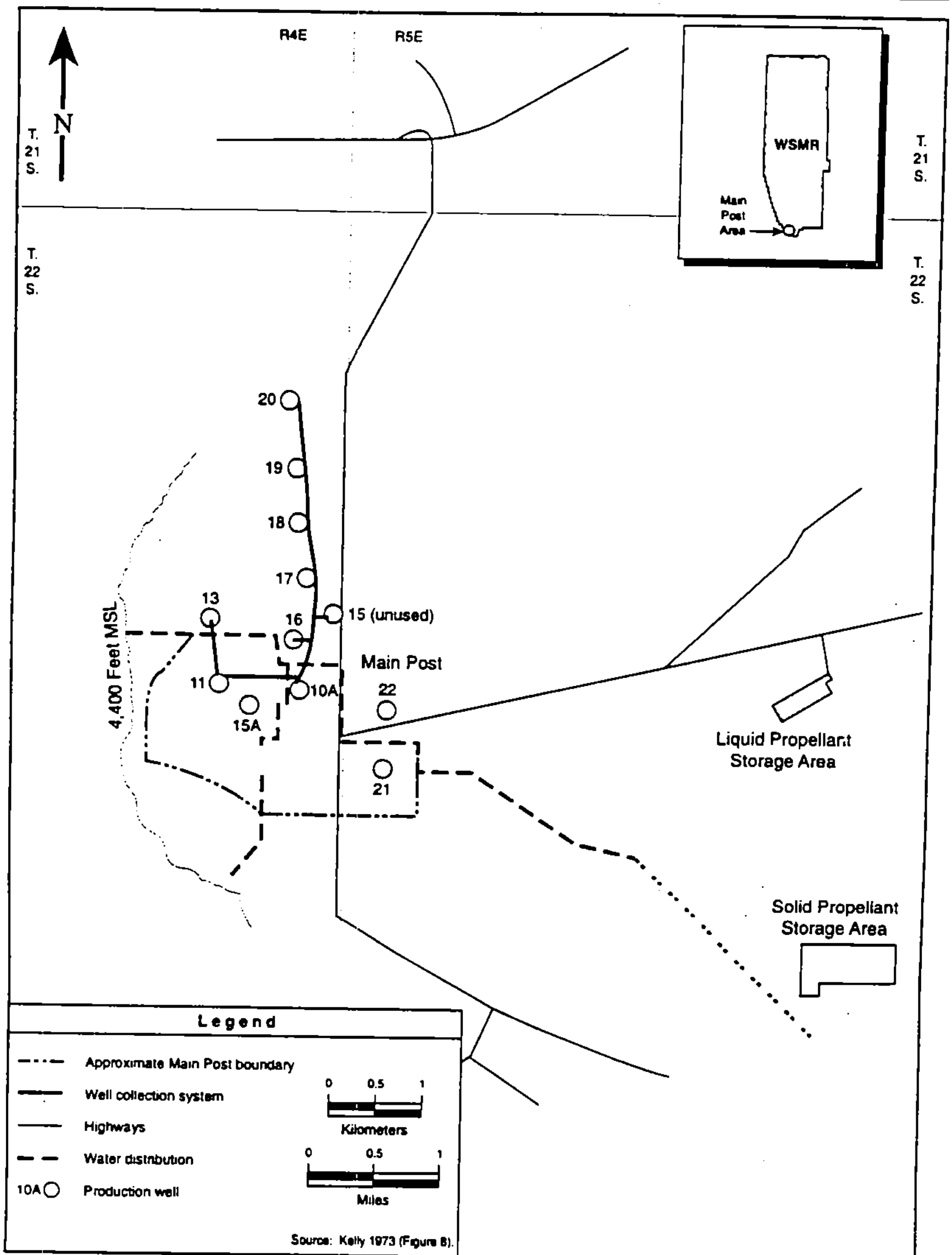

Figure 3-6. Location of production (supply) wells in the Main Post area

Since 1988, the Main Post well field supply has been supplemented by two production wells located in the Soledad Canyon reentrant area (Wilson and Myers 1981). This production capacity is being expanded to provide up to 0.93 million m^3 (750 ac-ft) per year (see Section 3.2.5.12). Impacts of this expanded well field capacity have not been assessed; an Environmental Assessment (EA) is pending (Cave, pers. com. 1994). A comprehensive water resource management analysis proposed to supplement this EIS will offer recommendations concerning aquifer use.

3.2.4.2 WSMR Wastewater System Analysis. The wastewater collection system for the Main Post area consists of more than 32,000 linear m (105,000 ft) of vitrified clay and concrete pipe, ranging from 10 to 53 cm (4 to 21 inches) in diameter (COE 1979b; U.S. Army 1986b). The entire system is designed for gravity flow; hence, no force mains are required. The elevation of the highest manhole in the system is 1,330.9 m (4,366.47 ft) MSL, and the outfall elevation at the wastewater treatment plant is 1,245.6 m (4,086.50 ft) MSL (COE 1979b). The general condition of the collection system was good in 1979. Manholes are spaced satisfactorily, joints appear adequate, and the manholes appear to be in generally good condition. A continuing maintenance program has been in progress to raise manhole rims above ground level in order to minimize the likelihood of inflow through rims and pull-holes during periods of heavy precipitation and runoff. Some root penetration and low-gradient problems have been identified (COE 1979b). During peak-flow periods, selected flowmeter measurements indicated that the collection network had been operating between 20 and 25 percent of maximum capacity, indicating that the system can tolerate additional flow.

The wastewater treatment facility servicing the Main Post is located approximately 2.4 km (1.5 mi) southeast of this area (COE 1979b; U.S. Army 1986b). Initially constructed in 1958, this facility is a trickling-filter plant capable of achieving secondary wastewater treatment. The trickling filters were modified and the sludge-drying beds (destroyed by flash floods) were repaired in 1978. The methane produced is used in the heat exchanger or flared. The Orogrande ponds serve as wastewater treatment oxidation ponds (see Section 3.8.6).

From 1971 through 1978, influent wastewater flows ranged from 0.021 to 0.028 m^3/s (485,000 to 650,000 GPD), with the higher values exceeding 0.026 m^3/s (600,000 GPD) occurring frequently during the summer months (COE 1979b). For an 18-month monitoring period (January 1977 through June 1978), inflow biochemical oxygen demand averaged 132 mg/L, which was lower than the expected demand of 280 mg/L for average daily flows of 0.018 m^3/s (412,000 GPD). Mean total suspended solids concentration for this same period was 137 mg/L, again indicating possible effects of dilution by extraneous flows into the wastewater collection system (COE 1979b).

Future expansion in wastewater treatment needs will be documented in environmental regulatory documentation tiered to this EIS. Technological and economic tradeoffs occur when considering any of the options. Use of a low-energy, low-maintenance system has obvious advantages.

3.2.4.3 Stallion Range Center. Water pumpage data and potable water consumption data at SRC for 1980 through 1985 were compiled by Higginbotham & Associates, P.C. (U.S. Army 1986a). Production from the two supply wells was relatively constant for this six-year period, averaging nearly 35,200 m^3 (9.3 million gal) per year. The SRC facility is serviced with a desalinization plant. This plant consists of three 50,000 GPD ionics, electrodialysis reversing systems. The influent water quality being treated is approximately 3,900 mg/L dissolved solids, whereas, the output water quality is approximately 700 mg/L dissolved solids (Cave, pers. com. 1994).

The SRC area is served by a central wastewater collection system connecting nearly all of the habitable buildings that contain sanitary waste disposal facilities (COE 1979b). Several of the facilities have dry wells that intercept and dispose of non-sanitary wastewater. The wastewater collection system conveys sewage to a septic tank facility located approximately 274 m (900 ft) southeast of the headquarters building. This conventionally designed septic tank facility then discharges into wastewater ponds located adjacent to and approximately 76 m (250 ft) southwest of the septic tank. This tank consists of four compartments and is constructed to allow parallel operation of two 2-compartment units. Wastewater flowing into the septic tank enters the settling and digestion chamber, which has a nominal volume of 36,643 L (9,680 gal) per unit. Wastewater flows through the tank into the final clarification zone, which has a nominal capacity of 11,886 L (3,140 gal) up to the invert of the outlet pipe. The total volume of the septic tank, including both sides below the outlet pipe, is 97,058 L (25,640 gal) (COE 1979b).

The present wastewater system was constructed in 1961. At that time, the existing septic tank discharged to one of two oxidation ponds located downstream from the tank Since that time, the two oxidation ponds have been separated by earth berms to form four ponds, with a total volume of approximately 4,920 m^3 (1.3 million gal). Due to the relatively low influent flows, the level of these pond cells is negligible, and the full capacity of the oxidation pond cells has not been used. Any overflow from these ponds would be directed to the southeast into nearby natural drainages (COE 1979b). The existing capacity of this system was calculated at approximately 0.004 m^3/s (9,000 GPD), presuming a 6.4-ac ft per acre annual rate of evaporation, but neglecting any effects of subsurface percolation.

3.2.4.4 WSTF JSC. Initially, a water requirement of 0.013 m^3/s (300 gpm per 16-hour day) was proposed for the National Aeronautics and Space Administration (NASA) Apollo Propulsion System Development facility, which was the previous name for the WSTF JSC facility (Doty 1963). To assist in meeting this water requirement, four exploratory wells (C, D, G, and H) were drilled by a contractor; however, these provided inadequate yields, even when the USGS redrilled well C (NASA 1989). Certain details of the water supply wells are provided in Section 3.2.5.1.

3.2.4.5 Holloman AFB. Historical annual water consumption for Holloman AFB ranges from 0.15 million m^3 (41 million gal) in 1946 to nearly 4.33 million m^3 (1,143 million gal) in 1971 (COE 1991a). For the recent baseline year of 1989, water use was nearly 3.3 million m^3 (872 million gal or 2,679 ac-ft). Water-use forecasts for the years 2000 to 2030 project this water use to range between 3.44 and 3.45 million m^3 (2,790 and 2,795 ac-ft) (COE 1991a). Projected water requirements thus reflect less than a 5-percent increase over the 1989 baseline use and appear to remain relatively flat over the 40-year forecast.

3.2.5 Water Resources Studies in Other Areas

The following subsections summarize hydrologic settings and data sources for selected areas of interest in this EIS, including Bosque del Apache, SRC, Salinas Peak, Rhodes Canyon, and the High Energy Laser System Test facility (HELSTF).

3.2.5.1 White Sands Test Facility. WSTF, operated by the NASA JSC, is located along the eastern part of the Jornada del Muerto Basin (Figure.3-1). This basin is a broad, north-south trending, intermontane region approximately 160 km (100 mi) long by 40 km (25 mi) wide. It extends from the Sierra Caballo on the north, through the Doña Ana Mountains, to the Franklin Mountains on the south (Figure 3-1). This basin and associated Mesilla Bolson were created by late Tertiary faulting associated with the basin and range structure of the area.

The land-surface center of this closed basin is approximately 152 m (500 ft) higher than the Rio Grande Valley to the west (see Figure 3-1). Moreover, this basin is separated physically by mountains and high ridges from the Rio Grande and the Mesilla Bolson to the west (NASA 1989).

Surface Water

WSTF is located on an alluvial fan that slopes generally westward from the San Augustin and southern San Andres Mountains into the Jornada del Muerto Basin (Figure 3-1). The facility complex is located just south of the terminus of Bear Canyon, one of the major transverse canyons through the San Andres Mountains. Surface slopes in this area range between 3 and 5 percent to the west. These slopes are characterized by drainage patterns that are widely spaced, parallel, and westward-trending arroyos. Other than a small spring and pool located along rock outcrops east of the 200 Area, WSTF has no natural permanent surface water bodies and no perennial streams (NASA 1989).

Annual precipitation in the WSTF area averages approximately 20 cm (8 inches) per year (NASA 1989). This appears to agree with the precipitation isohyetal contours reported for the WSMR region by Weir (1965) (Figure 3-2). Recharge to the alluvial aquifer is relatively small and sporadic in timing; however, a continuing source of recharge from this source is believed to occur. Due to relatively high evaporation and transpiration, runoff occurs only during snowmelt or summer thunderstorms.

Floodplains

The WSTF regional drainage is from the base of the western flank of the San Andres Mountains westward towards the Jornada del Muerto Basin. This basin is closed and there are no perennial streamflows nearby. In the WSTF area, deeply incised arroyos occur, which typically contain sediment-laden flows caused by infrequent, often intense, summer thunderstorms (NASA 1980). The contributing drainage area totals approximately 8.5 km^2 (3.3 mi^2). An unnamed arroyo passes from east to west through the WSTF area. However, near the confluence of Bear Creek and the unnamed arroyo, additional runoff from the 17.6-km^2 (6.8-mi^2) Bear Creek watershed potentially may impact the WSTF area. The WSTF site access road is subject to flooding at arroyo crossings. Culverts have not been placed at numerous smaller arroyos, and heavy thunderstorm runoff in these arroyos may result in short-duration flows across this road. The flows subside quickly after storms. No floodplain delineation mapping is known to exist for the WSTF area; however, results of a preliminary flood hazard investigation have been reported (COE 1982).

Groundwater

Active parts of WSTF are scattered over a 20.7-km^2 (8-mi^2) area along the eastern edge of the Jornada del Muerto Basin, and on the western flanks of the San Augustin and San Andres mountains. Because of this large area and its location between two quite different geological regimes, aquifers and associated groundwater flow underlying WSTF are quite complex. The aquifers vary in type, thickness, permeability, and lithology (NASA 1989). Groundwater flow directions, volumes, infiltration of precipitation, and interdependence of surface and groundwater resources are affected by localized surface and subsurface conditions. Hydrogeologic conditions at WSTF have been investigated as part of its Resource Conservation and Recovery Act (RCRA) contamination assessment program (NASA 1989).

Nearly all of the water used at WSTF as well as other areas in the Jornada del Muerto Basin is from groundwater resources. The principal aquifer of the Jornada del Muerto Basin is the Tertiary-Quaternary age sedimentary basin-fill (alluvial deposits) of the Santa Fe Group. Areal ground water resources development and associated water use are discussed in a NASA (1989) report as well as by Geoscience Consultants, Ltd. (NASA-JSC 1992).

The principal water supply for WSTF is obtained from two wells drilled west of WSTF under the supervision of the USGS (Doty 1963). Prior to completion of these wells, four other wells (C, D, G, and H) were drilled but provided inadequate yields, even when well C was redrilled by the USGS (NASA 1989). The two successful wells were completed in the alluvial (bolson) deposits of the saturated zone at 283 and 279 m (862 and 850 ft) in depth for wells I and J, respectively (Doty 1963; U.S. Army 1993c). Transmissivities of these two water supply wells were estimated to be 0.007 m^3/s per meter (48,000 GPD per foot) for well I and 0.011 m^3/s per meter (80,000 GPD per foot) for well J (Doty 1963).

Selected water quality characteristics of waters from both the earlier and the two supply wells are provided in U.S. Army (1993c, Appendix Table B-1). The resultant groundwater samples were extremely hard (267 to 630 mg/L as calcium carbonate). The samples exhibited sulfate concentrations ranging between 227 and 713 mg/L (U.S. Army 1993c, Appendix Table B-1), which in all but one case exceeded the recommended EPA drinking water standard of 250 mg/L (NASA 1989) and in two cases exceeded the New Mexico sulfate standard of 600 mg/L (Table 3-3). Groundwater characteristics with respect to water quality are summarized in Table 3-8.

Potential Sources of Contamination

Potential sources of contamination to the WSTF area are described in NASA Johnson Space Center RCRA Part B Permit Application (NASA 1992). With the exception of small quantities of manifested undiluted wastes and polychlorinated biphenyls (PCBs), no other chemicals, including scrap garbage, have been shipped off site (NASA 1986). All diluted liquid wastes are stored in evaporation tanks, or are neutralized and disposed. WSTF continues to recover silver generated from the photographic wastes from the photographic facility. Until 1988, when the photographic facility was closed, silver was recovered from photographic wastes prior to disposal. In 1985, as part of its RCRA permit application, NASA initiated a contamination assessment program involving the groundwater resources of the WSTF area. Currently, over 100 wells on WSTF and on Bureau of Land Management (BLM) lands west of WSTF are included in a groundwater monitoring and reporting program.

3.2.5.2 SRC, Mockingbird Gap, and Nearby Areas. Water quality analyses for selected wells and springs sampled during Weir's (1965) investigations (U.S. Army 1993c, Section 3.6.2) covering north WSMR are provided as a baseline characterization (U.S. Army 1993c, Appendix Tables C-1 and C-2, respectively). These water quality characteristics are summarized in Table 3-9. Hydrologic and geologic investigations of the northern part of WSMR conducted by the USGS (Weir 1965) included site-specific studies of the Stallion Site Camp (renamed SRC; see Section 3.2.4.3), Oscura Peak Station, Oscura Range Center (ORC) (including the Mockingbird Gap area), and Red Canyon Range Camp. Based upon preliminary reconnaissance-level surveys, seven drilling test holes were selected near three of these installations (Weir 1965). The primary purpose of this drilling program, conducted during late 1955 and 1956, was to locate low-yield sources of perched ground water for possible water supplies to these remote installations.

Table 3-8
Water quality summary for selected NASA WSTF wells[a]

Sample Location:		C	D	G	H	J[g]	J[g]	Gardner Spring	Love Ranch
Number of Samples:		1	1	1	1	3	3	1	1
Chemical Constituent	New Mexico Standards[b] (mg/L)	Mean Concentrations (mg/L)[c]							
Silica (SiO_2)	—	25	10	10	—[d]	—	35	—	—
Iron, Dissolved (Fe)	1.0	.05	.15	.05	.05	—	.02	—	—
Calcium (Ca)	—	—	—	—	—	—	76	—	—
Calcium Oxide	—	136	122	140	—	—	—	—	—
Magnesium (Mg)	—	—	—	—	—	—	48	—	—
Magnesium Oxide	—	86	18	116	—	—	—	—	—
Sodium Oxide	—	—	500	300	—	—	—	—	—
Sodium (Na) + Potassium (K)	—	—	—	—	—	—	—	100	—
Bicarbonate (HCO_3)	—	223	190	216	99	—	193	—	—
Carbonate (CO_3)	—	—	—	—	—	—	0	—	—
Sulfate (SO_4)	600	227	658	562	713	403	337	—	—
Chloride (Cl)	250	44	168	122	110	48	54	—	—
Fluoride (F)	1.6	1.5	1.1	1.4	2.1	—	0.6	—	—
Nitrate (NO_3-N)	10.0	—	—	—	—	—	9.5	—	—
Arsenic	0.1	—	—	—	—	—	—	.003	—
Barium	1.0	—	—	—	—	—	—	.035	.082
Dissolved Solids (calculated)	1,000	743	1,750	1,487	—	—	751	—	—
Dissolved Solids (residue on evaporation)	1,000	—	—	—	—	—	784	—	—
Suspended Solids	—	304	56	113	—	—	—	—	—
Alumina	—	15	4	9	—	—	—	—	—
Hardness (as $CaCO_3$)	—	413	267	630	340	—	378	—	—
Noncarbonated Hardness (as $CaCO_3$)	—	—	—	—	—	—	220	—	—
Specific Conductance[e]	—	—	—	—	—	1,140	1,080	1,250	950
pH (standard units)	6.0 to 9.0	7.95	7.5	8.5	—	—	7.6	—	7.9
Color	—	Colorless[f]	Colorless[f]	Colorless[f]	—	—	2	—	—

a See U.S. Army 1993c (Appendix Table B-1) for complete set of water quality analyses.
b Dash indicates no standards have been established.
c Reported in mg/L, unless otherwise indicated.
d Dash indicates no data available.
e Reported in micromhos per centimeter at 25 °C.
f With sediment.
g Location provided in U.S. Army 1993.
Notes: mg/L = milligram per liter, °C = degree celsius

Table 3-9
Water quality summary for selected wells and springs in the northern WSMR area[a]

Type/Number of Samples[b]		Wells/50	Wells/26	Wells/56	Springs/20
Chemical Constituent	New Mexico Standards[b] (mg/L)	Mean Concentrations (mg/L)[d]			
Silica (SiO_2)	—	7.2 - 34	7.0 - 19	3.8 - 37	5.9 - 46
Iron (Fe, total)	1.0	.00 - .02	.01	.00 - .11	—[e]
Calcium (Ca)	—	12 - 143	145 - 178	391 - 540	71 - 700
Magnesium (Mg)	—	3.8 - 90	115 - 119	114 - 491	7.6 - 301
Sodium (Na) + Potassium (K)	—	86 - 208	45 - 272	99 - 349	3.4 - 684
Bicarbonate (HCO_3)	—	104 - 586	64 - 409	57 - 379	57 - 620
Carbonate (CO_3)	—	0 - 33	0 - 45	0	0
Sulfate (SO_4)	600	77 - 397	516 - 1,660	1,440 - 3,260	39 - 2,680
Chloride (Cl)	250	10 - 102	36 - 96	36 - 2,210	9 - 1,200
Fluoride (F)	1.6	0.2 - 7.0	0.3 - 2.3	0.5 - 1.0	0.2 - 1.0
Nitrate (NO_3)	10.0	0.6 - 181	0.4 - 20	0.2 - 261	0.1 - 25
Dissolved Solids (residue on evaporation)	1,000	301 - 896	1,080 - 2,650	2,670 - 4,720	331 - 5,220
Hardness (as $CaCO_3$)	—	62 - 727	822 - 1,890	940 - 3,340	42 - 2,520
Noncarbonate Hardness (as $CaCO_3$)	—	0 - 431	476 - 1,670	862 - 3,230	0 - 2,480
Specific Conductance[f]	—	475 - 1,500	1,520 - 2,570	3,080 - 9,440	451 - 6,290
Percent Sodium	—	7 - 95	11 - 81	1 - 39	5 - 46
Sodium Adsorption Ratio (SAR)	—	0.4 - 124	0.7 - 7.1	0.1 - 4.9	0.1 - 5.7
pH (standard units)	6.0 to 9.0	7.3 - 8.8	6.6 - 8.1	4.5 - 8.1	7.4 - 7.9
Temperature (°F)	—	58 - 83	53 - 94	46 - 76	38 - 75

a See U.S. Army 1993c (Appendix Tables C-1 and C-2) for full set of water quality analyses.
b Separated by range of specific conductances.
c Dash indicates no standards have been established.
d Reported in mg/L, unless otherwise indicated.
e Dash indicates no data available.
f Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter
°C = degree celsius
°F = degree Fahrenheit

Weir (1965) reported details of this drilling and testing program. As part of this areal study, 158 wells and 17 springs in the area were investigated. Well and spring records and associated field measurements and water quality data were included in a USGS study report (Weir 1965).

Prior to 1960, water for all purposes at SRC was hauled by tank trucks from the Murray supply well (8.5.32.431) approximately 35 km (22 mi) to the southeast. This well had a marginal yield relative to the pumping demands placed on it (Hood 1968). In 1956, three test wells (S-1, S-2A, and S-3) were drilled at SRC (Doty 1969). Well S-1 was cased and capped after testing, and the other two wells were plugged and abandoned (COE 1986).

During June and July 1960, a nonpotable water supply well (SRC-1) was completed at SRC for fire protection, operation of sewage facilities, and other uses where water quality was not a critical consideration (Hood 1968). This well (SRC-1), designated by the USGS as 6.3.5.232, was drilled to 229 m (750 ft) below ground level and was cased with 122 m (400 ft) of 15-cm (6-inch) pipe and 107 m (350 ft) of 15-cm (6-inch) pipe with torch-cut slots 10 cm (4 inches) in length. For the final well completion testing, the well indicated a specific capacity of 2×10^{-7} m^3/s per meter (1.62 GPD per foot) of drawdown and a computed transmissivity of approximately 4×10^{-4} m^3/s per meter (3,000 GPD per foot) (Hood 1968). Water quality analyses of a sample from this well are given in U.S. Army (1993c, Appendix Table C-3). Pumping volumes from this well have been recorded since June 1963 and it was estimated that an average pumping rate of 5.65×10^{-4} m^3/s (12,867 GPD) was maintained during a nine-year period (June 1960 through July 1969) (Lyford 1970).

During June and July 1969, a second nonpotable water supply well (SRC-2) was constructed at SRC approximately 175 m (575 ft) northwest of well SRC-1 (Lyford 1970). This second well was completed at a depth of 213 m (700 ft) and was cased with 32.4-cm (12.75-inch)-outer-diameter pipe with mill-cut slots from 152 to 213 m (500 to 700 ft). The well was gravel-packed into a 48-cm (19-inch) hole. Aquifer tests on well SRC-2 indicated that the aquifer had a transmissivity of 13 m^2/d (140 ft^2/d) and indicated a storage coefficient for the aquifer of approximately 2.9×10^{-4}. Consequently, a permanent pumping rate of 160 gpm was recommended. Water quality analyses for two sampled intervals of well SRC-2 along with another set of analyses for well SRC-1 are given in U.S. Army (1993c, Appendix Table C-3). Dissolved solids concentrations ranged from 3,100 to nearly 3,500 mg/L. Sulfate was the dominant anion, with concentrations ranging from 2,100 to slightly over 2,500 mg/L.

In a more recent preliminary water supply investigation conducted at SRC for the Ground Based Free Electron Laser-Technology Integration Experiment (GBFEL-TIE) Project (COE 1986), water level measurements ranged from 64 to 65.5 m (210 to 215 ft) below ground level for the two nonpotable water wells SRC-1 and SRC-2. Production from these wells is linked to a desalinization plant with a capacity of 4.38×10^{-3} m^3/s (100,000 GPD), which reduces the dissolved solids (ranging from 3,100 to 3,300 mg/L) to approximately 550 mg/L. Total production of this plant during 1984 was nearly 36,720 m^3 (9.7 million gal), or 1.14×10^{-3} m^3/s (26,500 GPD) (COE 1986). Proposed water supply alternatives for this site were development of a nonpotable well field on site combined with construction of a reverse osmosis water treatment plant, or development of a shallow well field in the Rio Grande Valley alluvium, with construction of a water conveyance pipeline to this site. For this latter alternative, ground water resources in the Rio Grande alluvium are characterized by an approximate 650 mg/L dissolved solids concentration (COE 1986). SRC area groundwater quality characteristics are summarized in Table 3-10.

3.2.5.3 Salinas Peak Area. Through 1960, 6.3×10^{-6} to 175×10^{-6} m^3/s (143 to 4,000 GPD) of water was hauled by truck to this area (Hood 1963). In 1961, projected water

Table 3-10
Water quality summary for the SRC wells[a]

Well Sample Location:		Test S-1	Test S-2A	Test S-3	SRC-1	SRC-2	Test B-1	Test B-5	Test B-7
Number of Samples:		2	1	2	2	2	3[b]	4[b]	3[b]
Chemical Constituent	New Mexico Standard[c] (mg/L)	Mean Concentrations (mg/L)[d]							
Silica (SiO_2)	—	—[e]	—	—	32	—	35	35	56
Iron (Fe)	1.0	—	—	—	—	—	.11	.37	0.1
Calcium (Ca)	—	—	—	—	410	—	6.4	29	34
Magnesium (Mg)	—	—	—	—	170	—	1.5	9.1	9.5
Sodium (Na)	—	—	—	—	289[f]	—	230	165	134[f]
Potassium (K)	—	—	—	—	—	—	8.3	5.1	—
Bicarbonate (HCO_3)	—	—	—	—	49	—	230	216	163
Carbonate (CO_3)	—	—	—	—	0	—	0	2	0
Sulfate (SO_4)	600	2,065	904	218	2,330	2,245	248	188	177
Chloride (Cl)	250	42	39	19	42	52	116	93	129
Fluoride (F)	1.6	—	—	—	—	—	1.4	0.7	0.5
Nitrate (NO_3-N)	10.0	—	—	—	—	—	0.2	0.1	1.2
Dissolved Solids (calculated)	1,000	3,050	—	—	3,130	3,280	697	719	541
Dissolved Solids (residue on evaporation)	1,000	—	—	—	3,380	—	—	—	528
Hardness (as $CaCO_3$) (as $CaCO_3$)	—	—	—	—	1,900	—	22	134	124
Noncarbonate Hardness	—	—	—	—	1,860	—	0	0	0
Specific Conductance[g]	—	3,195	2,010	386	3,615	3,635	1,243	1,015	899
pH (standard units)	6.0 to 9.0	—	—	—	7.5	—	8.1	8.2	7.9
Temperature (°F)	—	—	—	—	82	—	—	—	—

(table continues)

Table 3-10 (continued).

a See U.S. Army 1993c (Appendix Table C-3) for complete set of water quality analyses.
b Analyses for relatively saline zones were not included.
c Dash indicates no standard has been established.
d Reported in mg/L, unless otherwise indicated.
e Dash indicates no data available.
f Represents sodium plus potassium (Na + K).
g Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter
°C = celsius
°F = Fahrenheit

demands ranged from 131 x 10^{-6} to 219 x 10^{-6} m^3/s (3,000 to 5,000 GPD), with a future long-term demand projected as high as 876 x 10^{-6} m^3/s (20,000 GPD). A reconnaissance survey was conducted over a 168 km^2 (65 mi^2) area to assess potential groundwater supply areas. Existing data were obtained for wells and springs in the area (Table 3-11). The condition of these sources varied. It was concluded that an areally extensive water table probably did not exist, although wells surveyed in the area indicated water levels generally less than 30 m (100 ft) below ground level (Hood 1963). The only potable water source sampled was from Grapevine Spring. Wells and springs in the area yielded water containing between 1,500 to 2,000 mg/L dissolved solids, with sulfate concentrations exceeding 500 mg/L. All water sources were quite hard. It was concluded that potable water may occur in the Salinas Peak area in sufficient quantities for site use. However, test holes were proposed to confirm this conclusion (Hood 1963).

3.2.5.4 Rhodes Canyon Range Center Area. In 1962, a proposed expansion of this area increased the potential water demands to approximately 1.23 x 10^{-3} m^3/s (20 gpm) for a 16-hour pumping day (Hood 1963). Potable water for domestic use is brought to the center in tank trucks because of the salinity of groundwater at the site. In this part of the west-central Tularosa Basin, saline groundwater occurs close to the mountain front. This is due in part to the relatively low elevations of the central and southern San Andres Mountains, resulting in low precipitation potentially recharging groundwater in this area. A well located approximately 6.4 km (4 mi) south of the center (Henderson well) yielded water containing approximately 6,000 mg/L dissolved solids and 2,400 mg/L chloride (Hood 1963). The depth to water for this well is reported to be 16.5 m (54 ft) below ground level. Potable water may occur to the west and northeast of the center. The McDonald South well has a reported water level of 100 m (328 ft) below ground level. Historically, soldiers from the center used water from that well before potable water was trucked in. Potential potable water sites in this area were described by Hood (1963).

Two test wells (RC-1 and RC-2) were drilled in 1964 in search of a joint water supply for the Salinas Peak and RCRC installations in the uprange WSMR area (Doty 1968a). Well RC-2 yielded water of such poor chemical quality that drilling was stopped and the hole was plugged and abandoned. Well RC-1 was drilled to a depth of 287 m (942 ft), sampled and tested for yield, and abandoned (Doty 1968a). The water obtained from well RC-1 was judged to be perched because the yield did not increase after drilling to 287 m (942 ft). Water quality analyses for wells RC-1 and RC-2 are given in U.S. Army (1993c, Appendix Table D-1). It is noteworthy that the water quality results indicated potable water from well RC-1. Potable supply well RC-4 (T13S, R4E, Section 11, SWSW) was drilled; however, no information is available regarding this well.

In 1969, well RC-3 was drilled to a depth of 21.3 m (70 ft) below ground surface. Clay and clay with gypsum were encountered during drilling of this well (Lyford 1970). Dissolved solids concentrations exceeded 27,000 mg/L in four zones sampled. Because of the relatively poor water quality and poor water-bearing properties of the material penetrated in this test well, a well drilled in this area would not meet production and desalting requirements. Therefore, no development or further tests were made in this area, and the well was sealed (Lyford 1970). Water quality characteristics of sampled wells in the RCRC area are summarized in Table 3-12.

3.2.5.5 NW30 Tracking Station Area. A test well (NW30-1) was drilled in the NW30 Tracking Station area to assess the quality and quantity of water available in this general area. This well penetrated bolson and fan deposits of sand, gravel, and clay of Quaternary and Tertiary age (Doty 1968b). The specific conductance varied widely with depth (Table 3-13). The well was cased to 204 m (670 ft). and the specific conductance of the pumped water was

Table 3-11
General information for selected wells and springs in the Salinas Peak area

Location No.	Name	Depth m (ft)	Diameter cm (inches)	Altitude m (ft)	Geologic Source[a] (ft)	WATER LEVEL Below land-surface datum m	Date of Measurement	Chemical Analyses[b]	Remarks
8.5.32.431	Murray well	70 (230)	—	1,561 (5,120)	Psg	59.8 (196.3)	04/18/60	X	Principal water source for the northern part of WSMR.
10.4.31.244	Martin well (97±)	30 (6)	15 (5,150)	1,570	Pa7.9 (26.0)	07/10/56	X		Formerly stock well, now supplies wildlife.
11.2.16.422	Cain Ranch headquarters	—	—	1,664 (5,460)	—	45.7 (150)	—	X	Formerly stock well, now unused.
11.3.12.211	Gilliland Ranch headquarters	—	15 (6)	1,611 (5,285)	Psg	21.9 (71.8)	07/08/55	—	Formerly stock well, now unused.
11.3.36.132	John Wood	30.5 (100±)	16.5 (6.5)	1,769 (5,805)	Pa26.5	07/11/56 (86.9)	—		Unused stock well.
11.3.36.444		—	20.3 (8)	1,814 (5,950)	PDI and Pa	—	—	—	Unused stock; drilled into fault plane between Abo sandstone and rocks of Pennysvanian age. Could not measure well.
11.4.27.241	Grapevine well	38.1 (125±)	14 (5.5)	1,722 (5,650)	PDI or Pa(42.0)	12.8	07/11/56	X	Formerly stock well, now used for wildlife.
11.4.29.141	Smith well	0.91 (3)	91 (36)	1,707 (5,600)	Pa0.6	07/25/56 (2.0)	X		Unused dug well.

(table continues)

Table 3-11 (continued).

Location No.	Name	Depth m (ft)	Diameter cm (inches)	Altitude m (ft)	Geologic Source[a]	WATER LEVEL Below land-surface datum m (ft)	Date of Measurement	Chemical Analyses[b]	Remarks
S11.4.35.233	Brady Spring	—	—	1,829 (6,000)	PDI	—		X	Formerly developed spring in floor of canyon.
2 1 11.5.8.241	Brown well	7.3 (24)	91 x 152 (36 x 60)	1,564 5,130)	PDI	6.6 (21.5)	07/03/56	—	Unused, dug stock well.
11.5.19.121	Thoroughgood well	18.9 (62)	17.8 (7)	1,666 (5,465)	—	10.7 (35.2)	07/03/56	—	Unused stock well.
11.5.19.323	Greer well (17)	5.2 (60)	152 (5,620)	1,713	PDI (13.5)	4.1	09/02/60	X	Unused, dug stock well.
12.2.13.213	Wood Ranch headquarters	—	16.5 (6.5)	1,887 (6,190)	Py	22.2 (72.8)	07/05/56	—	One of three unused wells at house. All now sealed shut.
12.2.27.211	Harden Ranch	—	— (6,430)	1,960	Pa (204)	62.2	—	X	Used stock and domestic well.
12.3.11.231	H.A. Wood (120±)	366 (8)	20.3 (6,130)	1,868 Py	Pa or (116.7)	35.6	08/15/56	—	Unused stock well.
S12.4.2.141	Grapevine Spring	—	—	1,890 (6,200)	Psg	—	—	X	Spring issues from limestone in side of canyon bottom. Now used for wildlife.

[a]Psg - San Andres Limestone and Glorieta Sandstone
Pa - Abo formation
PDI - Maglena Group
Py - Yeso formation

Notes: m = meter
cm = centimeter
ft = foot

[b]Source: Hood 1963.

Table 3-12
Water quality summary for RCRC wells[a]

Well Sample Location:		12.5.31.434 (RC-1)	12.5.28.432 (RC-2)	RC-3
Number of Samples:		1	1	3
Chemical Constituent	New Mexico Standard[b] (mg/L)	Concentration (mg/L)[c]		
Silica (SiO_2)	—	15	21	10 - 19
Iron (Fe)	1.0	—[d]	—	.03 - .07
Calcium (Ca)	—	85	134	950 - 2,000
Magnesium (Mg)	—	40	52	421 - 1,420
Sodium (Na) + Potassium (K)	—	64	961	8,440 - 64,800
Bicarbonate (HCO_3)	—	204	140	54 - 98
Carbonate (CO_3)	—	0.0	0.0	0
Sulfate (SO_4)	600	232	1,010	5,280 - 6,120
Chloride (Cl)	250	62	1,040	11,950 - 103,000
Fluoride (F)	1.6	1.6	1.8	1.6 - 1.9
Nitrate (NO_3-N)	10.0	18	0.5	0.0 - 0.4
Dissolved Solids (calculated)	1,000	618	3,290	27,100 - 177,000
Dissolved Solids (residue on evaporation)	1,000	627	3,370	28,100 - 183,000
Hardness (as $CaCO_3$)	—	376	548	4,100 - 10,700
Noncarbonate Hardness (as $CaCO_3$)	—	209	434	4,020 - 10,700
Alkalinity (as $CaCO_3$)	—	167	115	—
Specific conductance[e]	—	967	5,150	38,500 - 181,000
pH (standard units)	6.0 to 9.0	8.2	7.6	7.1 - 7.6
Color (units)	—	—	—	5.7
Temperature (°C)	—	—	—	23 - 25

a See U.S. Army 1993c (Appendix Table D-1) for complete set of water quality analyses.

b Reported in mg/L, unless otherwise indicated.
c Dash indicates no standard has been established.
d Dash indicates no data available.
e Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter
°C = degree celsius

16,700 micromhos per centimeter (Table 3-13). After well development, the well was pump-tested and the coefficient of transmissibility was estimated at 1.74 x 10^{-2} m^3/s per meter (130,000 GPD per foot) (Doty 1968b).

3.2.5.6 Multifunction Array Radar/High-energy Laser Systems Test Facility Area. The USGS conducted a water supply feasibility study with a test well program for the MAR area (Doty 1968c), which is located approximately 29 km (18 mi) northeast of the Post Headquarters (Figure 3-1). The specifications for the proposed well field were a minimum

Table 3-13
Water quality analyses for the NW30 tracking station area

Well Identification:			NW30-1	
Sample Interval/Depth (feet):		Open to 352	620 to 735	Total Screen
Date of Collection:		02/12/67	02/15/67	01/26/67
Chemical Constituent	New Mexico Standard[a] (mg/L)	Concentration (mg/L)[b]		
Silica (SiO_2)	—	—[c]	—	23
Iron (Fe, dissolved)	1.0	—	—	.01
Manganese (Mn)	0.2	—	—	—
Calcium (Ca)	—	—	—	418
Magnesium (Mg)	—	—	—	264
Sodium (Na) + Potassium (K)	—	—	—	3,040
Bicarbonate (HCO_3)	—	—	—	203
Carbonate (CO_3)	—	—	—	0
Sulfate (SO_4)	600	613	2,330	744
Chloride (Cl)	250	156	24,200	5,520
Fluoride (F)	1.6	—	—	0.7
Nitrate (NO_3-N)	10.0	—	—	6.1
Dissolved Solids (calculated)	1,000	—	—	10,100
Dissolved Solids (residue on evaporation)	1,000	—	—	10,500
Hardness (as $CaCO_3$)	—	—	—	2,130
Noncarbonate Hardness (as $CaCO_3$)	—	—	—	1,960
Specific Conductance[d]	—	1,490	61,600	16,700
pH (standard units)	6.0 to 9.0	—	—	7.7
Temperature (°F)	—	73	80	78
Color (units)	—	—	—	3

Source: Doty 1968b.

a Dash indicates no standard has been established.
b Reported in mg/L, unless otherwise indicated.
c Dash indicates no data available.
d Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter
°C = degree celsius
°F = degree Fahrenheit

Table 3-14
Water quality summary for the MAR area wells[a]

Well Sample Location[b]: / Number of Samples:		MAR-1 (Test)[c] 3	MAR-2 (Test)[c] 1	MAR-3 (Test)[c] 1	19.5.17.331 MAR-1 1	19.5.17.334 MAR-2 3	MAR-4[c] 3
Chemical Constituent	New Mexico Standard[d] (mg/L)	Mean Concentrations (mg/L)[e]					
Silica (SiO_2)	—	25	21	—[f]	25	24	24
Iron (Fe)	1.0	.02	.02	—	—	.34	.13
Calcium (Ca)	—	81	53	—	78	73	82
Magnesium (Mg)	—	36	38	—	41	41	40
Sodium (Na)	—	42[g]	94[g]	—	43	44	32[g]
Potassium (K)	—	—	—	—	—	2.3	—
Bicarbonate (HCO_3)	—	254	212	—	256	257	258
Carbonate (CO_3)	—	0	0	—	0	0	0
Sulfate (SO_4)	600	163	225	258	180	173	174
Chloride (Cl)	250	44	55	45	36	36	35
Fluoride (F)	1.6	0.5	0.7	—	1.4	0.9	0.4
Nitrate (NO_3-N)	10.0	6.9	8.0	—	6.0	6.0	6.6
Dissolved Solids (calculated)	1,000	520	559	—	536	526	512
Dissolved Solids (residue on evaporation)	1,000	—	612	—	—	552	570
Hardness (as $CaCO_3$)	—	352	290	—	364	352	370
Noncarbonated Hardness (as $CaCO_3$)	—	144	116	—	154	142	158
Specific Conductance[h]	—	828	917	930	818	810	790
pH (standard units)	6.0 to 9.0	7.4	7.8	—	7.5	7.6	7.6
Temperature (°F)	—	—	—	—	—	—	78

(table continues)

Table 3-14 (continued).

[a] See U.S. Army 1993c (Appendix Table D-2) for complete set of water quality analyses.
[b] See Figure 3-4.
[c] Analyses for relatively saline sample intervals were omitted.
[d] Dash indicates no standard has been established.
[e] Reported in mg/L, unless otherwise indicated.
[f] Dash indicates no data available.
[g] Represents sodium plus potassium (Na + K).
[h] Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter
°C = degree celsius
°F = degree Fahrenheit

production of 0.6 x 10^{-2} m^3/s (139,000 GPD) and a maximum production of 0.9 x 10^{-2} m^3/s (200,000 GPD). Three test holes (MAR-1, MAR-2, and MAR-3) were drilled in 1963. Water quality analyses of samples from these three wells and another well (19.6.21.434) at the MAR site are provided in U.S. Army (1993c, Appendix Table D-2). Based upon this test hole program, two production wells were completed in 1963 (Doty 1968d). Aquifer test data were inconsistent in providing estimates for transmissivity and storativity due to the relatively slow drainage from less permeable beds and possible boundary effects from clay beds in the bolson deposits (Doty 1968d). However, these production wells were judged adequate for the existing needs of the facility, but inadequate for larger, projected water demands. Well MAR-3 was completed during 1990 and provided an on-line supply beginning in 1993. This well was completed to a depth of 246 m (750 ft) using 25-cm (10-in) diameter pipe, and depth to water was measured at 89 m (272 ft) (Cave, pers. com. 1994).

Test well MAR-4 was drilled to evaluate whether or not a larger yield could be obtained from wells drilled west of the MAR production wells. This well, which was drilled into the upper part of the alluvial fan on which the well field is located, penetrated bolson and fan deposits of sand, gravel, and clay of Quaternary and Tertiary age. Four water samples were collected as drilling progressed (U.S. Army 1993c, Appendix Table D-2) (Table 3-14). The transmissivity of well MAR-4 was computed to be 39 x 10^{-3} m^3/s per meter (295,000 GPD per foot), compared to values not exceeding 0.27 x 10^{-3} m^3/sper meter (20,000 GPD per foot) for the existing well field (Doty 1968b).

The MAR area now includes the HELSTF. A groundwater assessment was conducted by international Technology Corporation on behalf of the COE Huntsville (Alabama) District (COE 1992b). The primary study objectives were to describe hydrogeologic properties of the HELSTF area, groundwater aquifer gradients and quality, and impacts of past contaminant releases on the perched and regional water-bearing zones. A USGS groundwater study of the HELSTF area (Basabilvazo et al. 1991) delineated a regional aquifer located approximately 21 m (69 ft) below ground surface. This study finding confirmed results of limited soils-boring data obtained in 1962 around the perimeter of the Laser Systems Test Center Building (COE 1992b). As part of the USGS field program, three test wells (HELSTF-1, HELSTF-2, and HELSTF-3), which were completed at depths ranging between 40 and 305 m (130 and 1,000 ft) below ground surface, were used in conjunction with the MAR-CW well for testing of this aquifer. Well HELSTF-1 was screened between 21.3 and 27.4 m (70 and 90 ft), whereas wells HELSTF-2 and HElSTF-3 were screened between 24.4 and 152 m (80 and 500 ft) (COE 1992b). Based upon data from wells 2 and 3, the estimated aquifer properties were as follows:

- transmissivity = 63.5 m^2/d (683 ft^2/d),
- storativity = 4.8 x 10^{-3} and
- hydraulic conductivity = 1.6 m (5.2 ft) per day (COE 1992b).

This was representative of a semiconfined aquifer that was generally slightly saline at the top and generally brackish to brine elsewhere. Dissolved solids ranged from 5,940 to 11,500 mg/L; the predominant ions were sodium and sulfate. In comparison, dissolved solids were 111,000 mg/L at a depth of 248 m (815 ft) below ground surface, and the predominant ions were sodium and chloride.

The regional aquifer potentiometric surface developed from the USGS study is depicted in Figure 3-7; a generally southward gradient is noted. Two localized perched zones have been identified, and recent and more detailed water level and water quality data have been derived

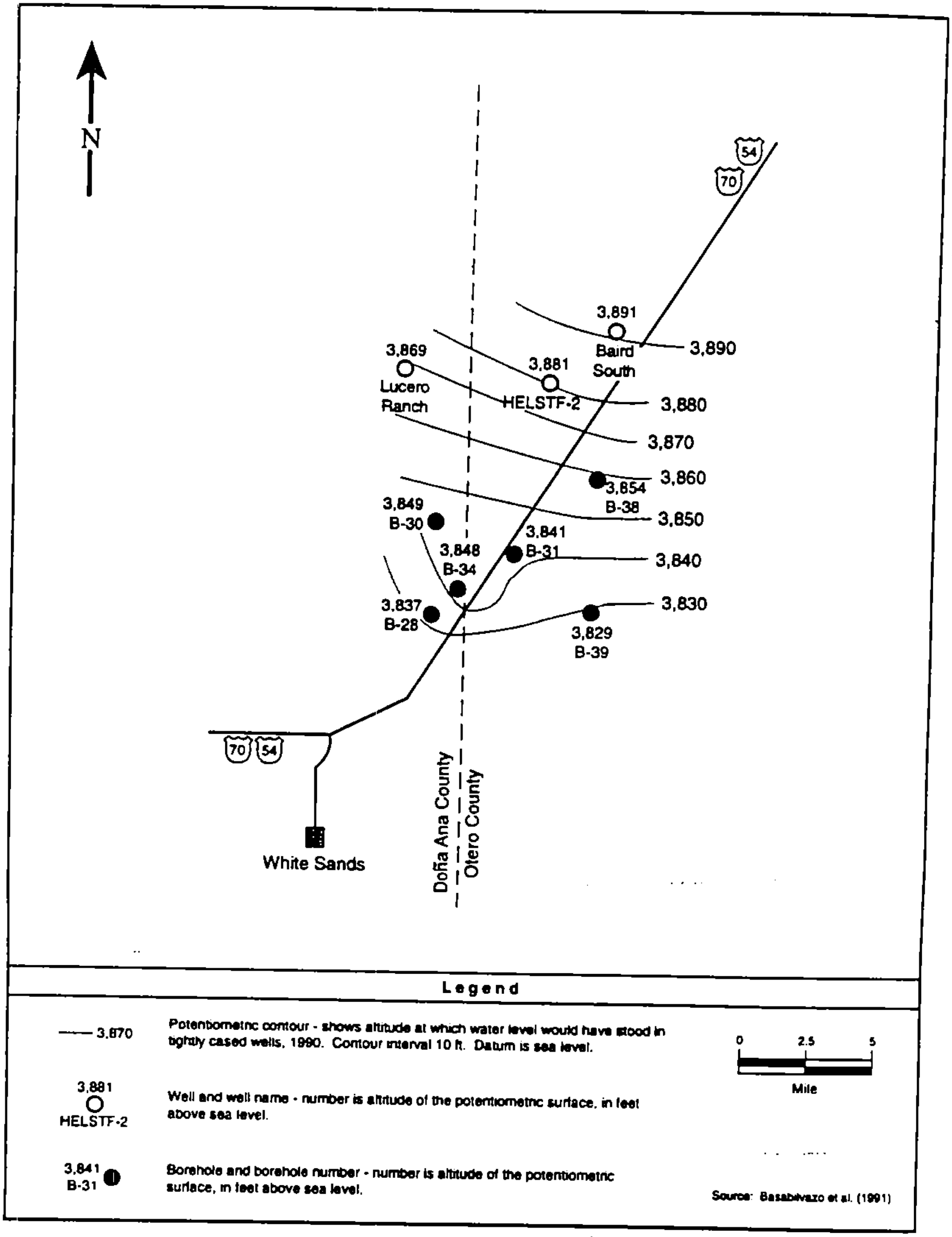

Figure 3-7. Altitude of potentiometric surface regional aquifer HELSTAF groundwater assessment

from 15 additional monitoring wells completed for the RCRA Facility Investigation (RFI) (COE 1992b). This additional drilling has provided information for detailed geologic cross sections underlying the HELSTF area (COE 1992b, Figures 3-2 and 3-3). Also, more detailed water resources data for the HELSTF area were obtained through interim remediation measures field investigations (U.S. Army 1993d).

3.2.5.7 Hazardous Test Area. In July 1960, the USGS investigated the feasibility of obtaining a water supply of between 6.3 x 10^{-4} to 9.5 x 10^{-4} m^3/s (10 to 15 gpm) in the northern part of the HTA to provide for the domestic needs of a planned small installation, which was constructed later (Hood 1963). A brief reconnaissance survey of this area indicated that only two wells might supply the required amount of water. These wells, equipped with windmills, were used periodically to supply water to wildlife. In 1966, two test wells (HTA-1 and HTA-2) were drilled with a cabletool rig to ascertain if small quantities (3.2 x 10^{-4} to 6.3 x 10^{-4} m^3/s [5 to 10 gpm]) of potable water were available for domestic use. Relatively high nitrate and fluoride concentrations were noted (Table 3-15). Supply well HTA-1 (21.4.23.233) still provides potable water (Cave, pers. com. 1994). A relatively new well (HTA-3; 21.4.14.114) has been drilled (see Figure 3-1), with an approximate depth to water between 16 and 17 m (48 and 51 ft) and still provides potable water (Cave, pers. com. 1994).

3.2.5.8 Small Missile Range Area. Until 1961, the potable water supply for the Small Missile Range area was obtained from a shallow well that has been providing water since 1952, and servicing a group of buildings in the principal work area (Hood 1963). The original yield was 9.5 x 10^{-4} m^3/s (15 gpm); however, by 1961 the yield was only 6.3 x 10^{-4} m^3/s (10 gpm), which was judged to be inadequate for the needs of the area. Attempts to rehabilitate this well were unsuccessful (Hood 1963). The USGS conducted reconnaissance surveys upslope towards the mountains to the west in T.21S, R.5E, Sections 16 and 17, where the probability of obtaining potable water from coarse sand and gravel appeared greater. During 1960, two test wells (SMR-1 and SMR-2) were drilled approximately 1.6 km (1 mi) east of a fault scarp that extended northeastward through the northeast corner of Section 21 (T.215, R.5E). The measured transmissivity computed from pump-testing data for well SMR-2 was approximately 2.7 x 10^{-3} m^3/s per meter (20,000 GPD per foot). From the drill cuttings, it was concluded that the bolson fill in this area was a mixture of debris from rocks in the adjacent mountains (Hood 1963).

The saturated bolson fill at these test-well sites was more than 137 m (450 ft) thick. The top of the saturated zone was approximately 1,186 m (3,890 ft) MSL for well SMR-1 and approximately 1,187 m (3,894 ft) MSL for well SMR-2. The water source in this area is west of the well sites. Groundwater flows east-southeast from the well sites toward the flatlands of the Tularosa Basin and then flows southward wells are provided in U.S. Army (1993c, Appendix Table D-3). At the time of this survey, little was known concerning the lateral distribution of potable water. However, it is known that water quality (in terms of salinity) deteriorates eastward and with depth. This deterioration was demonstrated by the Gregg well area results (see Section 3.2.5.10) and influenced by the geology of the lower parts of the Tularosa Basin where saline playas and lakes occur.

A test well (SMR-3) was drilled during December 1966 and January 1967 to evaluate near-surface materials in a prominent alluvial fan north of the Small Missile Range (Doty 1968b). The well was drilled to 308 m (1,010 ft), and samples were collected at three distinct intervals (U.S. Army 1993c, Appendix Table D-3) (Table 3-16). These test results indicated that high-yield wells could be constructed in this area, and that the quality of the groundwater is satisfactory. However, there were questions regarding availability and permanence of a water supply in the area. Specifically, test well SMR-3 did not penetrate the saline-water interface or

Table 3-15
Water quality analyses for the hazardous test area wells

Well Identification: Sample Interval/Depth (if applicable) (feet): Date of Collection:		HTA-1 Total Depth 10/05/66	HTA-2 Open to 189 11/16/66
Chemical Constituent	New Mexico Standard[a] (mg/L)	Concentration (mg/L)[b]	
Silica (SiO_2)	—	34	24
Iron (Fe, dissolved)	1.0	.00	.02
Manganese (Mn)	0.2	13	—[c]
Calcium (Ca)	—	82	82
Magnesium (Mg)	—	—	13
Sodium (Na) + Potassium (K)	—	53	60
Bicarbonate (HCO_3)	—	221	238
Carbonate (CO_3)	—	0.0	0
Sulfate (SO_4)	600	116	115
Chloride (Cl)	250	28	34
Fluoride (F)	1.6	4.0	4.0
Nitrate (NO_3-N)	10.0	29	22
Dissolved Solids (calculated)	1,000	468	471
Dissolved Solids (residue on evaporation)	1,000	0.0	476
Hardness (as $CaCO_3$)	—	260	260
Noncarbonate Hardness (as $CaCO_3$)	—	79	65
Specific Conductance[d]	—	711	746
pH (standard units)	6.0 to 9.0	7.5	7.7
Temperature (°F)	—	72	—
Color (units)	—	0	—

Source: Doty 1968b.

a Dash indicates no standard has been established.
b Reported in mg/L, unless otherwise indicated.
c Dash indicates no data available.
d Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter
°C = degree celsius
°F = degree Fahrenheit

Table 3-16
Water quality summary for the Small Missile Range area wells[a]

Well Sample Location[b]:		21.5.15.411	SMR-1	SMR-2	SMR-3
Number of Samples:		1	3	4	4
Chemical Constituent	New Mexico Standard[c] (mg/L)	Concentration (mg/L)[d]			
Silica (SiO_2)	—	24	—[e]	32	24
Iron (Fe)	1.0	—	—	.31	.00
Calcium (Ca)	—	59	74	77	86
Magnesium (Mg)	—	45	51	41	47
Sodium (Na) + Potassium (K)	—	29	—	38	38
Bicarbonate (HCO_3)	—	195	287	246	262
Carbonate (CO_3)	—	0	0	0	0
Sulfate (SO_4)	600	170	151	174	209
Chloride (Cl)	250	36	26	32	41
Fluoride (F)	1.6	1.6	1.0	1.7	0.5
Nitrate (NO_3-N)	10.0	3.1	4.6	3.6	7.2
Dissolved Solids (calculated)	1,000	—	484	525	573
Dissolved Solids (residue on evaporation)	1,000	464	522	547	568
Hardness (as $CaCO_3$)	—	332	378	351	406
Noncarbonate Hardness (as $CaCO_3$)	—	172	142	149	192
Specific Conductance[f]	—	725	787	797	896
pH (standard units)	6.0 to 9.0	—	7.8	7.7	7.5
Percent Sodium	—	16	7	17	—
Sodium Adsorption Ratio (SAR)	—	—	0.3	0.8	—
Temperature (°F)	—	—	80	82	79

a See U.S. Army 1993c (Appendix Table D-3) for complete set of water quality analyses.
b See Figure 3-3 for well locations.
c Dash indicates no standard has been established.
d Reported in mg/L, unless otherwise indicated.
e Dash indicates no data available.
f Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter
°C = degree celsius
°F = degree Fahrenheit

bedrock. Thus, the saturated thickness of the potable water-bearing zone is unknown (Doty 1968b).

3.2.5.9 Gregg Test and Production Wells Area. In 1961, an experiment was proposed to cool the land surface around an optical tracking station (Hood 1963). The purpose of the experiment was to suppress heat waves that might distort telescopic images during the tracking of missiles. Surface cooling was to be accomplished by growing salt-tolerant vegetation (if possible) or flooding around the station because it was inferred that fresh water would not be available at the selected Gregg site optical tracking station. Either method required relatively large quantities of water (Hood 1963).

In anticipation of this experiment, a test well and a production well were drilled from August October 1961. The test well was drilled to a depth of 308 m (1,010 ft) and subsequently cased to a depth of 152 m (500 ft). The production well was drilled approximately 1.2 m (4 ft) south of the test well and was completed to a depth of 146 m (478 ft). A performance test on the production well indicated a specific capacity of 12.4 gpm/ft at the end of the pumping period and a transmissivity of 2.6 x 10^{-3} m^3/s per meter (19,600 GPD per foot). These values indicate that this well would sustain pumping rates of several hundred gallons per minute for prolonged periods of time. A pumping rate of 3.8 x 10^{-2} m^3/s (600 gpm) was recommended with a pump set at a depth of 91 m (300 ft) (Hood 1963). Water quality data for both the Gregg site test and production wells are provided in Table 3-17.

3.2.5.10 Hazardous Waste Storage Facility Area (Building 22895). Three test wells were drilled to a depth of 91 m (300 ft) using the hydraulic-rotary method during July, August, and October 1983, as exploratory and monitoring wells for this facility, located on Nike Avenue at WSMR (Myers and Pinckley 1987). A fourth test well (TW-4) has been drilled near this site. The January 1989 results of extensive water quality analyses (including priority pollutants) for these four wells are provided in U.S. Army (1993c, Appendix Table D-4) and summarized in Table 3-18.

The WSMR Hazardous Waste Disposal Facility includes a landfill operated between 1971 and 1981 that contains various types of chemical wastes (Abeyta 1992). Hydrogeologic conditions of this facility were evaluated by the USGS to assess the potential for contaminant migration of hazardous wastes buried in the landfill. A qualitative water balance of the facility also was performed (Abeyta 1992). Depth to water at the facility is 70 m (230 ft) below land surface; the water table slopes to the southwest at approximately 0.2 m per km (1 ft per mi) in the area of the facility and at approximately 1.3 m per km (7 ft per mi) northwest of the facility. No streams, ponds, or lakes occur in the area, and the nearest production well yielding potable water is located 12.9 km (8 mi) west of the area (Abeyta 1992). Transmissivity values obtained from an aquifer test conducted on the site ranged from 92.9 to 121 m^2/d (1,000 to 1,300 ft^2/d). The specific capacity of the aquifer in the area tested was 4 x 10^{-4} m^3/s per meter (2.1 gpm/ft) of drawdown. Estimated values of hydraulic conductivity for the assumed water producing zone ranged from 3.8 to 5 m (12.5 to 16.3 ft) per day (Abeyta 1992).

Groundwater in the area typically contained concentrations of dissolved solids ranging from 10,000 to 35,000 mg/L; this water is considered very saline. Chemical analyses indicated concentrations of 110 to 160 µg/L of manganese, 510 to 1,200 µg/L of zinc, and 0.3 to 1.30 µg/L of toluene in water from wells upgradient from the landfill. The lindane concentration in water from a test well downgradient from the landfill was at the detection limit (0.01 µg/L) (Abeyta 1992). It is noteworthy that this landfill was "clean-closed" and that all chemicals have been removed (Myers, pers. com. 1994).

3.2.5.11 Soledad Canyon Area. The Soledad Canyon reentrant and adjacent areas are located south of WSMR in the northern part of the Doña Ana Range complex on Fort Bliss property. The USGS (Wilson and Myers 1981) identified some freshwater resources between the contact between the bolson deposits and underlying bedrock. Water quality analyses are summarized in Table 3-6 (sites T-15 through T-18). Wilson and Myers (1981) estimated that 2.8 billion m^3 (2.3 million ac-ft) of fresh water were available to pump from this water source,

Table 3-17
Water quality summary for the Gregg site wells

Well Sample Location[a]:		1[b]	2[c]	3[d]	4[e]
Sample Interval/ Depth (if applicable) (feet):		1,010	281 to 300	1,010	
Date of Collection:		08/18/61	08/18/61	09/07/61	10/30/61
Chemical Constituent	**New Mexico Standard[f] (mg/L)**	**Concentration (mg/L)[g]**			
Silica (SiO_2)	—	—	35	40	—
Calcium (Ca)	—	—	360	455	—
Magnesium (Mg)	—	—	180	478	—
Sodium (Na) + Potassium (K)	—	—	1,900	3,340	—
Bicarbonate (HCO_3)	—	—	194	317	318
Carbonate (CO_3)	—	—	0	0	0
Sulfate (SO_4)	600	—	4,910	8,730	8,830
Chloride (Cl)	250	262	350	708	744
Fluoride (F)	1.6	—	1.5	6.4	—
Nitrate (NO_3-N)	10.0	—	4.1	0.3	—
Dissolved Solids (calculated)	1,000	—	7,840	13,900	—
Dissolved Solids (residue on evaporation)	1,000	—	7,970	14,300	—
Hardness (as $CaCO_3$)	—	—	1,640	3,100	3,170
Noncarbonate Hardness (as $CaCO_3$)	—	—	1,480	2,840	2,910
Specific Conductance[h]	—	5,970	8,890	14,900	15,000
pH (standard units)	6.0 to 9.0	—	8.2	7.4	7.4
Percent Sodium	—	—	72	70	—
Sodium Adsorption Ratio	—	—	20	26	—
Temperature (°F)	—	—	—	79	78

Source: Hood 1963.
a See Figure 3-3 for general location.
b Test hole; diameter 22.22 cm (8.75 inches). Water level 70 m (230 ft) below LSD. Drill-stem test; packer set 86 to 91 m (281 to 300 ft). Sampled after well had recovered overnight.
c Drill-stem test in bolson fill. Sampled after water level was lowered by bailing.
d Cased test hole; cased to 152 m (500 ft). Sampled after 7.5 hours of pumping at 175 gpm. Density 1.010 grams per milliliter.
e Production well; 36-cm (14-inch) casing to 146 m (478 ft) in bolson fill. Sampled at end of pumping test. Density 1.011 grams per milliliter.
f Dash indicates no standard has been established.
g Reported in mg/L, unless otherwise indicated.
h Reported in micromhos per centimeter at 25 °C.

Notes: mg/L = milligram per liter, gpm = gallon per minute, ft = foot, °C = degree celsius, °F = degree Fahrenheit

Table 3-18
Water quality summary for the toxic waste storage facility wells[a]

Water Supply Sample Location[b]:		TW-1	TW-2	TW-3	TW-4	
		22S.06E.16.233	22S.06E.16.234	22S.06E.16.234A	22S.06E.16.412	
Number of Samples:		1	1	1	1	
Chemical Constituent	New Mexico Standard[c]				Concentration (mg/L)[d]	
Elevation of Land Surface Datum (ft above National Geodetic Vertical Datum)	—	4,032	4,038	4,037	—	
Temperature (°C)		—	26.5	26.5	26.0	—
pH (standard units)	6.0 to 9.0	7.0	7.0	7.2	7.2	
Specific Conductance (µs/cm)	—	21,000	20,600	20,600	19,900	
Dissolved Solids, Residue at 180°C	1,000	15,900	14,900	14,800	—	
Nitrogen, Ammonia Total (N)	—	—	—	—	0.2	
Nitrogen, Ammonia + Organic Total		—	—	—	—	
Nitrogen, ($NO_2 + NO_3$) Total	—	—	—	—	< 0.1	0.4
Nitrogen, ($NO_2 + NO_3$) Dissolved	10.0	1.2	1.6	1.6	< 0.1	
Phosphorus, Total (P)	—	—	—	—	.06	
Phosphorus, Dissolved (P)	—	—	—	—	< 0.01	
Cyanide, Dissolved (Cn)	0.2	—	—	—	< 0.01	
Silica, Dissolved (SiO_2)	—	33	36	30	30	
Calcium, Dissolved (Ca)	—	990	1,100	1,200	560	
Magnesium, Dissolved (Mg)	—	820	820	800	760	
Sodium, Dissolved (Na)	—	2,800	2,500	2,700	3,600	
Potassium, Dissolved (K)	—	25	27	27	28	

(table continues)

Table 3-18 (continued).

Water Supply Sample Location[b]: / Number of Samples:		TW-1 22S.06E.16.233	TW-2 22S.06E.16.234	TW-3 22S.06E.16.234A	TW-4 22S.06E.16.412
		1	1	1	1
Chemical Constituent	New Mexico Standard[c]				Concentration (mg/L)[d]
Alkalinity as $CaCO_3$	—	181	148	141	241
Sulfate, Dissolved (SO_4)	600	3,800	3,100	3,000	8,000
Chloride, Dissolved (Cl)	250	6,600	6,700	6,900	3,700
Fluoride, Dissolved (F)	1.6	0.2	0.1	0.2	0.3
Bromide, Dissolved (Br)	—	3.5	3.4	3.5	—
					Concentration (µg/L)
Antimony, Dissolved (Sb)	—	—	—	—	60
Aluminum, Dissolved (Al)	—	—	—	—	< 1.0
Arsenic, Dissolved (As)	100	26	29	3.0	2.0
Barium, Dissolved (Ba)	1,000	100	100	100	< 100
Beryllium, Dissolved (Be)	—	—	—	—	< 10
Boron, Dissolved (B)	—	290	300	270	590
Cadmium, Dissolved (Cd)	10	< 1.0	< 1.0	< 1.0	< 2.0
Chromium, Dissolved (Cr)	50	5.0	5.0	4.0	6.0
Cobalt, Dissolved (Co)	—	—	—	—	< 1.0

(table continues)

Table 3-18 (continued).

Water Supply Sample Location[b]:		TW-1 22S.06E.16.233	TW-2 22S.06E.16.234	TW-3 22S.06E.16.234A	TW-4 22S.06E.16.412
Number of Samples:		1	1	1	1
Chemical Constituent	**New Mexico Standard[c]**				**Concentration (mg/L)[d]**
Copper, Dissolved (Cu)	1,000	4.0	22	5.0	14
Iron, Dissolved (Fe)	1,000	80	80	80	280
Lead, Dissolved (Pb)	50	< 5.0	< 5.0	< 5.0	< 2.0
Lithium, Dissolved (Li)	—	340	340	330	—
Manganese, Dissolved (Mn)	200	40	40	160	110
Molybdenum, Dissolved (Mo)	—	—	—	—	33
Nickel, Dissolved (Ni)	—	—	—	—	2.0
Selenium, Dissolved (Se)	50	6.0	9.0	10	< 1.0
Silver, Dissolved (Ag)	50	1.0	< 1.0	< 1.0	< 2.0
Strontium, Dissolved (Sr)	—	23,000	28,000	28,000	850
Zinc, Dissolved (Zn)	10,000	510	710	1,200	100
Toluene, Total		750	0.3	0.6	1.3 < 0.2

[a] See U.S. Army 1993c (Appendix Table D-4) for complete set of water quality analyses, including priority-pollutant organic compounds.
[b] See Figure 3-3.
[c] Dash indicates no standard has been established.
[d] Reported in mg/L, unless otherwise indicated.

Notes: µg/L = microgram per liter
mg/L = milligram per liter
°C = degree celsius

and the estimated recharge to the aquifer from the Soledad Canyon watershed is 0.9 million m (750 ac-ft) annually.

The COE (1988) documented the results of a complementary test well drilling program. Three test wells (SC-1, SC-2, and SC-3) and a corresponding observation well were completed within the Fort Bliss Military Reservation just south of WSMR. Bolson fill deposits at these well sites were estimated to be over 1,067 m (3,500 ft) thick.

During November 1982, test well T-23 was drilled to a depth of 262 m (860 ft) as an exploratory and monitoring well in the proposed Soledad well field at the Fort Bliss Military Reservation (Myers and Pinckley 1985). The well penetrated interbedded clay, silt, sand, and gravel in the Quaternary alluvium and bolson fill.

Specific details of the expanded Soledad Canyon water supply well field were obtained through discussions with the WSMR utilities department (Cave, pers. com. 1993), and performance of a field site visit on July 14, 1993 (Figure 3-8). This well field is located on Fort Bliss property approximately 11 km (7 mi) (distance of pipeline) south of the Post Headquarters. Two existing production wells (completed in 1988) in this well field currently supply 0.6 million m^3 (500 ac-ft) annually to the WSMR co-mingled supply; existing well 2 yields approximately 6.2×10^{-2} m^3/s (980 gpm), and existing well 3 yields approximately 6.4×10^{-2} m^3/s (1,020 gpm). For two wells (T-16 and T-17), hydraulic conductivity estimates were 15 and 18 m (50 and 60 ft) per day (Orr and Myers 1986, p. 67). Under the COE contract currently in progress, two new production wells (1 and 4, not shown on Figure 3-8) have been drilled, and a total of 11 monitoring wells have been completed (Figure 3-8). With the additional production capability from this well field, it is envisioned that up to a maximum of 0.9 million m^3 (750 ac-ft) per year would be supplied, which can be compared with a current production capacity of 1.5 million m^3 (1,250 ac-ft) per year from the Post Headquarters well field (see Section 3.2.4.1).

3.2.5.12 Holloman AFB Area. During World War II, the town of Alamogordo was able to supply the modest water requirements of Holloman AFB (Hood 1963). However, beginning in 1947, this base was reorganized into a major research center, resulting in a doubling to tripling of the town population. The town water supply, from nearby Boles well field located approximately 8 km (5 mi) south of town, became insufficient for both sources of water use. Additionally, Holloman AFB requirements increased from an average of 1.1×10^{-2} m^3/s (0.25 MGD) in 1947 to more than 4.4×10^{-2} m^3/s (1 MGD) in 1955, two-thirds of which was pumped from the Boles well field (Hood 1958).

Unconsolidated rocks of middle Tertiary to Holocene age form the alluvial-fan and basin-fill deposits that are present west of the escarpment and comprise the primary source of groundwater for Holloman AFB and the town of Alamogordo; these deposits have been referred to as the bolson aquifer (Burns and Hart 1988). Aquifer test results published in previous reports (Hood 1958; Garza and McLean 1977) indicate aquifer transmissivities ranging from 18.6 to 1,860 m^2/d (200 to 20,000 ft^2/d) and storativities ranging from 0.00043 to 0.085. The specific yield of this bolson aquifer was estimated to be 0.08 (Garza and McLean 1977) and 0.09 by Hood (1958). The general direction of groundwater flows underlying this area is to the south and southwest. The Boles, Douglas, and San Andres well fields supply groundwater to Holloman AFB.

Burns and Hart (1988) evaluated the potential change in water levels that might occur as a result of increased groundwater withdrawals from the middle Tertiary to Holocene basin-fill and alluvial deposits in the vicinity of Holloman AFB. Perennial streams are not present in this

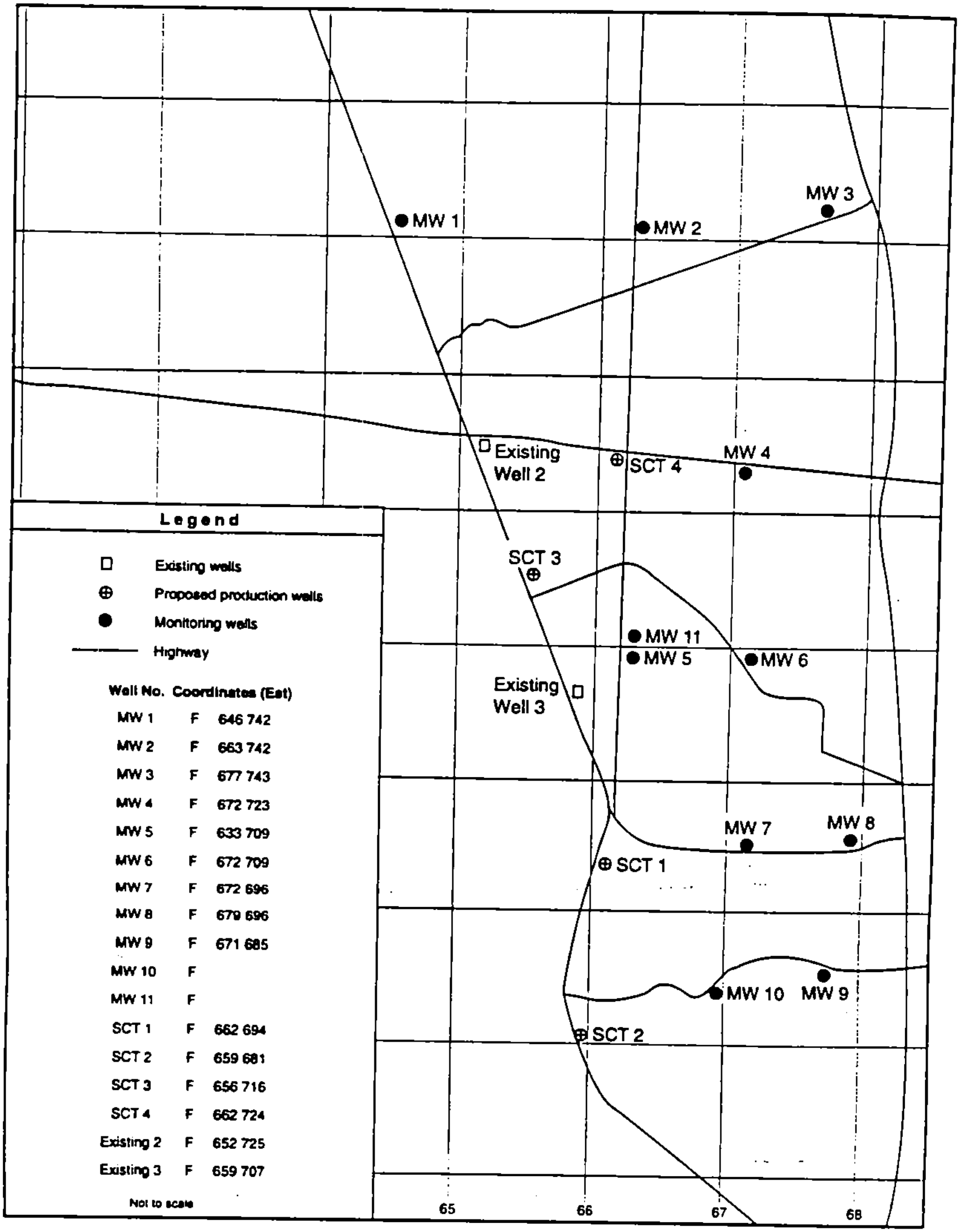

Figure 3-8. Expanded Soledad Canyon water supply well field and monitoring wells

area and the aquifer has a saturated thickness estimated to range between 0 and 914 m (0 to 3,000 ft). The aquifer system is recharged by the intermittent stream flow from the nearby mountains infiltrating into the alluvial fans. Alternative groundwater withdrawal scenarios were evaluated using a two-dimensional, finite-difference computer model. Based upon a 10-percent increase in Holloman AFB water demands, alternative allocations among five well fields (Boles, Douglas, San Andres, Dog Canyon, and Escondido Canyon) were assessed (Burns and Hart 1988).

3.3 AIR QUALITY

The weather conditions encountered on the Missile Range have a profound effect on the operation and success of many projects at the facility (Eschrich 1992). The air quality of WSMR is affected by the daily weather conditions and the overall climate of the region as well as the individual and collective sources of air pollutants. This section describes the existing climate, weather, meteorology, and air quality of the WSMR area and discusses the regulations pertaining to air quality at the site.

3.3.1 Existing Climate, Weather, and Meteorology

The climate of the Tularosa Basin in south central New Mexico is typical of arid regions at low latitudes. Sunshine is abundant throughout the year. Year-round averages from 1951 through 1973 indicate that 41 percent of the days were clear, 27 percent were characterized by scattered clouds (1/10 to 5/10 sky cover), 18 percent by broken clouds (6/10 to 9/10 sky cover), and 14 percent as overcast. During these years, visibility was typically 71 km (44 mi) (Hoidale and Newman 1974a).

The average annual precipitation is 28 cm (11 inches), but around the range this is highly variable with elevation (Eschrich 1992). For example, for the years 1964 to 1973 the mean annual precipitation at A Station (Post Headquarters & elevation 1,292 m [4,238 ft] was 30.38 cm (11.96 inches), whereas at Apache site (approximately 5 km [3 mi south of Lake Lucero, elevation 1,206 m [3,956 ft]), it was 20 cm (7.87 inches) (Hoidale and Newman 1974b) (Figure 3-9). Several months without rain are not unusual. The spring months, April and May, are the driest time of the year. Half of the annual precipitation falls from afternoon and evening thunderstorm activity in July, August, and September, known as the summer "monsoon" season. Warm, moist air from maritime tropical air masses is advected northward from the Gulf of Mexico (Novlan 1982). The most precipitation recorded in one 24 hour period was 10.8 cm (4.25 inches) on August 23 to 24, 1959. Hail sometimes accompanies these summer thunderstorms. An average of one hail event occurs each year at WSMR. Most hail is less than 1.3 cm (0.5 inches) in diameter (Eschrich 1992).

During October and November, precipitation is infrequent (Eschrich 1992). In the autumn, WSMR sometimes experiences several days of light rain and drizzle caused either by hurricanes moving west across the Gulf of Mexico or by Pacific storms moving east into Mexico and southern California (Novlan 1982). Snowfall is typically light during the winter months, December through April, because the fronts that precede intrusions of maritime polar air from the west usually dissipate before reaching WSMR (Novlan 1982). The mean annual snowfall at A Station for the period 1950 to 1973 was 16.5 cm (6.5 inches) (Hoidale and Newman 1974b).

Heavy snowfall may occur when a continental Arctic air mass moves into the Tularosa Basin and is overridden by moist, southwest flow aloft (Novlan 1982). The greatest recorded snowfall from one storm was 62.2 cm (24.5 inches) on December 13 to 14, 1987 (Eschrich 1992).

During the winter, daytime temperatures reach 12.8 to 15.6 °C (55 to 60 °F); nighttime temperatures often drop below freezing. The coldest recorded temperature was -23.3 °C (-10 °F) on December 15, 1987 at Bldg 21925, C Station. In the summer, temperatures typically rise above 32 °C (90 °F), and frequently above 38 °C (100 °F), during the day. The highest recorded temperature was 44.4 °C (112 °F) on July 12, 1979 at Bldg. 21610, about two miles west of C Station. At night, temperatures fall into the 15 to 20 °C (60 to 70 °F) range (Eschrich 1992; Hoidale and Newman 1974b).

Temperatures vary considerably over WSMR. The cause of these temperature changes are many but on a large scale, elevation and latitude are most important, with elevation playing the more important role. Data compiled from weather stations throughout New Mexico make clear the strong control of temperature by elevation, and the fact that the control is not constant: in northern New Mexico temperatures changes about 4.9°F per 1000 feet rise in elevation for July daily minima, whereas in southern New Mexico temperatures change about -1.6°F per 1000 per feet rise in elevation for January minima. Often, instead of decreasing with higher elevation, temperature becomes warmer. This condition most frequently is caused by nighttime drainage of cold air from mountain slopes into nearby valley bottoms. Because of the strong influence of elevation on temperature, WSMR is colder in winter and cooler in summer than it would be if located near sea level.

The prevailing wind direction throughout the year, with a significant exception, is from the west. That exception occurs in July and August when winds with a strong southerly component stimulate thunderstorm activity. Spring is notable for dust storms, caused by the combined effects of strong west winds associated with rapidly advancing frontal systems, little moisture, dry soil, and sparse vegetation (Eschrich 1992; Novlan 1982). For the period 1951 to 1973, the mean number of days with blowing dust was two in the month of March, three in April, and only one or none in the other months of the year (Hoidale and Newman 1974b).

Local weather conditions across WSMR are influenced by the immediate topography. The mountain range on the western side of WSMR adds noticeably to the gustiness of high winds and causes variable wind directions during periods of light winds. Snow and rain are usually higher in the mountains than on the valley floor. Temperatures at Post Headquarters are typically a few degrees warmer at night and cooler during the day than at lower elevations in the basin (Eschrich 1992).

The U.S. Army Research Laboratory operates an extensive surface meteorological data collection system for the WSMR facility. New Mexico State University Physical Sciences Laboratory designed and built the system, called Surface Atmospheric Measuring System (SAMS), under contract with the U.S. Army Research Laboratory/Battlefield Environment Directorate. SAMS is a network of remote weather data collection stations controlled by a central data processing computer. Data collection by SAMS began in 1990 (Field, pers. com. 1992).

Prior to 1990, a sequence of three stations collected weather data at WSMR. The A Station at Post Headquarters operated from January 1, 1950, to May 3, 1978. Global site took over until December 20, 1979. Finally, C Station has been in continuous operation since December 21, 1979, and is a component of the SAMS network (Eschrich 1992).

As of 1992, the SAMS network has 24 stations (Figure 3-9, Table 3-19). All sites, except Sacramento Peak, are within the facility boundaries. Four sites are on mountain tops (Salinas Peak, North Oscura Peak, Sacramento Peak, and Jim site); the rest are on the valley floor. All stations, except Apache site and Post-ASD site (Field, pers. com. 1992), currently are located at their original positions. A SAMS station consists of a 10-m (33-ft) tower supporting several sensors that monitor meteorological data, and a microprocessor (called a datalogger). Parameters sampled are temperature, relative humidity, pressure, wind direction, wind speed, peak wind speed, vertical temperature gradient, solar radiation, and precipitation. The data are stored in the datalogger memory.

The central data processing computer retrieves the stored meteorological data from each remote station via hardwire, telephone line, or radio frequency link, every 15 minutes. The central computer processes the data into formatted reports and stores them in a data base. Data for 15-minute and 1-hour intervals are stored on 9-track magnetic tape. Monthly summaries are available on floppy disk (Table 3-20). Real-time data for the previous 15-minute interval and the last 24-hour running average also can be accessed by telephone modem, with access permission obtained from the U.S. Army Research Laboratory (Field, pers. com. 1992).

Other WSMR directorates and tenants have initiated special surface meteorological data collection programs in conjunction with particular projects or events. These data collection programs typically last only a few days, weeks, or months and are confined to a relatively small area of the range. Often, they are designed to obtain parameters peculiar to the individual project. The data frequently are not stored in a processed format. For these reasons, results of single purpose surface meteorological data collection programs are not useful in characterizing baseline conditions at WSMR.

3.3.2 Existing Air Quality

The EPA, in conjunction with the individual states have divided all geographic areas of the country into designated areas for air quality planning and management purposes. These planning districts, termed Air Quality Control Regions or AQCRs, are based either on political boundaries or on air shed characteristics and may consist of interstate or major intrastate areas.

Almost all of WSMR is located in New Mexico AQCR 6. New Mexico AQCR 6 includes Doña Ana, Otero, Sierra, and Lincoln counties (State of New Mexico Health and Environment Department 1990). These counties, along with six counties in Texas, also are part of the EPA El Paso-Las Cruces-Alamogordo Interstate AQCR 153 (Code of Federal Regulations 40 CFR 81.82). The northern part of the range in Socorro County is located in New Mexico AQCR 8. Socorro County is in EPA AQCR 156 (State of New Mexico Environment Department (NMED) 1990).

The air quality of an area is most frequently evaluated by compliance with national ambient air quality standards (NAAQS) established for six pollutants, labeled "criteria" pollutants, by the EPA. They are carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, respirable particulate matter, and lead. Primary NAAQS define levels of air quality to protect human health with a margin of safety. Secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant (Table 3-21).

For each criteria pollutant, an area is classified "attainment" if the area meets the NAAQS for that pollutant, "nonattainment" if it does not. All of WSMR is located in areas designated attainment for all six federal criteria pollutants (NMED 1991b; 40 CFR 81.332).

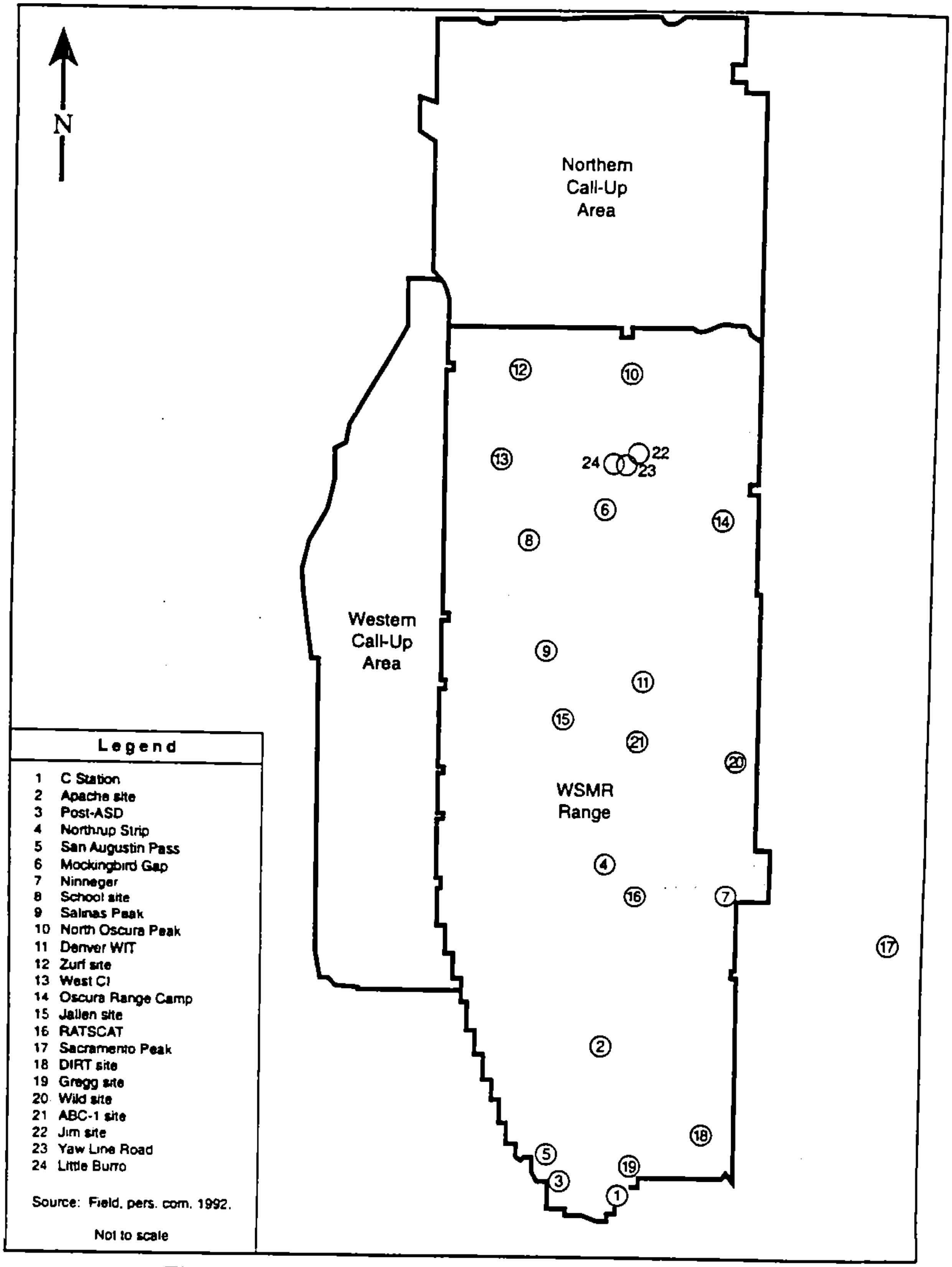

Figure 3-9. SAMS network at WSMR, New Mexico

Table 3-19
SAMS network at WSMR, New Mexico

Station No.	Station Name	Latitude	Longitude	m	Elevation in (ft)
01	C Station	32.400	106.380	1,221	(4,005)
02	Apache site	32.663	106.400	1,205	(3,953)
03	Post-ASD	0.000	0.000	1,301	(4,269)
04	Northrup Strip	32.900	106.410	1,192	(3,911)
05	San Augustin Pass	32.400	106.500	1,799	(5,901)
06	Mockingbird Gap	33.500	106.540	1,633	(5,356)
07	Ninneger	32.900	106.130	1,237	(4,058)
08	School site	33.470	106.580	1,503	(4,930)
09	Salinas Peak	33.300	106.530	2,761	(9,060)
10	North Oscura Peak	33.700	106.370	2,417	(7,930)
11	Denver WIT	33.300	106.350	1,249	(4,097)
12	Zurf site	33.800	106.590	1,458	(4,785)
13	West CI	33.400	106.630	1,414	(4,638)
14	Oscura Range Camp	33.500	106.210	1,422	(4,666)
15	Jallen site	33.170	106.490	1,235	(4,051)
16	RATSCAT	32.900	106.350	1,191	(3,908)
17	Sacramento Peak	32.500	105.820	2,795	(9,169)
18	DIRT site	32.500	106.200	1,220	(4,001)
19	Gregg site	32.400	106.330	1,214	(3,984)
20	Wild site	32.470	106.500	1,260	(4,134)
21	ABC-1	33.166	106.341	1,229	(4,031)
22	Jim site	33.500	106.360	2,576	(8,451)
23	Yaw Line Road	0.000	0.000	1,627	(5,337)
24	Little Burro	0.000	0.000	1,592	(5,224)

Source: Field, pers. com. 1992.

Notes: m = meter
ft = foot

In addition to the federal standards, the state of New Mexico has set forth, in Air Quality Control Regulation 201, ambient air quality standards that are as strict or more strict than the NAAQS (Table 3-22) (NMED n.d.). In addition to protecting human health, the New Mexico standards are designed to protect against air pollution that injures animals and vegetation, corrodes building materials and works of art, reduces visibility, and generally diminishes the quality of life (NMED 1991b).

The state of New Mexico ambient air monitoring network includes monitors statewide. However, monitoring of ambient air quality in the vicinity of WSMR is not extensive. Carbon monoxide, ozone, and fine respirable particulate matter currently are monitored in Las Cruces. Sampling for total suspended particulate matter in Alamogordo was discontinued after 1988 and in Tularosa after 1986. Total suspended particulate matter sampling has not been conducted

Table 3-20
Example of SAMS monthly summary data report

Min-Ave-Max Values
SAMS Daily Summarized Data Report

Elevation (ft): 4,005
Latitude: 32.40
Longitude: 106.38

1 May 1992 C Station

Date	Min Temp °F	Ave Temp °F	Max Temp °F	Ave RH %	Average Station Press mb	Dir of Av Vectr deg	Ave Wnd Spd mph	Max Wnd Spd mph	Ave Delta Temp °C	Total Solar Rad ly/mn	Total Precip in
1 May	56	78	95	23	876.6	260	8	33	.1	577.5	0.00
2 May	60	72	88	44	881.5	52	6	26	-.1	343.7	.08
3 May	58	63	74	79	884.9	18	7	17	-.2	306.4	.03
4 May	58	67	81	65	880.9	29	5	21	-.3	457.4	0.00
5 May	53	68	83	58	878.8	135	8	31	-.2	512.9	.02
6 May	52	66	81	69	882.6	132	9	29	-.1	473.4	.36
7 May	53	67	82	70	881.9	40	4	31	-.2	650.7	.31
8 May	53	67	84	64	875.8	212	6	33	-.3	639.9	.13
9 May	55	67	81	53	871.9	213	10	35	-.3	623.9	0.00
10 May	56	67	77	48	875.6	253	10	39	-.2	456.7	0.00
11 May	56	74	87	33	878.2	294	9	28	-.2	681.3	0.00
12 May	55	75	91	34	878.5	302	6	20	.0	669.9	0.00
13 May	58	71	92	44	878.1	351	8	34	-.1	500.0	0.00
14 May	53	71	89	47	875.6	292	6	31	-.2	569.5	0.00
15 May	50	70	90	44	874.5	102	6	39	-.0	554.1	0.00
16 May	54	71	93	48	876.4	144	6	33	-.1	655.0	.01
17 May	50	72	90	44	880.4	81	7	35	-.1	577.5	0.00
18 May	58	71	86	62	882.9	131	7	25	-.5	666.8	.05
19 May	56	72	84	54	878.7	153	7	31	-.3	539.9	0.00
20 May	58	67	82	67	876.7	45	7	35	-.4	522.9	.27
21 May	53	67	83	66	876.0	167	7	40	-.2	638.2	.09
22 May	54	67	85	64	877.3	21	9	33	-.1	598.4	.16
23 May	54	59	72	83	880.4	85	7	32	.1	340.3	.75
24 May	51	57	67	88	879.2	10	9	27	.0	357.5	.38
25 May	50	62	79	70	876.7	302	5	32	-.1	551.4	0.00
26 May	52	63	76	68	877.5	161	6	26	-.1	469.9	0.00
27 May	54	67	83	65	873.8	254	7	36	-.3	546.7	.01
28 May	32	69	84	54	874.7	44	6	26	-.3	652.6	0.00
29 May	55	64	81	70	876.4	111	7	31	-.4	527.8	.02
30 May	54	64	85	76	877.5	180	6	35	-.2	482.9	.17
31 May	49	68	85	63	877.8	4	5	37	-.3	653.0	.01
Min	32	57	67	23	871.9		4	17	-.5	306.4	0.00
Ave	54	68	84	59	878.0	129	7	31	-.2	541.9	.09
Max	60	78	95	88	884.9		10	40	.1	681.3	.75
STD	5	4	6	15	2.9		1	5	.1	105.4	.17
Total										16798.	2.85

Source: Field, pers. com. 1992.

Table 3-21
National ambient air quality standards

Pollutant	Averaging Time	Primary Standard	Secondary Standard
Carbon Monoxide (CO)	1-hour	35 ppm ($40,000 \mu g/m^3$)	none
	8-hour	9 ppm ($10,000 \mu g/m^3$)	none
Ozone (O_3)	1-hour	0.120 ppm ($235 \mu g/m^3$)	same
Nitrogen Dioxide (NO_2)	annual	0.05 ppm ($100 \mu g/m^3$)	same
Sulfur Oxides (measured as SO_2)	3-hour	none	0.50 ppm ($1,300 \mu g/m^3$)
	24-hour	0.14 ppm ($365 \mu g/m^3$)	none
	annual	0.03 ppm ($80 \mu g/m^3$)	none
Fine Respirable Particulate Matter (PM_{10})	24-hour	$150 \mu g/m^3$	none
	annual	$50 \mu g/m^3$	none
Lead (Pb)	quarter	$1.5 \mu g/m^3$	same

Source: Code of Federal Regulations 40 CFR 50.

Notes: National standards, other than ozone and those based on annual or quarterly averages or annual geometric means, are not to be exceeded more than once per year. Standards based on annual or quarterly averages are not to be exceeded. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above standard is equal to or less than one.

ppm = parts per million
µg/m3 = microgram per cubic meter

in Truth or Consequences or Socorro since 1986, or in Hatch since 1985 (NMED 1991b; State of New Mexico Health and Environment Department 1990). WSMR will collect air quality data to assess the cumulative impact of the no action alternative and to forecast the cumulative impacts of the proposed action (Appendix D). Cumulative impacts to air quality are discussed in Section 4.16 of this document.

Table 3-22
State of New Mexico ambient air quality standards

Pollutant	Averaging Time	Standard
Carbon Monoxide (CO)	1-hour	13.1 ppm
	8-hour	8.7 ppm
Photochemical Oxidants	1-hour	0.06 ppm
Nonmethane Hydrocarbons	3-hour	0.19 ppm
Nitrogen Dioxide (NO_2)	24-hour	0.10 ppm
	annual	0.05 ppm
Sulfur Dioxide (SO_2)	24-hour	0.10 ppm
	annual	0.02 ppm
Hydrogen Sulfide (H_2S)	1-hour	0.010 ppm
Total Reduced Sulfur	0.5-hour	0.003 ppm
Total Suspended Particulate Matter	24-hour	150 $\mu g/m^3$
	7-day	110 $\mu g/m^3$
	30-day	90 $\mu g/m^3$
	annual	60 $\mu g/m^3$
Beryllium	30-day	0.01 $\mu g/m^3$
Asbestos	30-day	0.01 $\mu g/m^3$
Heavy Metals (total combined)	30-day	10 $\mu g/m^3$

Sources: NMED 1991b; State of New Mexico Health and Environment Department n.d.

Notes: New Mexico standards are not to be exceeded. In cases where there is no New Mexico standard, the federal standard is not to be exceeded. *New Mexico defaults to the federal standards for PM_{10}, ozone, and lead.*

ppm = part per million

$\mu g/m^3$ = microgram per cubic meter

Carbon monoxide, a toxic gas, is produced primarily from incomplete combustion of fuels used in vehicles, by industries, and in space heating. The automobile is the main source of carbon monoxide in New Mexico. From 1985 through 1990, the maximum 1-hour average concentration of ambient carbon monoxide in Las Cruces was 13.0 ppm recorded in 1986 and again in 1987. The highest 8-hour average concentration of carbon monoxide in Las Cruces was 8.0 ppm in 1987. These concentrations do not exceed either the NAAQS or the New Mexico ambient air quality standards for carbon monoxide (NMED 1990, 1991b).

Ozone, a respiratory irritant, is a secondary pollutant that is produced when sunlight reacts with hydrocarbons and nitrogen oxides in the atmosphere. These precursors are emitted by automobiles and other combustion sources. During the years 1985 through 1990 (years of most recently available data), the highest 1-hour average concentration of ambient ozone in Las Cruces was 0.11 ppm in 1989. No ambient ozone readings exceeded the NAAQS (NMED 1990, 1991b).

Nitrogen dioxide is a primary pollutant as well as an ozone precursor. Nitrogen dioxide, another respiratory irritant, also is a visible component of smog and contributes to acid precipitation. The state of New Mexico does not operate a monitoring station for nitrogen dioxide near WSMR (NMED 1990, 1991b).

Sulfur dioxide, which irritates the respiratory system and contributes to acid precipitation, originates primarily from industrial sources such as metal smelters and power plants. The state of New Mexico does not operate a monitoring station for sulfur dioxide near WSMR (NMED 1990, 1991b).

Particulate matter originates from combustion sources and other industrial processes and from area sources such as mining operations, dirt roads, and motor vehicles. Windblown dust also is a source of particulate matter. Airborne particulate matter ranges in size from fine respirable particles to larger suspended dust particles that are not inhaled into the lungs. The fraction of total suspended particulate matter that constitutes a human health concern by irritating the respiratory system and aggravating asthma and other lung diseases is termed PM_{10}, particulate matter less than 10 microns in diameter. One micron or micrometer is one millionth of a meter, 10^{-6} m. For this reason, the EPA modified the NAAQS for particulate matter in 1987 to apply to fine respirable particulate matter rather than total suspended particulate matter. Fine particulate matter also degrades visibility by scattering light in the atmosphere (NMED 1990, 1991b).

During the period 1986 through 1988 and 1990 the state of New Mexico PM_{10} sampler in Las Cruces recorded one exceedance (258 $\mu g/m^3$) of the 24 hour NAAQS in 1987. The site did not operate in 1989. The highest annual average concentration of PM_{10} in Las Cruces for these years was 39 $\mu g/m^3$ in 1986. The annual average concentrations of PM_{10} in Las Cruces have not exceeded the NAAQS (NMED 1990, 1991b).

During the years 1985 through 1988 when the state of New Mexico did operate a total suspended particulate matter sampler in Alamogordo, the 24-hour NAAQS for total suspended particulate matter was exceeded once a year in three of those four years. The annual NAAQS for total suspended particulate matter was never exceeded. This situation can probably be attributed to the dust storms characteristic of the windy spring months in the Tularosa Basin (NMED 1990, 1991b).

To obtain current data concerning the levels of ambient particulate matter within the boundaries of the facility, WSMR Environmental Services Division supported a PM_{10} sampling project for calendar year 1993. Sampling was conducted at C Station, a site that meets the EPA criteria for selecting a monitoring location for regional-scale measurements (Ludwig et al. 1977). C Station also is station 01 of the WSMR SAMS network (Figure 3-9, Table 3-22). During the sampling period January 1 through December 27, 1993, the annual average ambient concentration of PM_{10} for 59 valid samples was 10.72 $\mu g/m^3$ with a standard deviation of 7.57 $\mu g/m^3$. The highest 24 hour average was 45.59 $\mu g/m^3$. These annual and 24-hour averages were below the NAAQS for PM_{10} (WSMR 1994b).

Aerosols are tiny particles, either fine solid or liquid, dispersed in the air. Atmospheric aerosols range in size from the submicron scale to several hundred microns in diameter. In the atmosphere, several physicochemical mechanisms change their size, number, chemical composition, and ultimate fate. Pinnick et al. (1993) recently completed a multifaceted study of the ambient aerosol characteristics in the Tularosa Basin. They reported a strong seasonal variation in aerosol mass loading, from a maximum of approximately 100 $\mu g/m^3$ during the spring windy season to a minimum of approximately 10 $\mu g/m^3$ in the fall rainy season. Annual average aerosol concentration can change over time at a given site, possibly due to annual variations of precipitation. Their data also suggested that local variations of ambient aerosol concentrations within the Tularosa Basin can be more pronounced than the annual variations at a given site. The total aerosol mass is dominated by a wind-derived supermicron component of quartz and clay minerals of soil origin. A submicron fraction consistently contributes less than one percent to the total aerosol mass. This submicron component, likely a product of long-range atmospheric transport, is composed mainly of ammonium and acid sulfates, soil derived particles, and black carbon. Black carbon is the primary agent of long-range visibility reduction except during the windy, dusty conditions in the spring.

Although the state of New Mexico operates a monitoring station near WSMR, no sampling for lead is undertaken and no baseline for this potential pollutant is available (NMED 1990, 1991b).

The air quality of a region is assessed not only by the attainment and maintenance of national and state ambient air quality standards but also by aesthetic evaluations such as long-range visibility. Visibility observations taken at A Station on the WSMR Main Post from 1951 through 1973 recorded that annual prevailing visibility averaged approximately 71 km (44 mi) (Hoidale and Newman 1974a). The WSMR Meteorological Team (STEWS-NR-DA-F) now makes hourly visibility observations at C Station (Rupe, pers. com. 1992). Observers use procedures specified by National Oceanic and Atmospheric Administration (1988).

To document and provide a historical record of existing baseline visibility conditions on the range, the WSMR Environmental Services Division sponsored a visibility monitoring program during calendar year 1993. An automated 35-millimeter camera system mounted in an enclosure on the roof of the 100K site building, south of the Main Post on the west side of WSMR Route 1, collected three photographs daily for the entire year. The situation of the building provided a target vista over the Tularosa Valley to the Jarilla Mountains and beyond to the Sacramento Range (Figure 3-10). The collection of developed 35-millimeter slides produced by the visibility monitoring program is archived with the WSMR Environmental Services Division (1994). WSMR is in the process of compiling emissions data for regulated air pollutants and hazardous air pollutants in order to comply with the requirements of Title V of the Clean Air Act.

3.4 BIOLOGICAL RESOURCES

WSMR has a variety of vegetation and habitat types that support a diversity of wildlife. These habitats are widely dispersed and form a mosaic of scrubs, grasslands, savannas, woodlands, forests, and wetlands. WSMR wildlife resources include mammals, birds, reptiles, amphibians, and numerous kinds of invertebrates. This section provides a general description

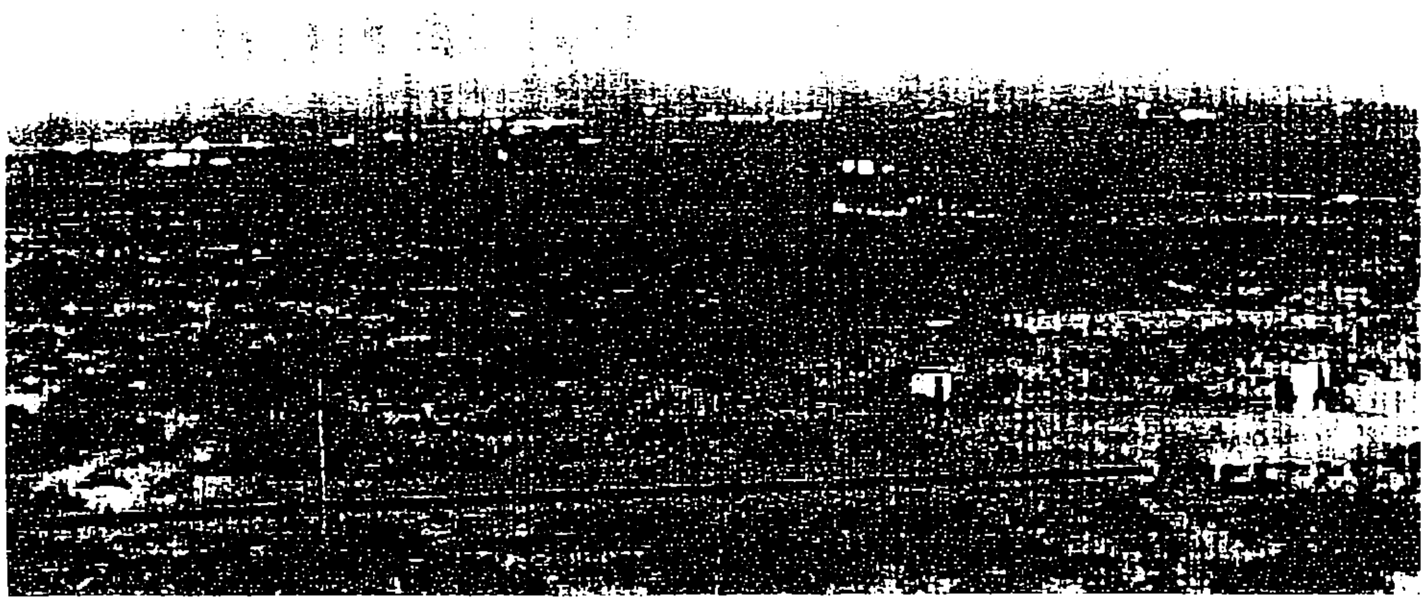

Figure 3-10. Visibility target vista

of the components of these habitats and relates them to the regional biotic context. It also identifies those plant and wildlife species that are listed as threatened or endangered by state and federal resource management agencies, or that are otherwise of concern. In addition, this section describes habitats that are identified as sensitive by the New Mexico Natural Heritage Program (NMNHP) or that are scarce or otherwise unique on a regional basis.

3.4.1 Vegetation

WSMR is located in south central New Mexico near the northern edge of the Chihuahuan Desert region. The relatively warm, dry climate associated with this region is the primary factor influencing the vegetation in the project area. Most of the surface of WSMR is located on the floor of the Tularosa Basin and Jornado del Muerto where summer rainfall is low (Section 3.2) (NMNHP 1992). The vegetation on these lowlands induces Chihuahuan desert scrub, closed-basin scrub, and desert grasslands. Rainfall increases and temperatures decrease with elevation in the Oscura and San Andres mountains (NMNHP 1992).

While soils, aspect, slope, and other factors play a role in determining the vegetation present at a given location, the climatic effects of increasing elevation are the predominant environmental factors. At elevations above the desert scrub and grasslands regions, plains-mesa grasslands may occur. These grasslands and the plains-mesa sand scrub are indicative of the location of WSMR near the western edge of the prairies that characterize the central portion of the continent. Both desert and plains-mesa grasslands form a broad savanna-like ecotone at higher elevations with the coniferous woodlands that dominate the cooler highlands of the Oscura and San Andres mountains. Junipers (*Juniperus* spp.) characterize the tree story of this transitional area. As slopes become steeper, the savanna develops a more woodland character and montane scrub vegetation forms part of the habitat mosaic. Gradually, pinyon pines (*Pinus edulis*) become more common until, near the summits of both mountain ranges, the coniferous woodlands are dominated by pinyon. Montane scrub continues to be present into the highlands. On Salinas Peak, montane coniferous forest dominated by ponderosa pine (*Pinus ponderosa*) is present.

The vegetation of southern New Mexico, including WSMR, has been subjected to a process of dynamic modification resulting from changing land use practices since the arrival of European settlers (Dick-Peddie 1993). Overgrazing of the relatively xeric habitats in the region led to reductions in grass dominance and increases in shrub cover and density (Dick-Peddie 1993). However, management practices during the last several decades have resulted in increasing grass dominance (Dick-Peddie 1993).

Vegetation classifications are produced to map and understand the pattern of variation that occurs on the landscape. The accuracy with which these classifications describe a particular stand of vegetation may vary, especially where transitions between vegetation types are gradual. The NMNHP (1993) is in the process of mapping and classifying the vegetation associations within the boundaries of WSMR. Some initial field verification was conducted in the Oscura Mountains during 1991, and a preliminary classification and test vegetation map was submitted to WSMR in 1992 (NMNHP 1992). Information derived from this initial effort was applied to satellite imagery of WSMR, and the NMNHP produced a digital vegetation map (NMNHP 1992). Although further field verification will be required, this mapping effort provides useful data that incorporate the regional classification scheme of Dick-Peddie (1993). This map was transferred to the Geographic Information System (GIS) data base prepared to support this EIS. The mapping is an ongoing effort by the NMNHP and is subject to revision as the data are verified and refined. The NMNHP was used as the primary source of information in developing the existing vegetation discussion below. The NMNHP (1992) effort did not include detailed descriptions of portions of the closed-basin scrub and wetland vegetation on WSMR; therefore, a variety of secondary sources were used for information on regional distribution and areas outside the NMNHP (1992) main effort.

The major divisions of the NMNHP classification are based on work by Dick-Peddie (1993). The NMNHP (1992) subdivided the vegetation types at WSMR into 11 vegetation/habitat types, which represent land areas capable of supporting a given plant association at climax (Table 3-23). These mapping units represent vegetation types or commonly occurring combinations of vegetation types. For example, while the coniferous woodland (pinyon pine series) vegetation mapping unit corresponds to only one of Dick-Peddie's (1993) types, the savanna and plains-mesa grasslands vegetation mapping unit includes two of Dick-Peddie's types. The NMNHP classification of vegetation on WSMR is discussed on a type-by-type basis in the following sections (Table 3-24).

3.4.1.1 Lower Montane Coniferous Forest. In New Mexico, lower montane coniferous forest generally occurs below 2,600 m (8,500 ft) (Dick-Peddie 1993). While Dick-Peddie does not provide separate acreage for lower and upper montane coniferous forest, he indicates that the combined acreage of this type is approximately 2,413,800 hectares (5,960,000 acres) in New Mexico.

The NMNHP (1992) recognized the occurrence of a small unit of the *Pinus ponderosa/Festuca arizonica* (ponderosa pine/Arizona fescue) habitat type on Salinas Peak in the San Andres Mountains. The limited data available indicate that mature ponderosa pine forms the over story of this type on WSMR. No pinyon pine or juniper were recorded as being present in this habitat type (NMNHP 1992). In addition to Arizona fescue, other plant species know to occur in the understory include mountain muhly (*Muhlenbergia montana*), junegrass (*Koeleria pyramidata*), and beardlip penstemon (*Penstemon barbatus*).

The occurrence of lower montane coniferous forest on WSMR is restricted to a small area on Salinas Peak. Other nearby occurrences are approximately 60 km (37 mi) east of Salinas Peak in the Sacramento Mountains, 80 km (50 mi) to the west in the San Mateo Mountains, and approximately 105 km (65 mi) to the south in the Organ Mountains. The intervening lands are characterized by much dryer and warmer habitats. The combination of distance and frequently inhospitable habitats probably prevents the movement of many species from the nearest similar habitat. These conditions strongly suggest that the lower montane coniferous forest on WSMR may represent the remnants of a vegetation type that formerly occupied larger portions of the project area.

3.4.1.2 Coniferous Woodland. Coniferous woodland vegetation in southern New Mexico is dominated by pinyon pines (*Pinus edulis*) and junipers (*Juniperus monosperma*). Pinyon pines and junipers may occur together or separately in nearly pure stands in coniferous woodland vegetation. Pines tend to dominate the cooler, more mesic upper portion of the woodlands elevational range, while junipers tend to dominate the lower, dryer portion of the range (Dick Peddie 1993). NMNHP (1992) data indicate this general pattern occurs on WSMR. The test mapping on the Oscura Mountains indicates that pinyon pine strongly dominates the upper elevations, and that juniper is most dominant at lower elevations. The existing mixed coniferous woodlands tend to occur at mid-elevation sites within the woodland range. On WSMR, the transition from the lower edge of the woodland formation often forms an ecotone with grasslands. Across this transitional area, junipers become less dominant and the grassland habitat increases to form a savanna.

Coniferous Woodland (Pinyon Pine Series)

On WSMR, vegetation characterized by pinyon pine (NMNHP 1992) occurs on approximately 38,900 hectares (85,500 acres) (Table 3-23). Approximately 11,200 hectares (27,200 acres) are dominated by pinyon pine (*Pinus edulis*) and an additional 23,392 hectares (57,800 acres) have been classified as pinyon pine/mountain mahogany (*Cercocarpus montanus*)dominated habitat (Table 3-23). On seed juniper (*Juniperus monosperma*) is present but is not the dominant tree species.

Mature pinyon pine stands on WSMR may have multilayered canopy structures with trees of varying age and height classes (NMNHP 1992). Pinyon pines may exceed 10 m (33 ft) in height. The woodlands often are characterized by moderately open to nearly closed (greater than 25 percent cover) tree canopies. Some stands, particularly after being burned, have canopy covers ranging from 5 to 25 percent. A shrub layer dominated by sclerophyllous shrubs is present commonly. Forbs and grasses may form an under story of variable cover and density.

The pinyon-pine dominated coniferous forest habitat occurs between 2,103 and 2,591 m (6,900 and 8,500 ft) on WSMR (NMNHP 1992). It generally occurs at somewhat lower elevations on cooler north- and east-facing slopes. In the Oscura Mountains, much of the habitat above 2,195 m (7,200 ft) is dominated by habitat types in the pinyon pine series. On the San Andres Mountains, the NMNHP mapped pinyon pine woodland habitat on or near Sheep Mountain, Salinas Peak, Ladybug Peak, several peaks east of Hardin Ranch and the Millers Ranch Headquarters, uplands south of Rhodes Grave, Blacktop Mountain, Kaylor Mountain, Strawberry Peak, Gardner Peak, and portions of the San Andres National Wildlife Refuge (1992).

On WSMR, the pinyon pine series includes seven habitat types (Table 3-24). Pinyon pine can dominate the canopy of the tree layer when the elevation exceeds 2,000 m (6,600 ft). However, within that range, the plant species dominating the shrub and herb layers may vary with elevation, slope, temperature, aspect, and fire history. These patterns of variation result in a mosaic-like patchwork of habitat types within the coniferous woodland type.

Species that may occur as codominants in the coniferous woodland (pinyon pine series) vegetation include Gamble oak (*Quercus gambelii*), Scribner needlegrass (*Stipa scribneri*), wavyleaf oak (*Quercus undulata*), blue grama (*Bouteloua gracilis*), beargrass (*Nolina microcarpa*), sideoats grama (*Bouteloua curtipendula*), and New Mexico muhly (*Muhlenbergia pauciflora*). Differing slope, elevation, aspect, and soil type influence which of these species may be codominant at a particular site (NMNHP 1992).

Coniferous Woodland and Montane Scrub

In the same elevation range where coniferous forest and woodland habitats occur (approximately 1,433 m [4,700 ft] above MSL and 2,377 m [7,800 ft] above MSL), montane scrub habitats also may be present (NMNHP 1992). This scrub habitat occurs on approximately 23,400 hectares (57,800 acres) on the Oscura and San Andres mountains. The shrub-dominated habitats tend to occur on sites where the environmental conditions are more extreme or where disturbance events occur at high frequencies. The NMNHP recognized one montane shrub habitat type and seven montane shrub community types as occurring on WSMR (Table 3-24). These were considered to be predominantly successional. However, the succession to coniferous or woodland was identified as often being slow (NMNHP 1992).

Table 3-23
Vegetation types occurring on WSMR

Vegetation Type	Hectares (acres)
Coniferous Woodlands (Pinyon Pine Series)	
Pinyon Pine	11,200 (27,700)
Pinyon Pine and Mountain Mahogany	23,400 (57,800)
Savanna and Plains-mesa Grassland	91,200 (225,400)
Desert Grassland and Plains-mesa Sandscrub	174,000 (430,000)
Chihuahuan Desert Scrub	
Creosote Bush	222,000 (548,000)
Mesquite	114,600 (283,200)
Lava	16,900 (41,800)
Closed-basin Scrub	
Fourwing Saltbush and Tarbush	107,900 (266,600)
Arroyo Riparian and Wetlands	10,000 (24,700)
Barren Land	69,500 (171,700)
Dune Land	35,600 (88,000)
Total	877,100 (2,167,300)

Notes: Does not include 9,400 hectares (23,200 acres) of WSMR, which NMNHP (1992) mapped as having no associated data.

The NMNHP (1992) provides no acreage for the lower montane coniferous forest vegetation.

Table 3-24
Habitat types occurring on WSMR

Hierarchical Vegetation Classification

CONIFEROUS FOREST
Ponderosa Pine Series
Ponderosa Pine/Arizona Fescue (*Pinus ponderosa/Festuca arizonica*) Habitat Type

CONIFEROUS WOODLAND
Pinyon Pine Series
Pinyon Pine/Gamble Oak (*Pinus edulis/Quercus gambelii*) Habitat Type
Pinyon Pine/Scribner Needlegrass (*Pinus edulis/Stipa scribneri*) Habitat Type
Pinyon Pine/Wavyleaf Oak (*Pinus edulis/Quercus undulata*) Habitat Type
Pinyon Pine/Blue Grama (*Pinus edulis/Bouteloua gracilis*) Habitat Type
Pinyon Pine/Beargrass (*Pinus edulis/Nolina microcarpa*) Habitat Type
Pinyon Pine/Sideoats Grama (*Pinus edulis/Bouteloua curtipendulata*) Habitat Type
Pinyon Pine/New Mexico Muhly (*Pinus edulis/Muhlenbergia pauciflora*) Habitat Type

(table continues)

Table 3-24, Continued

Hierarchical Vegetation Classification

CONIFEROUS WOODLAND AND MONTANE SCRUB

Pinyon Pine Series

Pinyon Pine/Mountain Mahogany (*Pinus edulis/Cercocarpus montanus*) Community Type

Mountain Mahogany Series

Mountain Mahogony/Silktassle (*Cercocarpus montanus/Garrya flavescens*) Community Type

Mountain Mahogany/New Mexico Muhly (*Cercocarpus montanus/Muhlenbergia pauciflora)* Habitat Type

Mountain Mahogany/Fragrant Sumac (*Cercocarpus montanus/Rhus aromatica*) Community Type

Gamble Oak Series

Gamble Oak/Snowberry (*Quercus gambelii/Symphoricarpus oreophilus*) Community Type

Gray Oak Series

Gray Oak/Mountain Mahogany (*Quercus grisea/Cercocarpus montanus*) Habitat Type

Waveyleaf Oak Series

Wavyleaf Oak/Mountain Mahogany (*Quercus undulata/Cercocarpus montanus)* Community Type

Scrub Oak Series

Scrub Oak/Mountain Mahogany (*Quercus turbinella/Cercocarpus montanus*) Community Type

Scrub Oak/Black Grama (*Quercus turbinella/Bouteloua eriopoda*) Habitat Type

SAVANNA AND PLAINS-MESA GRASSLAND

One-seed Juniper Series

One-seed Juniper/Sideoats Grama (*Juniperus monosperma/Bouteloua curtipendula*) Habitat Type

One-seed Juniper/New Mexico Needlegrass (*Juniperus monosperma/Stipa neomexicana*) Habitat Type

One-seed Juniper/Black Grama (*Juniperus monosperma/Bouteloua eriopoda*) Habitat Type

One-seed Juniper/Blue Grama (*Juniperus monosperma/Bouteloua gracilis*) Habitat Type

One-seed Juniper/Hairy Grama (*Juniperus monosperma/Bouteloua hirsuta*) Habitat Type

One-seed Juniper/Mountian Mahogany (*Juniperus monosperma/Cercocarpus montanus*) Habitat Type

One-seed Juniper/Scrub Oak (*Juniperus monosperma/Quercus turbinella*) Habitat Type

(table continues)

Table 3-24, Continued

Hierarchical Vegetation Classification

Sideoats Grama Series

Sideoats Grama/Sotal (*Bouteloua curtipendula/Dasylirion wheeleri*) Habitat Type

Blue Grama Series

Blue Grama/Western Wheatgrass (*Bouteloua gracilis/Agropyron smithii*) Habitat Type

Blue Grama/Bigelow's Sage (*Bouteloua gracilis/Artemisia biglovii*) Habitat Type

Blue Grama/Sideoats Grama (*Bouteloua gracilis/Bouteloua curtipendula*) Habitat Type

Blue Grama/Winterfat (*Bouteloua gracilis/Eurotia lanata*) Habitat Type

Blue Grama/Sand Dropseed (*Bouteloua gracilis/Sporobolus cryptandrus*) Habitat Type

Blue Grama/New Mexico Needlegrass (*Bouteloua gracilis/Stipa neomexicana*) Habitat Type

Hairy Grama Series

Hairy Grama/New Mexico Needlegrass (*Bouteloua hirsuta/Stipa neomexicana*) Habitat Type

Hairy Grama/Blue Grama (*Bouteloua hirsuta/Bouteloua gracilis*) Habitat Type

Hairy Grama/Sideoats Grama (*Bouteloua hirsuta/Bouteloua curtipendula*) Habitat Type

Little Bluestem Series

Little Bluestem/Sandhill Muhly (*Schizachyrium scoparium/Muhlenbergia pungens*) Habitat Type

DESERT GRASSLANDS AND PLAINS MESA SANDSCRUB

Black Grama Series

Black Grama/Bigelow's Sage (*Bouteloua eriopoda/Artemisia bigelovii*) Habitat Type

Black Grama/Sideoats Grama (*Bouteloua eriopoda/Bouteloua curtipendula*) Habitat Type

Black Grama/Blue Grama (*Bouteloua eriopoda/Bouteloua gracilis*) Habitat Type

Black Grama/Hairy Grama (*Bouteloua eriopoda/Bouteloa hirsuta*) Habitat Type

Black Grama/Torrey Mormontea (*Bouteloua eriopoda/Ephedra torreyana*) Habitat Type

Black Grama/Sotol (*Bouteloua eriopoda/Dasylirion wheeleri*) Habitat Type

Black Grama/Desert Mormontea (*Bouteloua eriopoda/Ephedra trifurca*) Habitat Type
Nolina microcarpa phase (NOMI; Beargrass)

Black Grama/Mariola (*Bouteloua eriopoda/Parthenium incanum*) Habitat Type

Black Grama/New Mexico Needlegrass (*Bouteloua eriopoda/Stipa neomexicana*) Habitat Type

Black Grama/Soaptree Yucca (*Bouteloua eriopoda/Yucca elata*) Habitat Type

Black Grama/Red Grama (*Bouteloua eriopoda/Bouteloua trifida*) Habitat Type

(table continues)

Table 3-24, Continued

Hierarchical Vegetation Classification

New Mexico Needlegrass Series
- New Mexico Needlegrass/Sideoats Grama (*Stipa neomexicana/Bouteloua curtipendula*) Habitat Type
- New Mexico Needlegrass/Sotol (*Stipa neomexicana/Dasylirion wheeleri*) Habitat Type

Curlyleaf Muhly Series
- Curlyleaf Muhly/Ocotillo (*Muhlenbergia setifolia/Fouquieria splendens*) Habitat Type
- Curlyleaf Muhly/Bigelove Sage (*Muhlenbergia setifolia/Artemisia bigelovii*) Habitat Type
- Curlyleaf Muhly/Sotol (*Muhlenbergia setifolia/Dasylirion wheeleri*) Habitat Type

Gypgrass Series
- Gypgrass/Hartweg's Evening Primrose (*Sporobolus nealleyii/Calyophus hartwegii*) Habitat Type
- Gypgrass/Hairy Coldenia (*Sporobolus nealleyii/Coldinia hispidula*) Habitat Type
- Gypgrass/Ocotillo (*Sporobolus nealleyii/Fouqueiria splendens*) Habitat Type

Alkali Sacaton Series
- Alkali Sacaton/Burrograss (*Sporobolus airoides/Scleropogon brevifolius*) Habitat Type
- Alkali Sacaton/Blue Grama (*Sporobolus airoides/Bouteloua gracilis*) Habitat Type
- Alkali Sacaton/Saltgrass (*Sporobolus airoides/Distichlis stricta*) Habitat Type

Mesa Dropseed Series
- Mesa Dropseed/Broom Dalea (*Sporobolus flexuosus/Psorthamnus scoparius*) Habitat Type
- Mesa Dropseed/Spike Dropseed (*Sporobolus flexuosus/Sporobolus contractus*) Habitat Type

Giant Sacaton Series
- Giant Sacaton/Hall's Panic Grass (*Sporobolus wrightii/Panicum hallii*) Habitat Type

Sand Sage Series
- Sand Sage/Black Grama (*Artemisia filifolia/Bouteloua eriopoda*) Habitat Type
- Sand Sage/Mesa Dropseed (*Artemisia filifolia/Sporobolus flexuosus*) Habitat Type
- Sand Sage/Giant Dropseed (*Artemisia filifolia/Sporobolus giganteus*) Habitat Type

(table continues)

Table 3-24, Continued

Hierarchical Vegetation Classification

CHIHUAHUAN DESERT SCRUB (CREOSOTE BUSH)
Creosote Bush Series
- Creosote Bush/Black Grama (*Larrea tridentata/Bouteloua eriopoda*) Habitat Type
- Creosote Bush/Blue Grama (*Larrea tridentata/Bouteloua gracilis*) Habitat Type
- Creosote Bush/Hairy Coldenia (*Larrea tridentata/Coldenia hispidissima*) Habitat Type
- Creosote Bush/Fluff Grass (*Larrea tridentata/Erioneuron pulchellum*) Habitat Type
- Creosote Bush/Bush Muhly (*Larrea tridentata/Muhlenbergia porteri*) Habitat Type
- Creosote Bush/Mariola (*Larrea tridentata/Parthenium incanum*) Habitat Type
- Creosote Bush/Sparse (*Larrea tridentata/*Sparse) Habitat Type
- Creosote Bush/Alkali Sacaton (*Larrea tridentata/Sporobolus airoides*) Habitat Type

Tarbush Series
- Tarbush/Sideoats Grama (*Flourensia cernua/Bouteloua curtipendula*) Habitat Type
- Tarbush/Alkali Sacaton (*Flourensia cernua/Sporobolus airoides*) Habitat Type
- Tarbush/Southwestern Needlegrass (*Flourensia cernua/Stipa eminens*) Habitat Type

Ocotillo Series
- Ocotillo/Sideoats Grama (*Fouquieria splendens/Bouteloua curtipendula*) Habitat Type
- Ocotillo/Mariola (*Fouquieria splendens/Parthenium incanum*) Habitat Type
- Ocotillo/Tufted Rockmat (*Fouquieria splendens/Petrophytum caespitosum*) Habitat Type

CHIHUAHUAN DESERT SCRUB (MESQUITE)
Honey Mesquite Series
- Honey Mesquite/Fourwing Saltbush (*Prosopis glandulosa/Atriplex canescens*) Habitat Type
- Honey Mesquite/Alkali Sacaton (*Prosopis glandulosa/Sporobolus airoides*) Habitat Type
- Honey Mesquite/Mesa Dropseed (*Prosopis glandulosa/Sporobolus flexuosus*) Habitat Type

CLOSED-BASIN SCRUB (FOURWING SALTBUSH AND TARBUSH)
- Fourwing Saltbush/Alkali Sacaton (*Atriplex canescens/Sporobolus aroides*) Habitat Type
- Fourwing Saltbush/Giant Sacaton (*Atriplex canescens/Sporobolus wrightii*) Habitat Type

CLOSED-BASIN SCRUB (ARROYO RIPARIAN AND WETLANDS)
- Fourwing Saltbush/Parthenium (atriplex canescens/Parthenium confertum) Habitat Type

CLOSED-BASIN SCRUB AND BARREN LANDS (SALTBUSH/IODINE BUSH)[a]

CLOSED-BASIN SCRUB AND DUNE LAND (SALTBUSH AND GYPSUM DUNES)[a]

CLOSED-BASIN SCRUB AND LAVA*

Source: NMNHP (1992).

* The NMNHP (1992) has not delineated habitat types within this vegetation type.

Within the coniferous woodland and montane scrub vegetation type, six series have been distinguished (Table 3-24). Species dominating these series include pinyon pine, Gamble oak, mountain mahogany, gray oak (*Quercus grisea*), wavyleaf oak, and scrub oak (*Quercus turbinella*). The mountain mahogany series includes three subtypes in which yellow-leaf silktassle (*Garrya flavescens*), New Mexico muhly (*Muhlenbergia pauciflora*), and fragrant sumac (*Rhus aromatica*) are the defining codominant species. The scrub oak series includes a community types codominated by mountain mahogany and a habitat type in which black grama grass is codominant. Important species in the remaining four series include snowberry (*Symphoricarpos oreophilus*) and mountain mahogany.

3.4.1.3 Savanna and Plains-mesa Grassland. This mapping unit includes elements of the juniper savanna and plains-mesa grassland vegetation types (NMNHP 1992). On WSMR, the savanna and plains-mesa grassland vegetation occupies approximately 91,200 hectares (225,400 acres) (Table 3-23). The current mapping does not allow the acreage occupied by juniper savanna to be separated from plains-mesa grassland. The ongoing vegetation research and mapping being conducted on WSMR are expected to provide more detailed information in the future.

Juniper Savanna and Woodland

Vegetation with widely scattered trees in a grass matrix is referred to as savanna (Dick-Peddie 1993). In New Mexico, savanna vegetation often occurs as broad expanses at elevations intermediate between woodland and grassland vegetation. This area is considered to represent an ecotone between coniferous forests and grasslands. This is an abundant resource that is present on approximately 3,100,000 hectares (7,700,000 acres) in New Mexico, and also occurs in several other western states.

On WSMR, the lower edge of the coniferous woodland vegetation often transitions into extensive areas with scattered oneseed junipers having an under story of plains-mesa grassland. As defined by the NMNHP (1992), juniper savanna in the project area occurs between 2,140 and 1,700 m (7,000 and 5,800 ft) above MSL at the north end of WSMR and 1,890 m (6,200 ft) above MSL at the south end of WSMR. The juniper canopy cover can vary from as high as 50 percent to approximately 1 percent. The savanna character is best developed on land forms with low relief. The juniper-dominated vegetation may have woodland characteristics with a less developed grass/forb understory and more prominent shrub story where the terrain is steeper and hilly.

The NMNHP identified five major habitat types within the juniper-dominated savanna vegetation type (1992). All the habitat types are characterized by the presence of oneseed juniper. The habitat types are named for and distinguished by the presence of sideoats grama, New Mexico needlegrass, black grama, hairy grama (*Bouteloua hirsuta*), mountain mahogany, and scrub oak (Table 3-24).

The grass/forb layer of the savanna vegetation generally is dominated by species typical of the plains-mesa grassland vegetation type. In New Mexico, the savanna vegetation represents an ecotone between the lower, more xeric, portions of the coniferous woodland and more mesic portions of the plains-mesa grassland vegetation types (Dick-Peddie 1993). The lower and drier portions of the plains-mesa grassland form an ecotone with the desert grassland vegetation type.

Plains-mesa Grassland

Plains-mesa grassland generally blends into savanna and woodland vegetation along the mesic or higher-elevation portion of its range and into desert grassland or desert scrub along its more xeric, lower elevation edge. The most characteristic species of the plains-mesa grassland is blue grama (*Bouteloua gracilis*). Grasses generally dominate this vegetation type, and forbs, while usually present, rarely attain dominance. The plains-mesa grasslands of New Mexico (Dick-Peddie 1993) and Arizona (Lowe 1985) represent the southwestern most extension of the continental grasslands in the United States.

On WSMR, as in other portions of the type's range, plains-mesa grassland occurs between the woodlands and savannas and he lower-elevation desert grasslands and desert scrub (NMNHP 1992). It is dominated by grass and has a minor shrub component. Plains-mesa vegetation tends to occur on gently sloping land forms. In addition to blue grama, major grass species include sideoats grama (*Bouteloua curtipendula*), hairy grama (*Bouleioua hirsuta*), and New Mexico needlegrass (*Stipa neomexicana*). These species, along with little bluestem (*Schizachyrium scoparium*), define the five series identified by the NMNHP as occurring on WSMR (1992).

On WSMR, the sideoats grama series has one habitat type characterized by sotol (*Dasylirion wheeleri*). The blue grama series has habitat types marked by the presence of western wheatgrass (*Agropyron smithii*), Bigelow sage (*Artemisia bigelovii*), sideoats grama, winterfat (*Eurotia lanata*), sand dropseed (*Sporobolus cryptandrus*), and New Mexico needlegrass (Table 3-24).

The hairy grama series includes habitat types characterized by New Mexico needlegrass and sideoats grama. Vegetation dominated by New Mexico needlegrass (New Mexico needlegrass series) may include habitat types where sideoats grama and sotol are codominant. The little bluestem (*Schizachyrium scoparium*), series has one habitat type. On WSMR, this habitat type occurs on the fringes of the gypsum dunes and is codominated by sandhill muhly (*Muhlenbergia pungens*).

3.4.1.4 Desert Grassland and Plains-mesa Scrub. This mapping unit includes elements of the desert grassland and plains-mesa sandscrub vegetation types (NMNHP 1992). On WSMR, the desert grassland and plains-mesa sandscrub vegetation occupies approximately 174,000 hectares (430,000 acres) (Table 3-23). Currently, it is unknown which portions of this area can be separated into either of the constituent subtypes

Desert Grassland

Desert grassland generally merges with plains-mesa grassland or montane scrub on the relatively mesic or higher-elevation portion of its range and with Chihuahuan desert scrub or Great Basin desert scrub along its lower elevation and more xeric edge. The most characteristic species of the desert grassland is black grama (*Bouteloua eriopoda*). Grasses generally dominate this vegetation type and forbs, while usually present, rarely attain dominance.

Desert grassland vegetation variously has been considered to represent a broad ecotone and a distinct biome (Dick-Peddie 1993). In addition, overgrazing has resulted in increased shrub densities and extensive reductions in the cover and production of black grama and other palatable grasses. The NMNHP (1992) indicated that desert grassland vegetation occurs at elevations between 1,219 to 1,829 m (4,000 to 6,000 ft) above MSL. It is widespread on WSMR and may be found on various land forbs including mountain escarpments, bajadas, and basin floors.

In addition to black grama, grass species that characterize the desert grassland series include mesa dropseed (*Sporobolus flexuosus*), alkali sacaton (*Sporobolus airoides*), giant sacaton (*Sporobolus wrightii*), gypgrass (*Sporobolus nealleyi*), and curlyleaf muhly (*Muhlenbergia setifolia*) (NMNHP 1992). These species, when present, are considered to be indicators of desert grassland conditions. NMNHP also has identified six desert grassland series occurring on WSMR (1992). These six series have been further subdivided into 23 habitat types. The large number of habitat types associated with desert grassland result from its floristic diversity (Dick-Peddie 1993), wide elevation range, and adaptation to many soils and landforms.

Eleven habitat types in the black grama series occur on WSMR (Table 3-24). Shrubs codominate and characterize six of the habitat types. These include Bigelow sage, Torrey mormontea (*Ephedra torreyana*), sotol, desert mormontea (*Ephedra trifurca*), mariola (*Parthenium incanum*), and soaptree yucca (*Yucca elata*). The remaining five habitat types are codominated by grasses including sideoats grama, blue grama, hairy grama, New Mexico needlegrass, and red grama.

On WSMR, the curlyleaf muhly series includes three habitat types, all of which are characterized by shrub codominants (Table 3-24). These include ocotillo (Fouquieria spiendens), Bigelow sage, and sotol. The gypgrass (*Sporobolus nealleyi*) series on WSMR includes three habitat types (Table 3-24). One of these is characterized by the herbaceous Hartweg's primrose (*Calylophus hartwegii*). The other two habitat types are characterized by the hairy coldenia (*Coldenia hispidissima*) and ocotillo.

Desert grassland vegetation occurring on valley floors and basin bottoms is often referable to the alkali sacaton series. Three habitat types characterized by grass species are included in this series. In addition to alkali sacaton, these habitat types are identified respectively by the presence of burrograss (*Scleropogon brevifolius*), blue grama, and saltgrass (*Distichlis stricta*).

As it occurs on WSMR, the mesa dropseed series includes two habitat types. These are characterized by broom dalea (*Psorothamnus scoparius*) and spike dropseed (*Sporobolus contractus*). A giant sacaton (*Sporobolus wrightii*) series with one habitat type that is distinguished by Hall's panic grass (*Panicum hallii*) also occurs on the range.

Plains-mesa Sand Scrub

Plains-mesa sand scrub occurs on deep sands. The most characteristic shrub species in this type is sand sage (*Artemisia filifolia*). Various grasses and forbs adapted to growing in deep sands are common in this vegetation type. Plains-mesa sandscrub vegetation is most prevalent below 1,830 m (6,000 ft) above MSL. It occurs on sandy substrates along the perimeter of the upper Jornada Basin.

While sand sage characterizes the series, the currently known habitat types are characterized by grass species. These include mesa dropseed, giant dropseed (*Sporobolus giganteus*), and black grama (Table 3-24).

3.4.1.5 Chihuahuan Desert Scrub (Creosote Bush). Chihuahuan desert scrub's occurrence in New Mexico represents the northwestern edge of this biome. Its larger ecotones are formed with desert grassland, plains-mesa sandscrub, and closed-basin scrub. In a few locations, it extends to the juniper savanna and coniferous and mixed woodland (Dick-Peddie 1993).

Evidence exists that the current extensive distribution of Chihuahuan desert scrub in New Mexico is recent and the result of overgrazing (Dick-Peddie 1993). The most intense grazing pressure has been associated with occupancy by people of European descent from the late 1600s and continued until about 1920. During this time, the dominance of grasses on large areas known to have supported desert grasslands and plains-mesa grasslands ended. The shrub species, creosote bush (*Larrea tridentata*) and honey mesquite (*Prosopis glandulosa*), became dominant and the vegetation changed from grassland to desert scrub.

The NMNHP (1992) indicates that Chihuahuan desert scrub vegetation occurs on WSMR at elevations between 1,250 to 1,860 m (4,100 to 6,100 ft) above MSL. It is widespread on the range and may be found on various land forms including lower mountain slopes, bajadas, and basin floors. On WSMR, there are approximately 222,000 hectares (548,000 acres) of the Chihuahuan desert scrub (creosote bush) vegetation type (Table 3-24).

In addition to creosote bush, tarbush (*Flourensia cernua*) and ocotillo (*Fouquieria splendens*) may become dominant in some areas (NMNHP 1992). The presence and/or dominance of these species defines the three series in the Chihuahuan desert scrub vegetation type. These three series have been further subdivided into 15 habitat types (Table 3-24).

On WSMR, the creosote bush series includes eight habitat types, five of which are characterized by grasses as codominants and two of which are distinguished by shrub or subshrub codominants (Table 3-24). One habitat type is characterized by the low cover provided by other plant species and is designated as a "sparse" habitat type. The grasses that define habitat types are black grama, blue grama, fluff grass (*Erioneuron pulchellum*), bush muhly (*Muhlenbergia porteri*), and alkali sacaton. Mariola and hairy coldenia typify the shrub/subshrub habitat types.

The three habitat types in the tarbush series are defined by grass species as codominants (Table 3-24). These include sideoats grama, alkali sacaton, and southwestern needlegrass (Stipa eminens).

In the series dominated by ocotillo, there are three habitat types (Table 3-24). These are characterized by sideoats grama, mariola, and tufted rockmat (*Petrophytum caespitosum*).

3.4.1.6 Chihuahuan Desert Scrub (Mesquite). Honey mesquite (Prosopis glandulosa)-dominated vegetation has been included in Chihuahuan desert scrub by the NMNHP (1992) and in the plains-mesa sandscrub type by Dick-Peddie (1993). It occurs most frequently on deep, sandy soils and is strongly associated with coppice dunes. In most instances, the major plant species associated with coppice dunes are "disturbance types" (Dick-Peddie 1993). Other associated forbs and grasses commonly occur in desert grasslands.

The NMNHP (1992) indicates that the mesquite-dominated Chihuahuan desert scrub type occurs extensively on the floor of the Tularosa Basin and on the lower Jornada del Muerto. On WSMR, this series usually occurs on coppice dunes formed from the accumulation of wind-blown sand around the base of mesquite shrubs. The species diversity in this vegetation type tends to be very low. Approximately 114,600 hectares (282,900 acres) of Chihuahuan desert scrub (mesquite) are mapped as occurring on WSMR (Table 3-23).

Three habitat types dominated by honey mesquite occur in sandy soils on WSMR. The codominant species that distinguish the habitat types include fourwing saltbush (*Atriplex canescens*), mesa dropseed, and alkali sacaton.

3.4.1.7 Chihuahuan Desert Scrub and Lava (Creosotebush, Mesquite, and Tarbush). The Chihuahuan desert scrub and lava vegetation/habitat type occurs on lava flows. In the southwest, lava flows are referred to as malpais. The physical structure of malpais habitat allows water to accumulate in cracks, crevices, and pockets formed by the lava (Dick-Peddie 1993). As a result, more water is available to plants growing in the malpais than in surrounding habitats.

Approximately 16,900 hectares (41,800 acres) of Chihuahuan desert scrub and lava habitat occur on WSMR. Part of the Carrizozo malpais is located on WSMR. It extends from the east boundary of WSMR, north of the ORC, approximately 32 km (20 mi) in a southwesterly direction to Range Road 9. Dick-Peddie (1993) indicates that species more commonly associated with montane habitats occur on the northern Carrizozo malpais at an elevation of about 1,615 m (5,300 ft) above MSL. These include oneseed juniper, mountain mahogany, and algerita (*Berberis haematocarpa*). Lewis (1949) indicates that mesquite, sotol, lecheguilla (*Agave* sp.), atriplex, and iodine bush are present near the south end of the malpais 1,270 m (4,150 ft) above MSL.

3.4.1.8 Closed-basin Scrub. Closed-basin scrub occurs where appropriate geological conditions exist throughout the arid west and is most frequent in the basin and range province (Dick-Peddie 1993). In New Mexico, its larger ecotones are formed with Chihuahuan desert scrub, desert grassland, and plains-mesa sandscrub (Dick-Peddie 1993). In a few locations, it may be associated with dune areas and lava beds.

Closed-basin scrub generally occurs on internally drained depressions or basins (Dick Peddie 1993). The floors of these basins are characterized by the accumulation of salts, fine textured soils, and sheet flow drainage patterns (Wondzell et al. 1987; Henrickson 1977). Soil texture generally becomes finer and salinity higher along a gradient from the surrounding uplands to the lowest point of the basin system (Meinzer and Hare 1915). Plant species tolerant of relatively high levels of the soil salts (halophytes) dominate the areas of salt accumulation. The most tolerant species tend to occur as dominants nearest the basins low point(s), while less-tolerant species increase in dominance outward to where soil salts are no longer the controlling factor.

Four major variants of the closed-basin scrub occur on WSMR. These are the saltbush/tarbush (*Atriplex canescens/Flourensia cernua*) type, arroyo riparian and wetland type, barren lands (*Allenrolfia occidentalis/Atriplex canescens*) type, and the dune land (Atriplex canescens/gypsum dunes) type. The barren lands type tends to occur at the lower elevations in the Tularosa Basin on soils with high concentrations of salts (U.S. Navy 1993; WSMR Environmental Services Division 1993a). The saltbush/tarbush type replaces the barren lands type at slightly higher elevations where lower concentrations of soil salts are present. Fourwing saltbush dominates the sparse vegetative cover on the wind-blown accumulations of granular gypsum that constitute the White Sands dune formation. Where the local topography channels or accumulates water on the floors of the closed basin, arroyo riparian and wetland vegetation are present.

On WSMR, closed-basin scrub occurs primarily on the floor of the Tularosa Basin and on portions of the Jornada del Muerto Valley at elevations between 1,170 to 1,500 m (3,850 to 4,900 ft) above MSL (Table 3-23). It also may occur on the floor of arroyos and on alluvial flats adjacent to low-gradient drainage (NMNHP 1992). On WSMR, there are approximately 223,000 hectares (551,000 acres) of closed-basin scrub (Table 3-24).

Closed-basin Scrub (Fourwing Saltbush and Tarbush)

Fourwing saltbush (*Atriplex canescens*) tends to occur on soils with moderate levels of salts but is not restricted to them (USDA 1937). The NMNHP (1992) identified a fourwing saltbush series as occurring on WSMR, but did not identify a fourwing saltbush/tarbush series or habitat types. Dick-Peddie (1993) mapped much of the Tularosa Basin as closed-basin scrub and described the fourwing saltbush-dominated portion of this as closed-basin riparian vegetation. In addition, the WSNM (1980) identified saltbush flats dominated by fourwing saltbush and sparse bunchgrasses as occurring on portions of the Tularosa Basin.

The NMNHP (1992) mapping of WSMR identified the fourwing saltbush/tarbush vegetation type as occurring on approximately 107,900 hectares (266,600 acres). Transect studies conducted as part of the land condition trend analysis (LCTA) (COE 1991b) also identified fourwing saltbush and tarbush as species that occur together as codominants. As mapped, the closed-basin scrub (fourwing saltbush/tarbush) vegetation type probably represents a mosaic of habitat types that may eventually be regarded as belonging to more than one series.

As currently defined, the saltbrush series on WSMR consists of two habitat types (Table 3-24). In addition to the dominant saltbush, these habitat types are characterized by either alkali sacaton or giant sacaton, respectively.

Closed-basin Scrub (Arroyo Riparian and Wetlands)

Although WSMR is represented primarily by arid land environments, it does contain approximately 10,000 hectares (24,700 acres) of arroyo-riparian and wetland habitats. These habitats are rare and constitute approximately 1.1 percent of the total habitat on WSMR. The scarcity of these riparian and wetland environments makes them significant habitats for wildlife, but their scarcity also makes them less likely to be found in impact areas or other areas affected by activities at WSMR.

Arroyo riparian vegetation occurs in the lower-elevation portions of arroyos where the beds are wide (Dick-Peddie 1993). Other riparian vegetation occurs in higher-elevation drainages and canyons. Wetland vegetation may occur at any location where water remains at or near the surface and where hydrological conditions are conducive to their formation. Wetlands generally are associated with reducing soil conditions and the occurrence of hydrophytic vegetation (Reed 1988).

Arroyo riparian vegetation occupies drainages that dissect bajadas and mesas (Dick-Peddie 1993). On WSMR, flows in such drainages generally are intermittent and predominate during the summer rainy season. The plant species that dominate arroyo riparian vegetation on WSMR include desert willow (*Chilopsis linearis*), little leaf sumac (*Rhus microphylla*), honey mesquite, and apache plume (*Fallugia paradoxa*) (WSMR Environmental Services Division 1993a).

Montane arroyo riparian vegetation occurs at higher elevations on WSMR, but is poorly documented. Well-developed riparian vegetation, including oaks (*Quercus* sp.), cottonwoods (Populus fremontii), and velvet ash (*Fraxinus pennsylvania*) is reported to be associated with canyon springs (U.S. Army Strategic Defense Command [USASDC] 1993). California brickelbush (*Brickellia californica*) and oaks (*Quercus* sp.) also are expected to occur as components of montane arroyo scrub (Dick-Peddie 1993).

Little information is available currently on the wetland vegetation and habitat associated with the numerous springs known to occur in the San Andres and Oscura mountains. Where soils are permanently inundated and pools of water occur, obligate wetland species are expected to be present.

Wetland vegetation and habitat are described in Section 3.4.4.2. Its high values for wildlife, scarcity in the arid southwest, and protection by regulatory agencies make it sensitive habitat.

Closed-basin Scrub and Barren Lands (Saltbush/Iodine Bush)

The lowest elevations of the closed-basin environment of the Tularosa Basin are characterized by extensive flats with low vegetative cover and by playa lake beds. These barren lands may be referred to as salt or alkali flats. Barren lands occur under similar topographic conditions throughout the Chihuahuan Desert (Henrickson 1977). Soil salt levels that may exceed 5 percent combined with periodic flooding produce a highly restrictive physical environment. Plant species growing on these barren lands are highly adapted to growth under these conditions. Because relatively few species are capable of growing and reproducing under these conditions, the species diversity on the barren lands is low. Plant species diversity tends to increase toward the edge of the barren lands habitat where salt levels and periods of inundation are lower.

The USGS (Meinzer and Hare 1915) documented the occurrence of soils high in salts, including gypsum, on the salt and alkali flats of WSMR. The USGS and subsequent observers indicated that the barren lands of the Tularosa Basin are characterized by low plant cover dominated by iodine bush. The flats are the dominant feature of the NMNHP (1992) closed-basin scrub (barren lands) vegetation/habitat type. The closed-basin scrub (barren lands) type occurs adjacent to both mesquite and creosote-bush-dominated Chihuahuan desert scrub as well as the other closed-basin scrub habitats.

At the edges of this habitat type, iodine bush may be replaced by grassland vegetation dominated by salt- or gypsum-tolerant species (WSMR Environmental Services Division 1993a). Soap tree yucca, mesquite, and broom dalea (*Dalea scoparia*) also may be present in transitional areas. Herbaceous diversity is low generally. Portions of this transition zone may be characterized by a crust of lichens that bind the soil surface (WSMR Environmental Services Division 1993a). Such lichen crusts are known to occur in similar situations in other parts of the Chihuahuan Desert (Henrickson 1977).

NMNHP (1992) data indicate that approximately 69,500 hectares (171,700 acres) of closed-basin scrub (barren land) vegetation/habitat occur on WSMR. Its primary occurrence is associated with closed-basin scrub (saltbush and gypsum dunes) habitat.

Closed-basin Scrub and Dune Land (Saltbush and Gypsum Dunes)

The salt flats and playa lakes of the Tularosa Basin produce gypsum sand, which is carried eastward by the prevailing winds to form an extensive dune system (Powell and Turner 1977). The WSNM (1980) identified two major dune habitat types in the National Monument. These are the marginal dunes, which extend 3 to 5 km (2 to 3 mi) into the dune field along its southern and eastern margin, and the more central transverse and barchan dunes. On WSMR, dune habitat occurs on approximately 35,600 hectares (88,000 acres).

In the marginal dune area, large grassland areas occur on the interdune surface (WSNM 1980). Large shrubs including skunkbush sumac (*Rhus aromatica*) and hoary rosemary (*Poliomintha* *incana*) grow along the edges of the parabolic dunes. Individual soap tree yuccas and clumps of Rio Grande cottonwoods (*Populus deltoides* var. *wislizenii*) provide additional vertical structure in the habitat.

The transverse and barchan dunes are active and may move several meters/feet during a year (WSNM 1980). The most common plant species on the active portion of the dunes is sand verbena (*Abronia angustifolia*). Plant species occurring in the interdune spaces include Indian ricegrass (*Oryzopsis hymenoides*), evening primrose (*Oenothera* sp.), and groundsel (*Senecio* sp.).

3.4.1.9 Exotic Plants. A variety of exotic plants occur on WSMR. These plants include species that were intentionally planted (either by ranchers prior to the creation of WSMR or for landscaping at WSMR), and species which are naturalized and spreading throughout southern New Mexico and other portions of the southwestern United States and Mexico. At least a dozen species of non-native vascular plants have been identified on WSMR. These are: salt cedar (*Tamarix chinensis*), Siberian elm (*Ulmus pumila*), Russian olive (*Salsola kali*), African garbancillo (*Peganum harmala*), tocalote (*Centaurea melitensis*), Lehmann's lovegrass (*Eragrostis Lehmanniana*), bird-of-paradise (*Caesalpinia gilliesii*), tree of heaven (*Ailanthus altissima*), Russian thistle (*Salsola kali*), Bermuda grass (*Dactyloctenium aegyptium*), Johnson grass (*Sorghum halepense*), and goathead (*Tribulus terrestris*). Most of these species are restricted to very limited areas on WSMR and do hot appear to be a problem at present; they are being monitored by WSMR. Salt cedar and Russian thistle are currently of management concern. Salt cedar has moved into riparian areas and has the potential to severely degrade riparian habitats. In addition to riparian zones it also has the potential to occupy isolated springs in both the mountain and lowland environments and may out-compete native flora. Russian thistle is currently a problem on WTT and target areas. Russian thistle is a fast growing and aggresive annual species. It rapidly moves into the disturbed target areas and interferes with testing operations. Many of these species, such as Russian thistle, have become naturalized and represent a significant part of the flora in New Mexico.

3.4.2 Wildlife

The southwestern United States has a high diversity of animals (Parmenter et al. n.d.). Parmenter et al. (n.d.) relates this high biodiversity to three major causes: variability in elevation and accompanying range of climatic conditions, diverse biogeographic history of the southwestern United States, and variations in vegetation associations types.

The mechanisms used by Parmenter et al. (n.d.) to explain biodiversity on a regional scale are used on a more localized scale within WSMR. The location, large size, and accompanying diversity of landforms at WSMR are key factors in providing for the biodiversity that occurs on WSMR. As pointed out in Section 3.4.1, WSMR contains several mountain chains, creating a variety of physical environments and providing conditions leading to a diversity of vegetative associations.

Many of the vegetation associations seen on WSMR are part of larger, more widespread habitats mimicking the diverse biogeographic history noted in Parmenter et al. (n.d.). For example, the coniferous woodland types found in the Oscura Mountains in the northern part of WSMR are part of a large section of coniferous woodlands on Chupadera Mesa and other portions of central New Mexico (Dick-Peddie 1993). Similarly, the savannah and plains-mesa grasslands types found on WSMR are part of a vegetation community more extensive off WSMR, in the central and eastern portions of New Mexico (Dick-Peddie 1993).

The diversity of animals reported or expected to occur on WSMR is shown by the large number of animals listed as part of Appendix B. The taxonomy for reptiles and amphibians follows Collins (1990). The taxonomy for invertebrates follows Barnes (1980). A general discussion of major taxonomic groups of the animals located on WSMR follows.

3.4.2.1 Mammals. Parmenter et al. (n.d.) point out that the southwestern United States has a high diversity of animals, including mammals. The diversity of landforms and vegetation types found on WSMR accounts for the relatively high number of mammals. Appendix B includes a list of 86 mammals found or expected to occur on WSMR. This list of mammals was modified from a similar list obtained from the USFWS Ecological Services Center, with additions or deletions based primarily on geographic range and habitat use information in Findley (1987), and Findley et al. (1975). Scientific and common names for mammals in Appendix B follow Jones et al. (1992).

Small mammal trapping has taken place as part of the LCTA program on WSMR (U.S. Army 1989a, 1990a; Anderson 1991, 1992; COE 1991c). The LCTA program is part of the Integrated Training Area Management program. The U.S. Army Construction Engineering Research Laboratory developed the Integrated Training Area Management and LCTA programs to characterize natural resources on U.S. Army lands and to assess impacts to them. The LCTA program began in 1988 and was in operation at 26 installations in the United States and Germany by 1991 (COE 1991c). The most common rodents captured on LCTA transects were the Merriam's kangaroo rat (*Dipodomys merriami*), Ord's kangaroo rat (*Dipodomys ordii*), and deer mouse (*Peromyscus maniculatus*) (Anderson 1991, 1992).

Approximately 20 bats occur or are expected to occur on WSMR (Appendix B). These bats roost primarily in caves and crevices, though several species will make use of man-made structures (Findley 1987). Caves and crevices are located in the mountains and associated cliffs, and lava, or malpais areas. The hoary bat (*Lasiurus cinereus*) and the eastern red bat (*L. borealis*) are open-nesting bats and hang from vegetation, usually trees (Findley 1987).

Carnivorous mammals also are well represented on WSMR. The most commonly observed carnivorous mammal is the coyote (*Canis latrans*). The coyote can be found in almost any portion of WSMR (U.S. Army 1990a). Other canid mammals include the common gray fox (*Urocyon cinereoargenteus*) found primarily in the mountains and foothills, and the kit fox (*Vulpes velox*), which inhabits open areas of the grassland and desert shrubland habitats (Findley 1987).

There are two types of native cats present on WSMR. The mountain lion (*Felis concolor*) is the object of a long-term study. Mountain lions can be found in and adjacent to mountainous areas throughout most of WSMR. The other felid is the bobcat (*Lynx rufous*). Bobcats generally inhabit desert, grassland, and mountainous habitats.

There are several ungulate species on WSMR. Native species include the mule deer (*Odocoileus hemionus*), pronghorn (Antilocapra americana), desert bighorn sheep (*Ovis canadensis mexicana*), and elk (*Cervus elaphus*). Mule deer are most common in mountain and foothill habitats. They do occur in desert shrub and grassland vegetative types (Morrow, pers. com. 1993a). Mule deer are hunted on WSMR. Elk are known only in small bands in the Oscura Mountains, and are probably part of a herd that centered on Chupadera Mesa (Morrow, pers. com. 1993a). Pronghorn, which also is a game species on WSMR, inhabit grassland and shrub vegetation types.

The desert bighorn sheep (*Ovis canadensis mexicana*) historically occurred in New Mexico, Arizona, Texas, Sonora, Chihuahua, and Coahuila (Hall 1981). Native populations of desert bighorn historically occurred in the San Andres Mountains (NMDGF 1991). The population experienced a severe decline in 1978-1979 as a result of an outbreak of scabies. By 1979, the population had declined to an estimated 80 individuals (Hoban 1990). A salvage operation was implemented by NMDGF and 49 sheep were tranquilized and transported to a central treatment facility (35 sheep survived the capture). Seven of the tranquilized rams were sent to New Mexico State University, and 28 sheep were sent to the NMDEF's captive desert bighorn sheep breeding facility at Redrock, New Mexico in 1979. These animals were returned to the San Andres Mountains in 1981. Not all of the sheep were captured during the salvage operation in 1979. Consequently, the desert bighorn sheep population in the San Andres has never been extirpated. After the reintroduction in 1981, the San Andres population declined to about 30 to 35 animals in 1984 (NMDFG 1991). Despite various management strategies for controlling and eradicating scabies, the sheep population has not increased (Hoban 1990). The desert bighorn sheep are most abundant in the southern portion of the San Andres Mountains (U.S. Fish and Wildlife Service (USFWS] 1992a).

The feral horse (*Equus caballus*) and the oryx (*Oryx gazella*) are two species of introduced ungulates that are common on WSMR. The horse population has increased in spite of efforts to reduce numbers on WSMR. Four separate efforts conducted over the 20 years prior to 1995 resulted in a total of 751 animals removed from WSMR (U.S. Army n.d.b). More recently, disease has caused slight reductions in the horse population. Equine-specific bacterial pneumonia was thought to cause 37 known deaths in 1985, and parasites caused 49 deaths in 1989. The feral horse population on WSMR has outgrown the available resources. Many horses died in July of 1994 as a direct result of overpopulation and poor range conditions brought on by low rainfall and overpopulation. The feral horse population has also caused increased threats to protected native species due to degradation of sensitive habitats. In the past, feral horses have impacted the habitat of the White Sands pupfish. In order to address these issues, an environmental assessment for the management of feral horses was completed in February 1995 (Report No. EA-001-95). This document provides a template for the long-term management of feral horses on WSMR. The proposed action of this document is to maintain feral horses on WSMR at a level of sustainability in relation to: native forage production, all other native resident plant and animal species, threatened and endangered species and their habitats, and the WSMR testing mission. To this end, hundreds of feral horses were removed from WSMR in the summer of 1995. By managing the feral horse population, WSMR can avoid negative impacts to natural resources and remove the threat of starvation or epidemics brought about by overpopulation.

During the dry season, horses use habitats around water sources in the Tularosa Basin, particularly water at Oscura Range camp, the Mound Springs complex, Malpais springs area, and upper and lower Salt Creek areas (Morrow, pers. com. 1993a). During rainy periods, generally mid and late summer, the horses make extensive use of rainwater accumulations, including ditches alongside the range roads on WSMR (Morrow, pers. com. 1993a). Thus, the feral horses currently are restricted to the central and northeast portions of WSMR (U.S. Army n.d.b).

The horses that inhabit WSMR are not mustangs. Rather, they are the progeny of domestic livestock abandoned by the ranching community when exclusive military use of the region began in 1952 (U.S. Army 1983a). These feral horses are not protected under the Wild and Free Roaming Horse and Burro Act (U.S.P.L. 92-195) because they do not occupy USDA or U.S. Department of Interior land.

The oryx were released on WSMR by NMDGF beginning in 1969 (U.S. Army 1983a). The oryx population is currently estimated to be approximately 1,600 individuals (Morrow, pers. com. 1993a). Oryx are hunted yearly on WSMR (U.S. Army n.d.b). Oryx are great wanderers and are regularly sighted on virtually all major mountain ranges on WSMR. Oryx occur in all major vegetation types ranging from alkali grasslands through mesic pinon-juniper woodland to upper elevation conifer forest patches in the San Andres Mountains. WSMR oryx populations, however, are largest at low elevations in grassland vegetation where most of the reproduction takes place.

Oryx are impacting habitat on WSMR through overgrazing, particularly in the area in and around WSNM. In addition, oryx are naturally aggressive and in the wild may threaten a person or attack a vehicle. Oryx are particularly hard on wood fences and pens. They will take up grass roots, dig holes to bed in, and pound a network of paths. The Integrated Natural Resources Management Plan which is currently being developed will address the needs for a biological, ecological, and demographic assessment of the overall impact of oryx on plant communities and wildlife resources. WSMR will work in coordination with the NMDGF to ensure suitable management and the development of management actions for the oryx.

3.4.2.2 Birds. Appendix B includes 307 bird species found or expected to occur on WSMR. This list of birds is modified from a similar list found in Ecological Services Center (U.S. Army n.d.b) and includes species observed on the San Andres National Wildlife Refuge as part of point counts conducted by San Andres National Wildlife Refuge personnel on or near the San Andres National Wildlife Refuge (Weisenberger, pers. com. 1994). The scientific and common names follow the American Ornithologists' Union checklist and supplements (American Ornithologists' Union 1983, 1985, 1987, 1989, 1991, 1993). The large number of species is primarily related to the variety of vegetative types and the location of WSMR, which places it within or adjacent to portions of grassland and forest ecosystems other than the Chihuahuan desert (Parmenter et al. n.d.). The list of birds in Appendix B is modified from a similar list found in Ecological Services Center 1993).

Spring and summer transect counts show the most common birds on WSMR to be the black-throated sparrow (*Amphispiza bilineata*), northern mockingbird (*Mimus polyglottos*), mourning dove (*Zenaida macroura*), and western kingbird (*Tyrannus verticalis*) (U.S. Army 1989a, 1990a; Anderson 1991, 1992). These counts were conducted on a subset of the LCTA transects. These transects were allocated proportionally across the WSMR vegetation types; thus, the abundance of the individual birds on the transects should be relatively proportional to their overall abundance on WSMR (U.S. Army 1989a, 1990a; COE 1991c).

Bird densities and species diversity in Chihuahuan Desert habitats have been shown to be directly related to vegetative characteristics (Raitt and Maze 1968; Naranjo 1986). In general, the more xeric habitats contain lower numbers of species and lower numbers of individuals (Raitt and Maze 1968; Naranjo 1986). Raitt and Maze (1968) reported the lowest densities in habitat most dominated by creosote, with increases in numbers of both species and individuals correlated with increases in diversity of vegetation, mainly due to increases in number and height of noncreosote shrubs associated with arroyos. Naranjo (1986) showed similar trends, but the increases in shrub diversity were related to soil changes associated primarily with elevational changes on a bajada.

Raitt and Pimm (1976) described seasonal changes in numbers of bird species in black grama grasslands, a bajada with both creosote and creosote and shrub habitats, and a playa covered with tobosa and vine-mesquite grass. They found the black grama grassland and grass-covered playas were used by increased numbers of seed-eating birds in the winter.

Most of the previous comments about bird numbers and species diversity relate primarily to smaller birds, primarily passerines, which use habitat at smaller scales than larger birds, such as raptors. However, these factors do directly affect bird-eating raptors by determining abundance of prey.

There are some noticeable changes in bird species occurrence with a transition from desert scrub and grassland vegetation types found at lower elevations to the higher elevations, which support forest types. Probably the most noticeable bird species would be scrub jays (*Aphelocoma coerulescens*), pinon jays (*Gymnorhinus cyanocephalus*), and rufous-crowned sparrows (*Aimophila ruficeps*).

Raptors

The diversity in land forms and vegetation types on WSMR leads to the diversity of raptors listed in Appendix B. The more common hawks are Swainson's hawk (*Buteo swainsoni*) and red-tailed hawk (*Buteo jamaicensis*). Swainson's hawks occur in grassland and shrublands of lower elevations, and are found in the desert basins in the summer. Red-tailed hawks utilize cliffs in the mountainous habitats but are common in the desert basins in the winter.

The golden eagle (*Aquila chrysaetos*) is a permanent resident of much of WSMR. Recent raptor surveys in the northern portion of the San Andres Mountains and the Fairview and Mockingbird mountains found several golden eagle nests, and stick-nests thought to be red-tailed hawk nests (Skaggs 1990). The bald eagle (*Haliaeetus leucocephalus*) has occurred on WSMR (U.S. Army 1985a), but there is no nesting habitat available (fish prey base and large trees for nesting and roosting).

Probably the most abundant raptor on WSMR is the American kestrel (*Falco sparverius*). A cavity nester, this bird can nest in buildings, cliffs, trees, or large posts. With the exception of man-made structures, the American kestrel is generally restricted to nesting in habitats in the forested portions of WSMR. However this bird is quite common during the winter, and is often observed on power poles and other perches.

Other falcons, including the merlin (*Falco columbarius*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrinus*), and aplomado falcon (*Falco femoralis*) occur or have been observed in the past within WSMR. The peregrine and aplomado falcons are both federally listed species.

Another raptor observed during the spring, summer, and fall is the turkey vulture (*Cathartes aura*). Turkey vultures use both natural and man-made structures for nesting and roosting. These birds can be observed throughout the different vegetative types found on WSMR.

Of those listed in Appendix B, the burrowing owl (*Athene cunicularia*), great-horned owl (*Bubo virginianus*), and barn owl (*Tyto alba*) are probably the most common. These owls can be found throughout most of the vegetative types found on WSMR. Their presence or absence is more closely aligned with available nesting substrates than specific floristic associations.

Neotropical Migrants

Many of the neotropical migrant birds listed in Finch (1991) are present on WSMR as either breeders or migrants. These birds inhabit virtually all of the vegetation types located on WSMR. For example, the grasslands are used by sparrows during winter migrations (Raitt and Pimm 1976), and as a group, swallows listed in Appendix B can be found from the desert floor to highest elevations on WSMR. Finch (1991) suggests that population status of neotropical migrants that nest in western portions of the United States be studied to determine if population decreases noted in eastern forests are occurring in western bird populations. Finch's review (1991) also points out that there is both empirical and theoretical evidence to show that fragmentation and accompanying increases in habitat "edges" are associated with decreases in bird populations.

Wetland Birds

Several birds listed in Appendix B primarily are associated with aquatic habitats. Included in this group are the waterfowl (ducks and geese), wading birds (herons, egrets), and shorebirds (gulls, terns, plovers, sandpipers). The New Mexico Cooperative Fish and Wildlife Research Unit conducted a study of birds and other wildlife use of wildlife water units (USFWS 1992b). Many of the wildlife water units surveyed (USFWS 1992b) are man-made and provide habitat for wetland birds species at all but the highest elevations on WSMR, and thus can be found within almost all of the vegetation types discussed in Section 3.4.1.

Most of the habitat available for wetland birds is ephemeral. These areas are primarily playas and earthen stock tanks scattered throughout the Tularosa and Jornada basins. The presence of water, and accompanying species used by water birds for food, is highly dependent on rainfall, which is highly variable in the Chihuahuan desert.

There are some permanent or semi-permanent water locations that provide habitat for water birds. Most notable are the sewage runoff ponds located southeast of the Main Post installation of WSMR. Other locations for water birds to obtain more reliable habitat are springs located primarily in the Tularosa Basin. Section 3.4.4.2 more thoroughly discusses wetland and riparian habitats on WSMR.

Game Birds

The primary game birds on WSMR are two species of quail - scaled quail (Callipepla squamata) and Gambel's quail (*Callipepla gambelii*) - and two species of dove - the mourning dove (*Zenaida macroura*) and the whitewinged dove (*Zenaida asiatica*).

The Gambel's and scaled quail are desert shrub and grassland species primarily, and are likely to be found in any of the vegetative types at elevations below the coniferous woodland types. The Gambel's quail is more strongly associated with vegetative types dominated by shrubs (Hubbard 1978). The scaled quail is more strongly associated wfth open shrub and grassland vegetation types.

Hubbard (1978) describes the habitat of the Montezuma quail (*cyrtonyx montexumae*) as "grassy evergreen woodlands." Thus, this bird is associated primarily with the coniferous woodland and savannah and desert grasslands on higher elevations.

Montezuma quail have been sighted on grasslands within WSMR (Holderman, pers. com 1994). Montezuma quail are legal game on WSMR, but they are uncommon to rare across southern New Mexico (Holderman, pers. com 1994).

The mourning dove can be found in any of the vegetation types found on WSMR, and often congregates around water sources. The whitewinged dove is located primarily in lowland riparian areas (Hubbard 1978). There are almost no lowland riparian areas that have trees.

Whitewinged doves are likely to be most common near human dwellings and associated shade trees in areas such as the Main Post and the visitor center area at WSNM. These areas are not available for hunting.

The chukar (*Alectoris chukar*) and the wild turkey (*Meleagris gallopavo*) generally are considered to be game species, but neither is currently hunted on WSMR. The chukar was introduced as a game species and, for several years, was listed as present on the San Andres National Wildlife Refuge (USFWS 1968). However, no recent occurrences of chukar are known (Morrow, pers. com. 1993a; Berenzen, pers. com. 1994). Chukar generally are associated with grassland or shrub vegetation types in areas with steep slopes. Although wild turkey have been seen on WSMR, no hunting is allowed within the wildlife management unit that encompasses the range (U.S. Army n.d.b; NMDGF 1994).

WSMR provides relatively small amounts of habitat suitable for ducks and geese (U.S. Army n.d.). Most hunting of waterfowl is probably opportunistic and done while pursuing quail (Morrow, pers. com. 1993a).

3.4.2.3 Reptiles. Reptiles comprise an abundant and diverse group of inhabitants at WSMR, being ubiquitous throughout the range. The success of reptiles within the desert ecosystem can be attributed to their unique ecological roles, which are different than those of mammals and birds. Reptiles are ecothermic; body temperature varies with the environment. This results in activity patterns associated with specific temperature ranges, which vary daily and seasonally. Reptiles can thermoregulate their own activity and metabolic needs by seeking areas of preferred temperature within the region. This reduces metabolic energy requirements, which explains the ubiquitous and diverse nature of reptiles in the arid and resource-limited WSMR. A desert habitat that can support a limited bird and mammal population can sustain a much larger population of reptiles (Crawford 1986). Exothermic reptiles are more ecologically efficient than warm-blooded organisms in a desert setting. A larger proportion of the food they consume is converted into biomass and made available to predators at a higher trophic level than is true of bird or mammals of comparable size (Crawford 1986).

A thorough literature review of previous environmental documents, species checklists from various sources, and field guides was conducted to compile a list of species most likely to occur and those known on WSMR (Burkett 1994; Painter, pers. com. 1994). The complete list can be found in Appendix B. The reptiles of WSMR include 2 genera of turtle, 12 genera of lizards, and 21 genera of snakes (Appendix B). Lizards are the most frequently observed reptile (U.S. Army 1993e). Snake species also are abundant on WSMR. The Texas horned lizard (*Phrynosoma cornutum*) is the only sensitive reptile species present.

The ornate box turtle (*Terrapene ornata*) is the only turtle known to occur. This turtle has been observed at the CAIN and Three Rivers sites (WSMR Environmental Services Division 1991) as well as the DNA High Explosive Test Bed No. 2 (Science Applications International Corporation 1992). The yellow mud turtle (*Kinosternon flavescens*) also is expected to occur on WSMR (Burkett 1994).

The Texas banded gecko (*Coleonyx brevis*), roundtail horned lizard (*Phrynosoma modestum*), checkered whiptail (*Cnemidophorus grahamii*), bullsnake (*Pituophis melanoleucus*), blackneck garter snake (*Thiamnophis cyrtopsis*), Plains blackhead snake (*Tantilla nigriceps*), and western diamondback rattlesnake (*Crotalus atrox*) are common in the majority of habitat types on WSMR.

Common reptiles in the lower montane coniferous forest and the coniferous woodland habitats are the crevice spiny lizard (*Sceloporus poinsettii*), tree lizard (*Urosaurus ornatus*), short-horned lizard (*Phrynosoma douglasii*), Chihuahuan spotted whiptail (*Cnemidophorus exsanguis*), blackneck garter snake, striped whipsnake (*Masticophis taeniatus*), bullsnake, western diamondback rattlesnake, and the blacktail rattlesnake (*Crotalus molossus*).

Common reptiles in the savanna/plains-mesa grassland and the desert grassland habitat types are the ornate box turtle, lesser earless lizard (*Holbrookia maculata*), side-blotched lizard (*Uta stansburiana*), tree lizard, New Mexico whiptail (*Cnemidophorus neomexicanus*), Chihuahuan spotted whiptail, western terrestrial garter snake, plains blackhead snake, coachwhip (*Masticophis flagellum*), Big Bend patchnose snake (*Salvadora deserticola*), glossy snake (*Arizona elegans*), and the western rattlesnake (Crotalus viridis).

Common reptiles in the Chihuahuan desert scrub include the Texas banded gecko, greater earless lizard (*Cophosauros texanus*), collared lizard (*Crotaphytus collaris*), crevice spiny lizard, Prairie lizard (*Sceloporus undulatus*), side-blotched lizard, little striped whiptail (*Cnemidophorus inornatus*), western terrestrial garter snake, blackneck garter snake, plains blackhead snake, night snake (*Hypsiglena torquata*), coachwhip, Big Bend patchnose snake, glossy snake, blacktail rattlesnake, and the western rattlesnake.

Common reptiles in the closed-basin scrub include the sideblotched lizard, roundtail horned lizard, New Mexico whiptail, desert striped whipsnake, common kingsnake (*Lampropeltis getula*), and the western rattlesnake.

Several reptile species are restricted to specific habitat types on WSMR. The bleached earless lizard (*Holbrookia maculata ruthveni*) is restricted to the gypsum dunes and alkali flats of the closed-basin scrub habitat types. The southern plateau lizard (*Sceloporus undulatus tristichus*) is only known from the lava beds of the Chihuahuan desert scrub/lava habitat type. The White Sands Prairie lizard (*Sceloporus undulatus cowlesi*) is restricted to the gypsum dunes of the closed-basin scrub habitat type. The New Mexican whiptail is restricted primarily to the plains-mesa grassland habitat and the arroyo riparian areas of the closed-basin scrub habitat type. The New Mexico garter snake (*Thamnophis sirtalis dorsalis*) is known to occur in the arroyo riparian/wetland portions of the closed-basin scrub habitat type. The lyre snake (*Trimorphodon biscutatus*) should be found in pinyon juniper habitats and the creosote portions of the Chihuahuan desert scrub habitat type.

Lewis (1949) discovered that seven reptile genera and one amphibian collected from the malpais of the Tularosa Basin had coloration like that of the black substrate on which they lived. The reptile species collected included the sidblotched lizard, southern plateau lizard, collared lizard, blacktail rattlesnake, bullsnake, and ground snake (*Sonora semiannulata*) (Lewis 1949). The one amphibian collected was the Great Plains toad (*Bufo cognatus*) (Lewis 1949).

A study by the USFWS (1992c) showed that the overall effect of artificial water sources on reptiles at WSMR is uncertain. Thirteen reptile species were trapped from the field effort. The most common reptile trapped was the little striped whiptail.

3.4.2.4 Amphibians. Few amphibians are found in arid habitats, as they require abundant water for breeding and larval development. In desert environments, their activity is confined to seasonal wet periods. Because amphibians normally require water or extreme moisture during the early stages of their life cycle, and water resources are limited at WSMR, amphibian populations at WSMR are quite limited (COE 1992c). Available surface water resources are scarce due to the low annual rainfall and high rate of evapotranspiration. Numerous playas and temporary drainages form as the result of intermittent periods of heavy rainfall. Isolated permanent water sources consist of gypseous ponds and highly saline waters at Lake Lucero, Salt Creek, Malpais Spring, and Mound Spring (U.S. Army 1993e). These aquatic resources provide habitat for amphibian species.

A review of previous environmental documents, species checklists from various sources, and field guides was conducted to compile a list of species that are likely to occur or known to occur on WSMR. The amphibians of WSMR include one genus of salamander and five genera of frogs and toads for a total of ten species (Appendix B). There are no state or federally listed sensitive amphibians present on WSMR.

The tiger salamander (*Ambystoma tigrinum*) is common in the coniferous woodland and savanna/plains mesa grassland habitat types as well as riparian/wetland portions of the desert scrub habitat type. The Plains spadefoot toad (*Spea bombifrons*) and the New Mexico spadefoot toad (*Spea multiplicata*) are common in the loose, sandy and gravelly soils of most of the habitat types present on WSMR, except for the lower montane coniferous forest and wetland portions of the closed-basin scrub habitat types. Couch's spadefoot toad (*Scaphiopus couchii*) is common in the desert grassland/plains-mesa grassland, Chihuahuan desert scrub, and the riparian portions of the closed-basin scrub. The red-spotted toad (Bufo punctatus), green toad (*Bufo debilis*), and Woodhouse toad (*Bufo woodhousii*) are all common on WSMR. The red-spotted toad uses the coniferous woodland and the arroyo riparian portions of the closed-basin scrub habitat types. The green toad and Woodhouse toad use the savanna/plains-mesa grassland, desert grassland, Chihuahuan desert scrub, and the arroyo and riparian portions of the closed-basin scrub habitat types. The bullfrog (*Rana catesbeiana*) is restricted to the riparian and wetland portions of the closed-basin scrub habitat type.

Four amphibian species were trapped during the USFWS study (1992c). The most common amphibian trapped was the red-spotted toad. Several earthen tanks holding water had relatively high densities of tiger salamanders.

3.4.2.5 Fish. The White Sands pupfish (*Cyprinidon tularosa*) is the only native fish known to occur on WSMR (Appendix B). This species is listed as endangered by the NMDGF and as a federal Category 2 candidate by the USFWS. The White Sands pupfish is known to occur in Salt Creek, Malpais Spring and its associated outflow, Mound Springs, and Malone Draw/Lost River (NMDGF 1988). This species occupies shallow pools and calm spring runs, which are characterized by high fluctuations in daily temperatures; very saline water; and substrates of silt, sand, and gravel (NMDGF 1988). Refer to Section 3.4.3 for more detailed information.

Introduced fishes that are considered a threat to the White Sands pupfish include the largemouth bass (*Micropterus salmonoides*) and the mosquitofish (*Gambusia affinis*) (Turner 1987). The mosquitofish occurs at the pond south of the high-speed test track, Lake Holloman, the pond adjacent to Tula Pond, and the Camera Pad Road Pond (Turner 1987). Several goldfish (*Carissus auratus*) and a largemouth bass were observed in the southern pond that is located west of Tula Pond (Turner 1987). Other fish species include carp (*Cyprinus carpio*) and bluegill (*Lepomis macrochirus*), both of which have been introduced at WSNM (U.S. Army 1978).

3.4.2.6 Invertebrates. Invertebrates perform important functions in the ecosystem such as pollination, decomposition, and nutrient cycling. Invertebrate populations are valuable not only for functional roles, but also as a resource for scientific research (Crawford 1986).

Representative invertebrate fauna of the White Sands gypsum dunes are reported in a Checklist of Plants and Animals of the White Sands (WSNM 1980). There are 22 orders and 97 families represented on the list. Common insect orders include Orthoptera (grasshoppers and crickets), Hemiptera (bugs), Homoptera (cicadas, aphids), Coleoptera (beetles), Lepidoptera (butterflies, moths), Diptera (flies), and Hymenoptera (ants, bees, wasps). Other terrestrial invertebrates that occur on WSMR include the class Arachnida that contains scorpions, mites, ticks, spiders, and tarantulas.

Several studies of land snails have been conducted along the Oscura, Organ, Sacramento, San Andres and Black Brushy/Caballo mountain ranges (Metcalf 1984; Metcaff and Smartt 1977; Sullivan and Smartt 1990). In these studies, 17 genera, including at least 23 species of land snails, have been observed on WSMR (Appendix B). Six of these land snails are considered sensitive by NMDGF (WSMR Environmental Services Division 1993b), as described below in Section 3.4.3.2.

Aquatic invertebrates identified at WSMR included 10 orders, 20 families, and 16 genera (Turner 1987). Mound Spring had the most families of invertebrates (12) of all the sites sampled. The dominant invertebrate in numbers and biomass at Malpais Spring was the water boatman (*Gammarus*) (Turner 1987). Also common at Malpais Spring were aquatic Tubificidae, Planariidae, and a physid snail (*Physa virgata*). Six families of invertebrates were represented in the sample of Salt Creek (Tubificidae, Coenagriidae, Corixidae, Hydrophilidae, Cyclorrhapha, Chironomidae). Only one genus (*Trichcorixa*) of invertebrate was found as a result of sampling efforts at Malone Draw (Turner 1987). Five famlies of invertebrates were documented at Lost River (Ephydridea, Hydrophylidae, Ceratoponidae, Corixidae, and Stratiomvidae))Hopkins 1993). A crayfish was observed in the pond that is located west of Tula Pond (Turner 1987).

During the USFWS study of artificial water sources at WSMR (USFWS 1992c), 56 families of invertebrates were trapped using pitfall traps. Fifty-eight families were detected during tim area counts. There were 39, 36, and 22 families detected at mixed/shrub, pinyon-juniper, and grassland units, respectively.

3.4.3 Threatened and Endangered Species

The following subsections describe threatened and endangered species in the affected environment.

3.4.3.1 Plants. NEPA stipulates (Sec. 102 [42 USC § 4332]) that contact be made with federal, state, and local resource agencies to determine what species of concern to those agencies may be present in the project area. USFWS and New Mexico Forestry Resource Conservation Division have indicated that 38 plant species of concern occur or may occur on WSMR (Table 3-25). The species considered below are those listed by the WSMR Environmental Services Division on the WSMR Endangered Species List (WSMR Environmental Services Division 1 993b) and are referred to as sensitive plant species in this document.

The WSMR Environmental Services Division lists 24 sensitive plant species that occur on WSMR (1993). Habitat apparently suitable for an additional 14 plant species also occurs on WSMR. Some patterns in the distribution of these species and habitat are discussed below.

Todson's pennyroyal (*Hedeoma todsonii*) is the only plant species listed as endangered by the USFWS that currently are known to occur on WSMR (Table 3-25). Four other species listed by the USFWS as endangered potentially occur on WSMR. WSMR provides habitat for five plant species listed as Category 2 candidates for listing as threatened or endangered by USFWS. WSMR also has habitat apparently suitable for an additional nine plant species listed as threatened or endangered by the USFWS or that are candidates for listing (Table 3-25). These nine species are not known to occur on the range currently.

WSMR provides habitat for 14 plant species listed as endangered (List 1) by NMFRCD (Sivinsid and Lightfoot 1992) (Table 3-25). Habitat apparently suitable for nine more species listed as endangered (List 1) by NMFRCD occurs on WSMR. An additional 10 plant species listed as rare and sensitive (List 2) by NMFRCD are known to occur on WSMR (Table 3-25). Habitat apparently suitable for five other species listed as rare and sensitive (List 2) by NMFRCD is present on WSMR.

Sensitive plant species (Table 3-25) are known to occur in all of the major vegetation types on the WSMR except the Chihuahuan desert scrub (lava) associated vith the malpais. Five sensitive plant species potentially occur in the montane coniferous forest vegetation type. These include the endangered Todson's pennyroyal.

Habitat for 33 (87 percent) of the sensitive plant species is associated with coniferous woodland, coniferous woodland and montane scrub or savanna, and plains-mesa grasslands. These three vegetation types represent approximately 14 percent of the areal extent of WSMR. Todson's pennyroyal and the Mescalero pennyroyal, the only species listed as endangered by USFWS that occur on WSMR, are among the species that may occur in these three vegetation types. In addition, all of the Category 2 species occur in these vegetation types. These vegetation types are strongly associated with the slopes of San Andres and Oscura mountains on WSMR.

Fifteen of the sensitive plant species (39 percent) are associated with desert grassland and plains-mesa sandscrub, and Chihuahuan desert scrub (creosote) vegetation types. These vegetation types represent approximately 45 percent of the areal extent of WSMR. Desert grassland and plains-mesa sandscrub are strongly associated with the lower montane slopes and upper bajadas of the San Andres and Oscura mountains. Chihuahuan desert scrub tends to occur on the bajadas and higher-elevation portions of the valley floors.

The remaining 59 percent of WSMR areal extent is occupied by Chihuahuan desert scrub (mesquite), Chihuahuan desert scrub (lava), and four variants of the closed-basin scrub vegetation type. Only two sensitive plant species (5 percent) are known to occur in these vegetation types.

Habitat characteristics within a given vegetation type that may be associated with the presence of some sensitive species include limestone and granitic substrates, cliff faces, deep sands, moist or wetland conditions, shady microhabitats, and others (Table 3-25). For example, cliff faces may provide habitat for mescalero milkwort (*Polygala rimulicola* var. *mescalorum*), San Andres rock daisy (*Perityle staurophylla* var. *homoflora*), supreme sage (*Salvia summa*), cliff brittlebush (*Apacheria chiricahuensis*), and nodding cliff daisy (*Perityle cernua*) (Table 3-25). These species generally are not found in the surrounding noncliff habitat. Habitat for two species is associated with sand dunes and other deep sands. Tall prairie gentian (*Eustoma exaltatum*) occurs in riparian and wetland habitat.

Table 3-25
Sensitive plant species known or expected to occur on WSMR

Name	Status[a]	R-E-D[b]	WSMR[c]	Substrate	Vegetation Type[d]
Sacramento Prickly Poppy *Argemone pleiacantha* ssp. *pinnatisecta*	FE/L1	2-2-3	no		CWPP, CWMS, SPMG
Sneed's Pincushion Cactus *Coryphantha sneedii* var. *sneedii*	FE/L1	2-2-2	no	limestone	CWMS, CDSC
Kuenzlers's Hedghog Cactus *Echinocereus fendleri* var. *kuenzleri*	FE/L1	2-3-3	no	limestone	SPMG, DGPMS
Lloyd's Hedgehog Cactus *Echinocereus lloydii X*	FE/L1	NA	no	limestone	DGPMS, CDSC
Todson's Pennyroyal *Hedeoma todsenii*	FE/L1	2-2-3	yes	limestone with gypsum	CWPP, CWMS, SPMG
Sacramento Mountain Thistle *Cirsium vinaceum*	FT/L1	2-3-3	no	limestone	MCF, CWPP
Night Blooming Cereus *Cereus greggii*	C2/L1	1-3-1	yes		DGPMS, CDSC
Duncan's Pincushion Cactus *Coryphantha duncanii*	C2/L1	2-2-2	no	limestone	DGPMS, CDSC
Organ Mountain Evening Primrose *Oenothera organensis*	C2/L1	2-2-3	yes	wetlands	CWPP, CWMS
Sand Prickly Pear *Opuntia arenaria*	C2/L1	2-2-2	no	sand	DGPMS
Grama Grass Cactus DGPMS *Pediocactus papyracantha*	C2/L1	1-2-2	yes		CWPP, CWMS, SPMG,

(table continues)

Table 3-25 (continued).

Name	Status[a]	R-E-D[b]	WSMR[c]	Substrate	Vegetation Type[d]
Alamo Penstemon *Penstemon alamosensis*	C2/L1	2-2-3	yes	limestone	CWPP, CWMS, SPMG
Nodding Cliff Daisy *Perityle cernua*	C2/L1	3-2-3	no	"cliffs, igneous rock"	CWPP, CWMS, SPMG
Mescalero Milkwort *Polygala rimulicola* var. *mescalerorum*	C2/L1	3-2-3	yes	limestone cliffs	CWPP, CWMS, SPMG
Smooth Figwort *Scrophularia laevis*	C2/L2	2-1-2	no	"moist soil, shade"	MCF, CWPP, CWMS, SPMG
Cliff Brittlebush *Apacheria chiricahuensis*	C3c/L1	1-1-2	yes	cliffs	MCF, CWPP
Castetter's Milkvetch *Astragalus castetteri*	C3c/L2	1-1-3	yes	limestone	CWPP, CWMS, SPMG
Dune Unicorn Plant *Proboscidea sabulosa*	C3c/L2	1-1-2	no	"deep sands, dunes"	DGPMS, CDSM
Plank's Catchfly *Silene plankii*	C3c/L2	1-1-2	yes	granitic	CWPP, CWMS, SPMG
Guadalupe Mescal Bean *Sophora gypsophyla* var. *guadalupensis*	C3c/L2	2-1-2	no	limestone	CWMS, SPMG
Orcutt's Pincushion Cactus *Coryphantha orcuttii*	None/L1	2-2-2	no		CWMS, DGPMS, CDSC
Scheer's Pincushion Cactus *Coryphantha scheeri* var. *valida*	None/L1	2-2-1	yes	alluvial soils	DGPMS,CDSC
Standley's Whitlowgrass *Draba standleyi*	None/L2	2-1-2	no		MCF, CWPP, CWMS, SPMG
Button Cactus *Epithelantha micromeris* var. *micromeris*	None/L1	1-2-1	yes	limestone	CWMS, SPMG, DGPMS, CDSC

(table continues)

Table 3-25 (continued).

Name	Status[a]	R-E-D[b]	WSMR[c]	Substrate	Vegetation Type[d]
Sandberg's Pincushion Cactus *Escobaria sandbergii*	None/L1	2-2-3	yes		CWPP, CWMS, SPMG
Tall Prairie Gentian *Eustoma exaltatum*	None/L1	1-2-1	yes	riparian and wetlands	SPMG, DGPMS, CDSC, CDSM, CBSS&T CBSR&W, CBSBL, CBSDL
Wright's Fishook Cactus *Mammillaria wrightii* var. *wrightii*	None/L1	1-2-2	yes		CWPP, CWMS, SPMG, DGPMS
Pineapple Cactus *Neolloydia intertexta* var. *dasyacantha*	None/L1	1-2-1	yes	limestone	DGPMS, CDSC
Mosquito Plant *Agastache cana*	None/L2	1-1-2	yes	"moist, wetlands"	CWMS, SPMG
Organ Mountain Pincushion Cactus *Coryphantha organensis*	None/L1	1-2-3	yes		CWPP, CWMS
Mescalero Pennyroyal *Hedeoma pulcherrinum*	None/L2	1-1-3	yes		MCF, CWPP, CWMS
Payson's Hiddenflower *Cryptantha paysonii*	None/L2	1-1-2	yes	limestone	SPMG
Vassey's Bitterweed *Hymenoxys vaseyi*	None/L2	3-1-3	yes		CWPP, CWMS, SPMG
San Andres Rock Daisy *Perityle staurophylla* var. *homoflora*	None/L2	1-1-3	yes	limestone cliffs	CWPP, CWMS, SPMG
Desert Parsley *Pseudocymopterus longiradiatus*	None/L2	1-1-2	yes	limestone	CWPP, CWMS, SPMG
Supreme Sage *Salvia summa*	None/L2	1-1-2	yes	limestone cliffs	CWPP, CWMS, SPMG
Smooth Cucumber *Sicyos glaber*	None/L2	1-1-2	no		CWPP, CWMS, SPMG
Long-stemmed Flame Flower *Talinum longipes*	None/L2	1-1-3	yes	limestone	DGPMS, CDSC

(table continues)

Table 3-25 (continued).

Sources: WSMR Environmental Services Division (1993b); U.S. Department of the Interior (1979); COE (1987).

[a] Federal Status

FE Listed by the U.S. Fish and Wildlife Service (USFWS) as endangered.
FT Listed by the USFWS as threatened.
C2 Category 2 candidate species for listing by the USFWS as threatened or endangered.
C3c Previously considered for listing by the USFWS but now considered to be to widespread or not threatened.
None Not currently of concern to the USFWS.

New Mexico Status

L1 Listed by the New Mexico Forestry Resource Conservation Division (NMFRCD) as endangered (List 1).
L2 Listed by the NMFRCD as rare or sensitive (List 2).

[b] Rarity, Endangerment, and Distribution Code (R-E-D)

Rarity

1 Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low for the foreseeable future.
2 Occurrence confined to several populations or to one extended population.
3 Occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported.

Endangerment

1 Not endangered.
2 Endangered in a portion of its range.
3 Endangered throughout its range.

(table continues)

Table 3-25 (continued).

Distribution

1	More or less widespread outside New Mexico.
2	Rare outside New Mexico.
3	Endemic to New Mexico.

[c] Occurrence on WSMR

Yes	Presently known to occur or to have occurred on WSMR.
No	No known record of occurring or having occurred on WSMR.

[d] Vegetation Types With Which the Species May Be Associated

MCF	Montane coniferous forest
CWPP	Coniferous woodland (pinyon pine)
CWMS	Coniferous forest and montane scrub
SPMG	Savanna and plains-mesa grassland
DGPMS	Desert grassland and plains-mesa sandscrub
CDSC	Chihuahuan desert scrub (creosote)
CDSM	Chihuahuan desert scrub (mesquite)
CDSL	Chihuahuan desert scrub (lava)
CBSST	Closed-basin scrub (saltbush and tarbush)
CBSRW	Closed-basin scrub (riparian and wetland)
CBSBL	Closed-basin scrub (barren land)
CBSDL	Closed-basin scrub (dune land)

3.4.3.2 Wildlife. WSMR provides habitat for a number of state and federally listed threatened and endangered wildlife species protected under the Endangered Species Act (federal) and the Wildlife Conservation Act (state). There are 44 sensitive wildlife species that may occur or potentially may occur on WSMR (Table 3-26). Of these, 26 species are known to occur on WSMR; 5 are federal and 14 are state listed threatened and endangered species. WSMR also is committed to completion of the Sike's Act Agreement and Integrated Natural Resources Management Plan for the Conservation of Fish and Wildlife Resources on WSMR, which will include phased production of Endangered Species Management Plans for federally listed species known to occur on WSMR.

Birds

Federal Endangered Species – American bald eagle (*Haliaeetus leucocephalus*) (New Mexico State status E2) adults are easy to distinguish by their white crowns and immense wingspan 2.0 to 2.4 m (6.5 to 7.9 ft). They migrate and winter throughout New Mexico and are usually found near riparian habitats. They also have been reported in dry land habitats in New Mexico adjacent to WSMR, including the Sacramento Mountains. Their prey consists of small mammals, waterfowl, fish, and carrion (NMDGF 1988). There have been occasional sightings over WSMR.

American peregrine falcons (*Falco peregrinus anatum*) (New Mexico State status El) breed in mountainous areas with cliffs, laying eggs on cliff ledges. Their prey consists almost entirely of other birds (NMDGF 1988). The areas surrounding eyries are generally surrounded by forested vegetation types (NMDGF 1988). Home range estimates reported in Johnsgard (1990) are 44 to 65 km^2 (17 to 25 mi^2), and an estimate of 124 km^2 (48 mi^2) is obtained from a regression equation for falcons found in USFWS (1990).

The peregrine falcon is listed as having been observed as a permanent resident at San Andres National Wildlife Refuge from 1941 to 1968 (USFWS 1968). Peregrine falcons are not currently known to nest on the San Andres National Wildlife Refuge (Berenzen, pers. com. 1994). Peregrine falcons are known to occur on WSMR, but recent surveys found aeries in the more northern portions of WSMR (Skaggs 1990). Skaggs (1990) surveyed the Oscura, Fairview, Mockingbird, and San Andres mountains and found the most likely habitat in the vicinity of Silvertop Mountain. Skaggs (1990) reported that most of the areas surveyed were too xeric to support the avian diversity required by the peregrine falcon. There are records of migrating peregrines in southern New Mexico (Howard, pers. com. 1993).

The interior least tern (*Sterna antillarum athalassos*) (New Mexico State status El) is a water bird that nests on the ground, typically in sandy vegetation-free locations, including alkali flats. They feed on fish, crustaceans, and insects (NMDGF 1988). There are historical records of least tern occurrence at WSMR. The National Biological Service is conducting an in-depth survey for this species at WSMR in the spring of 1996. This survey will document the existing range and abundance of this species on WSMR.

The Northern aplomado falcon (*Falco femoralis septentrionalis*) (New Mexico State status El) is a raptor of grasslands punctuated by tall shrubs like yucca or mesquite, and savannah habitats (USFWS 1990). The primary prey of aplomado falcons are birds, often captured during cooperative hunts involving pairs (Hector 1986; USFWS 1990). Most foraging occurs within 1 km (0.6 mi) of nests, but longer hunts of 3 to 4 km (1.9 to 2.5 mi) have been observed in eastern Mexico (USFWS 1990). Like other falcons, the aplomado does not build its own stick platforms for nesting. The most abundant species providing potential nest platforms on WSMR would be Chihuahuan ravens, and Swainson's hawks (Johnsgard 1990).

Table 3-26
Sensitive wildlife species that occur or potentially occur on WSMR

Scientific Name	Common Name	USFWS Status[a]	NM Status[b]
Sterna antillarum athalassos	interior least tern	FE	E1
Falco femoralis septentrionalis	northern Aplomado falcon	FE	E1
Falco peregrinus anatum	American peregrine falcon	FE	E1
Grus americana	whooping crane	FE	E2
Haliaeetus leucocephalus	bald eagle	FE	E2
Canis lupus baileyi	Mexican gray wolf	FE	E2
Falco peregrinus tundrius	artic peregrine falcon	FT	E1
Charadrius melodus circumcinctusp	Piping plover	FT	E1
Strix occidentalis lucida	Mexican spotted owl	FT	S
Empidonax traillii extimus	southwestern willow flycatcher	FPE	E2
Charadrius alexandrinus nivosus	western snowy plover	FPT	S
Zapus hudsonius luteus	New Mexico meadow jumping mouse	C1	E2
Cyprinodon tularosa	White Sands pupfish	C2	E2
Ammodramus bairdii	Baird's sparrow	C2	E2
Tamias quadrivittatus australis	Organ Mountain Colorado chipmunk	C2	E2
Euderma maculatum	spotted bat	C2	E2
Cicindela nevadica olmosa	Los Olmos tiger beetle	C2	none
Dereonectes neomericana	Bonita diving beetle	C2	none
Lytta mirifica	Anthony blister beetle	C2	none
Phrynosoma cornutum	Texas horned lizard	C2	S
Accipiter gentilis	northern goshawk	C2	S
Buteo regalis	ferruginous hawk	C2	S
Charadrius montanus	mountain plover	C2	S
Lanius ludovicianus	loggerhead shrike	C2	S
Plegadis chihi	white-faced ibis	C2	S
Neotoma micropus leucophaeus	white Sands woodrat	C2	S
Sigmodon fulviventer goldmani	Hot Springs cotton rat	C2	S
Cynomys ludovicianus arizonensis	Arizona black-tailed prairie dog	C2	S
Eumops perotis californicus	greater western mastiff bat	C2	S
Myotis velifer brevis	southwestern cave myotis (bat)	C2	S
Myotis lucifugus	little brown myotis (bat)	C2	S
Ovis canadensis mexicana	desert bighorn sheep	none	E1
Ammodramus savannarum ammolegus	Arizona grasshopper sparrow	none	E2
Buteogallus anthracinus	common black-hawk	none	E2
Passerina versicolor	varied bunting	none	E2
Phalacrocorax brasiliensis	neotropic cormorant	none	E2
Vireo Bellii	Bell's vireo	none	E2
Vireo vicinior	Gray vireo	none	E2
Ashmunella harrisi	land snail, no common name	none	S
Asmunella kochi caballoensis	land snail, no common name	nono	S
Ashmunella kochi kochi	land snail, no common name	nono	S
Ashmunella kochi sanandresensis	land snail, no common name	nono	S
Ashmunella salinasensis	land snail, no common name	nono	S
Oreohelix socorroensis	Oscura Mountain land snail	none	S

(table continues)

Table 3-26, Continued

[a] Federal Status

FE	Listed by the U.S. Fish and Wildlife Service (USFWS) as endangered.
FT	Listed by the USFWS as threatened.
FPE	Proposed by USFWS for listing as endangered.
FPT	Proposed by USFWS for listing as threatened.
C1	Category 1 candidate species for listing by the USFWS as threatened or endangered.
C2	Category 2 candidate species for listing by the USFWS as threatened or endangered.
C3c	Previous considered for listing by the USFWS but now considered to be to widespread or not threatened.
None	Not currently of concern to the USFWS.

[b] New Mexico Status

E1	Listed by the New Mexico Department of Game and Fish (NMDGF) as endangered (group 1).
E2	Listed by the NMDGF as endangered (group 2).
S	Sensitive species; New Mexico species which have been singled out for special consideration, typically as being formally listed as threatened, endangered, or will be in the future.

The aplomado falcon recovery plan (USFWS 1990) provides an estimate of the upper limit for home ranges as 60 km^2 (26 mi^2), and a regression of home range on size (mass) from other falcons yielding an estimate of 34 km^2 (13 mi^2). The estimate of 60 km^2 (26 mi^2) for an upper limit of home range yields a radius of 4.4 km (2.7 mi), which corresponds closely with the longest foraging flights reported in the recovery plan (USFWS 1990). The aplomado falcon formerly nested regularly in southern New Mexico, including documented records from Otero, Doña Ana, and Sierra counties (Hector 1987). Aplomado falcons were sighted in or near WSMR in 1991 and 1992, and much of the non-mountainous areas of WSMR is considered potential habitat (U.S. Army 1993f). There also was an unconfirmed sighting in September 1993 (USFWS 1993).

The whooping crane (*Grus americana*) (New Mexico State status E2) breeds only in Wood Buffalo National Park in the Northwest Territories, and migrates across the great plains to winter on the Texas coastlands. An experimental population established in Idaho migrates to the central Rio Grande Valley to winter. Adults usually are found in pairs. They occupy the same habitat as sandhill cranes (*Grus canadensis*) in New Mexico, using sand bars and valley pastures (NMDGF 1988) but have not been sighted on WSMR. Sandhill cranes have been sighted over WSMR, and whooping cranes could migrate with these flocks.

The Southwestern willow flycatcher (*Empidonax traillii extimus*) (Endangered; New Mexico State status E2) is confined to riparian woodlands during breeding season. These habitats are typically characterized by the presence of surface water, moist soil, and dense riparian vegetation, such as willow or tamarisk, often with an overstory of cottonwood (NMGFD 1988). Although this species has not been sighted on WSMR, there may be potential habitat present. Within proposed activity areas, WSMR will identify any potential habitat for this species. If suitable habitat is discovered within the activity area, then WSMR will implement surveys for the southwestern willow flycatcher. Any action that may directly or indirectly affect habitat suitable for this species will be evaluated for potential impacts. Wherever possible, habitats for the southwestern willow flycatcher will be protected. If protection is not possible, then WSMR will work in coordination with management agencies to develop mitigation measures to reduce or offset impacts of the project.

Federal Threatened Species – The piping plover (*Charadrius melodus circumcinctus*) (New Mexico State status E1) occurs along bare shorelines and sandflats near rivers, lakes, and coasts (NMDGF 1988). It occupies breeding grounds from late March to August. A shallow nest scrape is made in the soil and then lined with pebbles. Adverse effects of human activity upon nesting grounds have resulted in a severe decline in the species since the 1930s (NMDGF 1988). This plover has not been sighted on WSMR. The Western snowy plover (*Charadrius alexandrinus nivosus*) (potentially threatened) breeds in New Mexico (NMDGF 1988) and has been reported to summer in the Tularosa Basin. It prefers alkali flats adjacent to water. There are a number of records of this species occurrence at WSMR. The National Biological Service is conducting an in-depth survey for this species at WSMR in the spring of 1996. This survey will document the existing range and abundance of this species on WSMR.

The arctic peregrine falcon (*Falco peregrinus tundrius*) (New Mexico State status El) is smaller and of lighter plumage than other peregrines. It breeds throughout arctic America, and winters from Baja California southward. It is a rare migrant in New Mexico (NMDGF 1988).

Mexican spotted owls (*Strix occidentalis lucida*) prefer densely wooded areas, neither too wet nor too dry, within the coniferous forest or in pine/oak woodlands, streamside woodland, or steep walled canyons. The spotted owl is strictly nocturnal and roosts in tall trees by day (Hubbard 1978). There are recent data to suggest that Mexican spotted owls may utilize pinon-juniper woodland at certain times during the year. If the Mexican spotted owl does utilize pinon-juniper woodland it would greatly expand the potential habitat for this species on WSMR. Some limited surveys have been conducted for this species on WSMR, but no recent surveys have located Mexican spotted owls at WSMR. This species may, however, occur in areas of appropriate habitat at WSMR.

The mountain plover's (*Charadrius montanus*) (C2) summer range includes the eastern New Mexico plains into the Tularosa Basin (Hubbard 1978). It prefers grasslands at middle to lower elevations (Hubbard 1978). It has been observed on WSMR.

Federal Candidate Species – Baird's sparrow (*Ammodramus bairdii*) (C2; New Mexico State status E2) is known as an occasional fall migrant in southern New Mexico (NMDGF 1988). It is found in association with extensive perennial grasslands (NMDGF 1988). Migrant populations may appear between August and November. No sightings have been confirmed on WSMR.

The Northern goshawk (*Accipiter gentilis*) (C2) is reported as a resident in the Sacramento Mountains (Hubbard 1978). It migrates and winters throughout the state, prefers to nest in high woodlands (Hubbard 1978), and has not been sighted on WSMR to date.

The ferruginous hawk (*Buteo regalis*) (C2) is a large hawk of semiarid grasslands. This hawk preys primarily on mammals, particularly rodents and rabbits (Johnsgard 1990). In New Mexico, ferruginous hawks are most common in the San Augustin plains and the grasslands of eastern New Mexico (Hubbard 1978). This hawk is a likely migrant in the northern range area.

The loggerhead shrike (*Lanius ludovicianus*) is a widespread resident of WSMR and southern New Mexico. The loggerhead shrike inhabits shrubby grasslands and desert and closed-basin scrub vegetation types (Hubbard 1978).

The white-faced ibis (*Plegadis chihi*) (C2) prefers habitats near water at lower elevations. The summer range of the white-faced ibis includes New Mexico, and it winters in the Bosque del Apache Refuge just north of WSMR (Hubbard 1978). It has been observed on WSMR.

State Endangered Species - The Arizona grasshopper sparrow (*Ammodramus savannarum ammolegus*) (New Mexico State status E2) tends to summer throughout New Mexico and winters in the southern portion of the state (NMDGF 1988). The species is primarily a ground forager, preferring grasslands, and consuming mainly seeds and insects (NMDGF 1988). It has not been sighted on WSMR.

The common black-hawk (*Buteogallus anthracinus*) (New Mexico State status E2) is characteristically found in heavily wooded areas along streams (NMDGF 1988). It nests in cottonwoods, willow tree groves, or pines, and is limited to riparian habitat (Hubbard 1978). The species summers primarily in the Gila, San Francisco, and Mimbres drainages at 1,370 to 1,675 m (4,500 to 5,500 ft). There are no documented records from the east or north parts of the state (Hubbard 1978). The species is not present in New Mexico during the winter. It has been observed on WSMR.

The varied bunting (*Passerina versicolor*) (New Mexico State status E2) is a plum-colored species of finch that eats seeds and insects. They summer in the vicinity of WSMR, preferring dense stands of mesquite and the vegetative growth of canyon bottoms (NMDGF 1988). They generally build nests in shrubbery. It has been sighted on WSMR.

The neotropic cormorant (*Phalacrocorax brasiliensis*) (New Mexico State status E2) is found in a diversity of aquatic habitats ranging from lowland marshes to mountain streams. It generally requires drowned groves or trees near water for feeding and nesting (Hubbard 1978). The species has been recorded in the Rio Grande Valley north to Socorro and south to Las Cruces, and may be considered a resident in New Mexico (Hubbard 1978). It is estimated that only a few hundred birds exost in New Mexico, and eight nests were counted in the Elephant Butte and Caballo Lake area between 1975 and 1979 (NMDGF 1988).

Bell's vireo (*Vireo bellii*) (New Mexico State status E2) is associated with dense shrub growth around lowland riparian areas (NMDGF 1988). Bell's vireo is known to occur as a summer breeding resident in the WSMR region. It is found in association with willow (*Salix*), mesquite (*Prosopis*), and seepwillow (*Bacchtaris*) thickets along streams (NMDGF 1988).

The gray vireo (*Vireo vicinior*) (New Mexico State status E2) has been observed as a breeding summer resident within the San Andres National Wildlife Refuge on WSMR (USFWS 1968). The gray vireo is insectivorous, gleaning prey from foliage. The species occupies pinyon-juniper and oak woodlands on dry mountain slopes. The population of this vireo in New Mexico is thought to have declined (NMDGF 1988). Gray vireos are likely residents in the wooded slopes of the San Andres mountain range.

Mammals

Federal Endangered Species - The Mexican gray wolf (*Canis lupus baileyi*) (New Mexico State status E2) has not been sighted on WSMR. However, the region constitutes part of the natural habitat of the species (Bednarz 1989). Prey consist of large ungulates, several species of which are located on WSMR (NMDGF 1988). The 1982 Mexican wolf recovery plan (USFWS 1982) proposes reintroduction of captive breeding groups within the historic range of the species. The ideal location would contain mid to high elevations and little or no overlap with livestock grazing areas (USFWS 1988a). Because of its suitability on all requirements, WSMR has been proposed as a potential region of reintroduction (Bednarz 1989). An EIS is being prepared by the U.S. Fish and Wildlife Service regarding the release of the Mexican wolf, which would include an evaluation of impact of the reintroduction to WSMR.

Federal Candidate Species – The New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) (C1; New Mexico State status E2) prefers a habitat containing permanent streams, moderate to high soil moisture, and diverse streamside vegetation consisting of grasses, sedges, and forbs (Findley 1987). It resembles other mice except for the long hind limbs and a jumping gait. The species is characterized by a long hibernation period (6 to 8 months) and production of only one or two litters per year (NMDGF 1988). The meadow jumping mouse has not been confirmed on WSMR, even though there are many occurrences of appropriate habitat. These potential habitat sites are included in the surface water sites presented and discussed in Section 3.2.2.

The Organ Mountain Colorado chipmunk (*Tamius quadrivittatus australius*) (C2; New Mexico State status E2) occurs in the Oscura and Organ mountains (Findley 1987). The Oscura and Organ populations constitute the sole area of occupancy and the key habitat for the southern subspecies of vicinities of Atom Peak, Moya Spring, and Oscura Peak (NMDGF 1988). They range from 2,380 to 2,515 m (7,800 to 8,250 ft) in the Oscura Mountains.

The spotted bat (*Euderma maculatum*) (C2; New Mexico State status E2) is a large-eared bat that roosts in cliffs and primarily eats moths (Whitaker 1980). Young are probably born in early summer, migrating to lower elevations in winter (NMDGF 1988). In New Mexico, recorded individuals have usually been netted over water surfaces (NMDGF 1988). It has not been sighted on WSMR, but a population is known to inhabit the lava beds near WSMR.

The White Sands woodrat (*Neotoma micropus leucophaea*) (C2) dwells in arroyos and grasslands. After intensive investigations on WSMR, no evidence of this woodrat was found (U.S. Army 1989a). The White Sands woodrat has been identified at two location son White Sands National Monument adjacent to the WSMR western boundary. Many areas of dunes-grassland habitat described by Findley (1987) exist on WSMR.

The greater western mastiff bat (*Eumops perotis californicus*) (C2) is the largest bat in North America (Whitaker 1980), and must roost high enough to free-fall into flight (Whitaker 1980; Schmidly 1991). This bat roosts in small colonies by day, and may fly hundreds of kilometers (miles) in search of insect prey (Findley 1987). This bat has been sighted on WSMR.

The Hot Springs cotton rat (*Sigmodon fulviventer goldmani*) (C2) inhabits areas of undisturbed and dense grasslands. It tunnels through the dense grass, preferring to avoid open areas (Findley 1987). It has not been reported on WSMR.

The Arizona black-tailed prairie dog (*Cynomys ludovicianus arizonensis*) (C2) builds large and socially complex colonies in grasslands habitats. Winter months primarily are spent underground. Offspring occur in spring and early summer (Findley 1987). It has not been sighted on WSMR.

The southwestern cave bat (*Myotis velifer brevis*) (C2) forages over water (Findley 1987). They are generally found where there are large open bodies of water, ponds, or streams. Colonies are found in building type structures or limestone caves (Schmidly 1991), and are known to inhabit the Bosque del Apache Wildlife Refuge northwest of WSMR (Findley 1987). Although this species has not been recorded in WSMR, it may occur on the range in areas of suitable habitat.

The occult little brown bat (*Myotis lucifugus*) (C2) forages over water surfaces and is found along rivers and in mountainous areas (Findley 1987). It forms large nursery colonies in caves and cavelike structures during the summer, and they may enjoy a reproductive life of as long as 24 or more years (Whitaker 1980; Schmidly 1991). Although this species has not been recorded in WSMR, it may occur on the range in areas of suitable habitat.

State Endangered Species – Desert bighorn sheep (*Ovis canadensis mexicana*) (New Mexico State status EI) occupy the upper reaches of the San Andres Mountains on WSMR, occurring as lone individuals or in scattered small bands. The population of desert bighorn sheep in the San Andres Mountains primarily occupies areas at approximately 1,830 m (6,000 ft), with average slope of 62 percent (USFWS 1988a). However, the sheep often descend to lower elevations for short periods to access water at canyon springs, and seldom are observed at distances greater than 2,000 m (6,560 ft) from water (Sandoval 1979).

The major seasonal change in locations inhabited by the sheep bands is the movement of some rams out of the established herd areas following the end of rut during winter months (Sandoval 1979). Ewes continue to inhabit the same general herd areas during lambing, although there is apparently some habitat selection by the ewes for cliff-associated sites with more eastern exposures (Sandoval 1979).

Reptiles

The Texas horned lizard (*Phrynosoma coronutum*) is a federal Category 2 candidate and a state sensitive species that is common throughout the Tularosa and Jornada basins, primarily in association with shrublands and grasslands on sandy and sandy/gravelly soils (Price 1990). Disturbance by humans and removal of individuals from the wild for sale in the pet trade may also be factors contributing to the decline (USFWS 1988b). Observations of the Texas horned lizard at WSMR include the Stallion Warhead Impact Target (WIT) site (WSMR Environmental Services Division 1992a), Launch Complex (LC)-32 (U.S. Army 1992c), the Forward Area Air Defense System (FAADS) Valley (U.S. Army 1993b), the Jim Site and Fairview Site (Physical Science Laboratory 1990), and the Three Rivers Site (WSMR Environmental Services Division 1991).

Fish

The White Sands pupfish (*Cyprinodon tularosa*) is a federal Category 2 candidate and a state endangered (group 2) species that is found in shallow, calm, highly mineralized water charged by alkali salt springs and sand and/or gravel bottoms. This species is endemic to the Tularosa Basin of New Mexico and is known only from Malpais Spring, Mound Spring, Salt Creek (all on WSMR), and Malone Draw/Lost River. Protection from toxicants and human disturbances and the maintenance of the habitat diversity at existing pupfish locations should permit the long-term survival of the populations (Turner 1987). WSMR recently entered into a cooperative agreement for the protection of the White Sands pupfish. This agreement (among the U.S. Army, U.S. Air Force, WSNM, USFWS, and NMDFG) commits to the creation of limited use areas around the White Sands pupfish habitat as well as a variety of other measures to avoid harm to this species. This agreement protects the habitat at Malpais Spring, Mound Spring, and Salt Creek on WSMR.

Invertebrates

The Los Olmos tiger beetle (*Cicindela nevadica olmosa*) is a federal Category 2 candidate species. Suitable habitat for this species is clay soil flats and gypsum soils. Surveys for this species were conducted for the ACTC Program (Physical Science Laboratory 1990). The Los Olmos tiger beetle was not observed during those surveys. Suitable habitat for this species occurs on WSMR.

Six land snails are considered sensitive by the NMDGF (WSMR Environmental Services Division 1993b). Among the state sensitive land snails present are five taxa from the genus *Ashmunella*. These include *Ashmunella Jiarrisi, Ashmunella kochi kochi, Ashmunella kochi sanandresensis, Ashmunella kochi caballoensis,* and *Ashmunella salinasensis*. The Oscura Mountain land snail (Oreohelix socorroensis) also occurs on WSMR.

Ashmunella harrisi is occurs on limestone talus in two canyons that indent Goat Mountain in the San Andres Mountains. The known populations occur at elevations between 1,600 and 1,700 m (5,250 to 5,580 ft).

Ashmunella salinasensis is found on the northwest-facing slopes of Salinas Peak at approximately 2,285 m (7,500 ft) (Metcalf 1984). *Ashmunella salinasensis* occurs only in talus accumulations of igneous rock on the highest northern-facing slopes of Salinas Peak (Sullivan and Smartt 1992).

Ashmunella kochi caballoensis is listed by the WSMR Environmental Services Division (1993b) as occurring on WSMR. This seems unlikely given that Metcalf and Smartt (1977) state the species is limited to the Sierra Caballo west of the San Andres Mountains.

Ashmunella kochi kochi occurs on Goat and Black mountains in the southern San Andres Mountains (Sullivan and Smartt 1992). Metcalf and Smartt (1977) reported *Ashmunella kochi kochi* as occurring on Black Brushy Mountain and Goat Mountain. *Ashmunella kochi kochi* is reported to occur at 1,830 m (6,000 ft) above MSL in a mixture of soil and limestone rocks on the northeast-facing wall of the canyon, which enters Salt Canyon from the southeast (Metcalf and Smartt 1977).

Ashmunella kochi sanandresensis was reported by Metcalf and Smart (1977) as occurring at 2,165 m (7,100 ft) above MSL on the west-facing slope of San Andres Peak 1.45 km (0.9 mi) east-southeast of Ropes Spring. They list the habitat in which it was found as "under shrubs in soil talus mixture."

In the Oscura Mountains on WSMR, *Oreohelix socorroensis* occurs near limestone cliffs along WSMR Range Road 332, 1.1 and 5 km (0.7 and 3.1 mi) north of Jim site (Sullivan and Smartt 1990). The Oscura Mountain land snail prefers microhabitats associated with rocky limestone slabs beneath cliff faces.

3.4.4 Sensitive Habitats

Habitat may be considered sensitive:

- due to its designation as critical habitat for species listed as endangered by the USFWS;
- if its loss or disturbance would result in the take of a species listed as threatened or endangered by the USFWS;
- because of legal considerations including permit requirements for the dredging and filling of wetlands and waters of the United States;

Table 3-27
Sensitive habitats occurring on WSMR

Name	Rank*
Black Grama/Longleaf Mormon Tea Grassland (*Bouteloua eriopoda/Ephedra trifurca*)	G3S2
Pinyon Pine/Scribner Needlegrass Woodland (*Pinus edulis/Stipa scribneri*)	G3?S3?
White Sands pupfish habitat	NA
Wetlands and Riparian Habitats	NA
Cliffs	NA
San Andres National Wildlife Refuge	NA
Malpais Areas (West and East)	NA
Agropyron Meadows (Oscura Mountains)	NA
Interior Chapparal Vegetation	NA
White Sands National Monument	NA
Strawberry Peak	NA
Caves, Mines	NA
Cactus Community Vegetation	NA
Known Raptor Nests	NA
Watering Areas (includes wildlife units)	NA
Arroyos (perennial and ephemeral)	NA
Mound Springs Complex	NA

Sources: Carlson, pers. com. 1993; Advanced Sciences, Inc., and WSMR Environmental Services Division biologists.

* New Mexico Natural Heritage Program (NMNHP) global and state ranks (Carlson, pers. com. 1993)

G3	Either very rare and local throughout its range or found locally (even abundant at some of its locations) in a restricted range or because of other factors making it vulnerable to extinction throughout its range. The number of occurrences is between 21 and 100.
G3?	Believed to have characteristics similar to G3 but more information is needed.
G5	Demonstrably secure globally, though it may be rare in parts of its range, especially at the periphery.
S2	Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or hectares [acres]) or because of some factor(s) making it very vulnerable to extirpation from the state.
S3?	Rare or uncommon in the state and more information is needed.
S5	Demonstrable in the state and essentially ineradicable under present conditions.
NA	Not ranked by NMNHP.

- if it is a unique characteristic of the geographical area;
- if it is an ecologically critical area; or
- if it is a habitat for the White Sands pupfish (per Cooperative Agreement for Protection and Maintenance of White Sands Pupfish, 1994).

Sensitive habitats occurring on WSMR are listed in Table 3-27. These habitats have been identified by the NMNHP and by WSMR. Several of these sensitive areas are discussed in greater detail in the following sections; others are discussed elsewhere in this document.

3.4.4.1 Vegetation. NMNHP has identified two habitat types that occur on WSMR as sensitive (Table 3-27). The NMNHP ranks sensitive habitats by the degree to which they are perceived to be threatened in New Mexico and globally.

Black Grama/Long Leaf Mormon Tea (*Bouteloua eriopoda/Ephedra trifurca*)

The black grama/long leaf mormon tea habitat type (Carlson, pers. com. 1993) is the same as the black grama/desert mormon tea habitat type described in Section 3.4.1. Black grama grasslands, as well as other desert grasslands, have declined greatly since the introduction of intensive grazing practices in New Mexico (Dick-Peddie 1993).

The NMNHP ranking (G3) of black grama/longleaf mormon tea habitat indicates that, on a global basis, it is very rare or its distribution is local throughout its range (Table 3-27). This ranking also indicates that, due to its restricted range or other factors taken into consideration by the NMNHP, it is vulnerable to extinction throughout its range.

On WSMR, black grama/longleaf mormon tea habitat occurs on the shoulders of fans and bajadas (NMNHP 1992). Generally, this habitat type is found where soils are gravelly and well-drained. As with other desert grassland vegetation, this habitat type occurs at elevations between 1,220 to 1,830 m (4,000 and 6,000 ft) above MSL.

Pinyon Pine/Scribner Needlegrass Woodland (*Pinus edulis/Stipa scribneri*)

The NMNHP indicates that more information is needed on the existing amount of pinyon pine/Scribner needlegrass habitat on both a global and statewide basis (Table 3-27). What is known currently, however, suggests that it is very rare and local throughout its range. Where found locally, it may be abundant at some locations; but due to its restricted range or because of other factors, it is vulnerable to extinction.

The NMNHP (1992) indicates that pinyon pine/Scribner needlegrass woodland on WSMR is characterized by partially closed, multilayered canopies that may exceed 9.1 m (30 ft) in height. These woodlands have an understory dominated by grasses. Pinyon pine/Scribner needle grass may occur in a finegrained mosaic with stands of pinyon pine that have a dense canopy and little or no understory.

On WSMR, pinyon pine/Scribner needlegrass woodland occurs in the Oscura Mountains on gentle to moderate slopes at elevations between 2,400 and 2,700 m (7,900 and 8,700 ft) above MSL (NMNHP 1992). While the pinyon pine/Scribner needlegrass habitat type is well represented in the Oscura Mountains, it is not known to occur elsewhere in New Mexico in such abundance or in as good a condition as it does on WSMR (NMNHP 1992).

3.4.4.2 Wetland and Riparian Habitats. The following paragraphs discuss the regulatory background, existing mapping, general location, and habitat types of wetland and riparian habitats on WSMR.

Regulatory Background

Under the authority of Section 404 of the Clean Water Act, discharge of dredged or fill material into waters of the United States, including wetlands, is regulated by the COE. The COE and the EPA have jurisdiction over making determinations of wetlands regulated under Section 404 of the Clean Water Act. For purposes of administering the Section 404 permit program, COE and EPA regulations define wetlands as:

> "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Wetlands are therefore defined by the presence of three factors: wetland hydrologic regime, wetland soil types, and vegetation adapted to grow in wetland conditions.

Existing Mapping

The USFWS National Wetland Inventory has mapped wetlands as present on WSMR (Table 3-28). National Wetland Inventory maps for WSMR have been digitized on the Geographic Resources Analysis Support System (or GRASS) developed at the U.S. Army Construction Engineering Research Laboratory (Morrow 1992). The National Wetland inventory maps are compiled from aerial photographs at a scale ranging from 1:60,000 to 1:130,000. Photointerpretation and some field reconnaissance are then used to define wetland boundaries. The information is then summarized on 1:24,000 and 1:100,000 maps that show wetland boundaries and wetland classification according to the system developed and published by USFWS (U.S. Department of the Interior 1979). The classification system provides general wetland types, but does not provide specifics as to vegetation or habitat present. The National Wetland Inventory maps are not considered regulatory boundaries. They often miss smaller wetland areas due to the scale at which they were developed. They also have a tendency to underestimate the extent of certain vegetation types. Deep water habitats are included in the National Wetland inventory mapping. Deep water habitats are not considered wetlands, but may be regulated as waters of the United States.

Of the 67,706 hectares (167,300 acres) of WSMR searched in the GIS data base, only approximately 3,816 hectares (9,430 acres) or 0.4 percent of the land surface was mapped as jurisdictional wetlands. The wetlands present are dispersed throughout the range. The majority of these wetlands, approximately 3,590 hectares (8,870 acres), were mapped as lacustrine wetlands. Lacustrine wetlands are generally associated with ponds and lakes. Of the lacustrine wetlands, approximately 3,360 hectares (8,300 acres) were mapped as being open waters, which means that they do not support vegetation. The remaining 227 hectares (560 acres) of lacustrine wetlands were mapped as littoral flats. Littoral areas lie along the shoreline of playa lakes. Approximately 230 hectares (570 acres) of palustrine wetlands also were mapped on WSMR. Palustrine wetlands are nontidal wetlands that are not in stream, pond, or lake beds. Of the palustrine wetlands, 150 hectares (370 acres) were palustrine scrub shrub, approximately 69 hectares (170 acres) were palustrine flats, and 12 hectares (30 acres) were palustrine open water wetlands. Scrub shrub wetlands are dominated by woody vegetation less than 6 m (20 ft) tall. Flats may not be vegetated or may be vegetated for only part of the year. Open water
areas do not support rooted vegetation.

Location

The National Wetland Inventory maps pockets of wetlands south of Route 6 and at the lower end of several canyons. Lake Lucero and Malpais Springs are some of the other large areas of wetlands mapped by the National Wetland Inventory. There also are isolated springs and sinkholes and small wetland areas mapped throughout the Tularosa Basin and Jornada del Muerto. Springs also occur in the San Andres and Oscura mountains.

Table 3-28
National Wetland Inventory maps for WSMR

Map Name	Aerial Photograph Date	Scale
Lake Lucero, New Mexico	2/75	1:24,000
Lake Lucero N.E., New Mexico	2/71	1:24,000
Tres Hermanos, New Mexico	3/76	1:62,500
Holloman, New Mexico	3/76	1:62,500
Bear Peak, New Mexico	2/71	1:62,500
Lake Lucero S.W., New Mexico	2/71	1:24,000
Lake Lucero S.E., New Mexico	2/71	1:24,000
White Sands N.E., New Mexico	3/9/76	1:24,000
Carthage, New Mexico	6/75	1:62,500
Bingham, New Mexico	6/75	1:62,500
Granjean Well, New Mexico	2/71	1:62,500
Mockingbird Gap, New Mexico	2/71	1:62,500
Chihuahua Ranch, New Mexico	2/71	1:62,500
Salinas Peak, New Mexico	2/71	1:62,500
Capitol Peak, New Mexico	2/71	1:62,500
Three Rivers, New Mexico	2/71	1:62,500
Lumley Lake, New Mexico	2/71	1:62,500
Tularosa, New Mexico	2/71	1:62,500
Kaylor Mountain, New Mexico	2/71	1:62,500

Note: These maps are U.S. Department of the Interior, Fish and Wildlife Service, and National Wetlands Inventory maps.

Wetland Habitats

The following paragraphs describe five different types of wetlands habitat found on WSMR.

Seeps/Springs – A systematic survey of natural water resources (seeps and springs) on WSMR is being conducted. Permanent and seasonal potable water is relatively abundant in the San Andres Mountains (Canestorp, pers. com. 1988). It occurs in the form of natural springs and seeps. These springs and seeps form streams that flow east to the Tularosa Basin or west to the Jornada del Muerto. Wetlands may form around the seeps and springs and along the streams.

Riparian/Arroyo Areas – Wetlands are apt to form in lower arroyos (Meinzer and Hare 1915). Mayberry, Dead Man Canyon, Lost Man Canyon, and Hembrillo Canyon, as well as several other arroyos, all have wetlands mapped in their lower reaches (Table 3-28, Kaylor Mountain, New Mexico National Wetland Inventory map). Cottonwood (*Populus fremontii*) – willow (*Salix* spp.) communities occur where water is permanent or predictably periodic (WSMR Environmental Services Division 1987).

Saline Permanent Water Wetlands – Saline permanent water exists in Malpais and Mound Springs and in Salt Creek and Malone Draw/Lost River. The wetland associated with Malpais Spring forms a relatively large salt marsh on the western edge of the lava flow. Dense stands of rushes (*Juncus* spp.), bullrushes (*Scirpus* spp.), sedges (*Carex* spp.), and cattails (*Typha* spp.) are typical of the inundated marsh area. Drier land adjacent to the marsh supports salt cedar (*Tamarix ramosissima*), saltgrass (*Distichlis spicata*), common reed (*Phragmites australis*), iodine bush (*Allenrolfea occidentalis*), and alkali sacaton (*Sporobolus airoides*) (WSMR Environmental Services Division 1987). *Chara* spp., spikerush (*Eleocharis rostellata*), *Potamogton pectinatis*, gentian (*Eustoma exaltatum*), marsh rosemary (Limonium limbatum), Samolus cuneatus, and salt cedar (*Tamarix ramosissima*) also have been observed growing at Malpais Springs (Turner 1987).

The wetland areas associated with Mound Spring and Salt Creek are very limited. Salt cedar (*Tarmarix chinensis*) is the primary riparian vegetation at these sites, although short stretches of Salt Creek also support saltgrass, rushes, cattails, iodine bush, and sedge species (WSMR Environmental Services Division 1987). *Chara* spp., cattalls (*Typha* spp.), saltgrass (*Distichiis spicata*), alkali sacaton (*Sporobolus airoides*), and salt cedar (*Tamarix ramosissima*) also have been reported at Mound Springs (Turner 1987).

Ruppia maritima, bullrush (*Scirpus maritimus*), cattails (*Typha* spp.), iodine bush (*Allenrolfea occidentalis*), saltgrass (*Distichiis spicata*), marsh rosemary (*Limonium limbatum*), *Samolus cuneatus*, alkali sacaton (*Sporobolus airoides*), and salt cedar (*Tamarix ramosissima*) also have been observed growing at Malone Draw/Lost River (Turner 1987).

Playa Wetlands – Playas are periodically flooded basins that often have water standing in them long enough to prevent the establishment of perrenials in their center. The larger of the playas may form marshlike ponds that rarely are completely dry. Other areas are highly variable seasonal wetlands. These depressional areas meet wetland criteria during the wetter portion of the growing season, but may lack indicators of wetland hydrology and/or vegetation during the drier part of the growing season.

Potable water is available seasonally in the numerous playa lakes on WSMR; however, permanent surface water rarely exists in the playas. Lake Lucero is the largest playa lake on WSMR. Some wetland plant species typically found growing in playa basins in New Mexico are salt cedar (*Tamarix* spp.), redsage (*Kochina americana*), and poison suckleya (*Suckleya suckleyana*) (Dick-Peddie 1993).

Alkali Flat Wetlands – This habitat occupies the lowest portion of the Tularosa Basin. The saline groundwater aquifer lies extremely close to the surface, and rains produce huge shallow lakes that disappear through evaporation rather than percolation (WSMR Environmental Services Division 1987). Vegetation, if present, typically consists of iodine bush (*Allenrolfea occidentalis*), saltbush (*Atriplex canescens*), saltgrass (*Distichlis stricta*), sacaton grasses (*Sporobolus airoides*, *S. wrightii*), and seepweeds (*Suaeda* spp.). These species may occur in mixed or nearly pure low-density stands (WSMR Environmental Services Division 1987). Other species that may occur in alkali sink associations are quailplant (*Heliotropium curassavicum*), marsh rosemary (*Limonium limbatum*), Bigelow glasswort (*Salicornia bigelovii*), and Sea Purslane (*Sesuvium verrucosum*) (Dick Peddie 1993).

The National Wetland Inventory has mapped numerous wetland areas in the southeast corner of Sierra County and in Otero County just south of Route 6 in the Tularosa Basin. There are several intermittent lakes mapped in this area on the Soil Survey of White Sands Missile Range, New Mexico (USDA 1976). The mapped wetlands and the intermittent water areas are most likely playa lakes and alkali wetland habitat.

Thermal Waters – There is one known thermal water source on WSMR. It is located at Carton Well in the Tularosa Basin. This is an artesian well, and its flow in 1965 was sufficient to maintain approximately 0.6 hectares (2 acres) of open lake and several hectares (acres) of marsh (Summers 1976). This is the only known thermal water area in the Tularosa Basin; therefore, it provides a unique wetland and open water habitat.

3.4.4.3 Cliffs. Extensive high cliffs of limestone, sandstone, and granitic rock characterize the western escarpment of the Oscura Mountains. In addition, cliffs are an important component of the terrain in the San Andres Mountains and other mountainous areas on WSMR. Several species of raptorial birds place nests on these cliffs (Skaggs 1990). Surveys conducted at six general locations in the Oscura, Mockingbird, Fairview, and northern San Andres mountains indicate that more than 30 nests were present at 15 cliff sites in 1990. Species observed indude prairie falcons, golden eagles, and red-tailed hawks. Skaggs (1990) attributed most of the stick nests to golden eagles and red-tailed hawks. The presence of two pairs of prairie falcons was confirmed during the 1990 surveys.

Cliffs on WSMR also provide habitat for sensitive plant species including Mescalero milkwort, cliff brittlebush, and the San Andres rock daisy. It is likely that bats, possibly including the sensitive western mastiff bat and spotted bat, use crevices and other openings in the cliff face as shelter and roosting sites. In addition, the talus that accumulates at the base of some cliff systems in the San Andres Mountains provides habitat for sensitive land snails of the genus Ashmunella (Metcalf 1984) (see Section 3.4.4.2). The Oscura Mountain land snail occurs beneath large slabs of limestone rock beneath cliffs in the Oscura Mountains (Sullivan and Smart 1990).

3.4.4.4 San Andres National Wildlife Refuge. This wildlife refuge provides habitat for a variety of sensitive species, and is contained entirely within the boundaries of WSMR. A species of particular interest is the desert bighorn sheep.

3.4.4.5 Malpais Areas. These rugged lava beds provide potential habitat to a number of species. Currently they are known to be used by various bat populations for roosting and nurseries. Other expected and potential species include rodents and birds.

3.4.4.6 Agropyron Meadows. These western wheatgrass meadows are located at higher elevations, and have somewhat higher moisture requirements than lower-level grasslands. They are found in the southern Oscura Mountains.

3.4.4.7 Strawberry Peak. This area is north of the San Andres National Wildlife Refuge, but still within the San Andres Mountains. It is a known habitat of the desert bighorn sheep, and has been used for lambing.

3.4.4.8 Caves and Mines. Caves and mines are located throughout the mountainous areas of WSMR. Both habitats are used extensively by bat populations for nesting and breeding as well as other migratory and feeding behaviors.

3.4.4.9 Cactus Community Vegetation. These communities are found primarily in the upper bajada regions surrounding the San Andres Mountains. They provide habitat for several species of cacti found on the state and federal lists of threatened and endangered species.

3.4.4.10 Mound Springs Complex. These geologic mound formations typically give rise to springs and are potential water sources. Springs already existing at some of these mounds provide habitat for the White Sands pupfish. The line of mounds is located just below the bajada on the southern side of the Oscura Mountains.

3.5 SOCIOECONOMICS

This section addresses the existing socioeconomic conditions and characteristics in the WSMR region of influence (ROI). The ROI for socioeconomics comprises those jurisdictions within which the majority of WSMR-related economic activity occurs and in which a majority of installation personnel reside. The ROI for socioeconomics indudes the counties of Doña Ana, Lincoln, Otero, Sierra, and Socorro in New Mexico, and El Paso in Texas (Figure 3-11). Socioeconomic resources analyzed include population, historic and current employment, income, housing, and public services. A brief description of demographic characteristics at the state level is provided. Major employment sectors, total personal income, and per-capita income are described. In addition, current levels of WSMR-related employment, payrolls, and expenditures are detailed. The housing subsection describes the existing conditions of the local housing market. Major public services also are discussed.

3.5.1 Population

Historic and current (1990) census populations for New Mexico, Texas, and the counties within the ROI are presented in Table 3-29. The estimated 1990 New Mexico population was approximated to be 1.5 million, a 16.2-percent increase over 1980 levels. During the first half of the decade (1980 to 1985), population in New Mexico increased 11.3 percent. In the second half of the decade (1985 to 1990), population growth slowed to 4.4 percent. Population in the state of Texas increased 19.4 percent over the decade to approximately 17 milllon. The six-county ROI can be characterized as generally rural, with most of the population concentrated in the cities of EL Paso, Las Cruces, and Alamogordo. The six ounty ROI had a 1990 census population of approximately 815,900. This represented a 24.9-percent increase for the decade. The largest counties in terms of population were El Paso (592,000) and Dona Ana (135,500); the smallest were Sierra (9,900) and Lincoln (12,200). Lincoln County experienced the largest increase during the first half of the decade (25.5 percent), but also experienced the only decrease in population during the second half of the decade (-11.5 percent).

Approximately 74 percent of the six-county ROI 1990 population was concentrated in the three largest communities, El Paso (515,300), Las Cruces (62,100), and Alamogordo (27,600). Communities within the ROI grew at varying rates. The population of the city of El Paso, Texas, grew 12 percent over the decade, a slower rate than either the state or the county. The cities of Alamogordo and Las Cruces in New Mexico had population growths over the decade of 15 and 38 percent, respectively. These increases were similar to the rates experienced by each of their respective counties.

Demographic data from the 1990 census for El Paso County indicated a racial composition of 76 percent white, 3 percent black, and 21 percent other. The 1990 census for the state of New Mexico population indicated a racial composition of 76 percent white, 2 percent black, and 22 percent other. The five New Mexico counties in the ROI, by comparison, were 88 percent white, 2 percent black, and 10 percent other.

3.5.2 Employment

Historic and recent employment data for New Mexico, Texas, and the counties within the ROI are presented in Table 3-30. Total employment over the decade (1981 to 1990) for New Mexico and Texas has grown 25.7 and 20.4 percent, respectively. The six counties composing the ROI experienced a slightly larger increase, 26.4 percent, for the decade.

The nonfarm component of employment increased at a rate approximately 2 percentage points greater than total employment over the decade for both New Mexico and Texas. The major

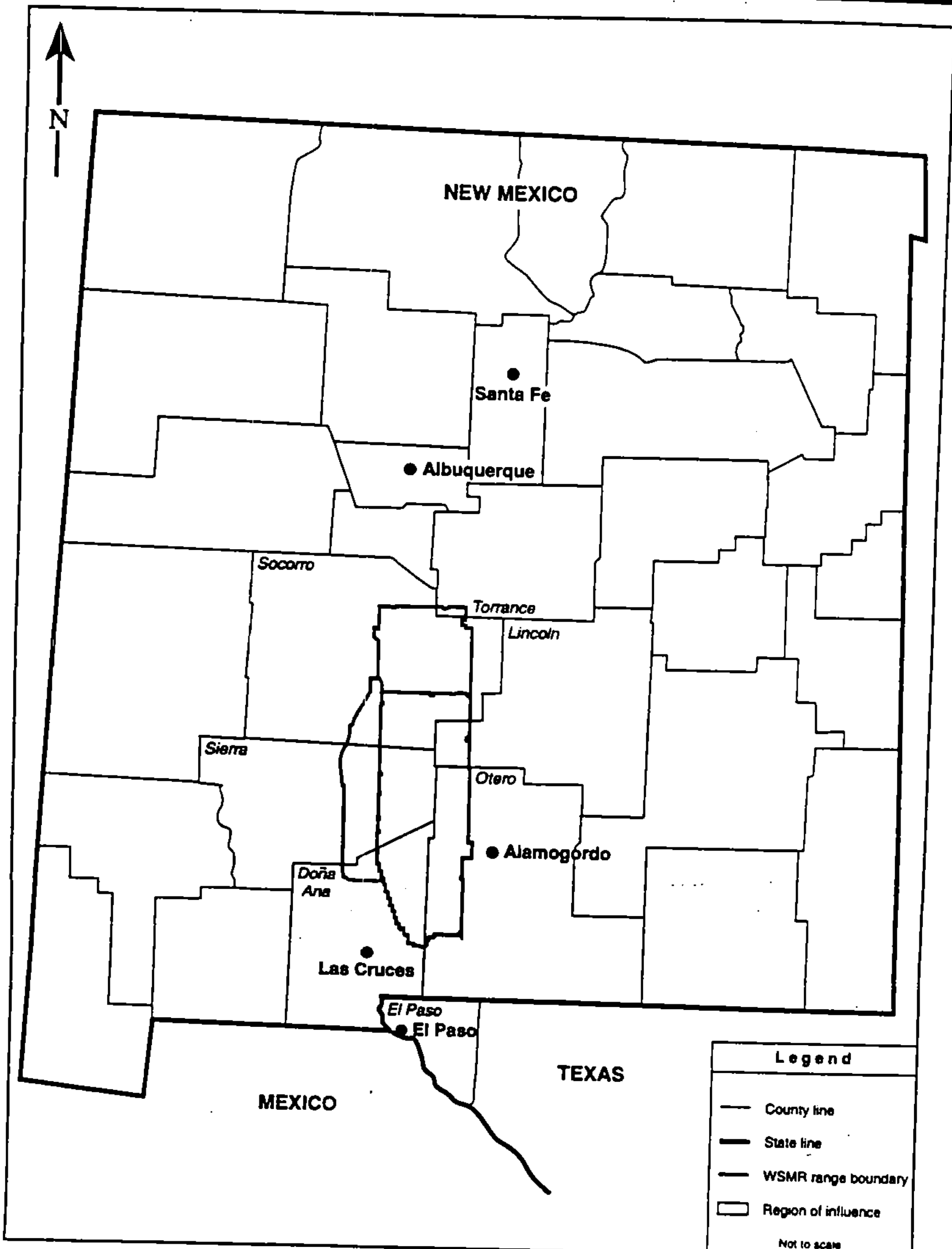

Figure 3-11. Socioeconomic region of influence

Table 3-29
Historic population for New Mexico, Texas, and the ROI from 1980 to 1990

Location	1980	1984	1986	1988	1990	Percent Change 1980 to 1990
State						
New Mexico	1,303,000	1,423,700	1,479,000	1,503,000	1,515,100	16.3
Texas	14,229,000	15,988,500	16,682,000	16,837,000	16,986,500	19.4
County						
Doña Ana	96,300	112,200	123,000	128,000	135,500	40.7
El Paso	479,900	526,500	561,500	585,900	591,600	23.3
Lincoln	11,000	13,500	13,600	13,400	12,200	10.9
Otero	44,700	49,500	50,200	50,800	51,900	16.1
Sierra	8,500	8,900	9,400	9,700	9,900	16.5
Socorro	12,600	14,500	14,700	14,500	14,800	17.5
Six-county Region	653,000	725,100	772,400	802,300	815,900	24.9

Sources: U.S. Bureau of the Census 1983a, 1983b, 1986a, 1986b, 1988a, 1988b, 1990a, 1990b, 1993a, 1993b.

non-farm employment sectors in the ROI are government (33 percent), services (23 percent), and retail trade (17 percent). Farm employment, on the other hand, decreased 13.4 percent in New Mexico and 12.0 percent in Texas over the decade.

Military employment for the counties within the ROI has varied. These changes are likely tied to fluctuations in military program budgets and activities at WSMR. From 1981 to 1990, three counties showed an increase in military employment and two showed decreases. Doña Ana, Lincoln, and Sierra counties showed increases of 49.6, 31.7, and 29.0 percent, respectively. The number of military personnel employed in these three counties has increased from 503 to 739, a 46.9-percent increase. Otero and Socorro counties showed decreases of 18.9 and 3.2 percent, respectively. The number of military personnel employed in these two counties decreased from 6,987 to 5,882, an 18.7-percent decrease. Overall, the number of military personnel employed in the five counties decreased from 7,490 to 6,621, a 13.1-percent decrease.

3.5.3 Income

Per-capita personal income for the state of New Mexico grew from $8,148 in 1981 to $14,052 in 1990, an increase of 72.5 percent (U.S. Bureau of Economic Analysis 1991c). In constant 1990 dollars, the increase measured 11.1 percent. Per-capita personal income for the state of Texas grew from $9,853 in 1981 to $16,580 in 1990, an increase of 68.3 percent (U.S. Bureau of Economic Analysis 1991d). In constant 1990 dollars, the increase measured 8.4 percent.

Table 3-30
Total employment for New Mexico, Texas, and the counties within the WSMR ROI

Location	1981	1985	1990	Employment Growth Percentage 1981–1985	1985–1990	1981–1990
State						
New Mexico	595,300	675,636	748,255	13.5	10.7	25.7
Texas	7,500,000	8,701,602	9,029,733	16.0	3.8	20.4
County						
El Paso	177,995	202,015	223,901	14.1	10.3	26.0
Doña Ana	39,260	47,897	56,755	22.0	18.5	44.6
Lincoln	6,220	7,419	6,987	19.3	-5.8	12.3
Otero	23,078	25,681	24,956	11.3	-2.8	8.1
Sierra	3,068	2,649	3,152	-13.7	19.0	2.7
Socorro	4,970	5,490	6,246	10.5	13.8	25.7
Six-county Region	254,591	291,151	321,997	14.6	10.3	26.4

Sources: U.S. Bureau of Economic Analysis 1991a, 1991b.

The counties within the ROI experienced a 54.7-percent increase in nominal per-capita income for the decade. Income in Socorro County increased the most (63.6 percent); in Sierra County the least (49.1 percent). In constant 1990 dollars, the increase measured 9.3 percent for the counties combined. The Socorro County increase was 15.6 percent, and for Sierra County it was 5.4 percent.

3.5.4 Housing

Housing for personnel employed at WSMR consists of housing on the installation, which is used primarily for military personnel, and within the surrounding communities. WSMR troop housing consists of three 326-person and two 163-person permanent U.S. Army barracks plus one 110-person U.S. Navy barrack (U.S. Army 1985a). Four separate Bachelor Officers Quarters provide capacity for 190 personnel. In addition, there are 885 family housing units at WSMR (U.S. Army 1985a). According to 1990 census data, Las Cruces had 24,450 total housing units, Alamogordo had 12,000, and El Paso had 168,600. The median value of owner-occupied housing units was $67,300 in Doña Ana County (Las Cruces), $58,000 in Otero County (Alamogordo), and $57,300 in El Paso County (USASDC 1993).

3.5.5 Public Services

School facilities are located on the Main Post at WSMR adjacent to the family housing area. There are two facilities, one for kindergarten (80-student capacity) and one operated by the Las Cruces School District for grades 1 through 8 (900-student capacity) (U.S. Navy 1993).

Civil and military police, fire protection, and emergency medical treatment services are operated and/or supervised by the U.S. Army at WSMR. Most of the personnel providing these services are based at the Main Post (U.S. Navy 1993). Health facilities are available through the McAfee U.S. Army Health Clinic (U.S. Navy 1993). For off-installation areas of the region, education, public safety, and health services are provided by local jurisdictions (city and county).

3.6 CULTURAL RESOURCES

This section describes the cultural resources on WSMR and in the northern and western Call-Up Areas. Programs designed to protect resources on the range, a cultural overview, and cultural-temporal sequences on site are also discussed.

3.6.1 Introduction

This section describes the existing archaeological program at WSMR, consultation of national and state registers of historic and cultural resources, consultation with Native Americans, and a model for predicting locations of cultural resources at WSMR.

3.6.1.1 The Archaeological Program. The archaeological program currently being implemented by the U.S. Army at WSMR is being conducted in accordance with NEPA Army Regulation AR 200-2, AR 420-40, Executive Order 11593, Section 106 (36 CFR 800) of the National Historic Preservation Act (NHPA) of 1966, and the Archaeological Resource Protection Act of 1979. Other regulations that must be taken into account include the Archaeological and Historic Preservation Act, the American Indian Religious Freedom Act, and the Native American Graves Protection and Repatriation Act (NAGPRA).

NEPA states that important cultural resources must be considered as part of the federal environmental impact planning process. The inclusion of this provision in the act reflects national concern over the destruction of cultural resources throughout the country, which led to passage of the NHPA in 1966. Although the Advisory Council on Historic Preservation and the Section 106 and 110 review processes were established at this time, it was not until Executive Order 11593 was implemented that federal agencies were directed to inventory federal lands for environmental compliance. In response to these factors, the U.S. Army issued AR 420-40, a regulation that directs all military installations that have or are likely to have cultural properties that meet criteria established by the National Register of Historic Places (NRHP) to prepare a comprehensive historic preservation plan.

Federal agencies are required by Sections 106 and 110 of the NHPA and the Advisory Council on Historic Preservation regulations implementing Section 106 to take into account the effect of any undertaking within their jurisdiction on properties included in or eligible for the NRHP. Before approval of any project that may affect such properties, agencies must afford the Advisory Council on Historic Preservation a reasonable opportunity to comment (36 CFR 800.1). Agencies must identify potential historic properties; evaluate them for eligibility for listing on the National Register; if eligible, manage them if they are under federal jurisdiction; consider the effects of actions on them; undertake and encourage their preservation; and/or document them if they must be altered or destroyed. In complying with these regulations, agencies are able to reduce effects on historic properties while meeting the needs of an undertaking.

For large or complex projects, or undertakings that would otherwise require numerous individual requests for Advisory Council on Historic Preservation comment, an agency's Section 106 responsibilities can sometimes be fulfilled through a Programmatic Memorandum of Agreement (PMOA). Such agreements, once approved and executed, satisfy Section 106 responsibilities for all individual undertakings within a proposed action (36 CFR 800.13[a][e]). WSMR entered into a PMOA with the Advisory Council on Historic Preservation, and the New Mexico State Historic Preservation Office (SHPO) in 1985. The PMOA implements provisions of the NHPA of 1966 and addresses the protection and management of historic and prehistoric properties on the range.

In addition to the PMOA, WSMR has entered into an Memorandum of Understanding (MOU) with the SHPO specifically addressing land use management for the Trinity National Historic Landmark located in the northern portion of the range. WSMR also has entered into an MOU with the National Park Service (NPS) regarding overflight and recovery activities within WSNM, as well as a data-sharing agreement with the New Mexico SHPO, signed in 1986.

Cultural resources are identified as significant if they are determined eligible for inclusion in the NRHP. Properties are deemed to be National Register-eligible if they are important in American history, architecture, archaeology, engineering, or culture. They must possess integrity of location, design, setting, materials, workmanship, feeling, and association, and meet at least one of the following four criteria (36 CFR Part 60.4):

a. be associated with events that have made a significant contribution to the broad patterns of our history;

b. be associated with the lives of persons significant in our past;

c. embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant distinguishable entity whose components may lack individual distinction; or

d. have yielded, or be likely to yield, information important in prehistory or history.

In implementing these definitions, it has become common practice to delineate three basic categories of resources: prehistoric resources, historic era sites, and ethnographic or traditional cultural properties.

Prehistoric resources are defined as sites and associated artifacts that date from before the time of written records. In southern New Mexico, "prehistory" refers to that period of time predating the Spanish entrada. Prehistoric resources represent Native American cultures and societies. Historic resources are defined as those sites or properties that were occupied or used after written records became available. Ordinarily, properties must be at least 50 years old in order to be deemed historic. The four NRHP criteria can apply to properties less than 50 years old within WSMR. An exception to the 50-year guideline is Cold War properties on the range. Federal agencies are considering stewardship of specific scientific and technical facilities that historically represent the nation's development and achievements during the mid- to late 20th century. These structures are monuments to the unique technological advances in the United States, but often are inactive or obsolete facilities threatened by inadequate maintenance or neglect. Ethnographic resources (Traditional Cultural Properties) are locations of heritage that are important to contemporary communities.

3.6.1.2 Consultation of National and State Registers. The NRHP and the New Mexico State Register of Cultural Properties were reviewed for register properties within the WSMR boundaries. Only two NRHP sites are located within the WSMR boundaries. Three

New Mexico State Register of Cultural Properties sites are located in areas adjacent to WSMR, one of which also is an NRHP site.

The first well known historic area, the Trinity Site, is located in the north-central portion of the range approximately 13 km (8 mi) southeast of SRC. It is both a National Historic Landmark and an NRHP property (Figure 3-12).

The Manhattan Project was begun during World War II to develop an atomic bomb. While research was conducted at Los Alamos, the Trinity Site was selected as a testing site. Work at the site began in 1944, and the test detonation occurred on July 16, 1945. The bomb was assembled at the nearby McDonald ranch house. The subsequent explosion left a crater 244 m (800 ft) in radius and 2.4 m (8 ft) deep. Trinitite, formed by sand being fused into glass under the heat and force of the detonation, was scattered in and about the original crater.

Trinity Site National Historic Landmark encompasses 14,736 ha (36,480 ac), and includes Ground Zero (detonation site), various instrumentation bunkers, the McDonald Ranch, a nearby base camp, and "Jumbo" – a huge steel vessel designed to enclose the plutonium in the event of an unsuccessful test. The McDonald Ranch complex consists of a stone farmhouse and several stone outbuildings. The ranch house has been renovated and includes restoration of test-era graffiti on the interior walls.

LC-33 is a National Register site and a National Historic Landmark, located 8 km (5 mi) east of the WSMR Main Post (Figure 3-13). There are two important structures at the site, the U.S. Army blockhouse and the gantry crane. The blockhouse was constructed in 1945 and was used as a laboratory for the study of captured German V-2 rockets. The gantry crane was constructed in 1946 to launch the V-2 and Viking rockets. The gantry crane has been restored to its original configuration and has an inert Viking Rocket (on loan from the Smithsonian Institution) on display.

The Mockingbird Gap site is an New Mexico State Register of Cultural Properties property adjacent to WSMR located on and administered by BLM. It is located approximately 0.4 km (0.25 mi) south of U.S. Highway 380, north of the Oscura Mountains. The site is a multicomponent Clovis campsite with a possible Folsom component, Archaic period artifacts, and a Formative period pithouse.

WSNM Historic District and the Parabolic Dune Hearth Mounds within the monument are both listed on the New Mexico State Register of Cultural Properties . The district also is on the NRHP. Both areas are located north of U.S. Highway 70, approximately 16 km (10 mi) west of Alamogordo, New Mexico. These areas are located within WSMR, but are administered by the NPS.

3.6.1.3 Consultation With Native Americans. Several Traditional Cultural Properties exist in the vicinity of the range. These properties are of primary interest to the Mescalero Apache, whose lands are on the northeastern periphery of WSMR. As of 1981, the Mescalero Apaches (population 2,145) occupied approximately 186,160 ha (460,000 ac) in the Sacramento Mountains of southern New Mexico. The population also includes the last remnants of the Lipan Apache tribe as well as an unreported number of Chiricahua Apaches. These three Apache tribes have intermixed widely and have become increasingly assimilated while retaining distinct cultural traits (Opler and Opler 1950).

Available records indicate that mountainous regions in the northern portion of WSMR have been used as traditional religious sites by Native Americans. Mr. Nathaniel Chee, an elder of

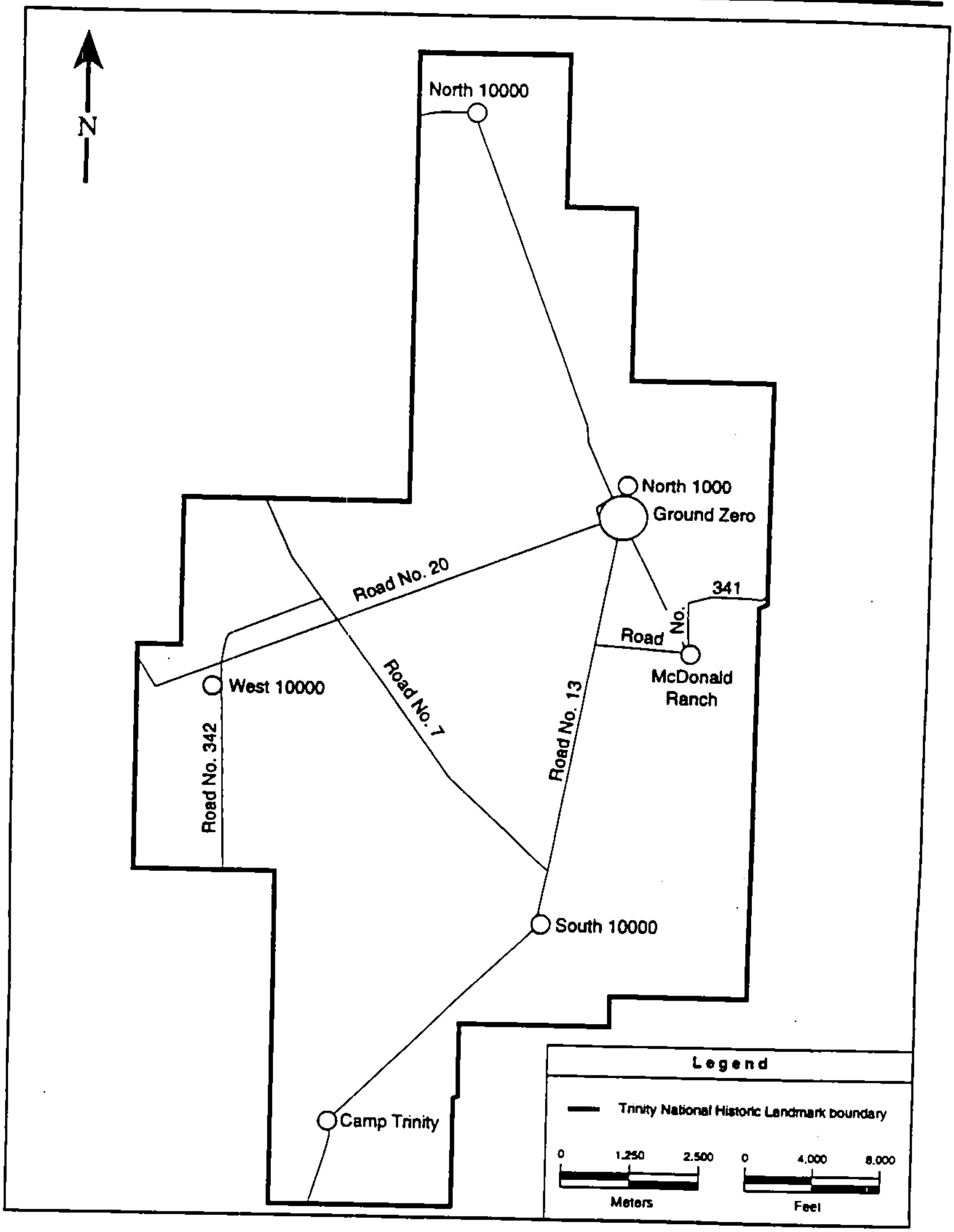

Figure 3-12. Trinity National Historic Landmark

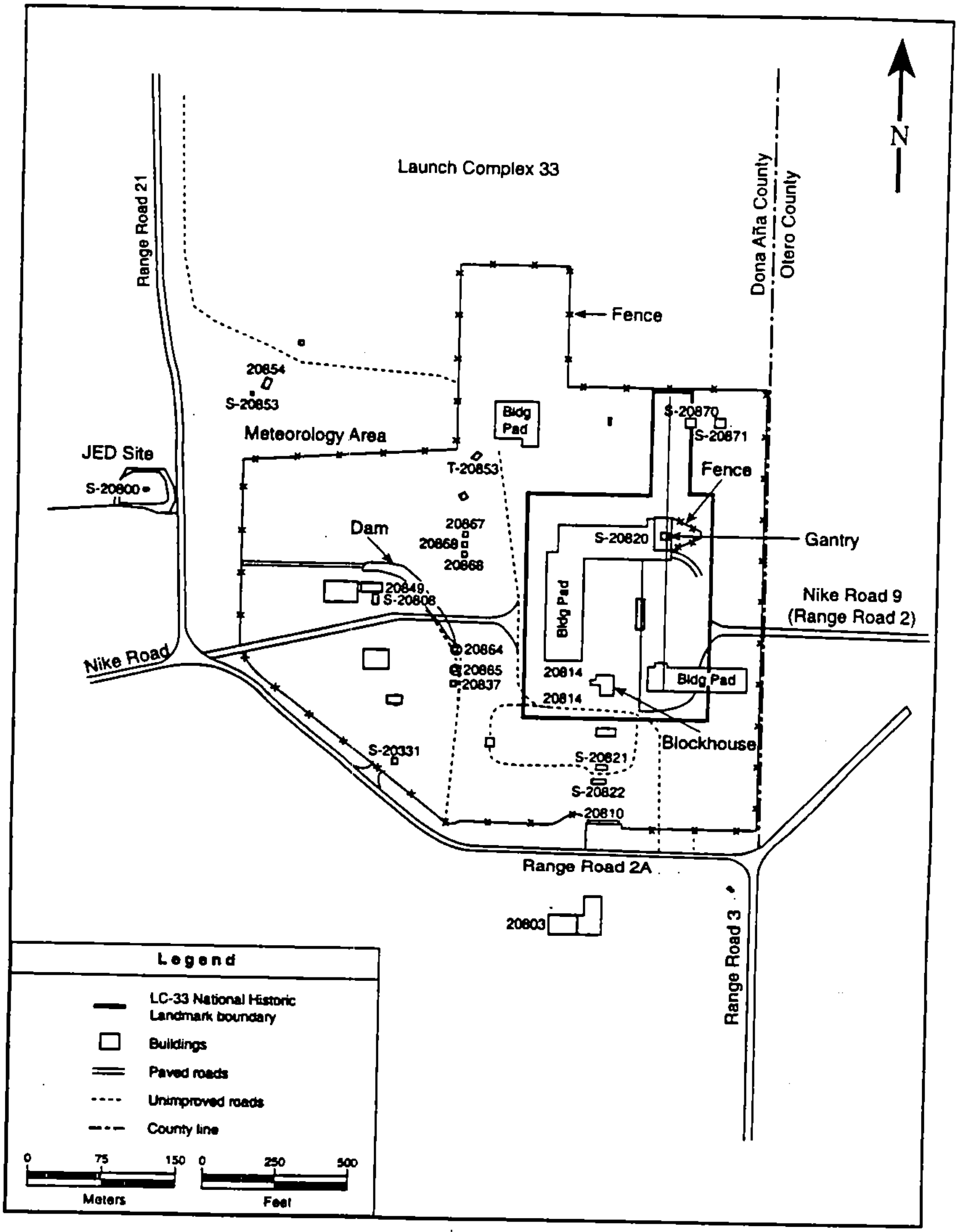

Figure 3-13. LC-33 National Historic Landmark

the Mescalero Apache tribe, has indicated that the Oscura Mountains are the Sacred Mountains of the northern region for the Mescalero Apache tribe. Mr. Chee also indicated that there are prayer sites located throughout the Oscura Mountains. Salinas Peak, in the San Andres Mountains, is the Sacred Mountain for the eastern Chiricahua Apaches (Human Systems Research, Inc. 1991).

3.6.1.4 Surveyed Area and Estimated Density of Archaeological Sites. As of September 1993, archaeological surveys have been conducted on 6.72 percent, or 59,484 ha (146,983 ac), of WSMR; 93.29 percent remains uninspected. Survey coverage is separated into two distinct categories based on pedestrian transect widths; that is, the space in meters between archaeologists walking parallel transects across the terrain to survey an area. Transect spacing of 0 to 15 m between individuals is considered adequate by current standards.

Archaeological inspection of 2.76 percent, or 60,483 ac, of WSMR has been surveyed at this interval. Surveys with pedestrian spacing in excess of 15 m is questionable by current professional standards, as isolated artifacts and sediment-covered sites are difficult to locate at these distances. Surveys were conducted over 1.67 percent, or 14,763 ha (36,480 ac), of WSMR in this fashion. The majority of this work was performed prior to 1983, and represents transect spacing of 25 to 50 m. Data gathered from WSMR cultural resource reports indicates that 2.29 percent, or 22,359 ha (50,020 ac) of additional land within the range has been archaeologically surveyed. The coverage intensity for these surveys was not recorded in the documents, leaving the reliability of these surveys in question. The total number of documented sites for WSMR and WSMR Call-Up Areas totals approximately 3,000. The total archaeologically surveyed acreage of WSMR and the Call-Up Areas (approximately 147,000ac or 59,500 ha) divided by the toal number of sites equals approximately 13 sites per square mile (640 ac [259 ha]).

3.6.2 Cultural Overview

This section provides a cultural overview of WSMR and the surrounding region.

3.6.2.1 Previous Research. Cultural resources at WSMR have been investigated as a result of specific military actions and academic research. Archaeological investigations in the Tularosa Basin began during the 1930s and the 1940s. Archaeologists including Lehmer (1948), Cosgrove (1947), and Jennings and Neumann (1940) worked throughout this area of the southwest. Lehmer (1948) established the concept of the Jornada Branch of the Mogollon culture based on excavations at sites to the east and west of the WSMR boundaries. Temporal phases for the Formative period occupations (Mesilla, Doña Ana, El Paso) in the area were established based on the changes in the material culture and architectural assemblages. During the 1960s, Kelly (1984) examined several sites in the basin, and the El Paso Archaeological Society conducted a series of small excavations in the southern part of the Hueco Bolson. Large-scale cultural resource surveys began during the 1970s and continue today. This work is based primarily on cultural resource management legislation that requires this type of work on federally administered land.

It was not until the 1920s and the 1930s that archaeological research was initiated in south-central New Mexico and west Texas. Prior to that time, the area was virtually ignored due to the relative lack of visible prehistoric remains in contrast to other areas of the southwest, and to the purported peripheral nature of the prehistoric cultures inhabiting the area east of the Rio Grande (Breternitz and Doyel 1983).

The first major, systematic archaeological work in the Tularosa Basin and the Hueco Bolson was undertaken in the 1930s and the 1940s by Cosgrove (1947), Jennings and Neumann

(1940), Lehmer (1948), and Wilson (1930). Cosgroves' work includes the regional investigation of dry cave sites in southern New Mexico and West Texas, specifically the Mimbres, Gila, and San Francisco river drainages; the Southern Rio Grande Valley; and the Hueco Mountains. Additionally, Jennings and Neumann (1940) excavated two pithouse sites in the Sacramento Mountains, and Wilson (1930) excavated numerous rock "middens" in the nearby El Paso, Texas, area. These investigations, along with several others, pioneered the way for future archaeological work in the region (U.S. Army 1990b).

In order to reconstruct the cultural history of the region, Cosgrove (1947) classified and described the cultural material recovered from the caves including foodstuffs, weapons, textiles, sandals, basketry and matting, ceremonial objects, petroglyphs, pictographs, and burials. Cosgrove, and the archaeological community in general, viewed the culture and history of the Tularosa Basin and the adjacent Hueco Boison as peripheral to the major developments in other areas of the American Southwest, where aggregated populations and complex architectural or farming technologies had already been the focus of large-scale archaeological investigations. Cosgrove used the Pecos classification, the established cultural classification system for the prehistoric Pueblo Southwest, as the basis of his interpretive framework (Kidder 1927). Various sources (Carmichael 1986; U.S. Army 1990b) have noted that this view of the Formative period occupation of south-central New Mexico is a derivation of Anasazi adaptations that has persisted, in varying degrees, to recent times.

In 1948, Lehmer published the first large-scale cultural synthesis of the south-central New Mexico-west Texas area. Lehmer's work shares the viewpoint that the culture of south-central New Mexico was derived from Anasazi adaptations, and forms the intellectual foundation for all current cultural reconstructions of the prehistoric occupation of the region. Lehmer developed the concept of the Jornada Branch of the Mogollon culture area, following his excavations at the Los Tules pithouse village (Mesilla Phase), a number of pueblo (El Paso Phase) settlements near Alamogordo, and the La Cueva site (Doña Ana and El Paso Phases) for the Formative period, each of which is characterized by specific material and architectural assemblages (Breternitz and Doyel 1983).

Following this initial activity, the archaeological community showed little interest in south-central New Mexico until the 1960s, when the El Paso Archaeological Society began a series of small excavations at late Formative period sites (Carmichael 1986). The society has been active sporadically, primarily in the Tularosa Basin area, although these efforts have produced only small descriptive reports on isolated finds (Russell 1968).

The 1970s saw a dramatic rise in the amount of archaeological work undertaken in south-central New Mexico, due to the importance of cultural resource management legislation. The largest archaeological projects conducted in the region during this period were large, contracted surveys on Fort Bliss south of the WSMR boundary (Beckes 1977; Skelton et al. 1981; Carmichael 1982; Seaman et al. 1988; U.S. Army 1990b) and sample surveys in the Hueco Bolson (Whalen 1977, 1978).

Even with the increase in cultural resource management-associated projects, archaeological investigations conducted on lands within the WSMR boundaries have been limited. Before 1983, only 61 archaeological surveys had been conducted at WSMR, resulting in 325 recorded archaeological sites.

A historic-properties report was prepared in 1985 for the WSMR historic preservation plan (Brenner 1984). Major ranches and important military structures were identified and recorded. This included 64 ranches, homesteads, and line camps; 3 mining sites; 1 mining town (Estey

City); 3 stage stations; 1 school; 2 stone ruins; 1 sheep shed; Civilian Conservation Corps structures; and military structures. A total of 102 structures were identified. A review of this inventory project in 1989 (Eidenbach 1989) determined that many structures had been overlooked by virtue of their remote location and previously undocumented status. The uninventoried sites included buildings, stock tanks, windmill, and spring sites. This historic inventory has been updated as part of this project. Sections 3.6.3.5 and 3.6.3.6 review the historic structures as currently plotted in the WSMR GIS data base.

3.6.2.2 Recent Archaeological Survey and Mitigation Programs. The following is a general overview of recent archaeological survey and mitigation programs.

South-range Surveys

Archaeologists have conducted reconnaissance surveys and excavations on WSMR since the 1930s (Dennis 1931), but no complete synthesis was attempted until 1983. At this time, the U.S. Army DARCOM (the former name for the Army Materiel Command) conducted a comprehensive historical and archaeological literature survey of known properties within WSMR (Breternitz and Doyel 1983). A description of selected survey and mitigation projects ordered geographically from the southern end of WSMR and moving up range follows (Figure 3-14). Surveys south of U.S. Highway 70 cover approximately 21,850 ha (54,000 ac). Sixty surveys have been conducted in this southern portion of WSMR.

During the 1984 Border Star Readiness Exercise, a large government inventory survey was conducted (Seaman et al. 1988). The Border Star Survey was a two-phase project (based on survey intensity), which encompassed 225 km^2 (87 mi^2). A subsequent project, the Ground-Based Free Electron Laser Technology Integration Program (GBFEL-TIE), resulted in additional survey work of approximately 20 km^2 (7.7 mi^2) within the original Border Star project area. A total of 422 sites were identified in the GBFEL-TIE project area. Twenty-seven were tested formally, 16 of which were determined to be eligible for listing on the register. In 1986, a 26-ha (64-ac) parcel was surveyed at the site of the GBFEL-TIE project, with further testing conducted at the site during 1989. Additional surveys were carried out within the western portion of the original Border Star area in 1991 at the Orogrande site. Forty ha (100 ac) were surveyed in 8-ha (20-ac) sample parcels, and seven sites were documented.

WSTF has performed the most extensive survey of any tenant. WSTF lands are located within 24 km (15 mi) to the northwest of WSMR Main Post. Surveys in the WSTF area 4,000+ ha (10,000 + ac) to date, and findings represent all cultural periods.

Central- and North-range Surveys

To date, 192 surveys have been conducted in the central and north range areas on WSMR north of U.S. Highway 70. The surveys have covered approximately 37,640 ha (93,000 ac). This section describes selected projects within the area showing an overview of the type of work performed.

Northwest of the Oscura Range, Weber and Agogino (1968) excavated the Mockingbird Gap site, a large Clovis PaleoIndian campsite dating approximately 11,000 years before the present (BP). Recently, extensive surveys have been conducted throughout the central and north range. For example, surveys east of the Oscura Mountains (Shields 1991) include several bombing areas. The western slope of the Oscura Mountains (Browning 1990) has seen activity, and a sample survey based on environmental zones, defined by elevation and vegetation, was conducted in the central San Andres Mountains (Human Systems Research,

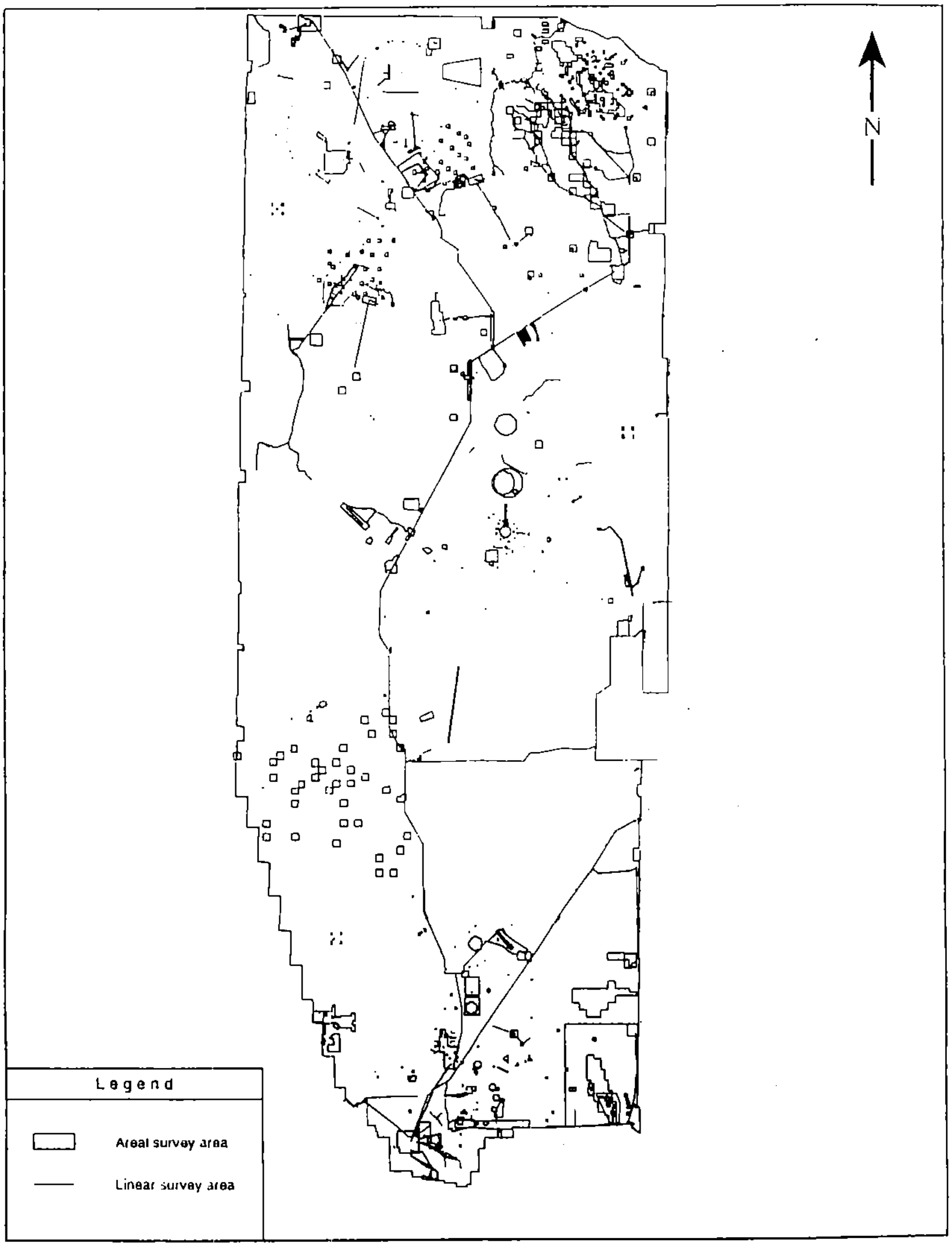

Figure 3-14. Areas within WSMR surveyed for cultural resources

Inc. 1991). In the Trinity Basin, four large compliance and management/planning surveys were completed including an inventory of the SRC (Kirkpatrick 1986), an inventory survey for explosive testing (Laumbach 1981), surveys for large target areas (Clifton 1986), and a stratified sample survey of the greater Stallion vicinity (Seaman et al. 1988).

Numerous other projects have provided extensive data on prehistoric and historic occupations in the northern and central portions of WSMR (Clifton 1986; Human Systems Research, Inc. 1973; Wimberley and Rogers 1977) and the WSNM (Eidenbach and Wimberley 1980).

3.6.2.3 Reconstruction of Paleoenvironmental Trends. The paleoenvironmental sequence for south-central New Mexico and the Basin and Range province has been studied in some detail. Paleoenvironmental sequences are closely tied to trends in prehistoric human behaviors related to land use. Late Pleistocene vegetation and climate histories of the northern Chihuahuan Desert have been reconstructed through studies of fossil packrat middens and soil genesis over the past 25 years. Several regional paleoenvironmental sequences have been based on evidence obtained from fossil pollen (Martin 1963), geochronology (Antevs 1955, 1983), and packrat middens (Van Devender and Spaulding 1979; Van Devender et al. 1983). Correlations with the European climatic sequences also have been developed (Antevs 1955).

The transition from Wisconsin conifer forests to modern Chihuahuan desert scrub occurred over the past 18,000 years. Changes in climate, plant communities, and associated animal populations would have affected the PaleoIndian and Archaic hunters and gatherers who lived in the region over the last 12,000 years. As the plant communities changed in composition and location, hunters and gatherers would have had to select new food resources and move to new locations to exploit these resources. These changes are reflected in the settlement and subsistence patterns of the PaleoIndian and Archaic cultures. The contemporary vegetative communities have appeared only within the last 4,000 to 5,000 years.

The climate for the past 4,000 to 5,000 years, the period during which formative sedentary agricultural subsistence strategies developed, is not well characterized. At the upper elevations, the mixed conifer forest evolved into a juniper-oak woodland. Somewhat later, the woodland shifted toward a grassland. At the lower elevations, the juniper-oak woodland evolved into a desert grassland and then to a Chihuahuan desert scrub (Breternitz and Doyel 1983; Human Systems Research, Inc. 1991).

Knowledge of late Wisconsin and Holocene vegetation and climatic changes has been derived primarily from the study of fossil packrat middens. The analysis of fossil packrat and, more recently, porcupine middens has allowed a very precise reconstruction of paleoenvironmental sequences. Analyses of packrat middens from canyons on the west slope of the Sacramento Mountains has produced an 18,000-year sequence (Van Devender et al. 1983), and middens from Rhodes Canyon in the San Andres Mountains on WSMR have produced a 14,000-year sequence (Van Devender and Toolin 1983). Fifteen carbon-14 dates from the Sacramento series and nine from Rhodes Canyon make these two locations the most accurately dated paleoenvironmental sequences in the study area. Another paleoecological site is reported from the Hueco Mountains (Van Devender and Spaulding 1979), located southeast of the Tularosa Basin. The studies outlined above represent the most complete picture of paleoenvironmental conditions from south-central New Mexico.

3.6.3 Cultural-temporal Sequences

This section reviews the past 9,000 years of human occupation on WSMR and briefly discusses the characteristics of each major cultural-historical period and the local subtraditions and phases recognized in south-central New Mexico. A thorough summary of the prehistoric cultural sequence in south-central New Mexico has been provided previously by Whalen (1978); Human Systems Research, Inc. (1973); Wimberley and Rogers (1977); and Breternitz and Doyel (1983). The area-specific overviews cited above provide more detailed information pertaining to south-central cultural chronology. Six broad cultural-temporal categories apply to the occupation sequence of the northern Tularosa and Jornada del Muerto basins. These categories include PaleoIndian, Archaic, Formative (for two distinct culture areas - the Jornada Mogollon in the southern portion of WSMR, and the Rio Abajo in the northern reaches of the range), Protohistoric, Euramerican/Mexican, and U.S. military (Table 3-31).

3.6.3.1 Paleoindian Sequence. The Paleoindian period dates circa 9000 to 6000 B.C., and appears to have sustained small, highly mobile groups of large game hunters (Carmichael 1985). Several Clovis phase sites - Mockingbird Gap/LA 26748 (Weber and Agogino 1968), LA 39142, and LA 39145 (U.S. Air Force 1983) – are located in the northern part of the basin. Folsom phase sites are slightly more common in this area and are usually situated in the canyons and foothills of large mountain ranges. LA 63880 is one of the largest Paleoindian sites in the basin, and was located and analyzed during a large survey project near the south WSMR boundary (Seaman et. al. 1988). Based on current studies of the Paleoindian occupation of the Tularosa Basin and geomorphic, vegetative, and alluvial processes occurring over the past 10,000 to 12,000 years, WSMR has the highest potential for producing a large quantity of undisturbed Paleoindian materials of any single area in New Mexico (Breternitz and Doyel 1983).

The earliest known occupation of the southwest dates to the early Holocene period, approximately 9000 to 600 B.C. (Lehmer 1948; U.S. Army 1990b). During this era, the climate was cooler and wetter than previously known with numerous lakes and streams found throughout the basin and range region of what is now WSMR. These water resources sustained populations of Late Pleistocene/early Holocene large animals, and with these, small bands of highly mobile human hunters dependent on large game (Carmichael 1985; U.S. Army 1990b; Beckett 1983).

The earliest Paleoindian artifact assemblages are characterized by the Clovis cultural sequence (9500 to 9000 B.C.). The subsequent Folsom phase of the Paleoindian period has been dated elsewhere in the southwest from 9500 to 8000 B.C., and is better represented in the Tularosa Basin and the Hueco Bolson than its predecessor (Judge 1973).

The tool assemblages for these populations consist mostly of lithic hunting and butchering tools, and are distinguished by finely made Lanceolate spear points. Although the phase is poorly represented in south-central New Mexico, isolated Clovis artifacts have been found in the southern Tularosa Basin and in the adjacent Rio Grande Valley. The Mockingbird Gap site and the Rhodes Canyon site (U.S. Air Force 1983) are two places within WSMR that represent the Clovis phase (9000 to 9500 B.C.) of the Paleoindian period.

The Folsom phase (9500 to 8000 B.C.) of the Paleoindian period is better characterized within the confines of WSMR. These sites typically are located adjacent to ancient playas or lakes. Folsom and Clovis phases have similar material culture assemblages across broad geographical regions. The Plano phase (8500 to 6000 B.C.) of the Paleoindian period follows in sequence and is characterized by assemblages that become diverse and spatially circumscribed (Cordell 1974). This phase also is characterized by a gradual drying of the climate, resulting in a regional trend toward an increased emphasis on areas with permanent water resources.

This final horizon of PaleoIndian culture appears to have been followed by a cultural hiatus characterized by increasing aridity and decreasing big game populations. Bison, camel,

Table 3-31
Cultural-temporal sequences within the WSMR region

Period	Date
PaleoIndian	
Clovis	
Folsom	
Plano	9000 B.C. to 6000 B.C.
Archaic	
Early Archaic	
Middle Archaic	
Late Archaic	6000 B.C. to A.D. 400?
Formative-Rio Abajo	
San Marcial	
Tajo Phase	A.D. 700 to A.D. 1000
Early Elmendorf Phase	A.D. 1000 to A.D. 1100
Late Elmendorf Phase	A.D. 1100 to A.D. 1300
Ancestral Piro	A.D. 1300 to A.D. 1546
Formative-Jornada Mogollon	
Mesilla Phase	A.D. 400? to A.D. 1100
Doña Ana Phase	A.D. 1100 to A.D. 1200
El Paso Phase	A.D. 1200 to A.D. 1400+
Protohistoric	
Colonial Piro	A.D. 1540 to A.D. 1680
Manso	A.D. 1540 to A.D. 1870
Apache	A.D. 1540 to A.D. 1870
Spanish	A.D. 1540 to A.D. 1821
Euramerican/Mexican/Apache	A.D. 1821 to A.D. 1942
Government/Military	A.D. 1942 to present

mammoth, horses, and other animals, along with the human populations exploiting them, began an easterly migration to the high plains (Beckett 1983). At approximately 5500 B.C., during the beginning of the Altithermal, the Archaic hunting and gathering tradition began to appear throughout the southeastern and central New Mexican Basin and Range region.

Currently, there are 29 identified PaleoIndian sites within WSMR (Figure 3-15). The distribution of sites by phase is as follows:

- Folsom - 4 sites
- Late/Terminal (Plano) - 1 site
- Unspecified - 24 sites

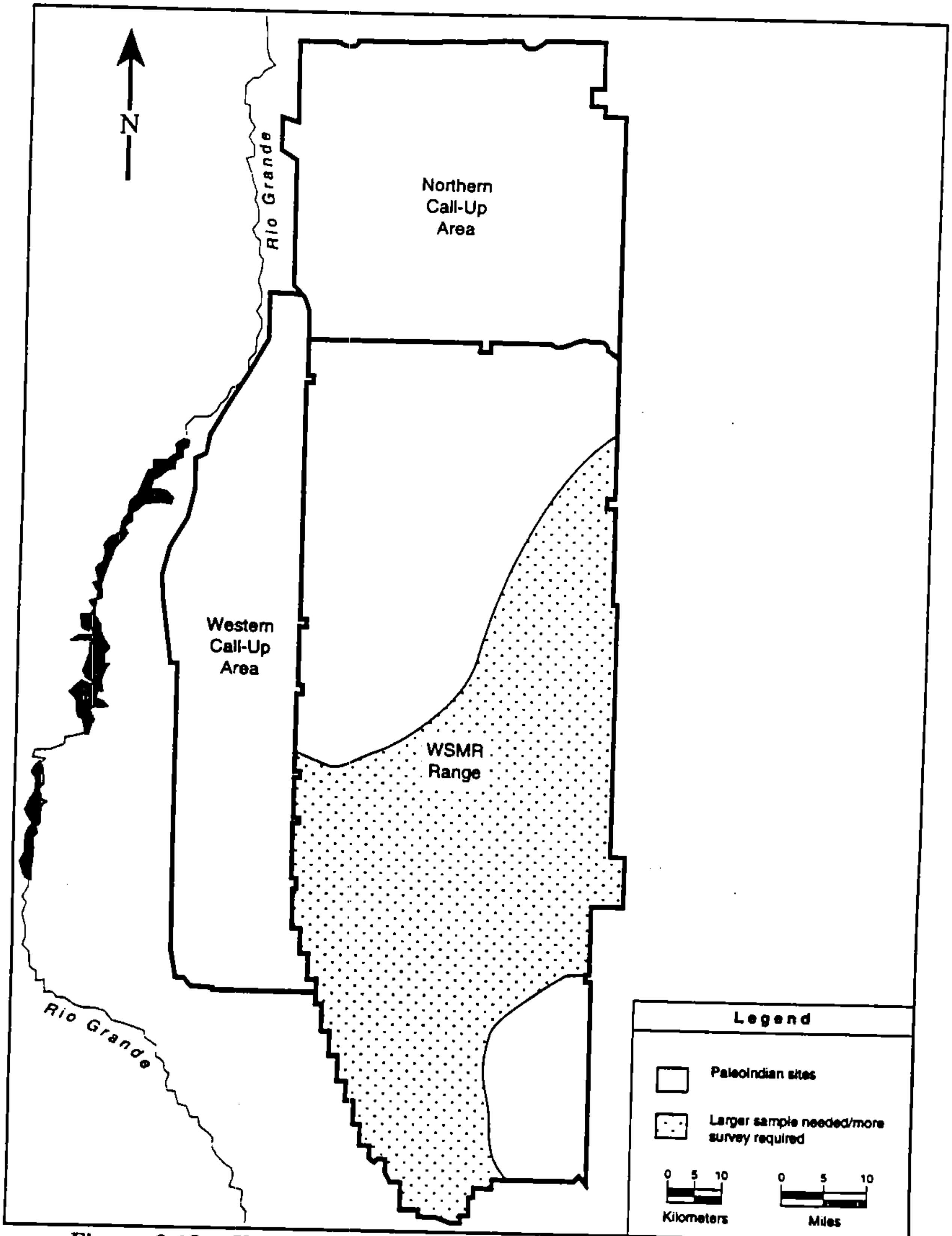

Figure 3-15. Known distribution of PaleoIndian sites within WSMR

3.6.3.2 Archaic Sequence. The Archaic period follows in sequence and represents a temporal span from 6000 B.C. to A.D. 400 (U.S. Army 1990b). Hunter-gatherer groups became slightly less nomadic and appear more territory based with seasonal residential mobility patterns. Agricultural subsistence begins at this time, with an early variety of corn, Chapalote, being recovered from a number of sites including Fresnal Shelter and Keystone, located just east and south, respectively, of the WSMR boundaries (U.S. Army 1990b). Most Archaic sites in the region are believed to represent short-term camps. Within the central basin, Archaic-period sites typically contain lithic debitage and groundstone, as well as fire-affected rock.

The generalized model of Archaic populations as highly mobile, broad-spectrum hunters and gatherers has been inferred mainly from cultural-historical reconstruction of adjacent areas (WSMR 1989a). Little archaeological data have been collected from the Tularosa Basin and the Hueco Boison to provide an independent analytical test of the appropriateness of this inference. In conclusion, most of the discussion of Archaic period demography, settlement, and subsistence of the WSMR area is based on external sources (Breternitz and Doyel 1983).

At present, there are 510 sites identified in the Archaic sequence on WSMR (Figure 3-16). The quantity of sites per phase follows:

- Archaic (early) – 32 sites
- Archaic (middle) – 66 sites
- Archaic (late) – 193 sites
- Archaic Unspecified – 219 sites

3.6.3.3 Formative Sequence. The Formative period began around A.D. 400 and continued until circa A.D. 1400. This period is characterized by an increase in agricultural practices, the manufacture of pottery, the use of the bow and arrow as opposed to reliance on the atlatl, and a progressing habitation preference toward sedentary or semisedentary village life.

Jornada Mogollon

This period of human adaptation in the Jornada Mogollon region differs from the preceding Archaic period primarily by the appearance of a brownware ceramic complex, pithouse architecture, and a subsistence base that was oriented toward agricultural pursuits. According to Lehmer's (1948) definition of Formative period adaptations, post-Archaic populations became increasingly dependent on agricultural production for their subsistence, as the evidence of intensification of farming practices indicates (Carmichael 1985).

Although much of the cultural reconstruction work in southcentral New Mexico has focused on the Formative period, there remains some scholarly disagreement over questions of chronology, terminology, and interpretation of archaeological context for the pithouse-to-pueblo transition in southwest archaeology. For general purposes, the period has been split into three phases based on architectural and ceramic changes.

The Mesilla phase began around A.D. 400 and lasted until A.D. 1100. This phase also has been called the Pithouse phase by Whalen (1980) and is primarily distinguished by both circular and rectangular pithouses. This lengthy occupation is characterized both by pithouse architecture and a variety of ceramic types that include Jornada brown, El Paso brownware, and Mimbres black-on-white.

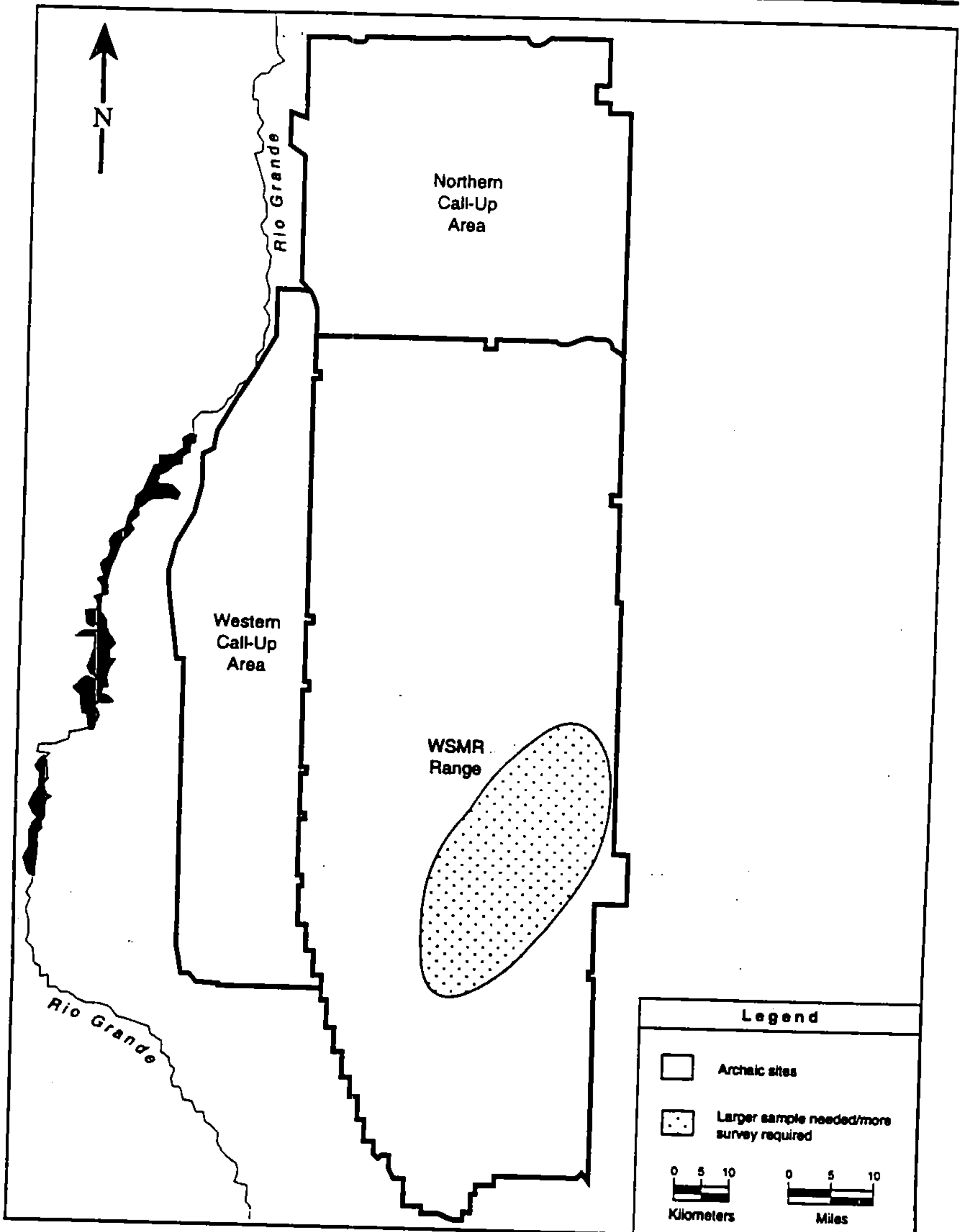

Figure 3-16. Known distribution of Archaic sites within WSMR

The Doña Ana phase (A.D. 1100 to 1200 A.D.), also referred to as the transitional Pueblo phase, follows the Mesilla phase. However, many archaeologists have questioned whether the Doña Ana phase is a useful construct. As defined by Lehman, the Doña Ana phase represented the transition from pithouse architecture to aboveground pueblo structures and an increased reliance on subsistence agriculture for survival (Breternitz and Doyel 1983). Other distinguishing characteristics of the Doña Ana phase include the increasing replacement of El Paso brownware by El Paso polychrome ceramics, and the appearance of intrusive ceramics from Northern New Mexico in the form of Chupadero black-on-white, and St. John's polychrome ceramics (Lehmer 1948).

The El Paso phase (A. D. 1200 to 1400) marks the latest and best-documented span of prehistoric human occupation in south-central New Mexico. Many of the Formative period sites that have been recorded on WSMR to date have been characterized as El Paso phase sites. The beginning of the El Paso phase, as defined by Lehmer (1948) is distinguished primarily by the complete transition to aboveground adobe pueblo architecture and an increase in intrusive ceramic types, including Chupadero black-on-white, Playas red, Three Rivers red-on-terracotta, Ramos polychrome, and Gila polychrome. El Paso polychrome is the dominant ceramic type produced in the region (Breternitz and Doyel 1983).

Currently, 780 sites on WSMR have been identified as belonging to the Mogollon sequence (Figure 3-17). The quantity and phase distribution for these sites are as follows:

- Mesilla – 228 sites
- Doña Ana – 34 sites
- El Paso – 94 sites
- Unspecified – 424 sites

Rio Abajo

The Rio Abajo culture area is divided into four phases: San Marcial, Tajo, early and late Elmendorf, and Ancestral Piro. As with the Jornada culture, this period is characterized by an increased reliance on agriculture, the manufacture of pottery, and a preference toward sedentary or semisedentary village life. The Tajo phase began around A.D. 700 and continued through approximately A.D. 1000. This occupation is characterized by plain and banded brownware ceramics and a change from pithouse to aboveground, rectangular, cobble-based jacal structures. The early Elmendorf phase began around A.D. 1000 and lasted until A.D. 1100. This brief period is noted by an increase in both population and agricultural subsistence, and a trend towards masonry pueblos. The late Elmendorf phase began around A.D. 1100 and continued until approximately A.D. 1300. Corrugated pottery is dominant and pithouses are rare. There was a strong trend during this phase toward large, fortified masonry pueblos built around plaza areas. This sequence is followed by the Ancestral Piro phase, which began around A.D. 1300 and continued until Spanish contact in A.D. 1546. This phase saw a large increase in population, and resulted in a marked growth in puebloan architecture. Pueblos of 200 to 600 rooms were constructed.

A total of 21 sites on WSMR have been identified as being part of the Rio Abajo (Anasazi) classification (Figure 3-18). The number of sites, as distributed by phase, follows:

- Tajo – 3 sites
- Elmendorf (early and late) – 1 site
- Unspecified – 17 sites

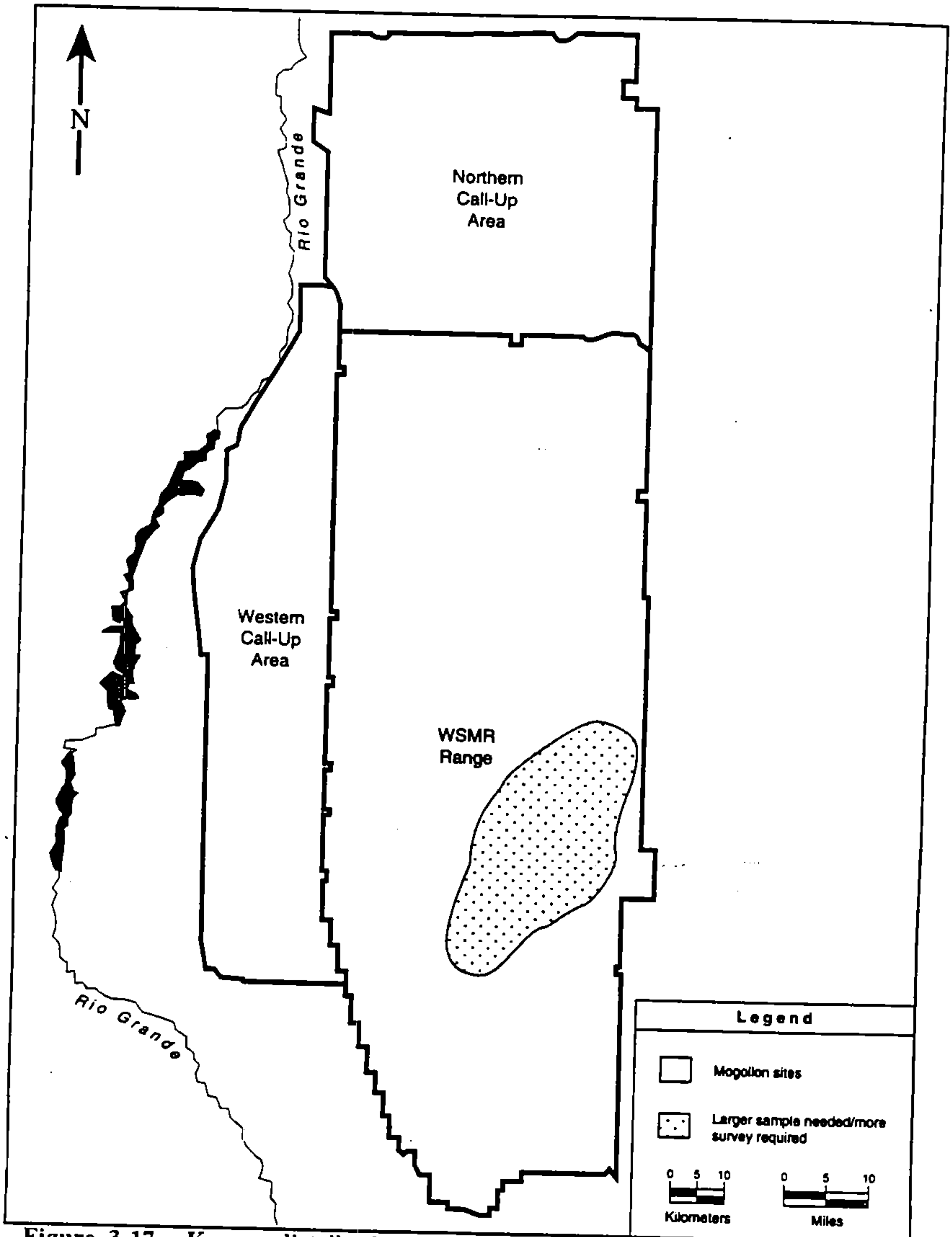

Figure 3-17. Known distribution of formative Mogollon sites within WSMR

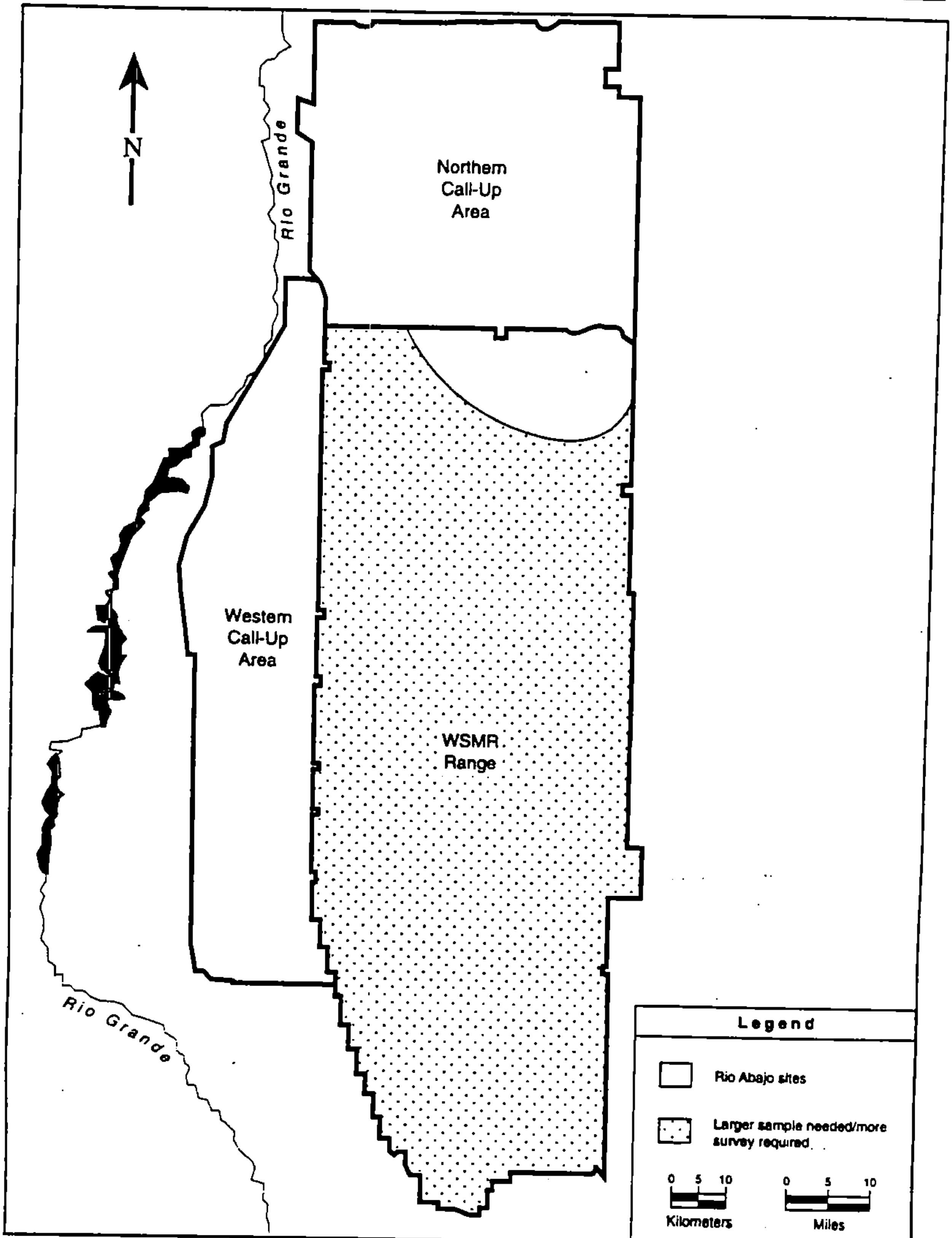

Figure 3-18. Known distribution of Rio Abajo sites within WSMR

3.6.3.4 Protohistoric Sequence. After a brief and as yet unexplained cultural hiatus, the Protohistoric-Apache-Mexican period began. From A.D. 1540 to 1870 little is known of life in the Tularosa Basin. No permanent settlements have been identified on WSMR from this time period, but it is presumed that the native population living along the Rio Grande used the basin plant and animal resources on a seasonal basis. New Mexico was a colony under Spanish rule until the war with the United States in 1846. After the treaty of Guadalupe Hidalgo was signed in 1848, increased settlement occurred, especially along the Rio Grande. The Apaches were beginning to move into south-central New Mexico and were regularly raiding the Rio Grande pueblos, a trend that continued until the late 1800s when they were forced to reside on reservations. As protection to the settlers and as a means of strategically protecting the river, the United States government built Fort Selden, Fort Filmore, Fort Thorn, and Fort Craig during this period.

Opler (1950) and Whiteley and Kelley (1983) have documented Mescalero history carefully. The Mescalero, an Apache/Athapaskan-speaking tribe, entered the New Mexico region just prior to the Spanish Entrada as part of a broader southward migration of the Athapaskan peoples of Canada (Spicer 1962). It is likely that the Mescalero were already in the territories with which they have been associated historically by the time Spanish exploration of the southeast began. When the Spanish arrived in New Mexico in 1540, a large contingent of the native population they encountered were situated along the Rio Grande in moderate to large settlements. Although no permanent settlements were identified in the Tularosa Basin-Hueco Bolson area, it has been presumed that the native population did exploit the resources there on a seasonal and temporary basis. The name "Apaches" was a general term applied to numerous nomadic groups, including Athapaskans.

Ethnographic evidence suggests that the Mescalero-Apache were beginning to move into the area of south-central New Mexico during the mid-16th century. They eventually occupied southcentral New Mexico, northwestern Texas, and the northern portions of the Mexican states of Chihuahua and Coahuila. Although the territory of the Mescalero was extensive, land use was mobile and temporary, not characterized by large concentrations of permanent village life as exhibited by the previous, agriculturally-based inhabitants of the area. The basis of Apachean subsistence was a trade-and-raid economy founded on the introduction of the horse in conjunction with the availability of resources from sedentary indigenous populations and migratory Mexican/Spanish (and later, Euramerican) populations. During the time of Spanish rule, the Apache were raiding and harassing the Rio Grande Pueblos, as well as other nearby populations. The Pueblo revolt of 1680 changed the demography of central New Mexico as most Pueblo people dispersed, while the seminomadic Apache used the mountain ranges as bases from which they conducted their raids. This relentless Apache raiding was one of the primary factors that limited the Spanish penetration of New Mexico, principally to the Rio Grande Valley. The hostilities provoked by the Mescalero persisted into the late 19th century.

During the period of Mexican rule, an increasing number of people moved northward along the Rio Grande to Las Cruces from the El Paso, Texas, area. The pattern of permanent settlement in the Tularosa Basin and the area currently occupied by WSMR was similar to other areas of New Mexico and the west. When titles to the lands of Texas and New Mexico were acquired by the United States from Mexico, it was presumed that the Spanish-Mexican precedents, which recognized no Indian claim to the land, would continue to be enforced. During this period, the Indians were considered squatters, obliged to move at the convenience of the Euramerican settlers, and the stage was set for years of prolonged conflict and hostility with the Mescaleros. In 1872, attempts were made to define the specific boundaries of a reservation for the Mescalero, and in 1873, a reservation consisting primarily of the eastern slopes of the White and Sacramento mountains was created by executive order.

In 1981, the Mescalero Apaches (population 2,145) occupied approximately 186,160 ha (460,000 ac). The population also included the last remnants of the Lipan Apache tribe, as well as an unreported number of Chiricahuas. Although these three Apache tribes have intermixed widely and have become increasingly assimilated, Mescalero Apache is still the dominant dialect (Opler and Opler 1950).

A total of five protohistoric sites were found in the WSMR call-up areas (Figure 3-19). The distribution of these sites by phase is as follows:

- Colonial Piro and Manso (Historic Pueblo) – 4 sites
- Spanish – 1 site

No protohistoric sites have been identified on WSMR proper, but there is a probability that they exist.

3.6.3.5 Euramerican/Historic Sequence. The Tularosa Basin, the San Andres and Oscura ranges, and the eastern portion of the Jornada del Muerto were avoided for the most part during the periods of Spanish and Mexican occupation of New Mexico. The natural aridity of much of the basin and the widespread presence of the Apaches made the area uninhabitable. Some copper mining occurred in the Oscura Mountains and some turquoise mining in the Jarilla Mountains during the Spanish and Mexican periods. Widespread use of the area by Euramerican peoples did not commence until the Historic period. Whiteley and Kelley (1983) have delineated periods within the early Euramerican settlement, which are summarized below.

The Saltero period began around 1824 and continued until approximately 1860. The earliest documented activity in the WSMR area was the mining of salt. Shortly after initial discovery by Hispanos from west Texas in 1824, a wagon road was constructed from El Paso along the east side of the Organ and San Andres mountains to the salt-gathering area. According to various accounts, a salt-gathering expedition was formed several times a year and consisted of a caravan of ox-drawn wagons accompanied by a large contingent of men.

Numerous efforts were made to control the saline areas and several claims were filed in 1848 and 1849. These private claims instigated by Anglos and the attempts to impose fees for gathering salt, created great animosity among the Hispano community. The antagonism generated by this conflict of interests culminated in the Magoffin Salt War of 1854. The advent of the railroad in the early 1880s decreased the importance of salt mining, defusing salt resource competition in the region because salt had become inexpensive (Bowden 1962).

A variety of historic trails and stagecoach routes bisected what is now WSMR. A freight-stage line ran between San Antonio and Nogal, and a similar line crossed the upper central range between the towns of Engle and Tularosa. Between 1866 and 1880, the Mesilla to Las Vegas (New Mexico) stage route transported people and mail across the southern reaches of the range (Williams 1986).

The ranching and mining period began around A.D. 1860 and continued until A.D. 1942. The San Andres, Oscura, and Jarilla mountains are the mining areas of importance in the WSMR vicinity. These ranges all contained a variety of metal and nonmetal mineral deposits including gold, silver, lead, iron, copper, turquoise, coal, fluorite, and zinc. Mining in the WSMR region was specific until the later 1870s. In 1879, gold was discovered at White Oaks northeast of the WSMR boundary, and hordes of prospectors descended into the general vicinity. The historic mining districts in the WSMR area were comparatively unproductive compared to other

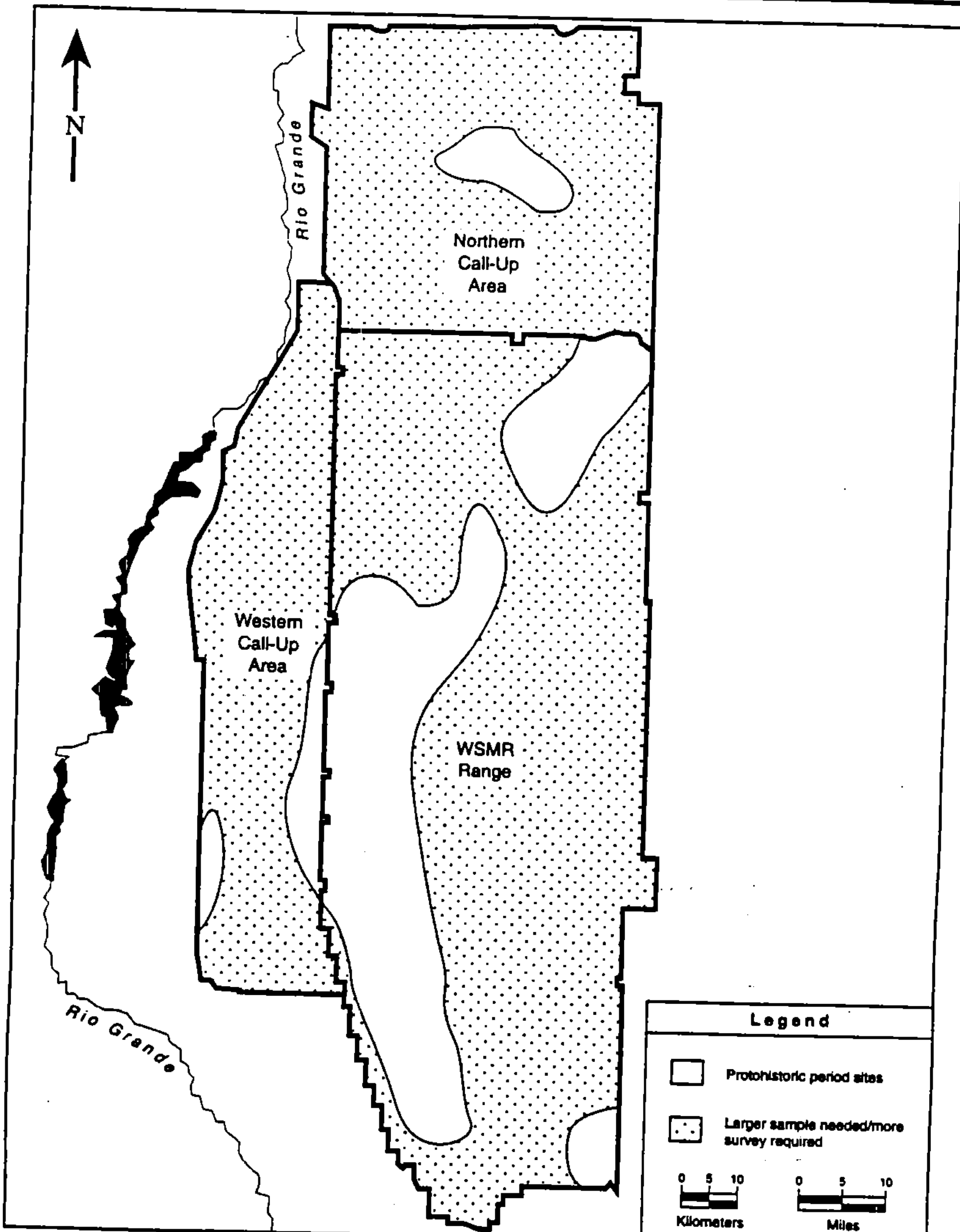

Figure 3-19. Known distribution of Protohistoric period sites within WSMR and extension areas

mining districts in adjoining counties. However, between 1900 and 1910, mining activity thrived and peaked, leading to large influxes of people and boom-bust settlements.

One of these settlements was Estey City, located on the eastern slopes of the Oscura Mountains. A store, warehouse, hotel, and various residences were constructed. Established in 1901, notable ore production was never realized and, by 1910, the city was declining. Eventually, it failed altogether.

The Homestead Act of 1862 opened up land for ownership. in the early 1860s, extensive flooding on the Rio Grande in the vicinity of the village of Doña Ana prompted a group of settlers to migrate, founding the town of Tularosa, located 8 km (5 mi) east of WSMR. Historic records indicate that this was the first successful attempt by Euramericans to settle in the Tularosa Basin. The founding of Tularosa had a significant effect upon the use of the basin in years to come. The stock introduced by these settlers provided the earliest occurrence of grazing in the area. Although not extensive, it proved to be the precursor to extensive ranching activities.

The expansion of the southern New Mexico cattle industry, beginning in approximately 1880, was the single most important factor in opening the region to Euramerican settlement. Properties with water sources were limited and often held by large cattle operations. Regardless of the hardships, dozens of ranches were homesteaded during this period. Many of these ranchers were post Civil War migrants from Texas. By the late 1880s, enough settlers had reached the area that even marginal resource areas like the basin were being claimed. During this period, several large ranches flourished in the area and, when the railroad reached Santa Fe and El Paso in 1880, the midwestern and California cattle markets opened up to New Mexico stockmen. The ranching development in the area thrived until the military purchase of the area in 1942 (Sonnichsen 1972).

Historic ranches and homesteads are scattered throughout the entire missile range. Mining sites were located primarily in mountainous regions of the San Andres, Oscura, and Jarilla ranges. There are 241 historic sites identified on WSMR (Figure 3-20). The distribution of these sites according to general type follows:

- Homestead/Ranch – 80 sites
- Mining – 101 sites
- Stage stops – 2 sites
- Other – 58 sites

3.6.3.6 Government/Military Sequence. Two areas currently encompassed by the range had been procured by other government agencies prior to military involvement at WSMR. In 1933, WSNM was established by the NPS. The San Andres National Wildlife Refuge was established in 1941 for the primary protection of desert bighorn sheep and other wildlife species.

In 1942, the U.S. military phase began with the establishment of the Alamogordo Bombing Range. Ranchers were bought out of their holdings through the early 1950s. In 1944, a test site was set aside from the Alamogordo Bombing Range, and Trinity base camp was constructed several kilometers (miles) south of the proposed ground zero site for the first atomic bomb test. There were approximately 200 scientists, technicians, and soldiers at the site by the summer of 1945. On July 9, 1945, WSPG was opened, and on July 16, 1945, the first

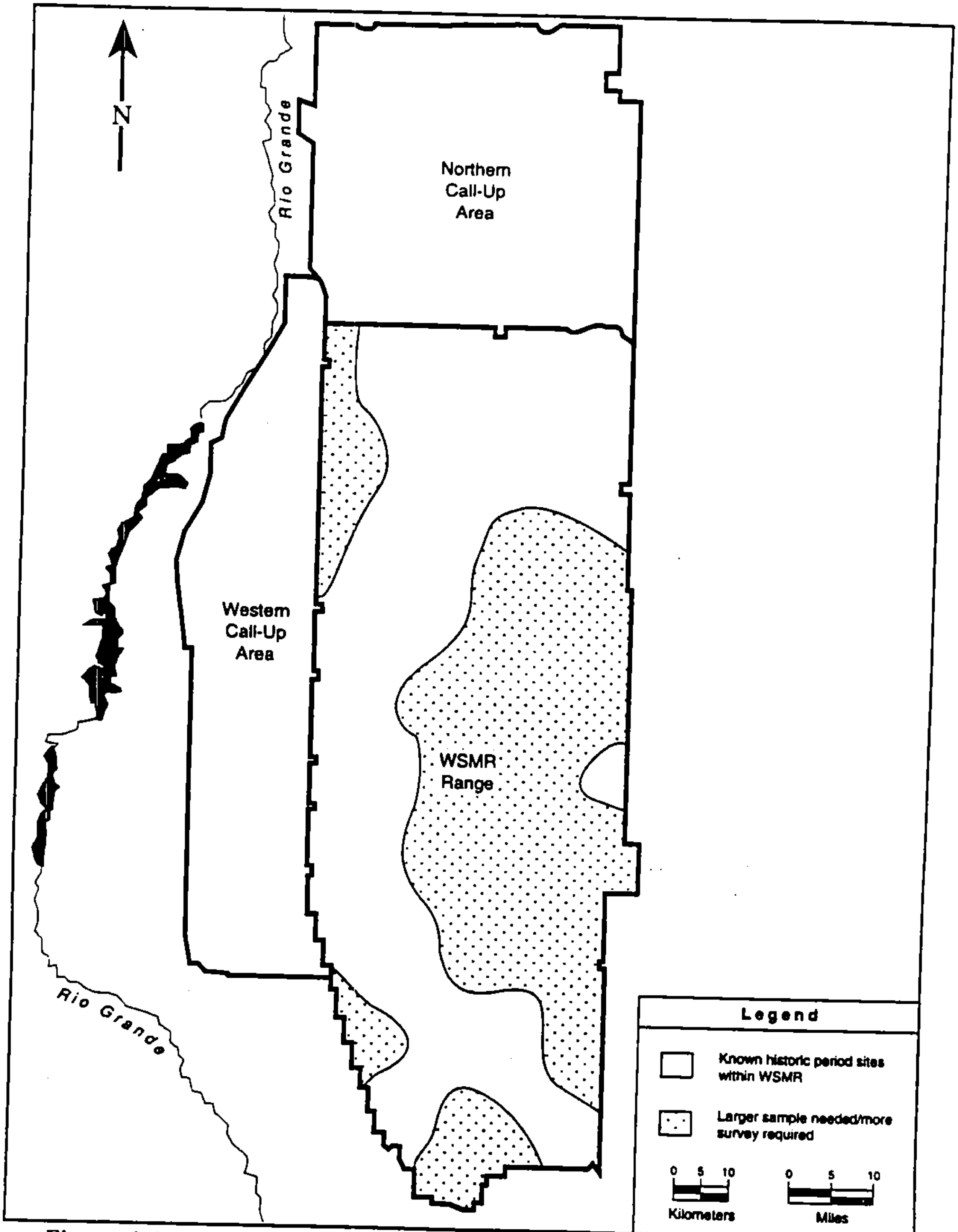

Figure 3-20. Known distribution of Historic period sites within WSMR

atomic bomb was detonated at Trinity Site. After 1945, Werner Von Braun and a group of captured German scientists conducted testing and refinement of the V-2 rockets, ultimately resulting in the development of the Neptune and Viking rockets in 1947. Although the area originally had been intended for temporary use, it soon became evident that the United States rocket program required a permanent facility, and WSPG was consolidated in 1948. The area officially became WSMR in 1958.

A U.S. Navy detachment was established on June 14, 1946, in order to participate in testing the German V-2 rockets. This led to later independent testing of the U.S. Navy Viking rocket. The U.S. Navy blockhouse structure was built to facilitate this testing, and it is still used as a missile testing facility.

Sites other than those associated with Trinity National Historic Landmark are generally located on or adjacent to the Main Post. These include unique sites such as the 45,360-kg (100,000-lb) thrust and the 226,800-kg (500,000-lb) thrust Static Test Facility buildings (buildings 19300 and 19241). Both were used for early rocket engine testing during the Von Braun era and for development of technology for the V-2 rocket, the Redstone Missile, and the Nike Missile. The 226,800-kg (500,000-lb) Static Test Facility was designed as the largest of four test facilities in 1947. Work was completed between 1948 and 1950. The site consists of concrete firing towers, gravity flow water storage tanks on the adjacent hillsides, a nearby viewing room and underground control room, and rails for rail platforms that contained mirrors for test viewing. Another important site from this cultural phase is the U.S. Army blockhouse and gantry crane at LC-33, built to test the V-2 rocket. Other buildings on the Main Post include officer housing, barracks, and quonset huts. Sierra Chapel is located on the Main Post, and is a standard 700 series military chapel of simple frame design with colored glass windows, a chimney, interior balcony, and a wooden steeple on the eastern end. Appendix C lists the age of each building on WSMR. Plywood City is a Cold War-period site located in the central portion of WSMR. It saw limited use during the 1960s by the U.S. Air Force as a training target. The approximate 16-ha (40-ac) site was built to look like a Russian surface-to-air missile battery. It contains dirt berms, sheet-metal missiles, and plywood trucks. The total number of sites identified as cultural resources during the Government-Military sequence is 34 (Figure 3-21). These sites are identified by general eligibility type as follows:

- State Register – 4 sites
- National Historic Landmark/District – 3 sites
  - Trinity National Historic Landmark
  - LC–33 National Historic Landmark
  - WSNM Historic District
- Other (from Historic American Buildings Survey) – 26 sites

3.6.3.7 WSMR Call-Up Areas. Call-up areas are maintained under joint-use agreements. The BLM and approximately 50 individual land owners control or manage these areas for multiple users. WSMR maintains MOUs with BLM, which define both agencies' responsibilities within the call-up areas. These areas are located primarily to the north and west of the range. Approximately 777,258 ha (1,738,831 ac) make up the call-up areas.

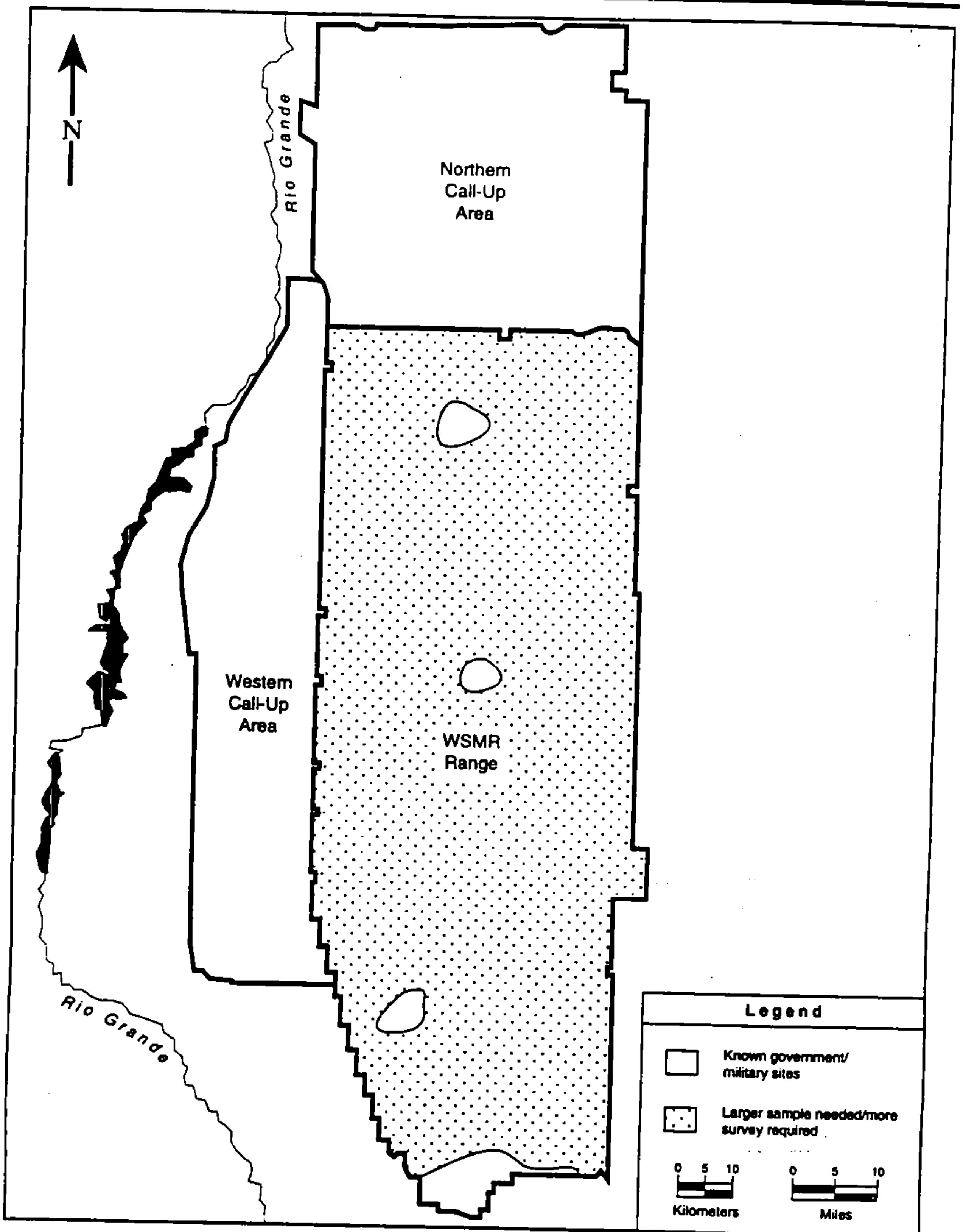

Figure 3-21. Known distribution of government/military era historic period sites within WSMR

The culture types represented most abundantly in the Archaeological Records Management Section (ARMS) data base include Mogollon, comprising 123 sites; Anasazi, comprising 144 sites; and Archaic, comprising 45 sites. Paleoindian sites numbered 9, protohistoric numbered 5, and historic sites numbered 49.

There are approximately 20 additional active use locations. These are multiple use areas including long-range missile testing and instrumentation sites. They are scattered throughout New Mexico and adjacent states, including Texas, Utah, Arizona, Colorado, and Idaho. Comprehensive archaeological survey of these areas has not been completed at this time.

3.7 LAND USE

WSPG was established in 1945 to provide a remote testing site designed to develop the United States rocket technology program. The Nuclear Age began with the detonation of the first atomic device at Trinity Site in the northwestern corner of WSPG. This early rocket testing program consisted of the development of domestically produced one and two-stage vehicles. With the testing of captured German V-2 rockets, high performance equipment test and evaluation became a standard WSMR activity. In 1952, WSPG became one of 19 U.S. Army triservice national ranges, with the U.S. Army retaining management responsibility. WSPG became WSMR in 1958. Since that time, WSMR has been the site of major technological events (U.S. Army 1985a).

The WSMR Main Post (headquarters) and the main test facilities are located in the southern portion of the range (Figure 3-22). The southern range boundary separates WSMR from the Doña Ana, Orogrande, and McGregor ranges of Fort Bliss, Texas.

As a national test range, WSMR contains an extensive complex of launch sites, impact areas, instrumentation sites, facilities, and equipment. Missile launch sites are located throughout the range. Although numerous missile impact areas have been designated and are specified for missions, almost any non-restricted area of the range can be used for missile impact (U.S. Army Test and Evaluation Command [TECOM] 1986). A variety of instrumentation systems are used during vehicle testing. These systems, together with the launch complexes, impact areas, and control centers, are linked by an extensive network of timing and communications systems. WSMR has over 1,000 instrumentation sites and approximately 700 types of optical and electronics instrument systems. The NASA White Sands Space Harbor (WSSH) also is located on the range. It is used for shuttle flight practice and is fully manned during two shifts each day. The range also provides experimental payload and missile component recovery, target support, air-to-ground multiple target control, calibration and standards, ordnance and propellants storage, geodetic surveying, and photography (U.S. Army 1991a; USASDC 1991b).

WSMR has listed three primary land use goals in the WSMR Land Use Plan Narrative (COE 1 992d). These goals and associated objectives are as follows:

- **Goal 1:** Promote the most efficient and cost-effective land use plan.
  - Objective 1.1: Guide the location of facilities in a way that supports the current and projected collective missions of the installation.
  - Objective 1.2: Ensure that functionally related uses are located in proximity to one another.

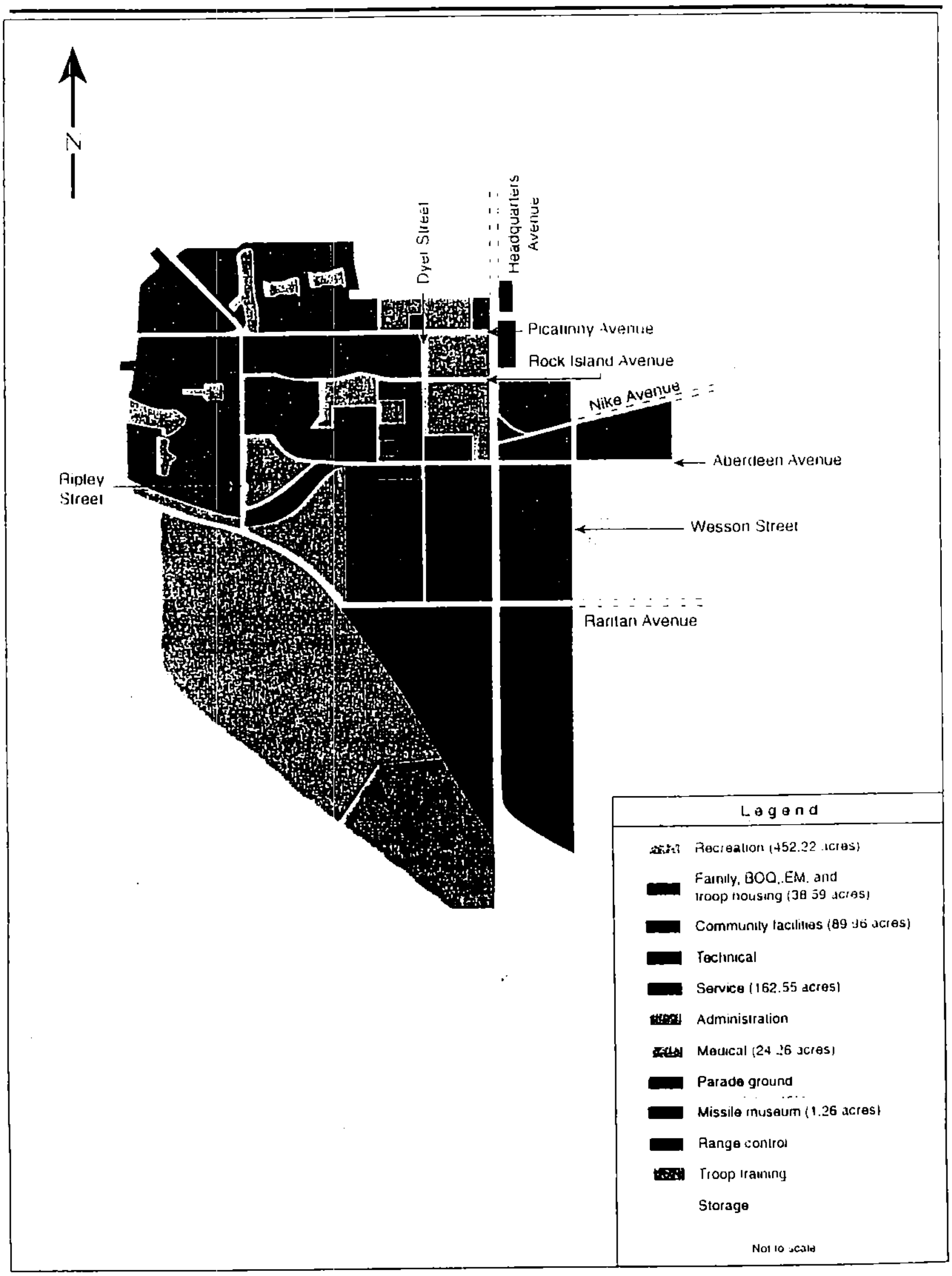

Figure 3-22. WSMR Main Post land use areas

- Objective 1.3: Promote energy efficiency in facility siting and layout of infrastructure (e.g., utility systems and circulation patterns).

- Objective 1.4: Encourage the grouping of compatible activities in consolidated structures and, where appropriate, consolidate all administrative functions within the Main Post area, and retain the open range area exclusively for operations and testing.

- **Goal 2:** Plan and coordinate development to ensure compatible land use growth and change.

  - Objective 2.1: Provide for future expansion and the construction of new facilities so that functional relationships are not adversely affected.

  - Objective 2.2: Ensure that future growth within the range does not limit the ability of the installation to perform its mission.

  - Objective 2.3: Ensure that on-range and off-range land uses are compatible.

- **Goal 3:** Enhance and preserve the visual, aesthetic, and natural resources of the installation.

  - Objective 3.1: Use visually compatible and complementary architectural designs and building materials.

  - Objective 3.2: Make optimal use of desirable natural landscapes, such as scenic views.

  - Objective 3.3: Integrate environmental protection and preservation activities to the fullest extent possible into the planning and execution of the basic test mission of the installation.

  - Objective 3.4: Protect, improve, and maintain the wildlife resources of the installation through the implementation of the WSMR Integrated Natural Resources Management Plan.

  - Objective 3.5: Minimize the adverse environmental impacts from WSMR-proposed future operational uses adjacent to the range through environmental reviews and the implementation of mitigation plans. Lands containing unexploded ordinance will not be opened for any recreational uses.

3.7.1 Region of Influence

WSMR can be categorized into two major land areas: the main range and the northern and western Call-Up Areas. The main range and the Call-Up Areas comprise over 1.54 million ha (3.8 million ac). The main range comprises all real estate within the WSMR boundary, totaling 923,387 ha (2,281,659 ac) (Table 3-32).

With the exception of WSTF, WSNM, San Andres National Wildlife Refuge, and Jornada Experimental Range (JER), which are operated under a co-use agreement, the main range is under the direct control of the U.S. Army on an exclusive-use basis, with unlimited use of the restricted airspace. This area has two major land use functions: test operations on the range and base operational support (the overall land use designation for this area) (COE 1992d).

Table 3-32
Ownership and area at WSMR

Use/Ownership	Hectares	(acres)
Ownership		
Withdrawn Private	154,479	(381,713)
Withdrawn BLM	721,390	(1,782,531)
Co-use	47,518	(117,415)
Other Uses[a]		
San Andres National Wildlife Refuge/JER[b]	48,593	(120,071)
White Sands National Monument*	57,726	(142,639)
Total	923,387	(2,281,659)

Source: COE 1992d.

[a] Hectares (acreage) included within the total of the three major land-ownership categories.

[b] These two independent areas overlap; therefore, their corresponding ha (acres) are reported as a single area.

The range is the largest overland test range available for U.S. Army, U.S. Navy, U.S. Air Force, NASA, and other agency missile and test flights. WSMR has several operational areas throughout the main range that support the various test missions. These areas (the Main Post, SRC, ORC, North Oscura Range Center [NORC], and Rhodes Canyon Range Center [RCRC]) are located in the south, north, and central areas of the range. Major mission-related areas, as well as nonmission-related areas, are described below.

The WSMR ROI has been divided into nine subsections for ease of discussion (Figure 3-23). These subsections and their designations are as follows:

- the Main Post and cantonment,
- the south range launch complex and support areas (from the Main Post east along Nike Avenue to LC-39 vicinity),
- other south range land use areas south of U.S. Highway 70 to the southern WSMR boundary,
- south range land use areas north of U.S. Highway 70,
- southwestern range area,
- central range land use (from Range Road 6 to coordinate N80),
- north range and Stallion Range land use (from coordinate N80 to the northern WSMR boundary),
- WSMR-controlled or joint-use areas outside of the WSMR boundary, and
- nonWSMR controlled nonjoint-use land use within 80 km (50 mi) of WSMR.

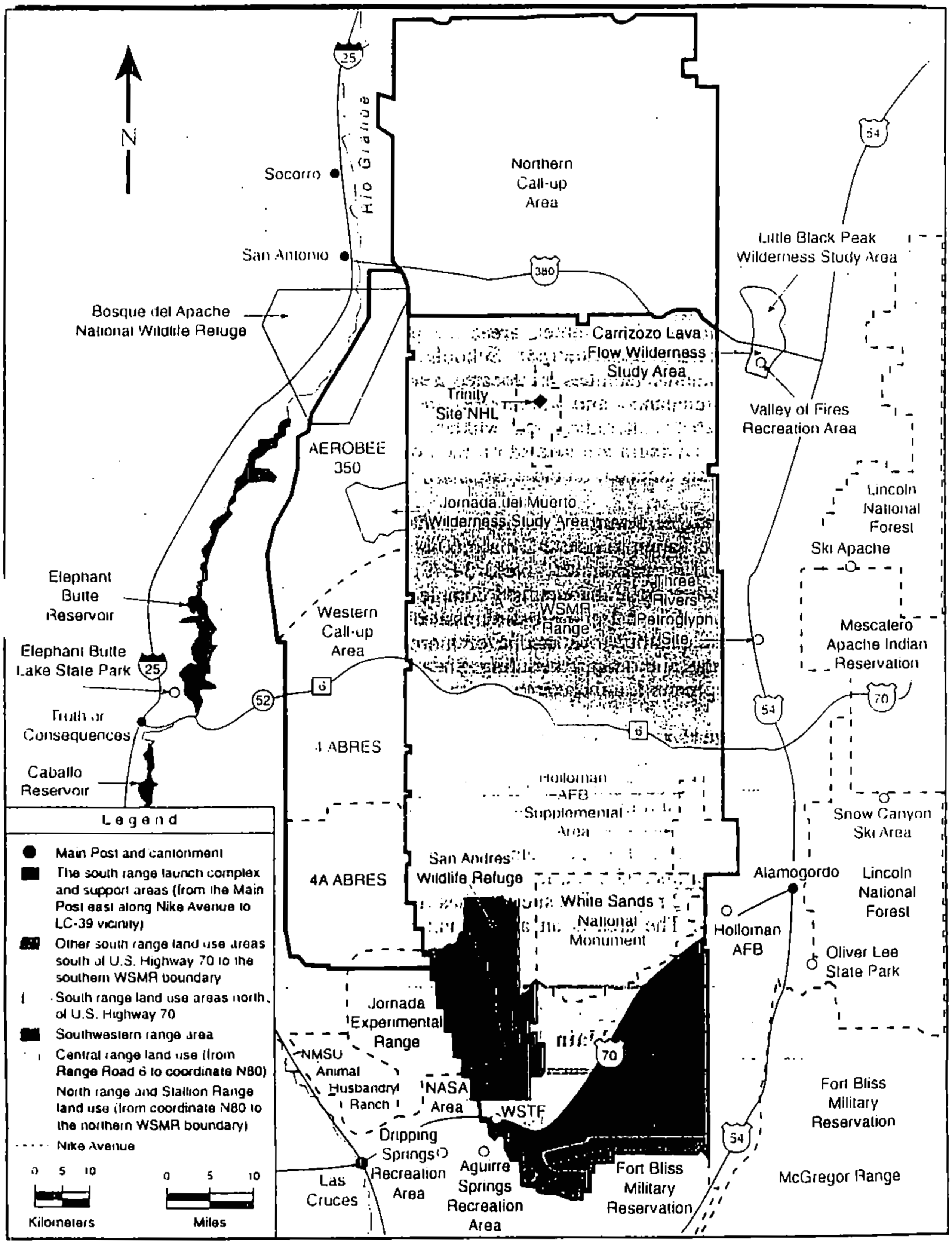

Figure 3-23. Land use areas on WSMR

Site-specific information for various research, development, testing, and experimentation programs and areas as well as for local recreation, national, federal, state, and private land use areas is listed in tables throughout the following sections. Information is provided within the tables for each site unless it is operation sensitive.

3.7.1.1 Main Post and Cantonment. The Main Post is located in the southwest corner of the main range and covers approximately 364 ha (900 ac). It is the WSMR primary headquarters and contains the majority of operational support land uses including administrative, industrial, community support, family and troop housing, maintenance and supply, and storage (Figure 3-22, Table 3-33).

Family and troop housing areas are located in the north and west portions of the Main Post and are sufficiently removed from other areas to provide a safe environment, free from objectionable traffic and/or noise sources. Schools, child care, commissary, chapel, and other community and recreational facilities are located nearby. Work areas including administration, technical, service/maintenance, and warehouses are located on the eastern half of the post. A few administrative areas, including the Military Police, the Intelligence Office, and the Explosives Ordnance Division are located on the north side of the post, near the Las Cruces gate. A warehouse area is adjacent on the west, and a technical area is located to the north.

3.7.1.2 South Range Launch Complex and Support Areas. The main launch complexes encompass an approximate 243-ha (600-ac) area extending 30 km (18.5 mi) east-west and 3.2 km (2 mi) north-south (Table 3-34, Figure 3-23). This area is north of Nike Avenue, east of the Main Post, and contains 8 complexes (LC-32 to LC-38 and LC-50). They support ground-to-ground and ground-to-air missile launches and the Navy Gun program. Each complex has the capability to host one or more firings based on need, safety criteria, instrumentation coverage, and range scheduling. Six additional launch complexes have been set aside for future development. Land use areas for this subsection are described in Table 3-34.

3.7.1.3 South Range Land Use Areas South of Highway 70. Condron Airfield is located 9.7 km (6 mi) southeast of the Main Post and has a 1,867-m (6,125-ft) east-west runway and a 1,322-m (4,338-ft) north-south runway. The area also includes a parking apron, a taxiway, an explosives loading pad, a beacon tower, and a control building.

LC-33, located 8 km (5 mi) east of the Main Post, is on the NRHP and is a National Historic Landmark. The site contains a U.S. Army blockhouse constructed in 1945 as a laboratory for the development of the V-2 rocket. The site also has a gantry crane built in 1946 to launch the V-2 and Viking rockets. The area is an active launch site with various instrumentation and camera locations on site.

Table 3-33
Land use on Main Post and Cantonment locations

Land Use Location	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
Headquarters Operational Support	767 (1,895)	administration, community and housing, technical, warehousing	U.S. Army	yes	yes

* Based on information in *Key Program Descriptions, Range-wide EIS* (U.S. Army 1993g).

Table 3-34
Land use on south range launch complex and support locations

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
LC-32	567 (1,402)	launch complex	Dept. of Defense	yes	yes
LC-33	487 (1,203)	launch complex	Dept. of Defense	yes	yes
LC-34	389 (960)	launch complex	Dept. of Defense	yes	yes
LC-35/Desert Ship	389 (960)	launch complex	Dept. of Defense	yes	yes
LC-36	487 (1,203)	launch complex	Dept. of Defense	yes	yes
LC-37	583 (1,440)	launch complex	Dept. of Defense	yes	yes
LC-38	777 (1,920)	launch complex	Dept. of Defense	yes	yes
LC-50	17 (41)	launch complex	Dept. of Defense	yes	yes

* Based on information in *Key Program Descriptions, Range-wide EIS* (U.S. Army 1993g).

The Nuclear Effects Laboratory is located between Range Road 1 and the south range boundary approximately 4.8 km (3 mi) southeast of the Main Post. The lab conducts tests of weapon systems in a simulated nuclear environment.

The magazine area houses both liquid and solid propellants. The liquid propellants are located in building area 21000, south of Range Road 2 and west of Range Road 19. Solid propellants also are located in building area 21000 but are north of Range Road 3 and west of Range Road 19. Both of these areas include paved roads, buildings, and have required inhabitant safety limits imposed for the type and quantity of explosives stored in them. Land use areas for this subsection are described in Table 3-35.

3.7.1.4 South Range Land Use Areas North of Highway 70. Several large support and test facilities are located in this area (Figure 3-23, Table 3-36) including the High Energy Laser System Test Facility (HELSTF) Radar Advanced Technology Backscatter (RATSCAT), and WSSH. A variety of weapon impact areas, the hazardous test area, and the Explosive Ordnance Division ordnance disposal area are located on this portion of the range.

The Small Missile Range is 12.9 km (8 mi) north of the Main Post, north of U.S. Highway 70. The 2,590-ha (6,400-ac) area is 1.6 km (1 mi) east-west by 16 km (10 mi) north-south. Relatively short-range missiles and gun systems are tested at this technical support area. The Naval Gun program has testing facilities at the Small Missile Range.

HELSTF is located north of U.S. Highway 70 approximately 6.4 km (4 mi) south of WSNM. The facility was once the Multiple-Function Array Radar (MAR) site, but is currently used by HELSTF. This is a joint Armed Services (U.S. Army, U.S. Navy and U.S. Air Force) facility used to perform high-energy weapons system testing on a variety of aircraft, ground vehicles, and missile systems.

WSSH is used for space shuttle landing and flight practice. Flight testing of Single Stage Rocket Technology (SSRT) development program vehicles and equipment is also undertaken at WSSH. The area consists of three runways and the necessary facilities for shuttle landings.

Table 3-35
Land use on south range, south of U.S. Highway 70

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
Orogrande Range Camp	259 (640)	launch site, support center	Dept. of Defense	yes	yes
AMRAD, RAM, RAMPART	—	missile program area	Dept. of Defense	yes	yes
Target Areas	—	impact areas	Dept. of Defense	yes	yes
Condron Airfield	615 (1,520)	airfield	Dept. of Defense	yes	yes
LC-33 National Historic Landmark	—	launch complex and NHL	Dept. of Defense	no	no
ETA and Nuclear Effects Lab	—	testing	Dept. of Defense	yes	yes
Magazine Area	97 (240)	missile and munitions storage	Dept. of Defense	yes	yes
Artillery Area	35,047 (86,600)	impact area	Dept. of Defense	no	yes
Sting	7,322 (18,093)	impact area	Dept. of Defense	yes	yes
G-10	—	impact area	Dept. of Defense	yes	yes
Missile Assembly Facility	—	assembly area	Dept. of Defense	yes	yes
NG-2	—	target/impact area	Dept. of Defense	yes	yes
Close Target	—	target/impact area	Dept. of Defense	yes	yes

*Based on information in *Key Program Descriptions, Range-wide EIS* (U.S. Army 1993g).

Note: Dash indicates no data available.

Lighting systems that equal 11 billion candlepower light the runways. The maintenance facility is staffed for two shifts daily, including professional staff, engineering, and research personnel. WSSH is operated as a combination launcg, practice, support, and recovery site that will be used in future aerospace programs such as the SSRT and the X-33 spacecraft.

Tularosa Range Camp is a 4-ha (10-ac) center located on the north side of the Holloman Air Force Supplemental Area 12.9 km (8 mi) west of Tularosa, New Mexico. This area is currently used as a support facility for range programs.

Table 3-36
Land use on south range, north of U.S. Highway 70

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
Small Missile Range	259 (640)	test facility	Dept. of Defense	yes	yes
HELSTF/MAR Site	269 (655)	laser test facility	Dept. of Defense	yes	yes
White Sands Space Harbor/Northrup Strip	—	shuttle landing	Dept. of Defense	yes	yes
White Sands Space Harbor/Northrup Strip	—	SSRT devlopment program	Dept. of Defense	yes	yes
White Sands National Monument	59,289 (146,500)	controlled impact	NPS	yes	yes
"G" Impact Areas (16, 20, and 25)	—	—	Dept. of Defense	yes	yes
Tularosa Gate/ Tula Range Camp	—	—	Dept. of Defense	yes	yes
RATSCAT	—	—	Dept, of Defense		
Hazardous Test Area	4,051 (10,010)	testing impact area	Dept. of Defense	yes	no
Brillo	—	launch complex	Dept. of Defense		
Tow Target (201,062)	81,370 range	bombing	Dept. of Defense		
Space Harbor/ Bombing Area	1,295 (3,200)	bombing range	Dept. of Defense	yes	yes
HAFB Supplement Area	16,447 (40,640)	bombing range	Dept. of Defense	yes	yes
Yonder	87,027 (215,040)	bombing range	Dept. of Defense	yes	yes
NE-30	5,084 (12,563)	bombing range	Dept. of Defense	yes	yes
J-37	12.5 (31)	impact area	Dept. of Defense	yes	yes
Salt Target South	12.5 (31)	impact area	Dept. of Defense	yes	yes
SC 50	12.5 (31)	impact area	Dept. of Defense	yes	yes

(table continues)

Table 3-36, Continued

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
NG-1	—	target/impact area	Dept. of Defense	yes	yes
Far Target	—	target/impact area	Dept. of Defense	yes	yes
Near Target	—	target/impact area	Dept. of Defense	yes	yes
RENT Site (TS-531)	—	gun location	Dept. of Defense	yes	yes
Navy Gun (T-601)	—	gun location	Dept. of Defense	yes	yes

* Based on information in *Key Program Descriptions, Range-wide EIS* (U.S. Army 1993g).

Note: Dash indicates no data available.

The Hazardous Test Area (HTA) is approximately 5 km (3 mi) west of the Small Missile Range, north of U.S. Highway 70. The HTA facility encompasses approximately 9,400 ac nestled in a remote desert valley surrounded by the San Augustin Mountains. The HTA contains three autonomous sites maintained and operated by three separate WSMR organizations to support a variety of test and evaluation operations, and for the conduct of demolition operations. These sites are the Electro-Magnetic Radiation Effects (EMRE) test area, Detonation Test Area (DTA), and Explosives Ordnance Disposal (EOD) area. The EMRE test area consists of a wide variety of sophisticated equipment and instrumentation used to perform tests to evaluate the effects of high frequency radiation environments on missile systems, parts, components, and related equipment. The DTA consists of a number of specialized testbeds that have been established for conducting hazardous and explosive missile components, MIL-STD 2105 Insensitive Munitions testing, static detonation (arena) testing, conflagration (slow/fast cook-off) testing, bullet impact testing, and 40-foot drop testing. The DTA is equipped with a wide variety of sophisticated equipment and instrumentation, used to conduct destructive and operational tests of explosive items to evaluate their safety and operational integrity. The EOD area consists of pits, associated equipment, and temporary storage facilities used to conduct demolition operations to destroy explosive residue and material waste.

The Yonder Area is one of the U.S. Air Force designated co-use impact areas on WSMR. This type of impact area is used on a scheduled basis with established limits for the accumulation of ordnance items. The Yonder Area is 22.5 km (14 mi) wide east-west by 38.6 km (24 mi) long north-south, and has been in use for the last 20 years. The U.S. Air Force and the New Mexico Air National Guard use the area for aircraft and pilot training on air-to-air gunnery (U.S. Army 1985a).

Flight testing at WSMR may involve overflights of WSNM. WSMR has an MOU with the NPS to allow this activity over the western portion of the monument. Such tests may require the closure of U.S. Highway 70 and the evacuation of WSNM. These are precautions used during flight tests, enforced by agreements with the New Mexico Highway and Transportation Department and the NPS. Recovery operations are conducted in accordance with guidelines established by the NPS (TECOM 1986).

Impact areas for planned missile impacts are designated all the way up range at required distances from the south launch complexes located north of Nike Avenue. These areas range from 16,188 to 46,945 ha (40,000 to 116,000 ac) in area and are surrounded by safety zones.

WSMR contains over 1,100 instrumentation sites scattered across the range. These instrumentation and support systems use both active and passive data collection methods for the specific mission under test. Land use areas for this subsection are described in Table 3-36.

3.7.1.5 Southwestern Range Area.

White Sands Test Facility

NASA Headquarters announced the site selection for the Johnson Space Center (JSC) Propulsion Systems Development Facility on July 6, 1962. Constructed in the early 1960s as a propulsion systems test site for the NASA Apollo space program, JSC Propulsion Systems Development Facility began testing in 1964. The name of the site was changed to White Sands Operations and then to the present White Sands Test Facility (WSTF). In the mid-1960s, at the peak of the Apollo era, WSTF employed over 1,700 people, almost three times the present population. The facility is located 32 kilometers (20 miles) northeast of Las Cruces, New Mexico, and 105 kilometers (65 miles) north of El Paso, Texas and occupies approximately 24,605 ha (60,800 ac) along the western flank of the San Andres Mountains in southwestern New Mexico. WSTF, as shown in Figure 3-24, is situated in an isolated area on WSMR to limit the effects of the inherent test hazards of the installation on the surrounding population with primary access via U.S. Highway 70 and the WSTF access road. The site comprises an industrial area and a surrounding buffer zone. Construction of facilities in the buffer zone requires prior approval from the WSMR Master Planning Board and the Commanding Officer; however, WSTF may make modifications within the industrial area without WSMR approval. NASA has three facilities at WSMR including WSTF, Goddard Space Flight Center (GSFC) White Sands Complex (WSC), and White Sands Space Harbor (WSSH).

Propulsion system testing began in September 1964 with the firing of the Apollo service propulsion system engine, and testing and development continued throughout the Apollo program. Beginning in 1967, WSTF developed a basic ability to evaluate the flammability and toxicity characteristics of materials used in the Apollo spacecraft. This capability expanded to include all facets of materials characterization and compatibility and component verification which would also be in support of Skylab, Space Shuttle, Space Station, and other Government and private reimbursable programs. With the end of the space race WSTF faced closure in 1970, but because of environmental advantages, existing test facilities and buffer zones, the facility was revitalized to perform hazardous tests for the Space Shuttle program. Demonstrating its capabilities and expertise as a propulsion system test and development resource, WSTF became recognized as a world-class laboratory. WSTF accomplishments include extensive second stage booster engine testing for the National Space Development Agency of Japan, development and testing on the Apollo service module engines and propellant storage module used in Skylab, materials and component testing, and evaluating the effects of the descent engine on simulated Martian surfaces for the Project Viking Lander. From 1974 through 1977, WSTF modified and improved the propulsion test facilities to accommodate extensive testing of the Space Shuttle propulsion systems, including propellant supply systems, electrical and data systems, articulated thrust structures, and movable shelters.

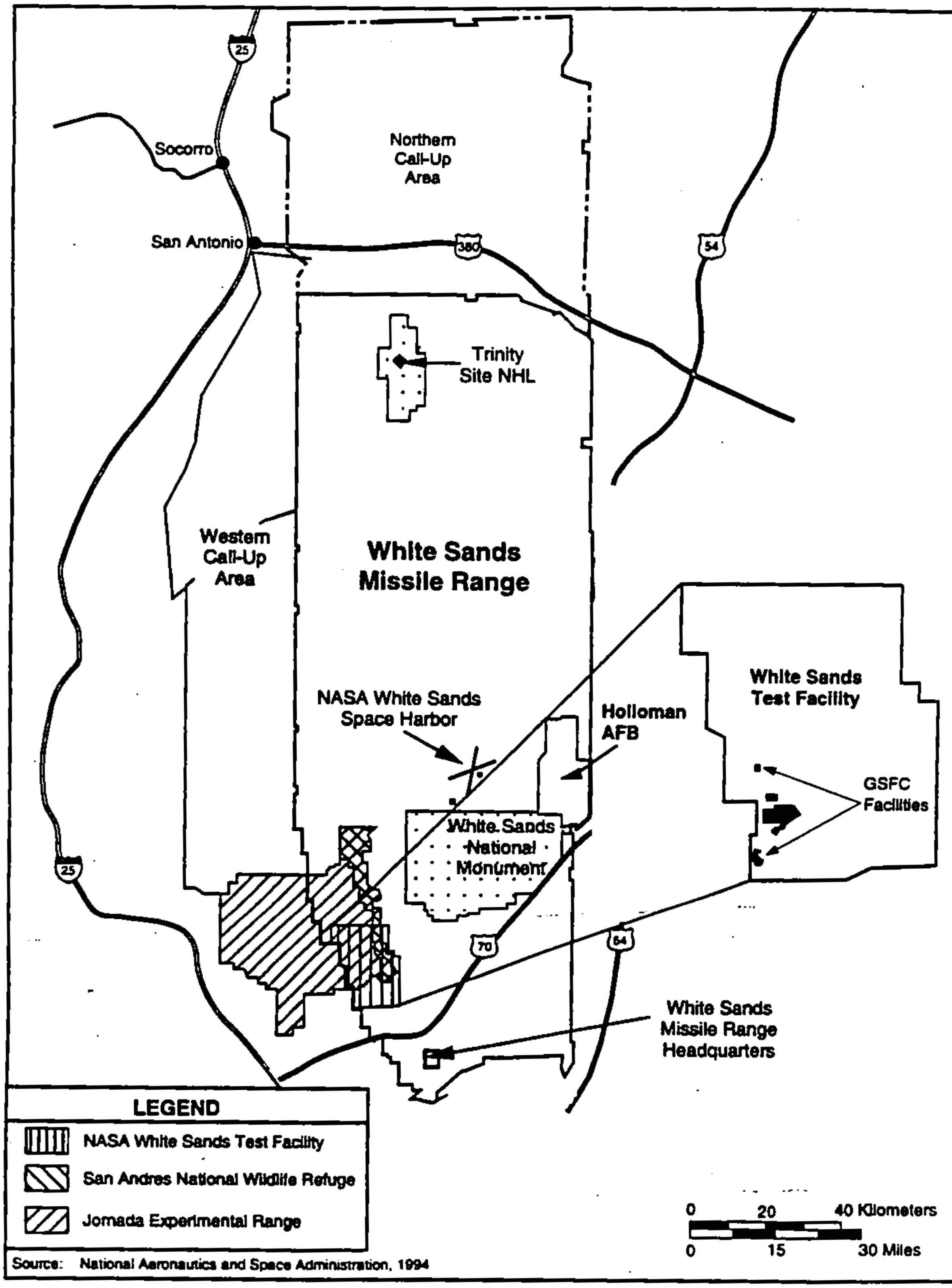

Figure 3-24. NASA Facilities at WSMR

Other tests through the mid-1970s included U.S. Navy solid rocket plume-microwave attenuation tests; characterization of filters for gases, hypergolic propellants, and cryogenic liquids; and evaluation of effects of dumping residual propellants on recovery parachutes. Other programs conducted during the Shuttle era include tests of a Department of Defense technology demonstrating a warhead intercept propulsion system and the development testing of the proposed Space Station Freedom propulsion modules.

To provide standard facilities, efficiency, and fast response to the many materials and hazardous test requirements, the test capabilities were consolidated into five test facilities with a total gross floor area of 37,197 meters^2 (400,000 feet^2): Materials Test Facility (800 Area), Hazardous Hypervelocity and Detonation Facilities (270 and 272 Areas), High-Flow Components Facility (250 Area), Chemistry and Metallurgical Laboratories (200 Area), and High-Energy Blast Facility (700 Area).

White Sands Complex

Established in 1977, the GSFC WSC comprised the Tracking and Data Relay Satellite System (TDRSS) and the NASA Ground Terminal (NGT) to provide communications and data links to NASA scientific users and the Space Shuttle through the tracking and data relay satellite fleet. Since then the White Sands Ground Terminal (WSGT), the Data Interface Facility (DIF), and the Second TDRSS Ground Terminal (STGT) have been constructed. WSC consists of two sites within the WSTF boundaries as shown in Figure 3-24. GSFC Mission Operations and Data Systems is responsible for the operation at WSC which include communications and data links to NASA and the Space Shuttle, relaying of scientific data from satellites to the TDRSS ground terminals for processing, and relaying to the various scientific centers. The DIF processes and relays data from the Earth Observation Satellite (EOS) to the scientific users located at GSFC in Greenbelt, Maryland.

The TDRSS and the NGT were constructed adjacent to WSTF on 5.7 ha (14 ac) of WSTF land. A ground depot and maintenance expansion were completed in 1982, and construction of the DIF was completed in 1994. Slightly more than 3.6 ha (9 ac) south of the WSTF 100 Area were granted to WSC in 1976 for TDRSS. In August 1986, and additional 16 ha (40 ac) 4.8 kilometers (3 miles) north of the WSTF main gate were grated to WSC for the STGT. These parcels are within the WSTF eight-section industrial area and do not require approval by WSMR or WSTF for further development. The Office of Space Communications determines all construction of facilities at WSC.

White Sands Space Harbor

The WSSH, shown in Figure 3-24, is an airfield and operations complex built on a dry gypsum lakebed. The airfield, known as Northrup Strip when established in 1948 by the U.S. Army, was and is to this day used as a recovery landing site for battle-damaged drone aircraft. WSSH is located north of U.S. Highway 70 within WSMR boundaries, about 88 kilometers (55 miles) northeast of WSTF and about 4 kilometers (2.5 miles) east of the San Andres Mountains. NASA selected WSSH for Space Shuttle pilot training in 1976 and as an alternate Space Shuttle landing site in 1979. Northrup Strip was renamed White Sands Space Harbor after the Space Transportation System-3 (STS-3) Space Shuttle landing on March 30, 1982.

WSSH is scheduled for use nearly every weekday for Space Shuttle pilots to practice approach and landing maneuvers in the Shuttle Training Aircraft (STA). The STA is a Gulfstream II aircraft that has been highly modified to simulate the flight characteristics and instrumentation of the Space Shuttle from about 11,000 meters (35,000 feet) to touchdown. Approximately 80 percent of all Space Shuttle training flights, an average of 10 per week, are conducted at

WSSH. WSSH is in operation normally two shifts per day. Three runways are available for enhanced Space Shuttle training. Runway 23/05 is marked to simulate the lakebed runway at Edwards Air Force Base and Runway 17/35 simulates the runway at Kennedy Space Center. In 1989 the third runway was constructed to allow pilots to practice transatlantic abort landings (TAL). The TAL runways are smaller and shorter than the primary runways. For each Space Shuttle mission, WSSH is prepared to accept an orbiter landing for an in-flight emergency or as a weather alternate to the primary landing sites at Kennedy Space Center and Edwards Air Force Base.

A launch and landing site for testing the prototype SSRT vehicle was constructed in 1993 at the old deservice pad area. The area will potentially serve as a launch and recovery site for the NASA X-33 Phase II re-usable launch vehicle (RLV) program

San Andres National Wildlife Refuge

The San Andres National Wildlife Refuge, located within the WSMR boundary, was established in 1941 to protect the desert bighorn sheep and hosted limited ranching activity as recently as 1951. WSMR currently uses the refuge as a buffer and safety zone (U.S. Army 1976). Land use areas for this subsection are described in Table 3-37.

3.7.1.6 Central Range Land Use. Current land uses in the central area of WSMR consist of military testing for weapons system research, development, testing, and experimentation programs including the operation of the ORC and the RCRC, as well as weapons impact areas and numerous instrumentation sites.

Oscura Range Center

The ORC is located in the northeastern portion of the central range and covers 22 ha (54 ac). In the past, this center was used as a full-support troop area. During the late 1980s, ORC was reactivated as an operational support center for testing in the northern sector of the range by the U.S. Army, U.S. Navy, and U.S. Air Force. Although primarily a technical support area for communications and instrumentation, ORC also can be used as a temporary base of operations for missile systems that require a down-range firing position. New temporary and semi-permanent facilities have been constructed at the ORC (Figure 3-25).

Oscura Bombing and Gunnery Range

The Oscura Bombing and Gunnery Range is located less than one mile north and west of ORC. The area is approximately 17 km (10.5 mi) long, north to south, and approximately 6.4 km (4 mi) wide, east to west. It consists of approximately 10,684 ha (26,400 ac). The area is used by the U.S. Air Force and some foreign governments for tactical aircraft air-to-ground and gunnery and bombing training.

Rhodes Canyon Range Center

The RCRC is located in the west-central portion of the central range and covers approximately 11 ha (28 ac). This is a permanent operational area to support missile missions by providing communications, troop, and maintenance support (Figure 3-26). Land use areas for this subsection are described in Table 3-38.

Richardson Ranch Training Complex

The Richardson Ranch Training Complex (RRTC), with approximately 2-km (1.3-mi) radius operating zone and 400-meter radius (1,312 ft) Live Fire Zone (LFZ), both centered on the

Table 3-37
Land use on southwestern range location

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
NASA Area and Buffer	24,605 (60,800)	systems testing	co-use	yes	yes
TDRSS	—	—	U.S. Army	yes	yes
San Andres National Wildlife Refuge	23,155 (57,216)	wildlife refuge	co-use, DOI, U.S. Army	no	no
OTD Laser Facility	—	—	U.S. Army	yes	yes

* Based on information in *Key Program Descriptions, Range-wide EIS* (U.S. Army 1993g).

Notes: Dash indicates no data available.
DOI = U.S. Department of the Interior

complex buildings, is used for Special Forces exercises and other training activities. Special Forces groups and special military combat units conduct one exercise per year consisting of ground troop movements at RRTC. Access to the RRTC is accomplished via conventional and experimental ground vehicles on existing access roads and other established routes.

Activities also include the use of helicopters which land at the RRTC to unload or evacuate ground forces. All helicopter landing zones are established on existing roads or other sites on WSMR approved by the WSMR Environmental Services Division. The RRTC offers operational, topographical, and logistical parameters that are essential to the training of special combat units for defense of the United States. Simulated mission capability offers the special operations personnel the opportunity to hone their skills in as realistic a setting as possible. This type and level of training enhances the success of actual missions.

3.7.1.7 North Range Land Use. The existing land uses in the northern area of WSMR consist of military testing for weapons system research, development, testing, and experimentation programs including the operation of the SRC.

Stallion Range Center

SRC is located in the northwestern portion of the range approximately 137 km (104 mi) north of the Main Post. SRC is the operational support headquarters (including mission support, maintenance, and security) for testing operations in the northern range and occupies 22 ha (55 ac). The U.S. Army operates an airfield at this location (Figure 3-27).

Trinity Site, described in Section 3.6, occupies 14,763 ha (36,480 ac) within the north central portion of the range.

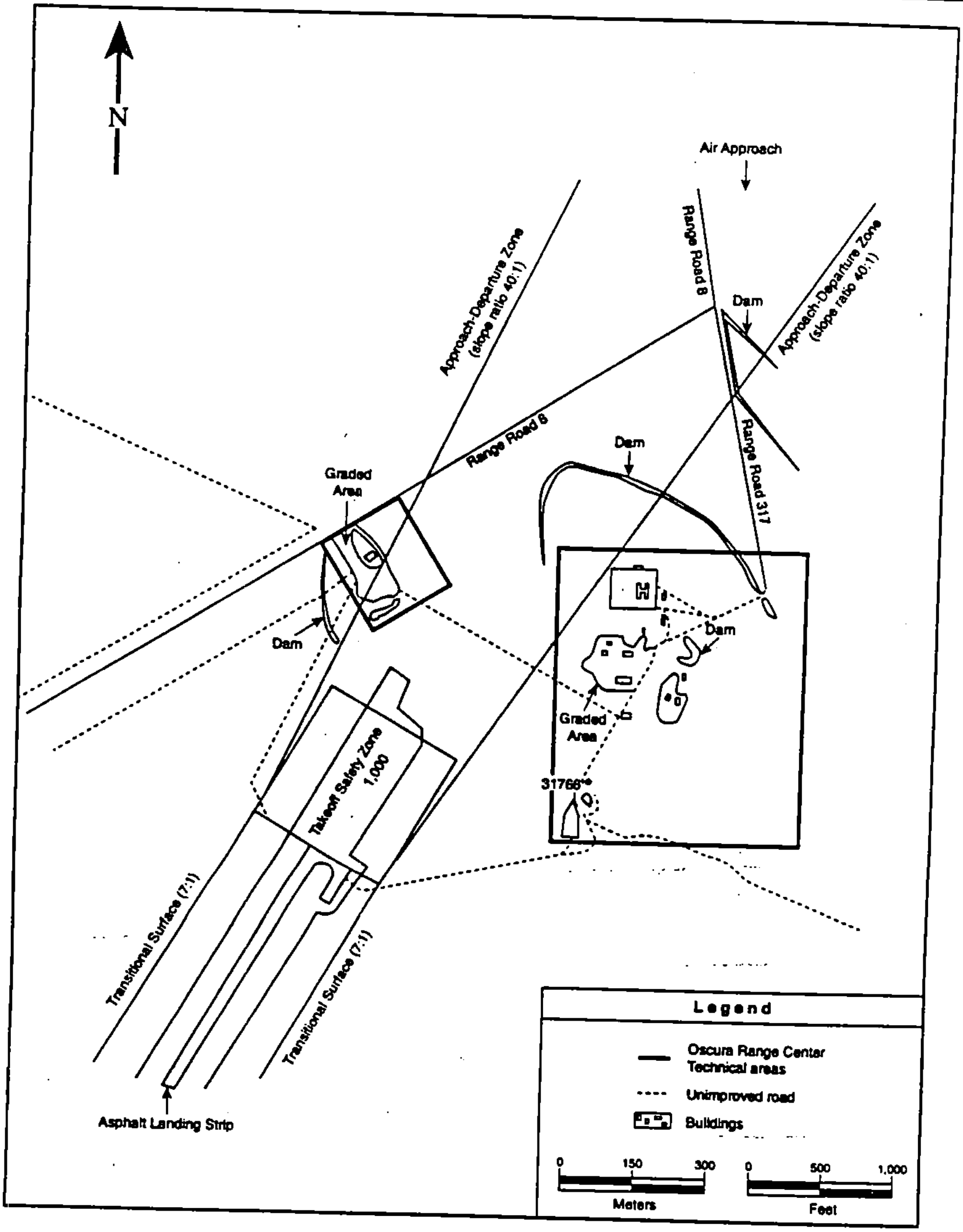

Figure 3-25. Oscura Range Center land use

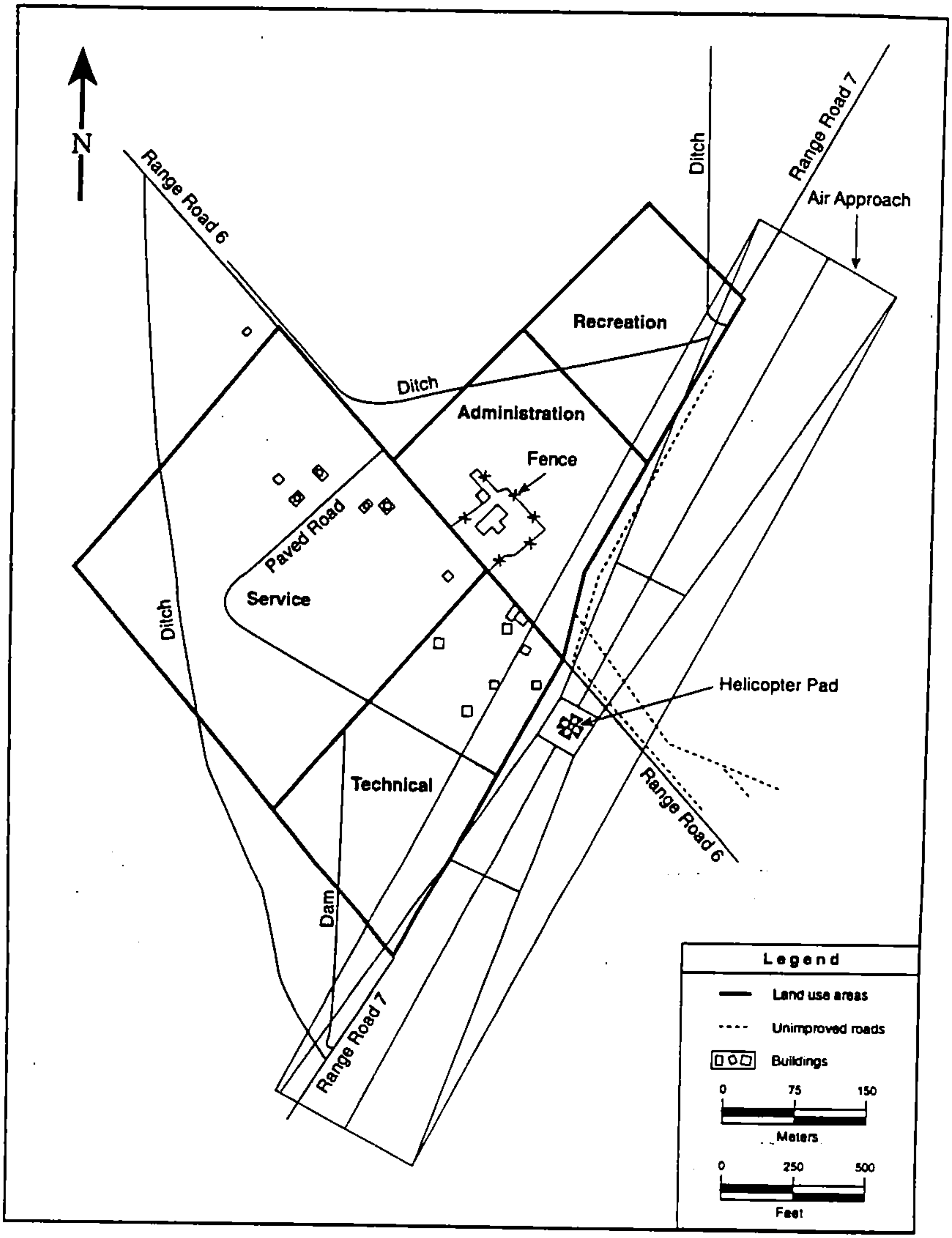

Figure 3-26. Rhodes Canyon Range Center land use

Table 3-38
Land use on central range location

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
Denver WIT	814 (2,011)	impact area	U.S. Army	yes	yes
Rhodes WIT	459 (1,133)	impact Area	U.S. Army	yes	yes
Salt	12.5 (31)	impact Area	U.S. Army	yes	yes
Hayfield Target	—	impact Area	U.S. Army	yes	yes
ABC-1, etc.	—	mid-range impact areas	U.S. Army	yes	yes
Richardson Ranch Training Complex	1,214 (3000)	training	U.S. Army	yes	yes
Rhodes Canyon Range Center	11 (28)	test and support	U.S. Army	yes	yes
RAMS—	test area	U.S. Army	yes	yes	
Oscura Range Center	2 (54)	support area	U.S. Army	yes	yes
TAC-3—	launch complex	U.S. Army	yes	yes	
Yonder Impact Area and Gunnery Range	—	impact and ordnance	U.S. Army	yes	yes
Formal and Informal Launch Sites	—	launch areas	U.S. Army	yes	yes
LC-30	—	launch complex	U.S. Army	yes	yes
Telles	—launch site	U.S. Army	yes	yes	
Rhodes Canyon Range Center	259 (640)	launch, support, testing	U.S. Army	yes	yes
Army 5, etc.	—	drone launch	U.S. Army	yes	yes
PUP	205 (506)	impact area	U.S. Army	no	unknown
J-140	—	target/impact area	U.S. Army	yes	yes
TS-513—	target/impact area	U.S. Army	yes	yes	

(table continues)

Table 3-38, Continued

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
NG-4	—	target/impact area	U.S. Army	yes	yes
NG-5	—	target/impact area	U.S. Army	yes	yes
WC-50—	launch area	U.S. Army	yes	yes	
649	—	impact area	U.S. Army	yes	yes
Zumwalt	37,038 (91,520)	test track	U.S. Army	yes	yes
AMRAAM	31,340 (77,440)	missile system	U.S. Army	yes	yes
Salt Soüm	12.5 (31)	impact area	U.S. Army	yes	yes
EC 50	12.5 (31)	impact area	U.S. Army	yes	yes
NE 50	12.5 (31)	impact area	U.S. Army	yes	yes
AIM	29,786 (73,600)	bombing range	U.S. Army	yes	yes
Queen 15	205 (506)	impact area	U.S. Army	yes	yes
ABC-18,133	impact area (20,096)	U.S. Army	yes	yes	
70-mile Area	—	target area	U.S. Army	yes	yes
Salinas Peak Site	—	instrumentation site	U.S. Army		yes

* Based on information in *Key Program Descriptions, Range-wide EIS* (U.S. Army 1993g).

Note: Dash indicates no data available.

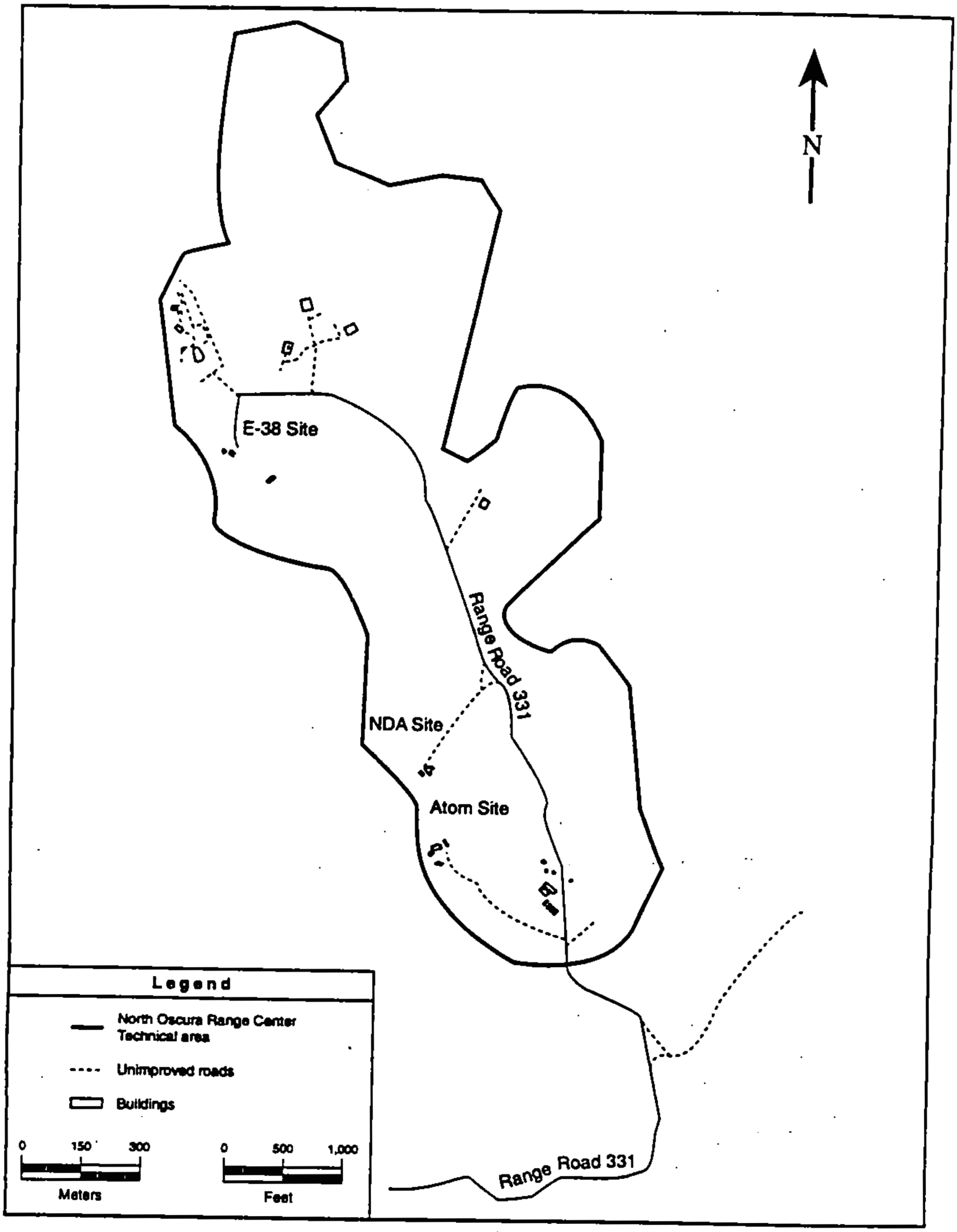

Figure 3-27. North Oscura Center Range Center land use

North Oscura Range Center

NORC is located north of ORC in the Oscura Mountains, just south of the northern WSMR boundary and covers approximately 259,000 ha (640,000 ac). NORC consists of four separate areas, located 6.4 km (4 mi) apart, and is used primarily as a communication, missile tracking, and instrumentation area for programs assigned to the north range (Figure 3-28).

The Forward Area Air Defense System (FAADS) Valley sites cover approximately 111,700 ha (276,000 ac) in the northeastern corner of the range. Testing and research activities are conducted throughout the area including missile system tests, target use, obscurant use, presence of support personnel and equipment, and communication systems (U.S. Army 1993b). Adjacent non-DoD land use includes intermixed public and private properties used primarily for ranching, hunting, and recreation.

The Red Rio Range is a U.S. Air Force impact area and gunnery located in the extreme northeast corner of WSMR. This is a 14.5-km (9-mi) northwest-southeast by 9.7-km (6-mi) northeast-southwest area at the foot of the Oscura Mountains. As with the Yonder impact area (Section 3.7.1.4), Red Rio missions are scheduled on a co-use basis (U.S. Air Force 1994). The broken terrain in this area is advantageous for air-to-ground gunnery and maneuver practice under simulated combat situations. The U.S. Air Force polices the range on a scheduled basis to recover expended training (including full-scale inert) bombs and non-explosive projectiles to ensure general area safety.

3.7.1.8 WSMR Joint-use Areas. WSMR requires the use of adjacent areas to the west and north of the range to test ground-launched missiles that cannot be accommodated within the 64 by 160-km (40- by 100-mi) main range (Figures 2-1 and 3-23). These "call-up" areas are utilized for public safety, military security, and in some instances missile impact. For all scheduled missions, WSMR requires that overhead airspace be restricted and all human inhabitants of these extensions be evacuated.

The Northern and Western Call-Up Areas are maintained under lease and other forms of agreements between WSMR, the BLM, and approximately 50 individual landowners. Land use in these areas consists primarily of livestock grazing, limited small-scale coal mining, and recreation. Residents are evacuated during tests in their vicinity and compensated for their time and inconvenience (U.S. Army 1985a). Call-up use provides flexibility in supplying safety impact areas and occasional launch sites to meet the needs of different testing programs, providing the necessary area without a disruption of the tax base or normal land use and without the large investment that would be required to purchase exclusive control of the areas.

Since 1960, WSMR has leased a 64- by 61-km (40- by 38-mi) call-up area for firing longer-range missiles. This area is adjacent to the north WSMR boundary. By agreement with the residents, missile testing is limited to 25 firings per year. All instrumentation associated with the tests is mobile or temporary, and it is relocated off the Call-Up area upon completion of the testing program. This northern Call-Up Area, also referred to as the FIX (firing in extension), contains 357,721 ha (883,916 ac) and is populated by approximately 160 people (COE 1992d).

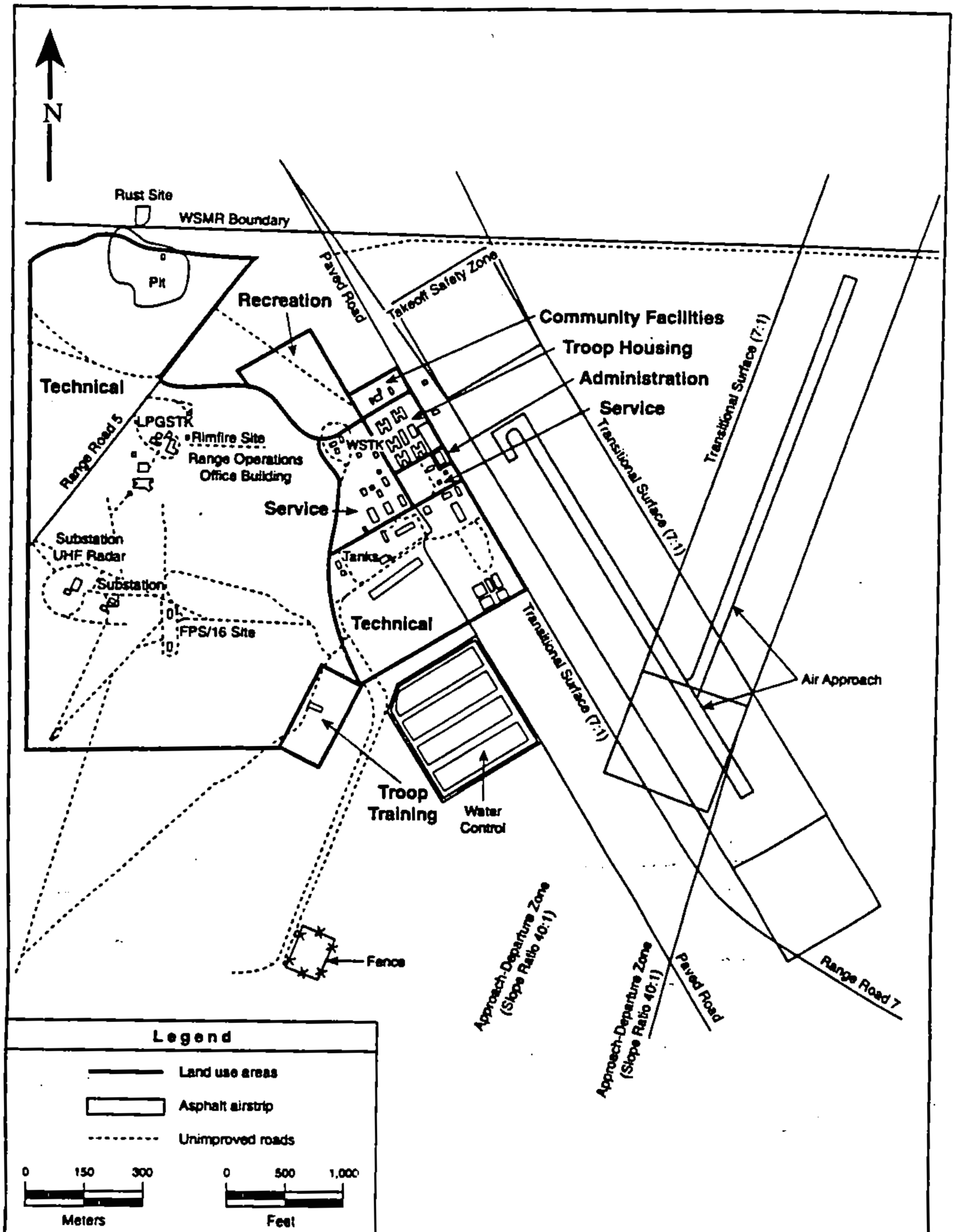

Figure 3-28. Stallion Range Center land use

Table 3-39
North range land use

Land Use Locations	Hectares (acres)	Description	Land Status	Present Activity*	Future Activity*
Stallion Range Center Airstrip and Stallion Gate	22 (55)	support and testing	U.S. Army	yes	yes
GEODSS Site	——	U.S. Army	no	yes	
Large Blast Thermal Simulator (LBTS)	——	U.S. Army	yes	yes	
PHETS Area	——	U.S. Army	yes	yes	
Stallion WIT	—	target area	U.S. Army	yes	yes
East CI	8,133 (20,096)	target area	U.S. Army	yes	yes
West CI	8,133 (20,096)	target area	U.S. Army	no	no
AFSWC	907 (2,240)	target area	U.S. Army	yes	yes
Trinity Site—	National Historic	U.S. Army Landmark	no	no	
Aerial Cable Test Capability Area	—	test and target area	U.S. Army	yes	yes
North Oscura Peak	259— (640)	U.S. Army	yes	yes	
Complex, ATOM Site	——	U.S. Army	yes	yes	
North Oscura Range Center	—	support area	U.S. Army	yes	yes
FAADS Valley Sites	—	impact areas	U.S. Army	yes	yes
Red Rio	14,644 (36,186)	impact and target area	U.S. Army	yes	yes
Oscura Impact Area/Gunnery Range	55,946 (138,240)	bombing range	U.S. Army	yes	yes
90 Mile	—	impact area	U.S. Army	yes	yes
COMA	205 (506)	impact Area	U.S. Army	yes	yes
ZURF	405 (1,000)	launch complex	U.S. Army	yes	yes
Sulf Site	—	launch area	U.S. Army	yes	yes
NECI	—	target area	U.S. Army	yes	yes
Radiological Hazard Area	1,943	hazardous	U.S. Army	yes	yes
	(4,800)	testing	U.S. Army	yes	yes
BECK	4,403 (10,800)	impact area	U.S. Army	yes	yes
NECI	5,698 (14,080)	impact area	U.S. Army	yes	yes

* Based on information in *Key Program Descriptions, Range-wide EIS* (U.S. Army 1993g).

Note: Dash indicates no data available

The Aerobee 350 area (97,639 ha [241,263 ac]), the ABRES 4A area (89,907 ha [222,157 ac]), and the ABRES 4AX area (77,518 ha [191,545 ac]) are adjacent to the northwest and west boundaries of WSMR. Usage is similar to that of the northern Call-Up Area.

The Jornada Experimental Range (JER) is a 40- by 34-km (25- by 21-mi) area located 32 km (20 mi) north of Las Cruces, New Mexico. The range encompasses approximately 80,940 ha (200,000 ac), 33,995 ha (84,000 ac) of which are managed under a co-use agreement with WSMR and 9,591 ha (23,700 ac) of which are included in the San Andres National Wildlife area. The JER is under the jurisdiction of the USDA. The U.S. Army uses its reserved portion of land within the range for missile research and development, and can erect structures and utility systems within this area.

3.7.1.9 Non-WSMR-controlled, Non-joint-use Land Use. Fort Bliss, Texas, is the U.S. Army Air Defense Center and contains the firing and maneuver areas adjacent to WSMR known as McGregor Range and Doña Ana Range, which extend into southern New Mexico. The fort was originally established in 1849, with permanent structures erected in 1892. Following World War II, Fort Bliss became an antiaircraft artillery center. WSMR has an MOU with Fort Bliss that defines the responsibilities and joint-use areas between the two installations. Additionally, the Orogrande launch complex on Ft. Bliss property is maintained on a permanent basis for missile firing in relation to troop training activities at Fort Bliss.

Holloman AFB is a large military reservation situated on the southeast boundary of WSMR, west of Alamogordo, New Mexico. This is a non-WSMR-controlled multiple-use facility. The base is currently home to three U.S. Air Force combat-ready F-117 Nighthawk squadrons and a combat rescue squadron equipped with HH-60 Pave Hawk, and conducts various training programs on several types of aircraft for both U.S. and foreign pilots. Numerous aircraft hangars house the aircraft and associated repair and maintenance facilities. The base features a cantonment area; entertainment and restaurant facilities; family housing; a golf course; a chapel; and administrative, technical, and maintenance offices. In addition, there are numerous research and testing facilities for munitions and a high-speed test track facility. The world's largest chimpanzee biomedical research facility is sited on the AFB. Land use areas for this subsection are described in Table 3-40.

3.7.1.10 Grazing Potential. Large portions of WSMR were used for domestic stock grazing prior to the military-use era. The following provides a descriptive analysis of grazing potential on WSMR (Table 3-41).

Natural Succession

Prior to the arrival of domestic livestock, much of the WSMR area contained a substantial semiarid grassland. As cattle were introduced, a marked increase in mesquite, creosote, and tarbush was noted, caused by a combination of overgrazing, drought, cattle dispersion of seed, and erosion. Although the area has not been grazed for nearly 50 years in many areas, the range grass has yet to replace the mesquite. However, the foot slope grasslands are rich with grama grasses, based on their slightly higher elevation, rolling topography, and loamy soils. The Red Rio bombing range is located within an area of this habitat, which continues to thrive despite years of repeated disturbance (U.S. Army 1985a).

Table 3-40
Non-WSMR-controlled, nonjoint-use land use adjacent to or near WSMR

Land Use Locations	Description	Land Status
Fort Bliss	military	U.S. Army
Doña Ana Range	military	U.S. Army
McGregor Range	military	U.S. Army
Holloman Air Force Base	military	U.S. Air Force
Lincoln National Forest (Three Rivers campground, White Mountain Wilderness Area, and Ski Apache ski area)	recreation	USFS
Cibola National Forest	recreation	USFS
Mescalero Apache Indian Reservation	recreation	private
Organ Mountains Special Management Area	recreation	BLM
Organ Mountains	wilderness area	BLM
Aquirre Springs	recreation	BLM
Dripping Springs	recreation	BLM
Jornada del Muerto	wilderness study area	BLM
Valley of Fires	recreation	BLM
Little Black Peak	wilderness study area	BLM
Three Rivers Petroglyphs	recreation	BLM
Bosque del Apache	national wildlife refuge	BLM
San Pasqual	wilderness area	BLM
Indian Wells	wilderness area	BLM
Elephant Butte, Caballo, and Percha Reservoirs	recreation	BLM
Oliver Lee	recreation area	state park
Fort Selden	recreation area	state park
Leasburg Dam	recreation area dam	state park
Elephant Butte	Lake State Park	state park
	recreation area	state park
Caballo	recreation area dam	state park

Table 3-41
Grazing potential of WSMR

Vegetation Group	Total Animal Units
Clay Grassland	10,023
Salt Flats	9,600
Sand Grassland	23,009
Gypsum Grassland	21,347
Gypsum Dunes	0
Intermittent Dunes	0
Foot Slope Grassland	7,343
Semidesert Shrub	3,369
Pinyon-juniper Mountains	9,940
Mountains, Nonwooded	8,744
Semidesert Hills	8,806
Lava Flows	509
Total	102,690

Source: Neher and Bailey 1970.

Grazing Potential and Use

BLM has estimated that WSMR could support approximately 210,000 animal units (the amount of feed to support a cow/calf pair for one month), while the SCS estimated closer to 102,000 (Neher and Bailey 1970). Table 3-41 lists estimates of grazing potential of vegetation types within the range boundary. No grazing is officially permitted on WSMR proper because it would potentially conflict with the mission of the installation.

3.7.2 Hunting Areas

No recreational access to WSMR is permitted except for hunting and the twice-yearly opening of Trinity Site. Fourteen seasonal open-hunting and trapping areas have been designated on WSMR for small game, bird, and "varmint" species (Figure 3-29) (Morrow, pers. com. 1993b). These animals may be hunted under the provisions of WSMR Regulation 190-1 and the NMDGF, Small Game Proclamation.

Annual special-permit hunting areas for big game are located in several areas. Stallion Range supports one pronghorn hunt and one oryx hunt per year. The Oscura Mountains and the Salinas Peak area each host one deer hunt annually. Three other special-permit hunts for oryx are held in the areas of the Small Missile Range, RCRC, and Red Canyon in the eastern portion of the basin. A "nontypical" oryx hunt occurs in different locations each year.. In addition, depredation oryx hunts are established on an as-needed basis (Morrow, pers. com. 1993b). Cougar hunting is permitted on WSMR in the Oscura Mountains and east of Range Road 7. Hunters must possess a state of New Mexico cougar license and a WSMR hunting permit. These are rifle hunts, with a single exception of one annual primitive weapon deer hunt. Both annual special-permit hunts and nontypical hunts are open for regulated hunting (WSMR Regulation 190-1) and are consistent with federal and state of New Mexico laws (U.S. Army

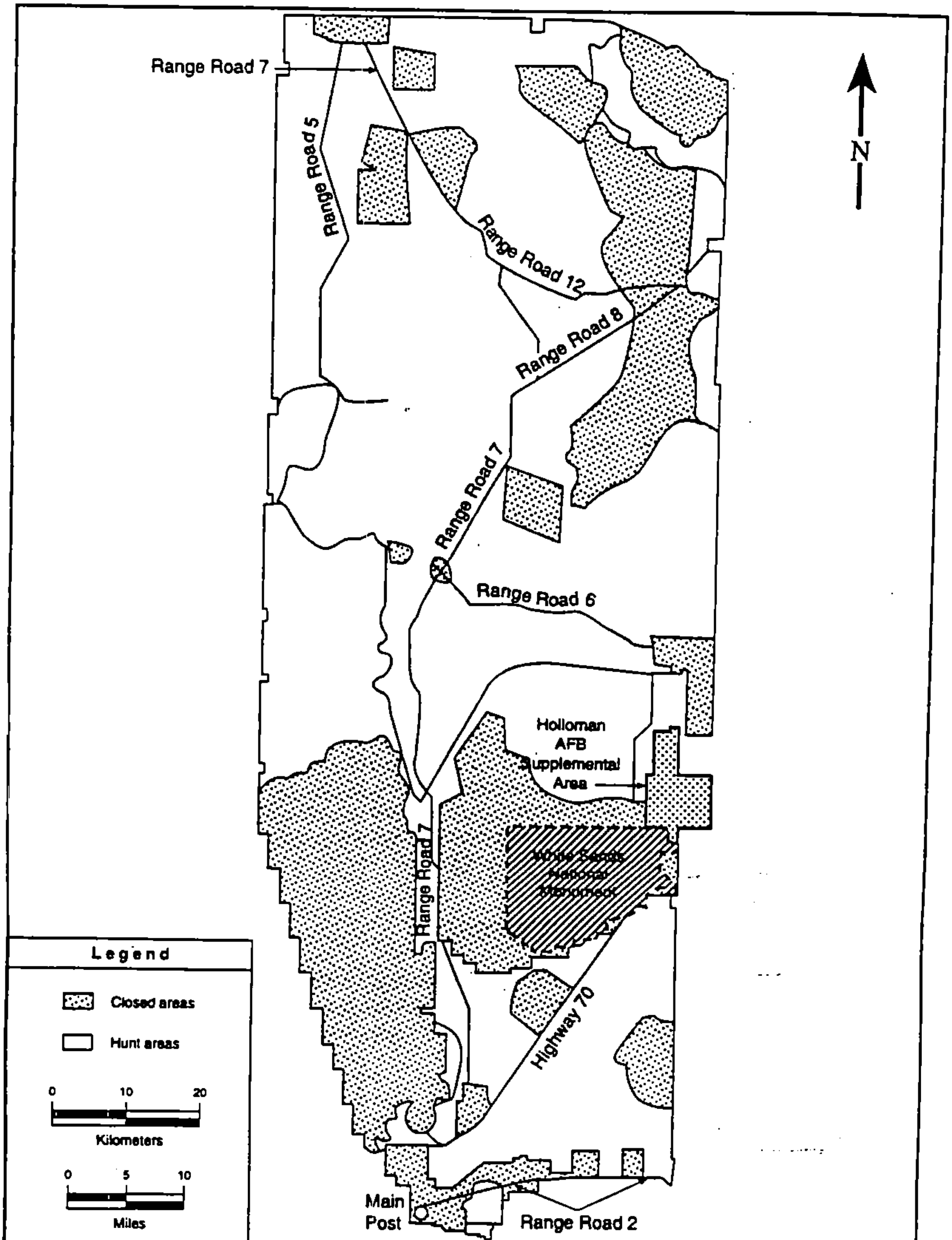

Figure 3-29. Hunting areas on WSMR

1993h). Future harvest objectives and hunt permit strategies on the range will be explained in detail in the WSMR Integrated Natural Resources Management Plan.

The basic hunting rules on WSMR adhere to the current New Mexico Hunting Proclamation and federal game laws. WSMR adds a few restrictions to maintain range security. Generally, public hunting on WSMR is prohibited outside of the organized permit-entry hunts coordinated between WSMR and the NMDGF. The NMDGF has the responsibility to administer WSMR special big game hunts. The military coordinates with NMDGF to supply logistical support. No special licenses or permits are required by WSMR for hunters participating in the organized special hunts. The NMDGF issues licenses, tags, and permits; uprange clearance is provided by military escort. A WSMR trapping permit and a state license are required for persons wishing to trap fur bearers on WSMR. The trapping permit is issued by the Security Directorate (Game Wardens). The establishment of harvest quotas for all big game species on WSMR is a coordinated effort between the military and NMDGF. Due to security restrictions regarding public access on WSMR, there is no potential for increased public hunting outside of WSMR special hunts (U.S. Army 1983a). By law and regulation no hunting or trapping is allowed on land administered by NPS on WSNM. No hunting or trapping is allowed on the San Andres National Wildlife Refuge.

In general, the U.S. Army is responsible for natural resources management on all installation properties through the office of the Facilities Engineer (AR 420-74). On WSMR, this responsibility encompasses the entire area within the installation boundaries, excluding the San Andres National Wildlife Refuge and the WSNM. Natural resources management within these areas is the responsibility of USFWS and NPS, respectively.

Coordination with local, state, and federal governmental and civilian conservation agencies relative to installation natural resources programs is part of the military responsibility in natural resources management (AR 420-74). In general the MOU negotiated between WSMR and the various conservation agencies charge WSMR with the overall responsibility for natural resources management on the installation, including the enforcement of military, state, and federal wildlife laws and regulations. WSMR is considered much like a privately owned property by state and federal wildlife law enforcement personnel, in that entry and land use are restricted by the landholder. The participating nonmilitary conservation agencies have the primary responsibility to provide technical assistance and advice to the Commanding General, WSMR, on fish and wildlife matters (U.S. Army 1983a).

3.8 UTILITIES AND INFRASTRUCTURE

This section addresses the facilities and systems that provide WSMR with electrical service, telephone service, natural gas, mobility fuels, water, and sanitary and solid waste handling. Descriptions of the existing conditions and capacities of these systems are included.

3.8.1 Electrical Service

Electricity at WSMR is furnished via commercial power from El Paso Electric Company (94 percent), and from Otero County Electric Cooperative, Sierra Electric Cooperative, and Socorro Electric Cooperative (6 percent). Socorro Electric Cooperative is the predominant service in the north range, whereas El Paso Electric Company serves the central and southern range areas. The electrical service points on the range are divided into four separate load areas (Figure 3-30). In fiscal year 1991 (October through September), WSMR consumed 109,041 MWh of electricity.

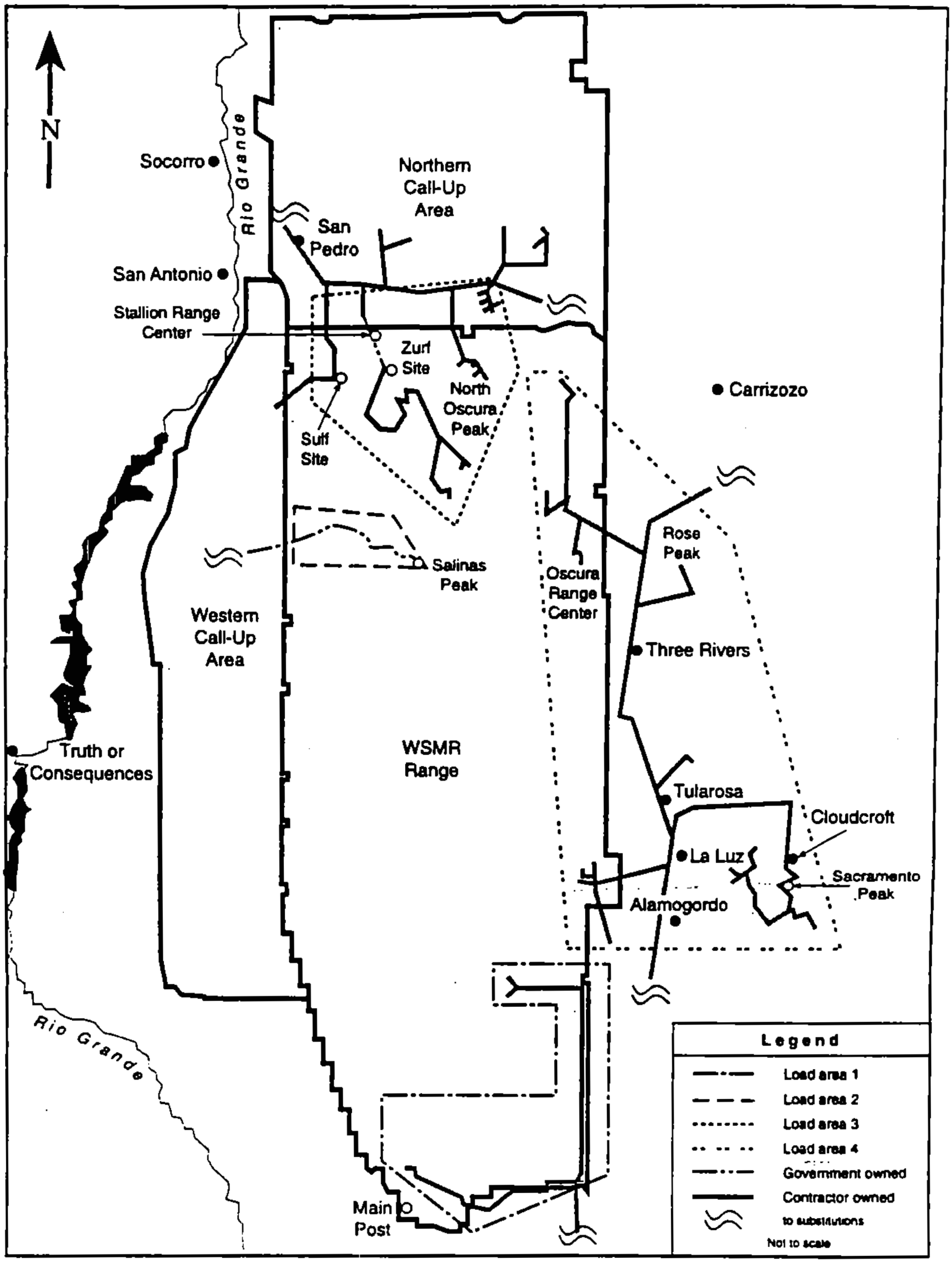

Figure 3-30. Electrical load areas

Powerlines can provide hazards for raptors and other birds, often resulting in electrocution. In 1981, the updated "Suggested Practices for Raptor Protection on Power Lines" was published by the Raptor Research Foundation, Inc. The recommendations of this report and updated guidelines are implemented into the design of new powerlines at WSMR to reduce injury and death of birds of prey from powerlines.

3.8.1.1 Distribution Substations. There are four distribution substations - El Paso Electric Company, Sierra Electric Cooperative, Socorro Electric Cooperative, and Otero County Electric Cooperative. El Paso Electric Company owns, operates, and maintains distribution voltage facilities throughout WSMR. El Paso Electric Company serves the majority of the southern range area of WSMR with 345- and 115-kV transmission lines and 14.0 and 24.9-kV distribution lines. This area, WSMR load area 1, consists of six delivery points. The current load is 102,650,000 kWh. Annual electrical consumption of each delivery point is presented in Table 3-42.

The El Paso Electric ALA-S distribution substation consists of feeders 2, 3, 6, and 7. These have a feeder voltage of 7.2/12.4 kV. The AMRAD distribution substation has feeders 1, 2, and 3. These each have a feeder voltage of 14.4/24.9 kV. Uprange feeder station 5 (MAR site) has feeder voltages of 2.4/4.16 kV and 14.4/24.9 kV. WSMR Main consists of several feeder substations with a wide variety of feeder wire types and feeder voltages (U.S. Army 1983b).

Sierra Electric Cooperative owns and operates an electric distribution system originating at Cuchillo Substation near Truth or Consequences, New Mexico, and extending into WSMR via its east system. Distribution into the north range is provided through a 14.4/24.9-kV line from Cuchillo to Salinas Peak Camp and to Rob site. This area, WSMR load area 2, consists of four delivery points with one additional delivery point planned for 1994. The current load is 404,000 kWh. Annual consumption of each delivery point is presented in Table 3-43.

Socorro Electric Cooperative owns and operates an electric distribution system that originates at Socorro Substation (115/69-kV transformer) and extends to the general area of Mockingbird Gap. A 69-kV subtransmission line runs from Socorro to a transformer location near San Antonio. This line is operated at 24.9 kV and has a 10-MW-load-carrying capacity. From San Antonio to SRC, the line is rated at 24.9 kV and is operated at that voltage. The Socorro Electric Cooperative system extends into the WSMR north range from SRC through a 14.4/24.9-kV system extension. These distribution lines serve existing WSMR loads along WSMR Range Road 7, Range Road 13, and Range Road 20. This area,

Table 3-42
Annual electrical consumption of WSMR load area 1

Distribution Point	Annual Consumption (kWh) Based on 1991 Consumption
Post Area	57,000,000
ALA-513,600,000	
AMRAD	1,800,000
HELSTF-MAR Site	20,400,000
HELSTF-EMRLD	350,000
NASA (WSTF)	9,500,000

Note: kWh = kilowatthour

Table 3-43
Annual electrical consumption of WSMR load area 2

Distribution Point	Annual Consumption (kWh) Based on 1991 Consumption
Rob Site	144,000
Communication Carrier Facility	10,000
Salinas Peak	250,000
BAT*/Zumwalt Test Track	9,000

* Planned delivery point, consumption is estimated by STEWS-DPW-PE.

Note: kWh = kilowatthour

WSMR load area 3, consists of five separate delivery points with three additional points planned for 1994. The current load is 4,882,500 kWh. The annual electrical consumption of each delivery point is presented in Table 3-44.

Otero County Electric Cooperative owns and operates an electric distribution system that originates at Alamogordo Substation (115/69-kV transformer) and extends through a 14.4/24.9-kV distribution line to ORC. This line is a direct service feed to the U.S. Army facilities at ORC, and there is no Otero County Electric Cooperative-owned transformer at the termination point. This area, WSMR load area 4, consists of 24 separate points. The current load is 1,104,500 kWh. The annual electrical consumption of each point is presented in Table 3-45.

3.8.1.2 Electricity Generation From Diesel Generators. Currently, 300 generators are available for use at WSMR. All generators are considered portable, although some are semi-permanently stationed. Generators range in their output capability from 10 to 700 kVA. Generators being used as semi-permanent emergency power systems are presented in Table 3-46.

Table 3-44
Annual electrical consumption of WSMR load area 3

Distribution Point	Annual Consumption (kWh) Based on 1991 Consumption
Stallion Range Center System	4,200,000
North Oscura Peak	300,000
Hunter's Lodge	10,500
Sulf Site	12,000
90-mile Area	360,000
Large Blast/Thermal Simulator*	5,356,800
Aerial Cable (Murray well)*	60,000
Aerial Cable (Phets East Park)*	302,000

* Planned delivery point, consumption is estimated by STEWS-DPW-PE.

Note: kWh = kilowatthour

Table 3-45
Annual electrical consumption of WSMR load area 4

Distribution Point	Annual Consumption (kVA) Based on 1991 Consumption
FAADS Command Post	40,000
Commo Vans	20,000
Fire Point East	15,000
D-10 Building 33470	1,500
ORC Guardhouse	8,000
Oscura Range Center	500,000
TAC Training Tower #1	5,000
TAC Training Tower #21	25,000
D-8 Building 31570	1,000
Phillips Hill #1	40,000
Phillips Hill #2	70,000
Rose Peak	1,500
Rita Site #1	250,000
Rita Site #2	50,000
Bate Site	1,000
WSSC Radion Monitor	60,000
Twin Buttes	5,000
Alamo Peak #1	22,000
Alamo Peak #2	60,000
Boresight Tower	15,000
Sacramento Peak	65,000
Booster Pump #1	6,500
Mule Peak	3,000
ASR-9 Radar	65,000

Note: kVA = kilovoltampere

3.8.2 Communications Systems

The Directorate of Information Management provides all areas of communications support to WSMR. This includes maintenance, distribution, and a scheduling clearinghouse. The structure and placement of communication lines can result in the collision and potential entanglement of raptors with communication and guywires. The 1981"Suggested Practices for Raptor Protection on Power Lines" found that collision with transmission lines is not a significant mortality factor for raptors. This report does include recommendations for reduction of entanglement of birds on wire wrapped lines. These recommendations are also incorporated into the design of communication lines at WSMR.

3.8.2.1 WSMR/U.S. Army Telephone System and Interface With National System. The on-range telephone system consists of a loop from the Main Post to Stallion Gate, King I to Oscura Range, and Junction 9 to Rhodes Canyon. This loop is being upgraded from underground copper cables to fiber optics carriers. All of the aboveground open copper wire has been removed with the exception of 8 km (5 mi). Approximately 610,000 sheath m (2 million ft) of underground lead-sheath copper wire still exists.

Table 3-46
Electrical generators on WSMR

Location	Generator Status	Generator Size (kVA)
LC-33	existing	60
LC-38	proposed	60
SMR-U-4	proposed	60
Building 123	existing	100
Building 300	existing	100
KING-I-U-6	existing	100
J-4-U-44	existing	60 and 15
Andre	existing	60 and 30
Rhodes-U-46	existing	60 and 15
ORC-U-45	existing	60 and 15
Stallion-U-25	existing	100
Q-16	existing	60 and 10
Salinas-U-52	existing	100 and 60
Salinas II	existing	100 and 60
NOP	existing	60 and 30
U-51	proposed	30
U-41	proposed	30
U-32	proposed	100
U-17	proposed	60
Comm. WSMR	proposed	30
Comm. Jess Site	proposed	30
Comm. El Paso	proposed	30 and 15
Comm. McGregor	proposed	30
Comm. HAFB	proposed	30
Comm. Sacramento Peak	proposed	100
Fire Department Main Post	existing	60
Airport Main Post	existing	60
Building 1408	proposed	200
Building 364	proposed	30
Building 1512	proposed	400
Alamo Peak Radio Station	proposed	60
Elephant Mountain Radio Station	proposed	60
MP Station	existing	30
Building 300	existing	60
Condron Field	existing	60
Fire Department	existing	60
Sulf Site	existing	100
Nuclear Reaction	existing	60
Building 100	existing	100
LC-33	existing	200
Commissary	existing	12.5
Building 1515	existing	80
Building 123	existing	30
LC-38	existing	100
King-I	existing	30
Blast Simulator	existing	200

Note: kVA = kilovoltampere

There are ten aboveground operator-facilitated central offices (Dial 1 stations) within the system, which are manned by small staffs of one or two technicians. The central office locations are as follows:

- Main Post (2)
- LC-33
- LC-38
- Small Missile Range
- Andre
- Rhodes Canyon
- Stallion
- J-9
- King I
- Oscura Range

3.8.2.2 Commercial Telephone Service. Currently, off-range telephone system infrastructure is entirely provided by U.S. West. They also service the residential portion of the Main Post as well as WSNM and Holloman AFB. U.S. West has a major fiber optic in-ground system running from Las Cruces to Alamogordo along U.S. Highway 70.

Microwave sites used for telephone communication are located at several sites within 80 km (50 mi) of WSMR boundaries. These microwave facilities are owned by various companies, as listed in Table 3-47.

Public communications carriers have microwave sites in locations surrounding WSMR, as do public agencies such as the police and the border patrol. In addition, Southern Pacific Railroad has lines running east of the range with microwave sites adjacent to those lines. The following public communications carriers have microwave sites within 80 kin (50 mi) of WSMR:

- U.S. West
- MCI
- AT&T
- Sprint
- Penasco Co-op (Artesia)
- Eastern New Mexico Rural
- S.W. Bell
- Contel General Telephone (Ruidoso).

3.8.2.3 WSMR Radio System. Air-to-ground communications at WSMR consist of the following:

Table 3-47
Location and owner of microwave sites within 80 km (50 mi) of WSMR boundaries[a]

Microwave Sites	usw	mci	att	spr	pc	enm	rui	pol
Sierra Blanca							X	
Rose Peak	X	X		X				
Cathy Peak	X							
Organ Peak	X		X					
Orogrande	X		X					X
Mountainair			X					
San Antonio			X					
Rincon			X					
Monticello			X					
Luis Lopez[b]			X					
Cutter Butte			X					
Fairacres			X					
Hueco Mountain			X					
El Paso			X					
Clanch/White Oaks			X					
Tinney			X					
Salinas Peak						X		
Bingham						X		
Socorro/Lemitar			X					
Little Carr Canyon					X			

[a] Owners are identified using the following abbreviations: usw = U.S. West, mci = MCI, att = AT&T, spr = Sprint, pc = Penasco Co-op, enm = Eastern New Mexico Rural, rui = Ruidoso General Phone, and pol = police agencies

[b] Louis Lopez is an underground (AT&T) site at San Antonio

- Radio guidance and control for command and destruct, which is limited to the 406- to 550-MHz frequency band. Use of these remote control units is scheduled with STEWS-IM 30 days in advance.

- Air-to-ground (aircraft communications) using discrete frequencies within both VHF and UHF frequency bands, specifically the 225- to 399.9-MHz range.

Ground communications at WSMR consist of the following:

- Intercommunications units (intercoms), two way between two locations — units use 115-Vac, 60-Hz power for operation

- Temporary ground communications — a portable radio pool, issued on a mission-by-mission basis

- Permanent ground communications-extended and exclusive use of a frequency channel (radio frequency authorization [RFA] is obtained through the U.S. Army Information Services Command) required for certain testing procedures.

- Surveillance of the WSMR radio environment-carried out by the frequency and timing division, There are seven radio surveillance sites with four on-range locations (Sacramento Peak, Holloman AFB, south range launch sites, and north range Small Missile Range) and three off-range locations (MacGregor Range, Fort Bliss, and Kirtland AFB). Surveillance receives radio frequency bands from 2 MHz to 20 GHz. Surveillance also has a mobile team.

3.8.2.4 Computer Systems (Information Systems Command). The U.S. Army Information Services Command/Directorate of Information Management at WSMR provides information mission area support to all elements and tenants at WSMR in the form of management, planning, and operations and maintenance for all communications, and records management (WSMR 1992a). The automated services available at WSMR include general-purpose scientific and engineering computers, and business computers to provide base support.

3.8.3 Natural Gas and Other Gas Heating Systems

The majority of the buildings in the Main Post area use natural gas, forced-air, heating systems. The Gas Company of New Mexico provides WSMR with natural gas through a pipeline consisting of two high-pressure (6.2 MPa [900 psi]) pipes. One pipe is 6.35 cm (2.5 inches) and the other is 7.6 cm (3 inches) in diameter. These two lines extend from El Paso, Texas, across Fort Bliss, and terminate in Alamogordo, New Mexico. A lateral connection from these gas pipelines supplies natural gas to the Main Post area metering station adjacent to building 1794, where the gas is metered, reduced in pressure to 0.16 MPa (22.5 psi), and fed into the Main Post distribution system (WSMR 1989b). All other facilities at WSMR use tank-fed propane gas heating systems with gas supplied by local area contractors.

3.8.4 Vehicle Fuels

There are 25 petroleum storage tanks located at WSMR Main Post, RCRC Station, SRC, HELSTF, and LC-38. Of the 25 tanks, 11 contain unleaded gasoline (Table 3-48) and 15 contain diesel fuel (Table 3-49). The capacities of vehicle fuel storage tanks on WSMR range in size from 11,356 to 567,810 L (3,000 to 150,000 gal). The total capacity for petroleum storage at WSMR is 1.8 million L (478,000 gal).

Jet Propulsion Fuel No. 8 is the type of aviation fuel currently used at WSMR; prior to September 1993, Jet Propulsion Fuel No. 4 was used exclusively. The fuel is dispensed directly to aircraft from 208,175-L (55,000-gal) tanker delivery vehicles. Three tankers are in use down range; two at the SRC/Rhodes Canyon area. No permanent storage tanks exist on WSMR for this fuel (Lara 1993). Permanent fuel tanks are owned by the U.S. Air Force and are located at Holloman AFB. Aviation fuels are managed and reported by the Energy Management Office at Holloman AFB for both tactical and administrative aircraft. Permanent helicopter refueling points are established at RCRC and SRC. Consumption logs for these centers are contained in Holloman AFB records. Table 3-50 lists the capacities and locations of each WSMR Jet Propulsion Fuel No. 8 delivery vehicle.

3.8.5 Water Systems

Main Supply Wells and Storage Facilities. The water system at WSMR was originally built to serve a relatively small temporary installation (COE 1949). As early as 1948, the installation obtained its water supply from five producing wells located at the base of the Organ Mountains. The total production of these wells was estimated at 264 gpm (COE 1949).

Table 3-48
Unleaded gasoline storage tanks on WSMR

Capacity in L (gal)		Location
22,712	(6,000)	WSMR Main Post
22,712	(6,000)	WSMR Main Post
22,712	(6,000)	WSMR Main Post
94,635	(25,000)	WSMR Main Post
94,635	(25,000)	WSMR Main Post
94,635	(25,000)	WSMR Main Post
22,712	(6,000)	Rhodes Canyon Range Center Station
94,635	(25,000)	Rhodes Canyon Range Center Station
94,635	(25,000)	Stallion Range Center
20,820	(5,500)	Oscura Base Camp
11,356	(3,000)	HELSTF

Notes: L = liter
gal = gallon

Table 3-49
Diesel fuel storage tanks on WSMR

Capacity in L (gal)		Location
22,712	(6,000)	WSMR Main Post
22,712	(6,000)	WSMR Main Post
22,712	(6,000)	WSMR Main Post
22,712	(6,000)	WSMR Main Post
94,635	(25,000)	WSMR Main Post
94,635	(25,000)	WSMR Main Post
94,635	(25,000)	WSMR Main Post
22,712	(6,000)	Rhodes Canyon Range Center Station
94,635	(25,000)	Rhodes Canyon Range Center Station
94,635	(25,000)	Stallion Range Center
18,927	(5,000)	Stallion Range Center
18,927	(5,000)	Stallion Range Center
20,820	(5,500)	Oscura Base Camp
567,810	(150,000)	LC-38/Main Post
3,785	(1,000)	WSTF – 150 Area

Notes: L = liter
gal = gallon

Water production increased annually from 1949 until the early 1970s when it stabilized at approximately 2.54 million m^3 (670 million gal). Since then, the trend in pumpage rates has been decreasing gradually to a current rate of 2.35 million m^3 (620 million gal). A listing of annual groundwater pumpage rates for the years 1948 to 1992 is presented in Section 3.2.3.2.

Table 3-50
WSMR jet propulsion fuel delivery vehicles

Location	Capacity of Delivery Trucks in L (gal)	
Main Post/Condron	18.927	(5,000)
	18.927	(5.000)
	7,571	(2,000)
Uprange/Stallion	7.571	(2,000)*
	18,927	(5,000)

* This truck will be replaced in 1994 with an 18,927-L (5,000-gal) tanker

Notes: L = liter
gal = gallon

Major waterlines for the Main Post supply run along three thoroughfares. Well-line Road is the waterlines running parallel to Owen Road. Lines run from Soledad Canyon to the Main Post and along Nike Boulevard to the eastern post boundary. Currently there are four types of pipe being used; transit pipe, cast iron pipe, concrete cylinder pipe, and PVC (polyvinyl chloride) pipe. Pipe replacement is occurring presently between LC-32 and LC-38, and has been completed previously from the eastern range boundary to LC-38. Antiquated concrete cylinder pipe is being replaced with modern PVC pipe.

The current source of water for the Main Post originates from four watersheds adjacent to the Main Post (COE 1992e). This water supply has a natural recharge of the potable water aquifer at 38 percent of the annual withdrawal (COE 1 992e). There are currently 11 wells serving the Main Post area with the capability of serving an effective population of 14,500 people (COE 1992e). The average daily usage in 1989 was 0.083 m^3/s (1.9 MGD), and a daily peak usage of 0.17 m^3/s (3.9 MGD). The capacity of the Main Post wells averages 0.25 m^3/s (5.65 MGD) based on a 16-hour pumping record (COE 1992e). The Main Post area has a maximum storage capacity of 11,356 m^3 (3 million gal) (COE 1992e), which can support an effective population of 10,000 and an actual population of over 13,000 (COE 1992d). Water from the Main Post wells is treated at the Main Post drinking water treatment facility. Treatment consists of sedimentation, disinfection, and fluorination.

At SRC, the primary source of water is groundwater. However, this water must be treated prior to storage and distribution. Only one of the two wells that supply water to SRC is operational (COE 1992e). Water storage at SRC consists of two 75,708-L (20,000-gal) tanks for untreated water, and one 378,540-L (100,000-gal) tank for treated water. The historical average consumption level at SRC is 4×10^{-4} m^3/s (9,600 GPD) with a pumping capacity of 4.4×10^{-4} m^3/s (100,000 GPD). SRC has an electrodialysis treatment plant in a continuous-feed stock system with pretreatment.

Water used at both Oscura and Rhodes Canyon range centers is hauled by truck from existing water supplies. Each building within these range centers has its own storage tank with a domestic pressure system.

There are no hauled-water programs at WSTF. All water is supplied through three 305-m (1,000-ft) wells located off site. Water is withdrawn from the Jornada aquifer through a permanent water withdrawal right with BLM. Wells are located within 7 km (4 mi) of WSTF boundaries and are pumped through transite water pipe across land held under easement with BLM. It is pumped approximately 10 km (6 mi) to a 3.8-mil-L (1-mil-gal) storage tank for distribution. Water is chlorinated at the WSTF facility, while 2,104-hectare (5,200-acre) water withdrawal rights apply. Presently only 121 hectares (300 acres) per year are used.

3.8.6 Sanitary Waste Disposal Systems

Two main wastewater processing facilities exist on WSMR. The wastewater treatment plant servicing the Main Post is located just east of the WSMR landfill, approximately 6.4 km (4 mi) from the Main Post. In the northern range, just south of SRC, several evaporative lagoons are located to process wastewater from SRC facilities. Additional wastewater processing occurs at the WSTF/NASA installation. Six lagoons are located at WSTF/NASA for processing and evaporation.

3.8.6.1 WSMR Wastewater Treatment Plants. The Main Post area of WSMR is served by a complete sanitary sewage collection and treatment system. All habitable outlying areas of the range are served by sanitary facilities. However, the treatment plant on the Main Post and the lagoon system at SRC are the major facilities.

The Main Post wastewater treatment facility was constructed in 1958 and has a rated capacity of 0.044 m^3/s (1 MGD). The system currently operates at approximately 50% of capacity.

The SRC wastewater treatment plant has a rated capacity of 12 x 10^{-4} m^3/s (27,000 GPD) and currently operates at 20 percent of capacity. Treatment at SRC is primarily a septic tank – evaporation pond system.

3.8.6.2 WSMR Main Post Collection System. The Main Post collection system is described in detail in Section 3.2.4.2. During a 1978 survey, flow meter readings taken at key locations throughout the system indicated that the collection network was operating at 20 to 25 percent of its maximum capacity during peak flow periods. In 1986 (U.S. Army 1986c), it was determined that the system was not operating at a significantly higher rate and, most likely, was running at or below the 1978 levels.

In 1960, the WSMR wastewater collection system served a work force of 13,000; in 1983, it served a work force of 7,489 (U.S. Army 1986c). The 1991 WSMR work force was 9,033 (WSMR 1992b). This indicates that the present collection system and treatment plant could support a 30-percent increase in population without requiring a major addition to the wastewater collection and treatment facilities. The wastewater treatment plant was entirely refit in the mid-1970s under a COE project. While currently operative at 500,000 GPD, it has 1 MGD capacity. The plant is constructed in a mirror-image design, which allows a 50-percent shutdown for repairs while still allowing a 50 percent operating capacity.

3.8.6.3 Inventory and Description of Septic Tank and Leach Field Systems. In 1991, the WSMR Environmental Services Division conducted a comprehensive review of the available documentation and performed a field survey of all liquid waste disposal systems located throughout WSMR. Concurrently, the WSMR Environmental Services Division conducted additional research at the NMED Las Cruces District Office. Of the 121 WSMR facilities located during the survey, NMED has issued permits for only 11 systems. NMED did not issue permits for any systems constructed prior to 1972. Discussions with the staff at the

NMED Las Cruces District Office indicated that the quality of the groundwater on WSMR that potentially could be affected by the construction of liquid waste disposal systems is extremely poor and nonpotable. Therefore, permits were neither requested nor required (U.S. Army 1991b).

Additional important results of the field survey include the following:

- 50 disposal systems had as-built blueprint plans available at Directorate of Public Works (DPW),
- 28 disposal systems could not be located,
- 5 disposal systems were no longer in use or in place,
- 12 disposal systems could not be correlated with a specific building, and
- 4 disposal systems located were not found on the WSMR facility listing.

The majority of the systems surveyed were found to be in good condition and suitable for their intended and continued use. A file containing a field data sheet, a 20- by 25-cm (8- by 10-inch) photograph, and an as-built blueprint drawing (if available) of each disposal system is available at the WSMR Environmental Services Division offices, WSMR building 150.

3.8.7 Solid Waste Handling Systems

The solid waste handling systems for the range consist of landfills and waste collection and transport. Three main areas operate and maintain landfills and solid waste transport systems, as described in this section.

3.8.7.1 Landfills. There are three operating landfills serving WSMR. The Main Post landfill is located 11 km (7 mi) east of the Main Post. The second is located at Stallion Range at the north end of WSMR and the third is operated by NASA in the 700 area. WSMR has issued an Notice of Intent (NOI) to the state of New Mexico to continue operations and to obtain a permit. WSTF/NASA also has a landfill, which serves its own needs exclusively.

Main Post Landfill

The Main Post landfill consists of two separate units. Located south and east of Post Headquarters, the Main Post landfill meets the solid waste disposal requirements of the Post Headquarters and surrounding area. This area collects the residential refuse of approximately 3,000 WSMR staff and their families. The Main Post landfill is a Class A landfill as defined by New Mexico Solid Waste Management Regulation 2. A Class A landfill is one serving a population of more than 3,000.

The Main Post landfill occupies 10 hectares (25 acres) and is bounded by roads to the south and southeast (Battelle Environmental Management Operations 1990). Landfill operations are anticipated to cover an area of 32 hectares (80 acres) before this site is closed (U.S. Army Environmental Hygiene Agency 1988). The anticipated life of this facility is at least 10 years (Battelle Environmental Management Operations 1990). The Main Post landfill can be subdivided into three sections based on period of usage and material disposed. These sections consist of the original sanitary landfill, the contractor area, and the present sanitary landfill. In addition to the Main Post landfill, an active asbestos disposal area is located to the southeast across from the solid waste landfill. This asbestos disposal area is surrounded by a chain-link fence with barbed-wire outriggers and is marked by several large warning signs.

The Main Post landfill area measures approximately 192 by 213 m (630 by 700 ft) and is surrounded by a 2.4-m-high (8-ft-high) chain-link fence. The main landfill entry gate and inspectors' post are located in the southeast corner of the facility. The original landfill, opened in 1983, is located to the east of the current landfill and consists of five filled and covered cells with approximate dimensions of 30.5 m long by 30.5 m wide by 7.6 m deep (100 ft long by 100 ft wide by 25 ft deep) (Battelle Environmental Management Operations 1990).

Immediately east of the original landfill is the contractors' area. This parcel occupies 2 hectares (5 acres) and is used by WSMR contractors for disposal of construction/demolition wastes. The older, inactive disposal cells are located in the southern portion of this area. As new cells are needed, they are opened to the north. This portion of the landfill may cover 6 hectares (15 acres) before this site is closed (Battelle Environmental Management Operations 1990). A 1.2-m (4-ft) barbed-wire fence separates the older portions of the contractors' area from a road to the southwest.

Waste in both the residential and contractor areas is condensed and compacted by a Caterpillar D7 bulldozer. Waste in the residential landfill is covered once a week, typically on Friday, by 15 cm (6 inches) of soil. Equipment used to cover waste consists of the bulldozer and a Caterpillar 621B scraper.

In 1992, WSMR undertook an effort to quantify and characterize the waste streams being delivered to the Main Post landfill (WSMR Environmental Services Division 1992b). One to four incoming loads of both residential and commercial waste were examined daily for a period of three weeks. Observation times were generated randomly and were unannounced. A total of 49 landfill observations were completed during the survey period. Table 3-51 provides an estimate of the different types of incoming waste observed during the survey period (WSMR Environmental Services Division 1992b).

Table 3-51
Percentage distribution of waste types delivered to the Main Post landfill during 1992 survey

Waste Type	Percent
Cardboard	37
Paper	30
Household Waste	13
Plastics	7
Wood	4
Construction Waste	3
Food Products	3
Glass	1
Agriculture	1
Miscellaneous	1

Source: WSMR Environmental Services Division 1992b.

Stallion Range Landfill

The Stallion Range landfill is located 1.6 km (1 mi) south of SRC and is 2 hectares (5 acres) in size. As no residential waste is disposed of at this site, the Stallion Range landfill qualifies as a Class B landfill as defined by New Mexico Solid Waste Management Regulation 2. A Class B landfill is defined as a sanitary landfill serving a population of less than 3,000 persons. Operations at this site are anticipated to remain for 10 years (Battelle Environmental Management Operations 1990). In addition, there is room for expansion immediately south of the present landfill and adjacent to the fence line. The Stallion Range landfill is subdivided into three sections including the original sanitary landfill, the present landfill, and a recycling area. There are no designated areas for disposal of contractor or special wastes.

To the west of the current landfill location, there are two recycling areas. These areas are unfenced and consist of a trench for wood and a trench for metals. Both trenches are 30.5 m long by 6.1 m wide by 4.6 m deep (100 ft long by 20 ft wide by 15 ft deep).

WSTF Landfill

WSTF/NASA also operates a landfill. Collection of solid waste occurs at dumpsters stationed adjacent to WSTF buildings. A 30-cubic-yard top-loading garbage truck services the dumpsters. The WSTF Solid Waste Management Facility is an 11.7-hectare (29-acre) unit located in the 700 area. NASA currently operates this landfill under interim status as a facility awaiting a Preliminary Site Assessment and permit priority ranking from NMED. Waste is segregated so that liquids, scrap metal, and hazardous wastes are excluded. Hazardous waste is stored separately in the RCRA-permitted storage unit and professionally transported by a designated subcontractor.

Commissary Landfill Project

An abandoned disposal trench (landfill) was discovered in August of 1994 in the construction footprint of the new WSMR commissary. A total of eight samples of material in the trench were obtained and chemically analyzed for hazardous constituents. Because levels of lead were discovered in excess of the regulatory limits, the landfill was treated as a hazardous waste site.

Due to the nature of materials excavated from the landfill (e.g., old Coke and other bottles with dates of manufacture, etc.) it was assumed that the landfill dated from the very earliest days of WSMR and thus was historically significant. An archaeological investigation was conducted by WSMR, and the decision was made to remove all landfill material in an expeditious manner so that the site could be returned to the commissary construction contractor. A total of 83 30-yard roll-off bins were used to contain the waste material and provide ultimate disposition of any hazardous waste.

WSMR took samples from the trench after all the material was excavated and tested for hazardous waste. Results of the analyses were compiled in report form and submitted to the NMED for concurrence for closure of the trench. NMED concurred and the trench was returned to the commissary construction contractor on October 14, 1994. Samples were taken from the roll-off bins, and analytical results revealed that seven out of the 83 roll-off bins exceed the regulatory limits for lead and thus were classified as hazardous waste. WSMR performed testing for radioactivity during trench excavation and tested the individual bins as they were accumulated. No radioactivity was discovered.

The bins which contained material note classified as hazardous waste were transported to the WSMR sanitary landfill to be beneficially reused as daily cover material. The seven bins identified as hazardous waste were manifested off WSMR in accordance with regulator requirements. The contaminated material will be stabilized and interred at a licensed and permitted hazardous waste disposal facility.

Landfills No Longer in Use

Previously, 10 landfills operated throughout WSMR, three in the Main Post area. The former WSMR Post Sanitary Landfill No. 1 was the first landfill to be operated in the post area, and closed in 1948. Several sources at WSMR indicate this landfill was located on the site presently occupied by Building 1678, in the southeast area of the post. This landfill, reportedly used for the disposal of inert materials, was investigated as a Solid Waste Management Unit (SWMU) during the Phase I and Phase II RCRA Facility Investigation (RFI) activities. No contaminants of concern were detected. Former Main Post Landfill No. 2, located in the southeast area of the Main Post, was in operation from 1948 to 1965 and presumably underlies the present site of Building 1747. Soils and groundwater in the vicinity of this landfill (also used for the disposal of inert materials), were investigated during the Phase I and II RFI activities. No significant release of contaminants was identified during the investigations. Landfill No. 3, located near the Nuclear Effects Directorate and the metal scrap yard, was used from 1965 until 1982, for the disposal of inert materials. Soils and groundwater in the vicinity of Landfill No. 3 were investigated during the Phase I and II RFI activities. No significant release of contaminants was identified.

There also were two landfills serving the solid waste disposal needs of the NORC. Both NORC landfills accepted a mix of commercial and residential waste types. Two landfills located east of the main HELSTF area were used from the early 1960s to 1989 for the deposition of HELSTF-generated construction debris such as wood, piping material, and insulation. These landfills are no longer operational. The two landfills at HELSTF were investigated as SWMUs for the Phase I and II RFI activities. No significant release of contaminants was identified. Additionally, there are two inactive landfills at RCRC. One landfill received sanitary waste and missile debris until 1976. The second, which last received waste in September 1987, opened in 1976 and accepted office refuse and construction debris from support operations at the range center.

3.8.7.2 Collection and Transport Systems. Waste from WSMR is collected and transported to the Main Post landfill by the WSMR Ground and Surface Area Branch staff. Solid waste is collected from Post Headquarters offices, residences, and other buildings. An automated truck (15-m^3 [20-cubic yard] packer) collects and compresses waste from an estimated 300 dumpsters around the Post Headquarters areas and trash cans used by 3,000 residents. Dumpsters are emptied on an as-needed basis, some as frequently as once per day (Monday through Friday). Waste collection in the residential area occurs twice a week.

Construction/demolition waste and yard waste are transported to the site by private-sector contractors and, to a lesser extent, by the WSMR Ground and Surface Area Branch staff. These wastes typically are brought to the Main Post landfill in open trucks and arrive on an irregular basis.

The SRC landfill is operated by the Stallion Uprange Branch for the disposal of solid and yard waste generated in and around SRC. This landfill also is used for the storage of recyclable metal and wood. There are no set operating hours for the landfill and the entrance gate is controlled by the Uprange Branch staff. Solid waste is collected on a weekly basis from approximately 10 dumpsters. Each dumpster is carried individually by truck to the landfill for disposal. One dumpster per week is carried from the commissary but the remainder of the wastes are generated in offices. No permanent residential areas exist at SRC.

3.9 TRAFFIC AND TRANSPORTATION

The following section describes the principal components of transportation within the region. The characterization is based on current conditions.

3.9.1 Roadways

Activities at WSMR require an extensive network of roadways, both on the range and off. This network, as well as public access controls over area roads, is described below.

3.9.1.1 Off-range Roadways. The primary interstates serving the region are Interstate Highways 10 and 25. Interstate Highway 25 extends from Las Cruces, beyond Albuquerque, to the north (Figure 3-31). Interstate Highway 25 has two lanes in each direction and is in generally good condition. Interstate Highway 25 handles the current level of traffic easily. Interstate Highway 10 intersects Interstate Highway 25 at Las Cruces, New Mexico, and extends to Lordsburg, New Mexico, and beyond. Interstate Highway 10 has two lanes in each direction and is in generally good condition. Interstate Highway 10 handles the current level of traffic adequately.

U.S.-designated highways serving the region include highways 54, 60, 70, 82, and 380. U.S. Highway 54 runs north and south parallel to the eastern boundary of WSMR and connects numerous cities and towns including Alamogordo and Tularosa. U.S. Highway 54 is in good condition and supports traffic volumes averaging approximately 16,000 vehicles per day. U.S. Highway 70 provides Las Cruces and Alamogordo access to WSMR via Range Road 1. U.S. Highway 70 is in good condition with traffic volumes averaging approximately 8,740 vehicles per day (Abeyta, pers. com. 1993). U.S. Highway 70 recently was expanded to three lanes in each direction at San Augustin Pass to accommodate its high-use rate for commercial trucks. U.S. Highway 60 connects Interstate Highway 25 and U.S. Highway 54 north of the northern WSMR extension area. U.S. Highway 380 connects Interstate Highway 25 and U.S. Highway 54 just north of the main WSMR boundary, inside the northern Call-Up Area. U.S. Highway 380 is in good condition and supports an average of 700 vehicles a day.

Access Points to WSMR

There are seven primary access points to WSMR (Diaz, pers. com. 1993a). U.S. Highway 70 provides direct access through the Small Missile Range gate and along Range Road 1 at the Las Cruces and El Paso gates. U.S. Highway 54 provides three access gates from local roads at Orogrande Range Camp, Tula gate in Tularosa, and ORC. U.S. Highway 380 provides access to WSMR from Range Road 7 at SRC. Each of these seven access points has a gate supported by a guard house. Visitors and their vehicles are subject to inspections prior to entering to the range. In addition to the main access points, there are approximately 87 entrances throughout the range. These access points provide limited access and are protected by locked gates.

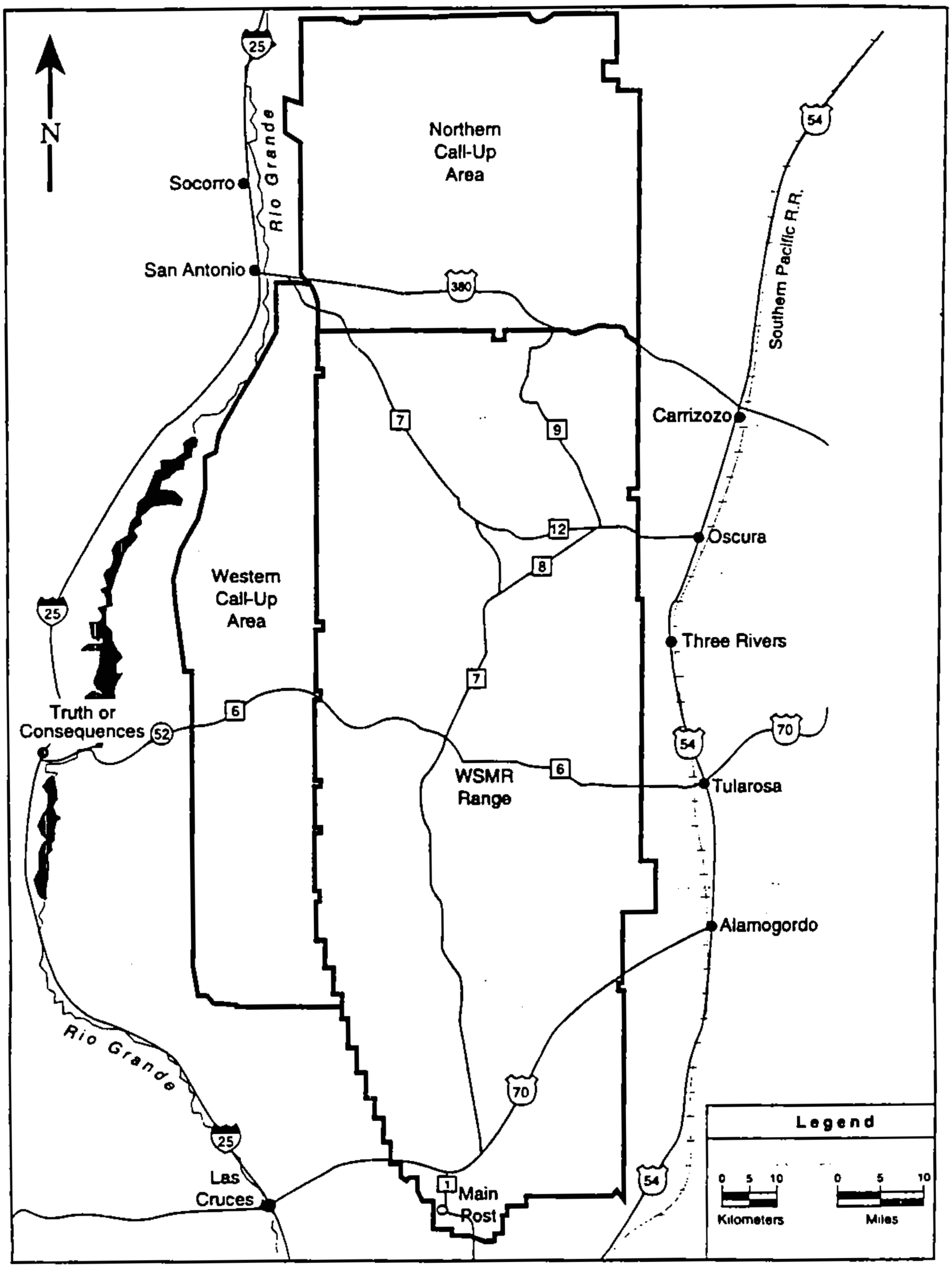

Figure 3-31. Transportation network in WSMR vicinity

The peak-use times for the Las Cruces and El Paso access gates are from 6:45 to 7:45 a.m. and 4:00 to 5:00 p.m. (Diaz, pers. com. 1993a). Use in each direction during these peaks is approximately 1,500 vehicles per hour at the Las Cruces gate and 900 vehicles per hour at the El Paso gate. These use rates are based on traffic counts taken during the busiest 15 minutes at each gate (Las Cruces gate: 4:20 to 4:35 p.m.; El Paso gate: 4:25 to 4:40 p.m.). The maximum capacity for each of these two access points is 1,200 vehicles in each direction per hour. The El Paso gate is thus under its maximum capacity and the Las Cruces gate is over capacity, resulting in congestion at the latter gate.

Roadblocks

As a safety precaution, an agreement with the state of New Mexico allows WSMR to establish off-range roadblocks on U.S. Highways 70 and 380. Under the agreement, a roadblock may last no longer than 1 hour and 15 minutes. U.S. Highway 70 is subject to an average of approximately one roadblock per day. U.S. Highway 380 is subject to approximately one roadblock per month. Electronic courtesy billboards are located outside the cities of Las Cruces and Alamogordo to inform drivers of upcoming roadblocks. A roadblock information hotline provides up-to-date roadblock information to the public. In addition, many of the local radio stations broadcast daily roadblock information. WSMR also establishes an average of five internal roadblocks per day. These roadblocks can occur anywhere on the main range and are from 2.5 to 3 hours in length (State of New Mexico 1968).

Hazardous Waste and Explosives Checkpoints

The Orogrande, El Paso, and Las Cruces gates have checkpoints for commercial vehicles carrying explosive materials. WSMR personnel check the bill of lading for the contents of each vehicle (Diaz, pers. com. 1993a). Section 3.8.7.2 discusses hazardous waste transportation on WSMR.

3.9.1.2 On-range Roadways. The road network on WSMR is extensive but in only an acceptable state of repair. Most major and secondary roads are repaired and maintained as funding permits (Diaz, pers. com. 1 993a). Typical maintenance activities for these roads include drainage repair, paving, sealing, and rebuilding. The paved roads on WSMR are designed to last 20 to 25 years but typically last for an average of 15 years. This is due partly to the wide temperature variations common to the region.

The three classes of roadways serving WSMR are major range roads, secondary roads, and trails. The major roads on WSMR are two-lane roads that are paved, graded, and maintained as funding permits. All the major roads on WSMR have the capacity to support 1,200 cars per hour for each lane. The major roads serving WSMR are Range Road 1, Range Road 2, Range Road 6, and Range Road 7. Range Road 1 extends in a north-south direction for approximately 9.7 km (6 mi). This road provides access to the Main Post area from the Las Cruces gate by way of U.S. Highway 70, and from the El Paso gate. Range Road 1 supports an average of 5,500 vehicles per day. Range Road 2 extends in an east-west direction from ORC to the Main Post area for approximately 32 km (20 mi). Range Road 2 supports an average of 3,500 vehicles per day. Range Road 6 extends in an east-west direction for 39 km (24 mi). Range Road 6 supports an average of 200 vehicles per day. Range Road 7 extends in a north-south direction from SRC to the Small Missile Range for approximately 190 km (118 mi).

There are approximately 966 km (600 mi) of secondary roads serving the WSMR network (Diaz, pers. com. 1993a). Secondary roads on WSMR are unpaved roads that are graded and maintained as funding permits. The WSMR road network has approximately 2,414 km (1,500 mi) of bladed trails. These unpaved trails are bladed but not maintained on a regular basis.

3.9.2 Airspace

There are two main military airstrips at WSMR located at Stallion and Condron fields. In addition, WSMR has two secondary military airstrips at Oscura and WSSH. The airstrip at Oscura is paved but is in need of repair. WSSH is a gypsum airstrip which can handle any aircraft including the Space Shuttle orbiter and proposed X-33 RLV..

Condron airstrip supports approximately four takeoffs and landings per day. During training maneuvers, up to 40 missions per day may occur. For this study, a mission is defined as one takeoff or one landing. The Stallion airstrip supports a maximum of four missions per week. Oscura airstrip supports approximately six missions per year. WSSH is used throughout the year for NASA shuttle training missions, drones, as needed for Space Shuttle landings, and potentially for the proposed X-33 RLV. WSMR also has approximately 35 helipads located throughout the range (Diaz, pers. com. 1993a).

3.9.2.1 Restricted Airspace. A total of 18 designated restricted airspace areas are located in the WSMR and Holloman AFB areas of southern New Mexico and Fort Bliss in northwest Texas (Figure 3-32). Thirteen of these areas are controlled by WSMR and are scheduled for research, development, testing and experimentation; military training; and civilian contract programs.

The remaining five areas are controlled by Fort Bliss and are primarily scheduled for use by U.S. Army training activities based there. One hundred and eighteen areas are charted as restricted airspace by the Federal Aviation Administration (FAA), which allows for hazardous activity use. Such hazardous activities include, but are not limited to, live ordnance delivery, missile firings, and laser shots.

Civil or military aircraft that have not been authorized and scheduled by the controlling agency are prohibited from entering active restricted airspace. In most cases, the airspace can be scheduled for use from the surface to unlimited altitude 24 hours per day. However, during part of each day, some of the WSMR restricted airspace may be returned to FAA control for use by civilian aircraft. This action is permitted under a shared-use agreement between WSMR and the FAA (Crnkovic 1991).

A priority scheduling system prescribes the use of WSMR airspace. Each authorized activity supported by WSMR is categorized as a range program. There are four priorities assigned according to the nature of these programs. The highest is a National Priority, which requires written U.S. Army direction. Priority 1 is assigned to research, development, testing, and experimentation; guided-missile firings; and high-energy laser operations. Priority 2 is assigned to nonresearch, development, testing, and experimentation guided-missile firings and high-energy laser operations. Priority 3 includes all other programs.

The major activities conducted in WSMR restricted airspace are associated with research, development, testing, and experimentation of military weapons systems including air-to-air, air-to-surface, and surface-to-surface types. Testing of space vehicle components, tracking systems and instrumentation is a significant range activity. Other missions include the operation of aerial drone targets; towed aerial targets; space probes; safety chase; aerial

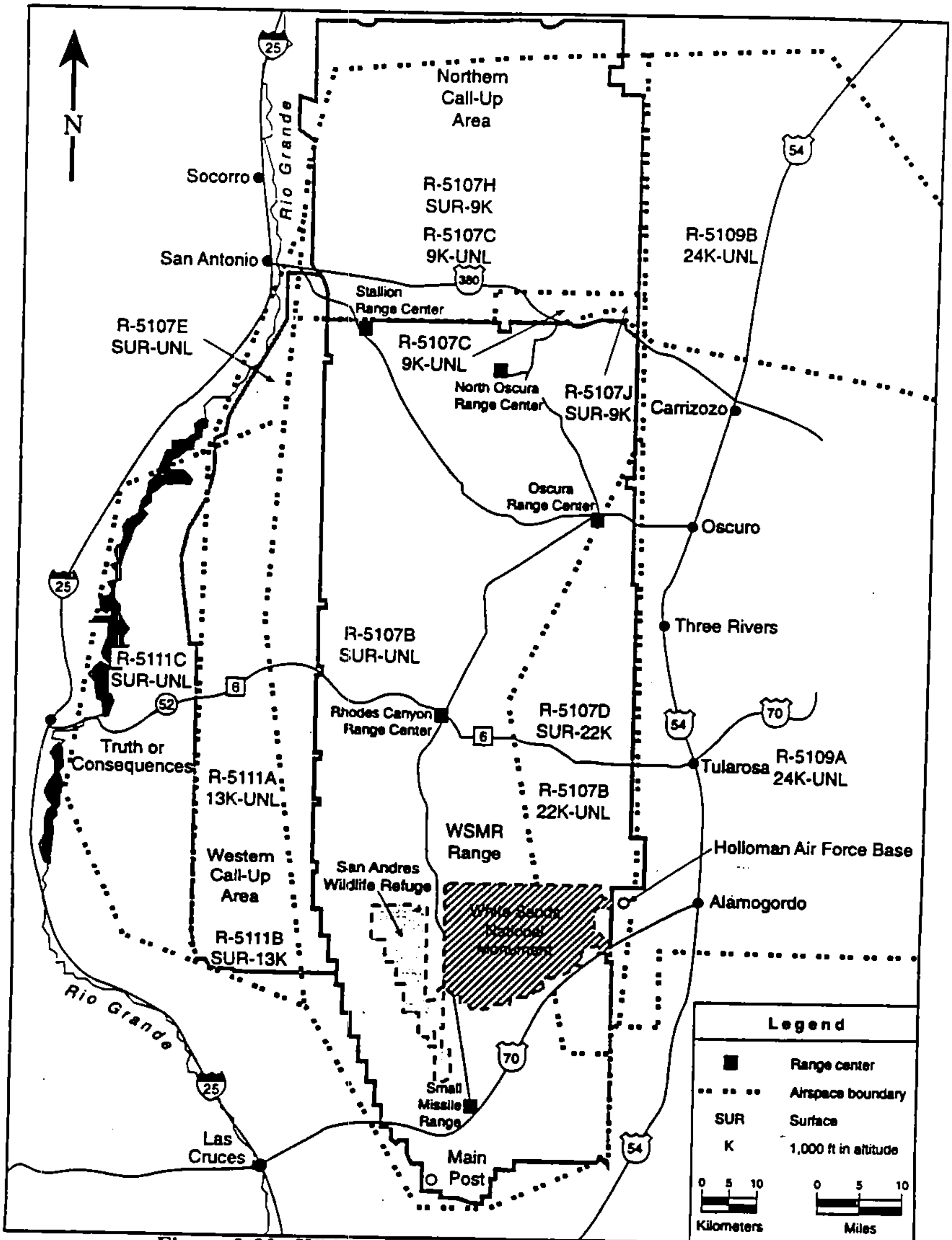

Figure 3-32. White Sands Missile Range restricted airspace

photography; fixed- and rotary-wing security patrols; live air-to-air and air-to-ground gunnery; and the recovery of missiles, rockets, boosters, and aerial targets. Training activities in the WSMR airspace include NASA shuttle training aircraft, bomb delivery, Air Combat Command and Air National Guard air-to-air combat maneuvers, and other military exercises. Large areas of the airspace are used as safety buffer zones for missile and rocket firings.

3.9.2.2 Civilian/Commercial Aircraft Activities. General aviation airports are located in Las Cruces and Alamogordo, New Mexico; and El Paso, Texas. The Las Cruces International Airport, located 40 km (25 mi) southwest of WSMR, is used primarily for general and some commercial aviation. Mesa Airlines provides regional service to and from Albuquerque, New Mexico. Approximately 450 passengers per month are served on six daily arrivals/departures (Matthews, pers. com. 1993). The Alamogordo/White Sands Regional Airport, located 6.4 km (4 mi) east of WSMR, is used primarily for general and some commercial aviation. Approximately 25 aircraft arrivals and departures occur daily at this facility (Kinser, pers. com. 1993). Mesa Airlines has eight arrivals and departures daily Monday through Friday, and four on Saturday and Sunday. Approximately 100 aircraft are based at this facility (Pavelke, pers. com. 1993). The El Paso International Airport, located approximately 59 km (37 mi) south of WSMR, is used primarily for commercial and general aviation. The El Paso International Airport has approximately 400 private aircraft. Approximately 165,000 arrivals and departures serving 3.4 million passengers were conducted in 1992. Approximately 160 daily arrivals and departures are supported by five major airlines and one commuter airline.

3.9.3 Railroads

Southern Pacific Railroad provides rail service to WSMR. Although there are no railroad tracks on WSMR itself, a railhead exists directly outside the gate at Orogrande Range Center. The railhead is used to transport tanks and other heavy equipment to and from WSMR. During the Gulf War, tanks and other heavy equipment were shipped to Beaumont, Texas (Doolittle, pers. com. 1993). In the last two years, only occasional use has been made of the railhead.

3.9.4 Transportation of Explosives and Hazardous Materials

WSMR receives commercial shipments of fuels, chemicals, and explosives on a regular basis. Examples of fuels transported onto WSMR include JP-8, diesel, unleaded gasoline, and propane. Chemicals transported onto WSMR include hydrazine and ammonia, as well as other household chemicals (for military family housing) and industrial chemicals (e.g., solvents, cleaning agents). Examples of explosives transported onto WSMR include munitions, missiles, and rocket engines.

Commercial vehicles transport these types of materials to WSMR by way of interstate highways, U.S. highways, and local roads. These vehicles travel through local communities at various times of the day enroute to WSMR. Commercial vehicles delivering explosives to WSMR are properly placarded as required by U.S. Department of Transportation (DOT) regulations.

Commercial shipments containing explosive materials may only enter WSMR through one of the four main entrances: Stallion, Orogrande, the Las Cruces gate, or the El Paso gate. Shipments are required to check in at inspection points located a safe distance from the main gates. An inspector from the Transportation Office is contacted to inspect the truck for safety. The vehicles are then escorted by military police to the ammunition storage area on WSMR.

All hazardous materials are shipped in accordance with 49 CFR requirements. Specifically, all incoming hazardous materials transports are properly manifested and placarded; the contents are labeled appropriately. In addition, WSMR ships hazardous materials and waste in accordance with the rules set forth in 40 CFR and 49 CFR. To this extent, WSMR files the standardized Uniform Hazardous Waste Manifest. All hazardous materials and waste are shipped to WSMR via standard commercial carriers and routes.

3.10 RECREATION

WSMR is located in the south-central portion of New Mexico, an area of extensive recreation opportunities. The area is noted for its rugged mountains and scenic landscapes. Recreation uses in the area are administered by federal, state, and local agencies. The uses include national forests, national and state monuments, wilderness areas, wilderness study areas, wildlife refuges, recreation areas, post facilities, and state and local parks (Figure 3-33).

3.10.1 Federal Facilities

The federal recreation facilities are administered by the U.S. Forest Service, NPS, USFWS, BLM, and U.S. Army. The NPS, USFWS, and BLM are agencies of the Department of the Interior. The U.S. Forest Service is an agency of the Department of Agriculture. The U.S. Army is part of the Department of Defense.

3.10.1.1 U.S. Army. WSMR has numerous recreation facilities and uses on the range. The Trinity Site is the site of the first atomic bomb detonation in 1945. The site is open to the public only twice a year – the first Saturday in both April and October. In 1992, approximately 3,000 visitors toured the site in April and 1,500 visited in October (Eckles, pers. com. 1993a). Monthly car caravans afford visitors the opportunity to visit Lucero. Special tours of Lake Lucero are granted on a case-by-case basis.

Other recreation uses include those offered at the Main Post and hunting in designated areas throughout the range. The Main Post activities include bowling; shooting; fitness; baseball; soccer; football; tennis; swimming; basketball; volleyball; riding; and various crafts. The recreation facilities on the Main Post include a bowling alley; a gymnasium (weight room, aerobics room, lockers, two indoor racquetball courts); a recreation center (game room, video rental, equipment rental, conference room); a library; an arts and crafts shop; an outdoor recreation equipment rental facility (camping, hiking, fishing); a community club (ballroom, dining hall, lounges, game rooms, swimming pool, lockers, two tennis courts); athletic fields; a youth services building; a teen center; and a child development facility. The range also has a nine-hole golf course, including practice greens, a driving range, and a pro shop. Hunting is allowed by permit in designated areas of the range. There are 20 designated hunting areas 14 small game areas and 6 big game areas. Small game includes quail, dove, rabbit, and varmint. Big game includes oryx, deer, and pronghorn antelope.

3.10.1.2 National Park Service. The 59,289-hectare (146,500-acre) WSNM is administered by the NPS. The site is one of the largest gypsum deserts in the world. Facilities include a visitor center, picnic areas, scenic vistas, and hiking trails. Visitation is heaviest between June and September and on weekends. In 1992, approximately 591,000 people visited the monument (Ditmanson, pers. com. 1993).

3.10.1.3 U.S. Forest Service. There are three national forests in the WSMR area. These include the Lincoln National Forest, Cibola National Forest, and Gila National Forest. The national forests provide a variety of general recreation opportunities including hiking,

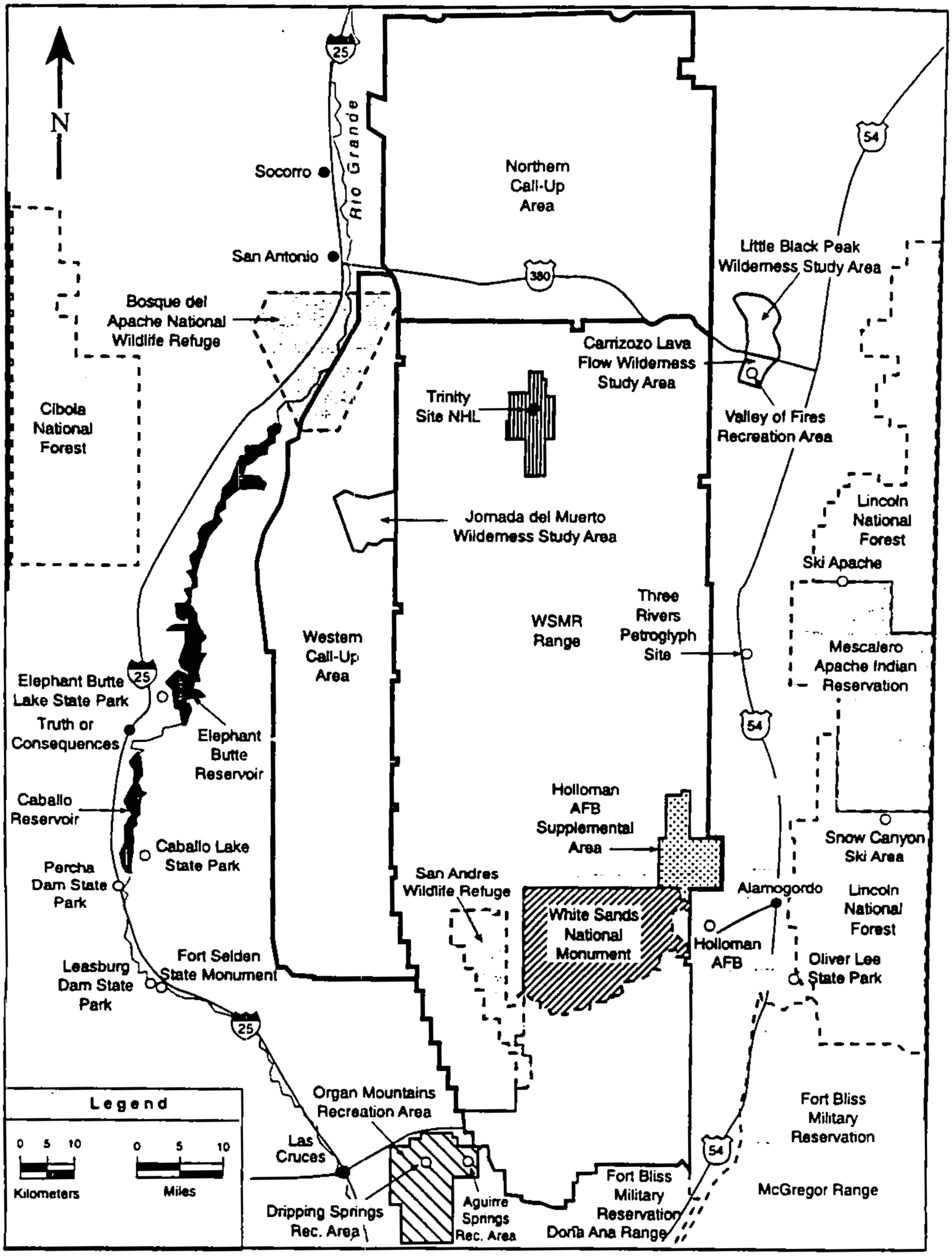

Figure 3-33. WSMR area recreation facilities

horseback riding, trail biking, backpacking, hunting, fishing, boating, water skiing, sightseeing, wildlife viewing, caving, off-road vehicle activity, and developed and primitive camping. Additional opportunities are provided in the winter including cross-country skiing, snowmobiling, and snow play areas.

The Lincoln National Forest is located east of WSMR. Lincoln National Forest provides the typical general recreation uses but, in addition, provides three unique areas - Three Rivers (Petroglyph) Campground, White Mountain Wilderness Area, and Ski Apache (U.S. Forest Service 1986). The Three Rivers (Petroglyph) Campground is associated with the prehistoric rock art of the Three Rivers Petroglyph site, which is located approximately 11.3 km (7 mi) to the west. The campgrounds include camping facilities and hiking trails. Visitation is not monitored. The White Mountain Wilderness Area is located on the western escarpment of Lincoln National Forest. The area provides hiking, hunting, fishing, and horseback riding. Approximately 20 man recreation visitor days of use occur per year. Ski Apache is a ski resort formerly known as Sierra Blanca. Ski Apache is located partially within the Mescalero Apache Indian Reservation. Six chair lifts and a gondola serve approximately 40 km (25 mi) of ski trails. In 1992, approximately 250,000 people visited Ski Apache (Crim, pers. com. 1992). Approximately 3 million people visited Lincoln National Forest in 1992 (Wilson, pers. com. 1993). Snow Canyon Ski Area is another ski resort located in the Lincoln National Forest south of the Mescalero Apache Indian Reservation (Figure 3-33).

Cibola National Forest is located in dispersed areas north of WSMR. Recreation uses include the typical national forest uses mentioned above in addition to gathering forest products, mountain climbing, and hang gliding. The Cibola National Forest has over 69 developed recreation sites, with 13 sites in the two ranger districts nearest to WSMR. The Magdelena Ranger District is located northwest of WSMR and Mountainair Ranger District is located northeast of WSMR. The Apache Kid Wilderness Area (17,807 hectares [44,000 acres]) and the Withington Wilderness Area (7,689 hectares [19,000 acres]) are located within the Magdelena Ranger District and have a variety of recreation uses (U.S. Forest Service 1985). Approximately 2.5 million people visited Cibola National Forest in 1992 (Stanley, pers. com. 1993).

The Gila National Forest is located west of, and is the farthest from, WSMR. Gila National Forest has the Aldo Leopold Wilderness Area, a 80,940-hectare (200,000-acre) area with 322 km (200 mi) of trails for hiking, horseback riding, and backpacking. Aldo Leopold Wilderness Area receives approximately 2,000 visitors per year (Kramer, pers. com. 1993).

3.10.1.4 U.S. Fish and Wildlife Service. The USFWS administers the San Andres Wildlife Area, which is located in the southwest corner of WSMR. The 23,068-hectare (57,000-acre) area provides protection for the state endangered bighorn sheep and other managed wildlife such as mule deer and mountain lions. No hunting or visitation is allowed. The USFWS also manages the 12,950-hectare (32,000-acre) Bosque del Apache National Wildlife Refuge located along the Rio Grande. The wildlife refuge is an area for migratory bird management including geese, sandhill cranes, and ducks. It also is a wintering area for waterfowl. Visitation is heaviest from November through January.

3.10.1.5 Bureau of Land Management. BLM administers approximately 5.3 million hectares (13 million acres) of public land in New Mexico, all of which is accessible to the public for recreational use. Recreational opportunities include hunting, fishing, rockhounding, cave exploration, camping, hiking, backpacking, horseback riding, picnicking, and off-road vehicle use. The areas discussed in this section are adjacent to or near WSMR.

Little Black Peak Wilderness Study Area is located within the Roswell District adjacent to the northeast boundary of WSMR on the north side of U.S. Highway 380. Scenic attractions include caves and volcanic lava flow formations. The area is approximately 10,927 hectares (27,000 acres) in size (Happel, pers. com. 1992). The Carrizozo Lava Flow Wilderness Study Area is located adjacent to and south of the Little Black Peak Wilderness Study Area. Only U.S. Highway 380 separates the two wilderness study areas (Figure 3-33). The main attraction at the Carrizozo Lava Flow Wilderness Study Area is the volcanic lava formations. The Wilderness Study Area, located within BLM's Roswell District, is approximately 4,050 hectares (10,000 acres) in size (Happel, pers. com. 1992).

Three Rivers Petroglyph site is located within the Caballo Resource Area approximately 40 km (25 mi) north of Alamogordo. The area contains camp sites with shelters and picnicking facilities. The site includes thousands of petroglyphs and pictographs made by Native Americans circa A.D. 1000. The recreation site attracts approximately 16,000 to 18,000 visitors per year (Sanchez, pers. com. 1992).

The Organ Mountains Recreation Area along with the Franklin Mountains comprise over 21,854 hectares (54,000 acres) of public land administered by BLM (BLM 1989). The area is adjacent to the southwestern boundary of WSMR and is approximately 24 km (15 mi) due east of the City of Las Cruces. Recreational sites, facilities, and activities are primarily provided in the Aguirre Springs Campground and the Dripping Springs Natural Area.

Aguirre Springs Campground is located in the Organ Mountains Recreation Area. The site contains 2 group camping areas and 55 family camping and picnicking units including shelters, tables, and fireplaces. Restroom facilities also are available at the site. The campground is open year-round (BLM 1989).

Dripping Springs Natural Area also is located within the Organ Mountains Recreation Area and is administered in cooperation with The Nature Conservancy. The area includes La Cueva Picnic Area, the A.B. Cox Visitor Center, and the Dripping Springs Area. The primary function of the visitor center is for BLM and Nature Conservancy educational and interpretive programs. Examples include school environmental education programs and Audubon Society and Nature Conservancy field trips (BLM 1989).

BLM also manages the Jornada del Muerto Wilderness Study Area, which is located near the northwestern boundary of WSMR within the western Call-Up Area (Figure 3-33). Due to the lack of roads, man-made structures, and a unique natural setting, the area meets basic BLM inventory criteria applied to wilderness areas. The area provides visitors with unique lava flow and volcanic formations, and abundant wildlife. The area is inaccessible, which accounts for the low annual visitation average of 50 visitors per year (Carson, pers. com. 1992). All public land administered by BLM in the Call-Up Areas is open to the public for recreational uses, except when the areas are evacuated for WSMR use.

Valley of Fires Recreation Area is located near the northeastern boundary of WSMR in the Roswell District. The main attractions include lava and volcanic formations, camping, hiking, and recreational vehicle sites. The recreation area attracts approximately 60,000 visitors per year (Happel, pers. com. 1992).

3.10.2 State Facilities

The State of New Mexico manages numerous state parks in the WSMR area. The five nearest state parks are Oliver Lee State Park, Elephant Butte Lake State Park, Leasburg Dam State Park, Caballo Lake State Park, and Percha Dam State Park.

The Oliver Lee State Park is located 16 km (10 mi) south of Alamogordo on U.S. Highway 54. The 81-hectare (200-acre) park has interpretative historic exhibits (nineteenth-century ranch house), exotic plants, camping, picnicking, and hiking (New Mexico State Parks Department 1991). Approximately 38,450 people visited the park in 1992 (Romas, pers. com. 1993).

Elephant Butte Lake State Park is located 11.3 km (7 mi) north of Truth or Consequences via Interstate Highway 25. The 9,915-hectare (24,500-acre) park includes the largest, most popular lake in New Mexico (New Mexico State Parks Department 1991). The park provides water-based recreation and land activities including boating, fishing, water skiing, camping, picnicking, playgrounds, hiking trails, and an interpretive center (New Mexico State Parks Department 1991). In 1992, approximately 1,960,000 people visited the park (Romas, pers. com. 1993).

The Leasburg Dam State Park is located 24 km (15 mi) north of Las Cruces via Interstate Highway 25. The 56.7-hectare (140-acre) park provides fishing, canoeing, kayaking, camping, picnicking, hiking, and playgrounds (New Mexico State Parks Department 1991). Approximately 28,800 people visited the park in 1992 (Romas, pers. com. 1993). The park is located adjacent to Fort Selden State Monument. Fort Selden was a military post established in 1865 to protect settlers from Apache raids (New Mexico State Parks Department 1991). A museum, visitor center, and trails are included as part of the monument. Approximately 10,000 visitors toured the fort in 1992 (Caperton, pers. com. 1993).

The Caballo Lake State Park is located 26 km (16 mi) south of Truth or Consequences. The 2,145-hectare (5,300-acre) park provides winter waterfowl observation areas, cactus gardens, a marina, a playground, an interpretive center, and a campground (New Mexico State Parks Department 1991). In 1992, approximately 268,000 people visited the park (Romas, pers. com. 1993).

The Percha Dam State Park is located 6.4 km (4 mi) north of the Caballo Lake State Park. The 32.4-hectare (80-acre) park provides facilities for fishing, hiking, camping, picnicking, and boating (New Mexico State Parks Department 1991). In 1992, approximately 68,200 people visited the park (Romas, pers. com. 1993).

3.10.3 Local Facilities

The local jurisdictions in the area of WSMR also provide recreation opportunities. The uses include golf, swimming, ball playing, fishing, boating, camping, sightseeing, and playgrounds. The local cities include Las Cruces, Alamogordo, Truth or Consequences, and El Paso. Las Cruces has Burn Lake, recreation centers, and 202 hectares (500 acres) of undeveloped parks (Bason, pers. com. 1993). Alamogordo has 18 parks, Bonito Lake, and Desert Lakes Golf Course (Lozano, pers. com. 1993). El Paso has 13 swimming pools, 13 recreation centers, 9 senior citizen centers, and numerous playing fields (Franco, pers. com. 1993).

3.11 AESTHETICS AND VISUAL RESOURCES

WSMR is located within an area of rich aesthetic and visual resources. The region is characterized by scenic landscapes and rugged topography, and the range itself offers some of the least spoiled natural viewscapes in the area. Natural resources of aesthetic value include the Organ Mountains, the San Andres Mountains, Los Pinos Mountains, WSNM, the

Jornado del Muerto and Malpais lava beds, and numerous wildlife areas including both designated and undesignated natural areas of great beauty and scenic diversity.

The ROI for this EIS has been defined as the areas located on or off the range from which portions may be viewed by the general public. In order to facilitate the appropriate management of aesthetic and visual resources within WSMR, the ROI has been divided into three major public view categories: Areas of Aesthetic Concern; Special Management Areas, and Public Roads and Highways. ROI viewing areas are described below and categorized by public view category (Figure 3-33).

Night light is being emitted from facilities such as the WSMR Main Post and NASA WSTF. These night light sources have been noted for disrupting night time astronomical observations. Lighting is required for safety and security and is a mitigable product of these requirements.

3.11.1 Areas of Aesthetic Concern

Areas of Aesthetic Concern are locations from which portions of WSMR may be viewed by members of the general public who primarily have an aesthetic interest in their surroundings. The nature of this interest is determined by the nature of the viewing areas themselves. Areas of Aesthetic Concern include outdoor recreation sites within or near WSMR.

3.11.1.1 White Sands National Monument (NPS). WSNM is surrounded by WSMR on three sides. Although currently no WSMR facilities can be viewed from the main visitor-use areas, the viewscape from WSNM is an integral part of the visitor experience.

3.11.1.2 Bosque del Apache National Wildlife Refuge (USFWS). This 12,950-hectare (32,000-acre) wildlife refuge is located along the Rio Grande and primarily serves as an area for migratory bird management. This refuge is a wintering area for waterfowl, and public visitation is most intense during the winter months.

3.11.1.3 Little Black Peak Wilderness Study Area (BLM). This study area occupies 10,927 hectares (27,000 acres) adjacent to the northeast boundary of WSMR, on the north side of U.S. Highway 380 (Happel, pers. com. 1992). Scenic attractions at the site include caves and volcanic lava flows.

3.11.1.4 Three Rivers Petroglyph Site (BLM). This ancient site is located within the BLM Caballo Resource Area, approximately 40 km (25 mi) north of Alamogordo. This area includes camp sites with associated facilities, and attractions include thousands of Native American rock etchings dating back 1,000 years.

3.11.1.5 Organ Mountains Recreation Area (BLM). This recreation area is located adjacent to the southwestern boundary of WSMR, east of the city of Las Cruces. These areas offer camping facilities and feature natural vistas and environmental education programs.

3.11.1.6 Jornada del Muerto Wilderness Study Area (BLM). This study area is located near the northwestern boundary of WSMR and falls within the western Call-Up Area. Area attractions include lava formations and wildlife. However, difficult access results in low visitation.

3.11.1.7 Valley of Fires Recreation Area (BLM). This recreation area is located near the northeastern boundary of WSMR. Its attractions include unusual lava formations, camping, hiking, and recreational vehicle use.

3.11.2 Special Management Areas

Special Management Areas are similar in many respects to Areas of Aesthetic Concern, except that their unique nature may demand special consideration during the planning of future projects within their viewscapes. Two areas within WSMR have been identified as Special Management Areas and both are described briefly below.

3.11.2.1 Trinity Site (NPS/U.S. Army). The Trinity Site, located in the north-central portion of the range, is the site of the first atomic bomb detonation in 1945. The site is administered under the existing MOU by the U.S. Army and includes a monument and a protected area of the original blast crater. The site is open to the public only twice a year: the first Saturdays in April and October. The desolate setting and viewscape surrounding the Trinity Site contributes to its somber theme. The Trinity Site is listed as a National Historic Landmark.

3.11.2.2 White Sands National Monument (NPS). WSNM is surrounded by WSMR and located approximately 24 km (15 mi) southeast of Alamogordo. The 59,289-hectare (146,500-acre) monument is one of the largest gypsum sand deserts in the world. Facilities include a visitor center, scenic vistas, and hiking trails. Visitation is most intense during the summer and on weekends. The current viewscape surrounding the WSNM is an important aspect of this national monument.

3.11.3 Public Roads and Highways

Public roads and highways on or near WSMR represent areas from which members of the general public may view areas within the range. The major public roads and highway in the vicinity of WSMR are described briefly below.

3.11.3.1 Interstate Highway 25. This highway runs north and south roughly parallel to the western boundary of WSMR. At the northern and southern ends of the base, the highway comes close enough so that public viewing of the range becomes possible. This portion of Interstate Highway 25 runs from the City of Las Cruces in the south, north through Truth or Consequences, and Socorro in the north.

3.11.3.2 U.S. Highway 54. This highway runs north and south approximately parallel to the eastern boundary of WSMR. At the southern and central portions of the base, the highway comes close enough so that public viewing of portions of the range becomes possible. This portion of U.S. Highway 54 runs through the town of Orogrande in the south, north through Tularosa, and Carrizozo in the north.

3.11.3.3 U.S. Highway 70. This highway passes through WSMR, coming from the City of Las Cruces and entering the range from the southwest. The highway continues northeastward through the base and passes by the WSNM on the way to Alamogordo east of WSMR.

3.11.3.4 U.S. Highway 380. This highway runs east and west just north of the border between WSMR and the northern Call-Up Area. This portion of the highway runs through Carrizozo east of WSMR to San Antonio on Interstate Highway 25 south of Socorro.

3.12 NOISE

This section describes the current noise-producing activities on WSMR. Following this are summaries of noise levels of major existing on-range WSMR programs.

3.12.1 Noise From Current WSMR Activities

The launch complexes and airspace over WSMR is the primary environment containing the major noise sources on the range. Restrictions on use of WSMR airspace are described in Section 3.9.2.1. Training activities in the WSMR airspace include bomb delivery, Air Combat Command and Air National Guard air-to-air combat and supersonic flight tactics, and other military exercises. In addition, drone flights and tests of missiles, rockets, and space vehicles occur in WSMR airspace. Large areas of the airspace are used as safety buffer zones for missile and rocket firings.

3.12.1.1 Summary of Current Noise Sources. The U.S. Air Force uses the airspace over the range areas of WSMR for approach and departure routing to Holloman AFB, for flights transiting the area enroute to western and northern tactical training areas, for gunnery pattern routes using the Red Rio and Oscura Gunnery ranges, and for supersonic air combat training. Generally, flight activities are at a high enough altitude and a low enough frequency to generate sound levels anticipated to be no greater than 70 dB, which is the sound level of freeway traffic (70 dB).

A special test of the frequency, magnitude, and duration of sonic booms (supersonic air combat training) was conducted in the WSMR airspace from July 1988 through January 1989. From this study, it was determined that supersonic aircraft operations could generate sound-pressure levels greater than 115 dBA. However, the average sonic boom LC_{dn} noise level was expected to be in the range of 50 to 60 dB at distances varying from 8-16 km (5-10 mi) from the source (Geo-Marine, Inc. 1993).

The U.S. Army in its support role primarily uses the airspace over WSMR for helicopter flight operations, search and rescue, drone recovery, test debris recovery, range evacuation missions, and general helicopter flights transiting all area. The U.S. Army range support helicopter is the UH-IH, which has an anticipated overflight sound level (at 1,000 ft. AGL) no greater than in the low 80-dBA range (Jones 1991).

Other significant sources of noise in the operational testing areas of WSMR include missile launches, ordnance explosions, aircraft drone overflights, gun firing, general vehicle traffic, and low-altitude military jet traffic. Representative of these activities would be a Homing All the Way to Kill (HAWK) missile launch generating peak sound pressure levels of 149.8 dB at 300 m (1,000 ft) (Medina, pers. com. 1992), a QF-100 full-scale aircraft target drone producing single-event noise levels of 95.7 dBA at 300 m (1,000 ft) (Hammer, pers. com. 1992), vehicular traffic typically rated at 70 dBA (Harris 1991), and low-altitude military jet traffic (B-52 aircraft or F-4 aircraft) producing estimated noise levels of 65 to 70 dBA at ground level directly below the aircraft (U.S. Air Force 1993a).

Noise levels at the WSMR Main Post area (the only range population center), the WSMR southern property boundary, and the San Andres National Wildlife Refuge (located approximately 19 km [12 mi] north of the WSMR Main Post area) have been estimated to be 55 to 65, 45 to 55, and 45 dBA, respectively (U.S. Air Force 1990a). During JTX, Roving Sands 93 and 94 ambient noise levels in the refuge were measured at levels between 18 and 21 dBA. (U.S.. Army Environmental Hygiene Agency 1994).

3.12.1.2 Space System Vehicles. The primary and potentially worst-case space vehicle noise source at WSMR would be the NASA Space Shuttle sonic boom(s) during an orbiter reentry recovery at WSSH. Reentry of the Space Shuttle would produce sonic booms over populated areas. Normal Space Shuttle overpressures during reentry should not exceed 24 Pa (0.5 psf) until the Space Shuttle is within 900 km (500 nautical miles) of a landing site. Overpressures would not exceed 48 Pa (1 psf) until the Space Shuttle is about 167 km (90 nautical miles) from a landing site, and the minimum overpressure for any reentry will not exceed 101 Pa (2.1 psf). The area that experiences overpressures between 9.8 and 10.2 kg per square meter Pa (2 psf and 2.1 psf) is small (generally 259 km^2 [100 mi^2]) and would be located no further than approximately 44 km (24 nm) from a landing site (NASA 1978).

During reentry, the sonic boom from a Space Shuttle would reach a maximum value of 101 Pa (2.1 psf). This corresponds to an impulse sound pressure level of 134 dB, which is well below the Committee on Hearing, Bioacoustics, and Biomechanics damage limit of 145 dB. At this level, startle reactions would occur in some people, but no extreme reflex body movements would occur (NASA 1978).

Additional noise sources associated with Space System Vehicles are generated by rocket engine (propulsion system) testing periodically conducted at NASA WSTF and are anticipated to result from X-33 RLV testing. Noise levels generated from the firing of large-scale-hydrogen oxygen explosions have been measured at an L_{max} of 104.3 dBC (114-dB peak) (Rossow, pers. com. 1992a). Noise levels generated from Cell 844 burst-disk testing have been measured at an L_{max} of 123.8 dB (140-dB peak) (Rossow, pers. com. 1992b). Noise levels generated from Area 300, Test Stand 301, firing procedures for the Aft Reaction Control Subsystem Fleet Lead 7-Day Mission Cycle (direction squib ignition) have been measured at an L_{max} of 124.9 dB (138-dB peak) (Rossow, pers. com. 1992c). X-33 RLV testing would produce noise levels similar to current single stage rocket technology testing.

3.12.1.3 Aircraft Operations. General military aircraft flight operations conducted on WSMR can be categorized as test program support or tactical training. In both cases, aircraft flying in the restricted airspace areas of the range are military jets that operate supersonic and subsonic, from surface to unlimited altitudes, and fly in all of the range airspace areas.

Light military and general aviation propeller aircraft occasionally transit the range enroute to on-range airfields for landings. Light aircraft flying on range are normally at or above 914 m (3,000 ft) above ground level (AGL) and are anticipated to produce noise Sound Exposure Levels (SELs) lower than those produced by range helicopter flights at similar altitudes (see Section 3.12.1.3). The U.S. Army C-12 propeller aircraft when operating at takeoff thrust and airspeed produces a SEL of 79.3 dBA at approximately 300 m (1,000 ft). At 305 to 366 m (1,000 to 1,200 ft) AGL, the C-12 produces a maximum noise level of 71.8 dBA. This is below the average 88 dBA for all propeller aircraft at 305 m (1,000 ft) AGL (U.S. Air Force 1993b).

Tactical training flight operations are generated primarily by the U.S. Air Force from Holloman AFB or from U.S. Air Force bases in proximity to the range. U.S. Navy and U.S. Marine aircraft flight activities on WSMR also may operate from these U.S. Air Force bases and from off range. Aircraft familiarization, basic fighter maneuver, and air combat tactics training operations are conducted in range special-designated airspace training areas. These training areas are the Mesa, Lava, Casa, and Yonder and are used from 152 m (300 ft) AGL to 15,200 m (50,000 ft) MSL (Figure 3-34). Red Rio and Oscura training areas are used as air-to-ground ranges and are used as low as 30 m (100 ft) AGL. Tactical training supersonic flight operations are conducted in the 49th Fighter Wing (49FW) Designated Supersonic

Airspace area from 3,000 to 9,000 m (10,000 to 30,000 ft) MSL (Figure 3-35). Military aircraft involved in subsonic and supersonic training include most fighter and bomber aircraft in the U.S. DoD inventory and similar aircraft from some foreign countries. The highest noise levels are generated by the F-16, F-15, and F-4. WSMR is capable of supporting up to 900 training sorties per month in these training areas, but a more realistic sustainable rate is 600 missions (including supersonic flights) (U.S. Air Force 1993b).

Test program support primarily involves missile/rocket launch, photo, and safety chase aircraft. A representative air-launched missile test program using launch, photo, and chase aircraft is the U.S. Air Force Advanced Medium Range Air-to-Air Missile (AMRAAM). Typically, support aircraft flying as low as 152 m (500 ft) AGL produce SELs as high as 115 dBA directly below the aircraft. A SEL of 115 dBA would attenuate to roughly 65 dBA at 6.4 km (4 mi) from the aircraft (U.S. Air Force 1993b). This represents a worst case, as AMRAAM support aircraft flights are at the lowest operating altitudes for missile and rocket launch test programs. There is an average of 70 aircraft test program missions flown on range each month (Brennan, pers. com. 1993).

Supersonic aircraft test support operations are conducted in the 46th TG (46TG) Designated Supersonic Airspace area from 91 m (300 ft) AGL to 10,000 m (30,000 ft) MSL (Figure 3-35). The aircraft involved in supersonic test program support in the 46th area are the F-4, F-15, F-16, PQM-100, PQM-106, and T-38 (U.S. Air Force 1993b). There is an average of two supersonic flights each month in the 46TG supersonic area (Brennan, pers. com. 1993).

The 1988 to 1989 Wyle Laboratory study of aircraft sonic booms in WSMR airspace considered supersonic flight in the range 49FW and 46TG Designated Supersonic Airspace areas. This study established that WSMR supersonic aircraft operations could generate SELs greater than 115 dBC. However, from a long-term noise exposure standpoint, it was determined that L_{dn} (C-weighted) sonic boom noise levels varied from 54.2 dB at the center to roughly below 40 dB at the edges of the range. The average boom overpressures were under 48 Pa (1 psf) with the strongest measured at 320 Pa (6.67 psf) (Geo-Marine, Inc. 1993).

Aircraft subsonic noise on WSMR at times may cause environmental concern. A number of independent studies have been conducted on aircraft noise levels during low-altitude flight. Results are recorded for all altitudes, as single-event peak or maximum, and as 24-hour average SELs. Military aircraft noise levels are generally listed in L_{max} (dBAs for flight noise or dBCs for sonic booms), in L_{dn} (dBAs or dBCs), and in special-use airspace (restricted airspace) as L_{dnmr} (A-weighted, monthly onset to the adjusted day-night level). Representative aircraft for tactical training in the WSMR airspace are the F-4, F-15, and F-16. Tactical training aircraft operate at or above 152 m (500 ft) AGL in the established training areas except for Casa, where flight levels are permitted as low as 91 m (300 ft), and Red Rio and Oscura where flight is at 77 m (250 ft) or lower. At 77 m (250 ft) AGL, the F-15 and F-16 produce L_{max} SELs of 99.9 and 123.0 dBA. At 1,000 m (3,281 ft), these attenuate to 78.9 and 102.2 dBA (Berry et al. 1991). The F-4 in the same altitude ranges produces an L_{max} SEL of 109.9 dBA, which attenuates to 81.9 dBA at 1,000 m (3,281 ft) (U.S. Air Force 1993b).

Sound intensity decreases with increasing distance from the source due to the dissipation of the sound energy over an increasing area. The sound intensity varies inversely with the square of the distance from the source. For each doubling of the distance from the source, the sound pressure is reduced by a factor of two, and the sound level, which is proportional to the square of the pressure, is reduced by a factor of four. This is equivalent to a decrease of approximately 6 dB in the sound pressure level for each doubling of distance (U.S. Air Force

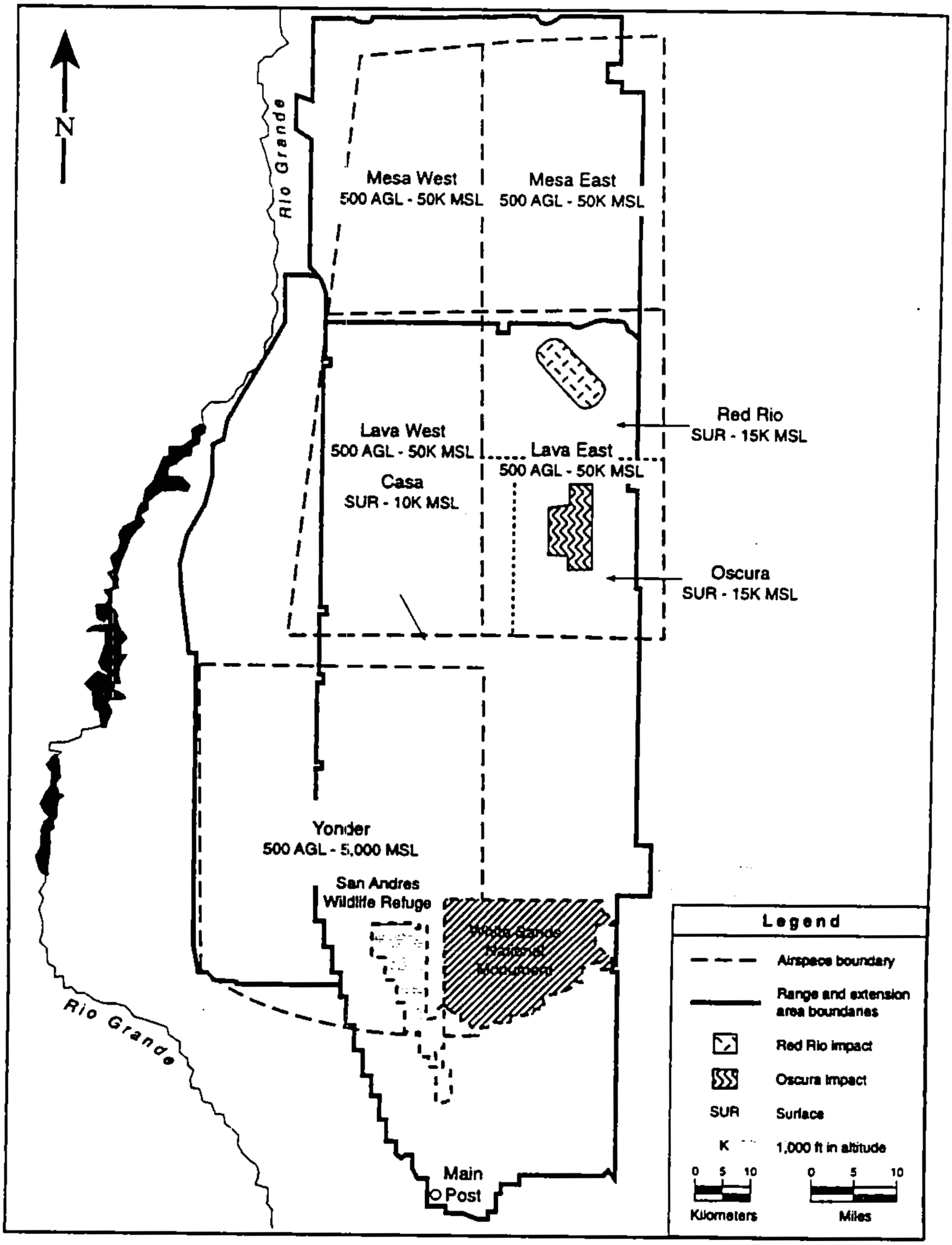

Figure 3-34. Range tactical training airspace

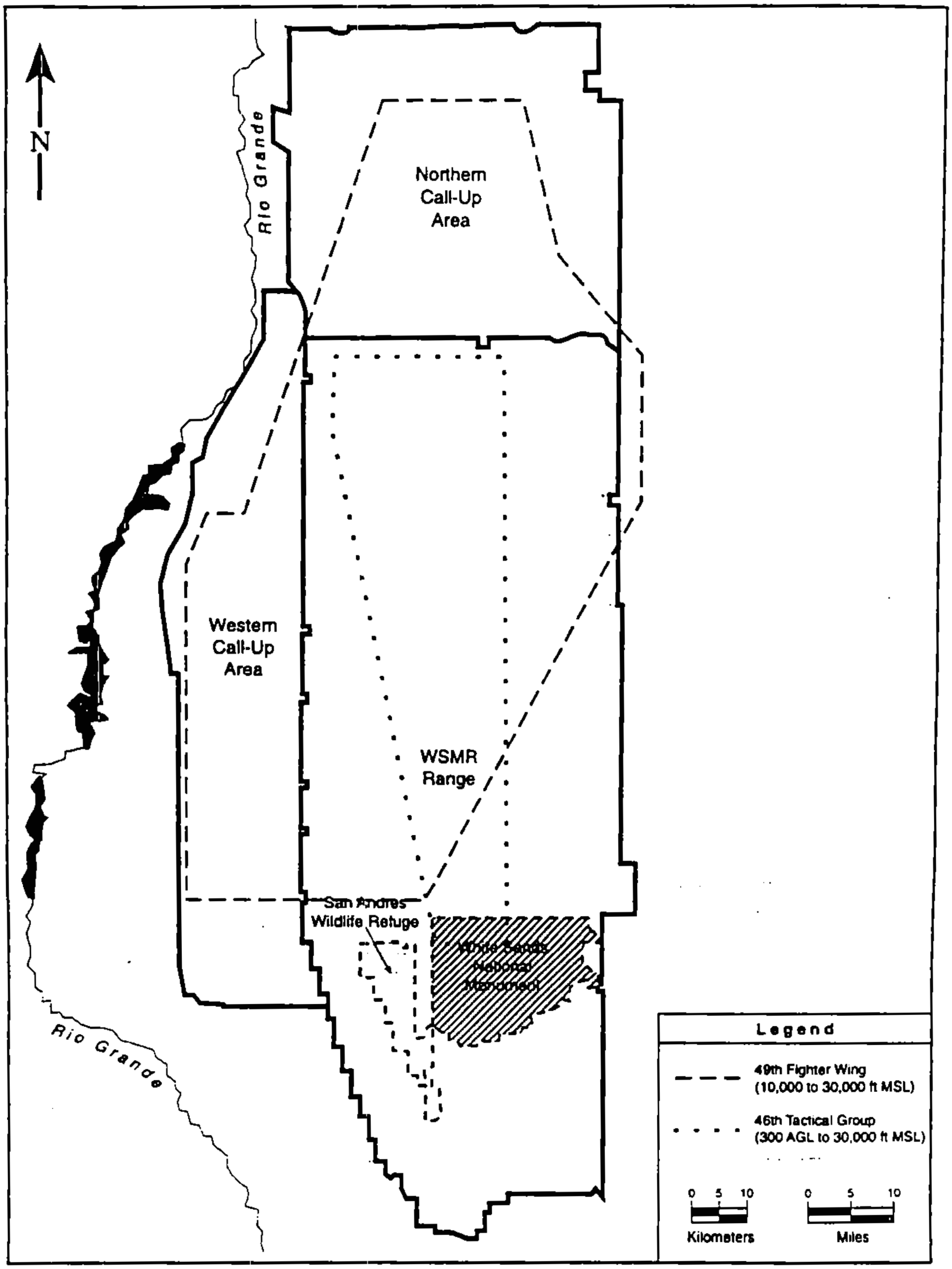

Figure 3-35. Range-designated supersonic airspace

1993b). In addition to spherical spreading, the atmosphere also attenuates sound. The atmosphere attenuation is linear with distance and hence is very important at long distances.

A sound attenuation decrease of 6 dB for each doubling of distance applied to an F-16, it results in the following L_{max} dBAs versus feet: 92.4 dBA at 15244 m (5,000 ft), 82.5 dBA at 3048 m (10,000 ft), and 70.9 dBA at 6096 m (20,000 ft). (Aerospace Medical Research Laboratory 1978.)

Red Rio Range (600 training flights per year) averages an L_{dnmr} of 80 dBA and Oscura Range (200 training flights per year) averages an L_{dnmr} of 76 dBA. Attenuated, both ranges would produce L_{dnmr} values less than 70 dBA at 2 km (1.2 mi) and less than 65 dBA at 4 km (2.5 mi) (U.S. Air Force 1993b).

The F-16 73 dBA L_{max}at 4 km (2.5 mi) and the Red Rio/Oscura ranges less than 65 dBA L_{dnmr} at 4 km (2.5 mi) fall below 85 dB, the noise level below which the likelihood of observable effects is considered minimal.

3.12.1.4 Helicopters. Military helicopters produce a regular source of noise throughout the range airspace. Flights are generally conducted at 152 m (500 ft) AGL for helicopters transiting all range areas. Helicopters will operate at lower altitudes when conducting low-level flyovers and turns (for approaches), ascents, and descents for landings. Helicopter landings of opportunity occur throughout the range in support of drone and test debris recovery, and search and rescue missions. Helicopters routinely operate from established airfields (Condron AAF, Stallion AAF, and WSSH), and mission support helipads (JFK, Medical, and TRASANA). Helicopter SEL should be essentially the same whether the operation is on a natural ground surface or a prepared (concrete or asphalt) surface.

Typical military helicopter SEL dBA values for ascent (takeoff), over flight, and descent (landing) are listed in Tables 3-52, 3-53, and 3-54. An average SEL of 92.1 dBA is generated by military helicopters in range level flyovers at 152 m (500 ft) AGL. Military helicopter SELs are reduced (attenuated) to the mid-70dBA ranges at distances of 1,524 m (5,000 ft) away, either directly overhead or at a slant.

3.12.1.5 Drones. Military drones used at WSMR fall into two basic categories, full scale and subscale. Both are used primarily as targets for air- and ground-launched missiles and rockets. All WSMR drones are either destroyed in the airspace over the range by a direct weapon intercept or are ground recovered when used as a no warhead or tracking target. The full-scale aircraft drones that are used on WSMR for testing support operate from Holloman AFB, New Mexico. WSMR subscale aircraft drones primarily operate from the range permanent (hardened) launch complex sites.

The QF-100 and QF-4 full-scale target aircraft drones are representative of the various full-scale drones that are used during testing program tracking or weapon intercept missions. Typically, a full-scale target aircraft drone will fly its tracking mission flight profile at 305 m (1,000 ft) AGL or higher. A QF-100 at 305 m (1,000 ft) AGL overhead generates an SEL of 95.7 dBA (U.S. Army 1992d). When in manned flight, full-scale target aircraft drones perform identically to other aircraft operating on WSMR.

The primary subscale target aircraft drones used on WSMR are the high-altitude AQM-37C, the BQM-34, and the MQM-107 series. The SELs produced by these drones are anticipated to be similar to other current and future subscale drones. The BQM-34 and MQM-107 drones produce a several-second launch pad SEL of 127 dBA during their jet-assisted takeoff

Table 3-52
Helicopter SEL values, dBA
level flyovers, ascents, and descents (combined)

Slant Distance m (ft)	CH-47D	UH-1H	UH-60A	AH-1G	AH-64	OH-58C	OH-58D
60.96 (200)	101.1	101.8	96.5	103.3	95.6	96.5	94.1
152.4 (500)	95.3	96.0	90.5	97.4	89.6	90.5	88.0
304.8 (1000)	90.8	91.4	85.6	92.7	84.8	85.8	83.1
609.6 (2000)	86.1	86.6	80.2	87.6	79.6	80.6	77.7
1524 (5000)	79.1	79.4	71.7	79.6	71.3	72.5	69.5
3048 (10,000)	72.9	73.1	63.7	72.3	63.6	65.0	62.2
6096 (20,000)	65.4	65.3	54.0	63.4	54.1	55.5	54.0

Notes: m = meter
ft = foot

launch. At an initial cruise altitude of 305 m (1,000 ft) AGL following jet-assisted takeoff bottle burnout, these drones are anticipated to produce SELs approximating those of light civil aircraft (U.S. Army 1992d). The high-altitude test altitudes associated with the AQM-37C is such that noise from this drone is anticipated to be imperceptible.

Table 3-53
AH-64 Helicopter SEL values, dBA
level flyover, ascent, and descent

Slant Distance m (ft)	Ascent	Flyover	Descent
61.0 (200)	95.0	97.5	99.5
152.4 (500)	89.5	91.5	92.0
304.8 (1000)	85.5	87.5	89.0
609.6 (2000)	80.0	81.5	81.5
1,524.0 (5,000)	72.5	74.5	74.5
3,048.0 (10,000)	< 60.0	< 60.0	< 60.0
6,096.0 (20,000)	< 60.0	< 60.0	< 60.0
9,144.0 (30,000)	< 60.0	< 60.0	< 60.0

Source: Schomer et al. 1988.

Notes: Flyovers at 91 m (300 ft) AGL, ascents and descents for landing.
m = meter
ft = foot
AGL = above ground level
dBA = "A" weighted decibel level

Table 3-54
HH-60G Helicopter SEL values, dBA
level flyover, ascent, and descent

Altitude Above Ground Level or Slant Distance m (ft)	Ascent	Flyover	Descent
61.0 (200)	85.6	93.0	88.6
152.4 (500)	81.7	89.0	84.6
304.8 (1,000)	78.6	86.0	81.6
609.6 (2,000)	75.6	83.0	78.6
1,524.0 (5,000)	71.7	79.0	74.6
3,048.0 (10,000)	68.6	76.0	71.6

Source: U.S. Army 1992e.

Notes: SEL = Sound Exposure Level
dBA = "A" weighted decibel level
m = meter
ft = foot

Subscale helicopter target aircraft drones are anticipated to produce SELs well below those of full-size helicopters at all operating altitudes. At approximately 610 m (2,000 ft) AGL or slant distance (less than 0.8 km [0.5 mi]), helicopter drone dBAs are below 85, that of the average full-size operational military helicopter (Table 3-52).

Characteristically, full-scale and subscale drone flight profiles are above 305 m (1,000 ft) AGL and most target drone missions range from 914 m (3,000 ft) AGL to 7,620 m (25,000 ft) MSL. At these higher altitudes, SELs are below 75 dBA. On occasion, drones are flown at altitudes below 305 m (1,000 ft) and are expected to produce SELs above 75 dBA of extremely short (fractions of a second) duration. Drone aircraft mission flight profiles within WSMR restricted airspace are designed to eliminate all flight over populated and wildlife areas. These procedures also result in a substantial reduction in possible noise impacts.

3.12.1.6 Exercises. Noise attributable to military exercises on WSMR is from aircraft operations, ground vehicle operations, and ordnance detonations. A typical large-scale exercise with the highest potential for noise impact and public concern is the Roving Sands series. Large-scale exercises take place both on WSMR and on Fort Bliss, Texas. However, this document addresses only the primary noise sources associated with WSMR. Small-scale exercises are expected to generate reduced noise levels. Small-scale exercises are routinely conducted in remote, unpopulated areas of WSMR and may entail no more than half a dozen military personnel being transported in and out by helicopters or ground vehicles over a period of several days.

Aircraft operating within the range restricted airspace at high speed and altitudes below 914 m (3,000 ft) AGL are the primary noise source of human concern during exercises. Exercise aircraft at higher altitudes are not anticipated to generate noise levels in excess L_{dn} 69 dB. Although the area is basically unpopulated, for purposes of comparison, this would produce less than a 20-percent highly annoyed population rate, as required by FAA Regulation Part 91.79 (U.S. Readiness Command 1985).

Table 3-55
Representative low-level aircraft noise levels at slant distance below 914 m (3,000 ft) AGL

Aircraft	Daily Flights	SEL (dB)	L_{dnmr}
A-10	25	92.6	71.5
A-7	17	89.6	53.6
F-111	15	95.9	64.9
F-4G	12	102.4	62.6
RF-4	12	102.4	64.1
OA-37	32	91.0	64.6
F-4	20	102.4	67.6
F-16	20	100.4	75.3

Source: U.S. Readiness Command 1993.

Notes:
m = meter
ft = foot
SEL = sound exposure level
dB = decibel
AGL = above ground level
L_{dnmr} = A weighted, day-night, onset rate adjusted

An average large-scale exercise may contain well over 150 aircraft flying subsonic high-speed, low-altitude missions each day (day and night), for a two-week period. Table 3-55 lists representative aircraft type, 24-hour sortie numbers, SEL, and L_{dnmr} for a WSMR Border Star exercise. These data are similar to those resulting from the current and proposed Roving Sands exercises.

The computed L_{dn} for the above representative group of high-speed, low-altitude exercise fighter aircraft is 65.5 dB. This noise is well below FAA Regulation Part 91.79 maximum levels. These subsonic aircraft flight activity L_{dn} levels are representative of the levels produced by WSMR large-scale exercises. The average L_{dn} would not vary appreciably asthe mix of participating exercise aircraft changes. Exercise planners design aircraft flight paths to avoid noise-sensitive population and wildlife areas.

Supersonic aircraft flight activities during exercises, with their consequent sonic boom occurrences, are restricted to at or above 3,048 m (10,000 ft) MSL (approximately 1,524 [5,000 ft] above ground) in the WSMR supersonic restricted airspace. During the conduct of any exercise air battles in supersonic airspace, the sonic booms that will be generated by aircraft engaged in aerial combat maneuvers will last for extremely short periods of time (fractions of a second) (COE 1992f). A study of the frequency, magnitude, and duration of sonic booms was conducted in the range airspace from July 1988 through January 1989. The study determined that supersonic aircraft operations could generate SELs greater than 115 dBA. However, the average SEL was expected to be in the 55 to 60 dBA range (Geo-Marine Inc. 1993). Supersonic flights along the boundaries of WSMR airspace have caused occasional noise complaints from small communities and ranchers living close to the range. Noise level contours developed in A WSMR sonic boom study showed that the highest noise level audible beyond WSMR airspace was 45 L_{dn} (C-weighted) (Geo-Marine, Inc. 1989).

Table 3-56
Description of noise zones (land use)

Noise Zone	Percentage Population Highly Annoyed	L_{dn} (A-weighted)	L_{dn} (C-weighted)
I – Acceptable	< 15 percent	< 65 dB	< 62 dB
II – Normally Unacceptable	15 to 39 percent	65 to 75 dB	62 to 70 dB
III – Unacceptable	> 39 percent	>75 dB	> 70 dB

Source: U.S. Army 1990c.

Notes: L_{dn} = day-night average sound level
dB = decibel

The threshold for annoyance generally is considered to be greater than 50 L_{dn} (Schomer et al. 1988). The U.S. Army, following the recommendation of the National Academy of Sciences (1981), has defined in AR 200-1 three land use zones for noise (Table 3-56). The 45-L_{dn} contour measurement (beyond WSMR airspace) falls within the acceptable "Noise Zone I" (U.S. Army 1990c).

During large- and small-scale exercises, military helicopters operate in most areas of the range airspace. The primary WSMR mission helicopter is the Huey UH-1 that is used throughout the range for operational, logistics, and administrative support. The UH-1 general flight profile, while supporting exercises, is at 152 m (500 ft) AGL producing an overflight SEL of 96.0 dBA. Military helicopters that participate in an exercise generally operate at or below 61 m (200 ft) AGL and produce the following SEL noise levels; UH-1H (103.3 dBA), UH-60 (97.4 dBA), HH-60 (93.0 dBA), CH47D (104.6 dBA), AH-64 (95.6 dBA), OH-58 (96.5 dBA), and UH-1 (101.8 dBA) (U.S. Army Environmental Hygiene Agency 1993). The average SEL for the above helicopters is 98.6 dBA and is expected to be representative of all helicopter exercise noise levels. Helicopter exercise tactics normally require a rapid approach and departure phase with minimum ground times. This results in short exposure times to SELs, minimizing potential helicopter noise impact.

Ordnance detonation and small arms firing is conducted on pre-established gunnery ranges (Red Rio and Oscura), weapon impact targets (e.g., Denver WIT), and cleared weapon firing areas (e.g., Richardson Ranch Training Complex). These areas are extremely remote, averaging no less than 16 km (10 mi) from range boundaries or 8 km (5 mi) from range personnel centers. Exercise ordnance detonations and small arms firing noise levels are similar to other ongoing range operations and are not anticipated to change SELs currently being experienced. Noise produced by ordnance or small arms would be short duration (tenths of a second) but may occur on a daily basis (e.g., at Red Rio and Oscura Ranges).

3.12.1.7 Missile/Rocket Weapon Systems. The primary weapon systems under development at WSMR are air-to-air, air-to-ground, ground-to-ground, and ground-to-air missiles and rockets. Each system produces a noise source that may affect humans, domestic animals, and wildlife. A representative air-to-air missile under testing at WSMR is the U.S. Air Force AMRAAM. The supersonic AMRAAM is aircraft launched at 1,524 m (5,000 ft) AGL or above, and follows a downward trajectory to target drone impact at approximately 152 m (500 ft) AGL. Sonic boom focused overpressures below the missile are 4.5 psi at 1,524 m (5,000 ft) AGL, 11 psi at 366 m (1,200 ft) AGL, and 21 psi at 152 m (500 ft) AGL. At 1.6 km (1 mi) to the side of flight track, a 27,580-Pa (4.0-psi) pressure may exist (U.S. Air Force 1992). Damage to general building structures can occur when overpressures exceed 75,840 Pa (11 psi) and to cultural resources and other sensitive material at or above 34,474 Pa (5 psi). Damage to roadways, bridges, and major structures is not expected to occur as these facilities withstand vehicle loads of 200,000 to 275,000 Pa (30 to 40 psi). Sonic boom overpressures at San Andres National Wildlife Refuge, at the WSMR post area, and at Holloman AFB are all less than 7,584 Pa (1.1 psi) (U.S. Air Force 1992).

The maximum SEL produced by an AMRAAM at its impact point of 152 m (500 ft) AGL is 120 dBA. At the AMRAAM launch point of 1,524 m (5,000 ft) AGL, the L_{max} is 97 dBA. At roughly 4.6 km (2.86 mi) to the side of the AMRAAM, these levels would attenuate to less than 75 dBA, a level below that (80 to 85 dBA) caused by large trucks. Because the AMRAAM flight paths are well away from populated areas such as the WSMR post area, Holloman AFB, and the city of Alamogordo, New Mexico, noise levels in these areas would range from 60 to 80 dBA at the post to below detectable levels at Holloman AFB and in Alamogordo. Noise levels at the edge of the range boundary closest to the AMRAAM flight path (approximately 32 km [20 mi]) would be less than 60 dBA. All air-to-air missiles tested at WSMR follow flight path and altitudes test parameters limitations similar to the AMRAAM. These limitations are designed to reduce the probability of sonic boom overpressure and missile noise impacts. Variations in missiles and rockets as to sonic booms and noise levels are evaluated, allowing for test location selection that ensures maximum mitigation for overpressure or noise impact.

Representative surface-to-air missiles at WSMR are the U.S. Army HAWK missile and the U.S. Navy Rolling Airframe Missile (RAM). The HAWK and RAM are ground launched and follow an upward trajectory to target drone impact at or above 305 m (1,000 ft) AGL.

The HAWK and RAM both generate their L_{max} at point of launch. An L_{max} for both the RAM and the HAWK was determined using the NASA standard far-field sound pressure calculations for rockets. It was calculated that the noise level for the RAM at the point of launch (0 to 30 m [0 to 100 ft]) would be an L_{max} of approximately 120 dBA, lasting for two seconds (WSMR Environmental Services Division 1992c). The L_{max} calculated for a HAWK launch was 122 dBA at the launch point (0 to 30 m [0 to 100 ft]) and lasted for several seconds. A single noise measurement of 149.8 dB has been recorded for a HAWK. However, the parameters and meteorological conditions were unknown (U.S. Army 1992d). For the HAWK launch, the NASA calculations predicted that launch noise would be attenuated to an L_{max} of 71 dBA at a distance of 6.4 km (4 mi) and 60 dBA at 12.9 km (8 mi) (U.S. Army 1992d).

A representative surface-to-surface weapons system being tested at WSMR is the U.S. Army Multiple Launch Rocket System (MLRS). The MLRS is a free-flight rocket system that comprises a tracked armored vehicle equipped with a protected cab for three crew members. The system is capable of firing 12 rockets. Noise measurements have been recorded inside the crew member cab during rocket firings that, although attenuated by sound insulation, should also approximate noise levels in the immediate vicinity of the MLRS. An average L_{max} of 148.5 dB was recorded in the crew cab for 55 firings. The MLRS operates at preselected remote launch sites on the range. These sites are located many miles from populated areas and animal or wildlife habitat. Crew members wear noise-mitigating headgear. For firings, a 1,200-m (0.75-mi) noise hazard area exists and may be occupied only by personnel wearing noise-mitigating hearing protection (U.S. Army 1991c).

3.12.1.8 High-explosive Tests. The Defense Nuclear Agency conducts high-explosive tests in an area west of the Oscura Mountains, southwest of Trinity Site, on WSMR. The testing area is referred to as the Permanent High Explosive Test Site (PHETS). Proposed testing over the next 20 years consists of small and large high-explosive detonations. The purpose of such testing is to study explosive characteristics; to conduct phenomenology experiments; and to expose structures, military systems, and military equipment to blast, shock, and thermal phenomena that simulate nuclear weapons effects. The Defense Nuclear Agency detonates between 544 and 8,854 metric tons (600 and 9,760 tons) of ammonium nitrate fuel oil (ANFO) every other year, four 18-metric-ton (20-ton) high-explosive explosions per year, and five 0.5-metric-ton (1,000-lb) high-explosive explosions each year through the 20-year life of the program (McMullan et al. 1987).

A fraction of a second impulse noise produced by a high-explosive detonation has the potential to cause ear injury at close range. The threshold for eardrum rupture in humans is 5 psi, which translates to 140 m (459 ft) for an 18-metric-ton (20-ton) detonation, 427 m (1,400 ft) for a 907-metric-ton (1,000-ton) detonation, and 1,067 m (3,500 ft) for a 14,515-metric-ton (16,000-ton) detonation. No personnel would be this close to Defense Nuclear Agency detonations (McMullan et al. 1987).

Occupational Safety and Health Administration (OSHA) 2206 and U.S. Army Instruction 6055.3 references establish 140 dB as the upper limit for exposure to impulse noise. This limit is designed for industrial applications where noise in the workplace can be measured. The limit is based on the premise that the noise is in the range of normal hearing (100 to 18,000 Hz). Industrial conditions are not applicable for short exposure to the noise from a large detonation at a distance where the higher frequencies have been attenuated by the atmosphere (McMullan et al. 1987).

Table 3-57 shows several PHETS measurement points, their corresponding ranges, and SELs for large-scale detonations. Because of the high SEL, exposed persons wear hearing protection devices at the locations shown in the table. Persons inside closed instrumentation trailers at the timing and firing park would not require hearing protection. This is not true for the office trailers in the administration area or the other locations shown in the table. All exposed persons closer than 9,200 m (30,200 ft) would be required to wear ear protection devices for detonations of 907 metric tons (1,000 tons) or larger. For 18-metric-ton (20-ton) detonations, only two locations exceed 140 dB: 147 dB at the administration area and 152 dB at the observation point (McMullan et al. 1987).

Although there are limited data on noise impact on wildlife, some data exist on test animals. There is a 1-percent probability that small animals can suffer eardrum rupture at a distance of 1,067 m (3,500 ft) from ground zero for 14,515-metric-ton (16,000-ton) detonations. Eardrum rupture occurring at 103,000 Pa (15 psi) and less are self-healing within two days. This overpressure occurs within 595 m (1,925 ft) for all detonation sizes discussed. There could be some temporary or possibly permanent hearing damage in animals at ranges closer than 3 km (1.9 mi) for 7,076- and 14,515-metric-ton (8,000- and 16,000-ton) detonations. As the range from ground zero increases, the noise from large-scale detonations would decrease until, at roughly 5 km (3 mi), it would sound like a loud thunderclap. Animals within 2 to 3 km (1.2 to 1.9 mi) probably would be startled into some action such as fleeing or running for cover. The noise level beyond these ranges would sound like thunder or a sonic boom, which are common in the PHETS area of WSMR. There is conflicting information published about stress effects on animals. The infrequent large-scale test detonations minimize impacts. Smaller tests would not create a significant noise problem. The distance to which 160 dB extends for 0.5-metric-ton (1,000-lb) tests is 400 m (1,312 ft) and for 18-metric-ton (20-ton)

Table 3-57
PHETS noise impacts

Location	Range m (ft)	SEL (dB)* 1 Kiloton	8 Kiloton	16 Kiloton
Timing and Firing Park	3,505 (11,500)	158	167	168
McDonald Ranch	3,658 (12,000)	157	166	167
Gus Site	4,353 (14,280)	155	164	166
Millers Watch	5,944 (19,500)	152	161	163
Administration Park	7,555 (24,788)	150	158	161
Observation Point	9,083 (29,800)	148	156	159

Source: McMullan et al. 1987.

* presuming standard atmospheric conditions.

Notes: m = meter
ft = foot
SEL = sound exposure level
dB = decibel

tests is 1,200 m (3,937 ft). The one-per-year average frequency of 18-metric-ton (20-ton) events further mitigates the concern (McMullan et al. 1987).

3.12.1.9 Transportation Systems – Highway and Rail. A constant yet relatively unnoticed source of noise at WSMR is the noise produced by highway (road) vehicles and the rail system. The network of roads serving the range are made up of two-lane paved, improved dirt or gravel, and unimproved dirt roads. The range roads are used by automobiles, light and heavy trucks, buses, and large test instrumentation vans. Road traffic on the range is extremely light except for the WSMR Main Post area where it can best be categorized at the level of suburban traffic.

The noise levels produced by vehicles can be attributed to three major causes:

- rolling stock (tires and gearing),
- propulsion system (engine and related accessories), and
- aerodynamic and body noise.

Tires are the dominant noise source at speeds greater than approximately 22 m/s (50 mph) for both trucks and automobiles. Tire noise levels increase with vehicle speed and also depend upon variables such as the road surface, axle loading, tread design, and wear condition. Changes in any of the variables can result in variations in noise level of up to 20 dB at constant vehicle speed. Truck tires are generally noisier than automobile tires because of their size and design constraints. Engine generated noise is normally the dominant noise for trucks and automobiles at speeds below 20 and 16 m/s (45 and 35 mph), respectively. This noise is radiated directly from the engine exhaust and intake openings and from the vibrating engine casing. The third source of highway vehicle noise includes noise produced by turbulent aerodynamic flow over the body and rattling of loose mechanical parts (EPA 1971).

The average automobile traveling at 13 to 26 m/s (30 or 60 mph) will produce 60 or 75 dBA at a distance of 15 m (50 ft). A large truck or van at 16 m/s (35 mph) will produce an SEL of 89 dBA at a distance of 15 m (50 ft). A bus is slightly quieter than a large truck and will average between 80 and 87 dBA at the same speed and distance (EPA 1971).

The median traffic noise levels for automobiles, trucks, vans, and buses near roadways including freeways are 75 to 80 dBA at 30.5 m (100 ft) from the roadway and 60 to 65 dBA at 305 m (1,000 ft) (EPA 1971). These decibel levels are representative of the road vehicle noise levels anticipated to exist throughout the road network on WSMR.

WSMR receives rail transportation services from the Southern Pacific Railroad that runs a main line between El Paso, Texas, and Alamogordo, New Mexico. The Southern Pacific main line does not enter or cross the range itself. However, a rail siding spur from the main line does enter WSMR from the east, runs on the range for approximately one km (less than one mile), and terminates at a loading/unloading area at the Orogrande Range Camp. The rail siding spur and loading/unloading area receive extremely limited use and are primarily intended for the unloading of equipment for research and development testing.

Noise in railroad systems is made up of the contributions from locomotives and the train cars that the locomotives haul. The sources of noise in a moving diesel-electric locomotive are, in approximate order of contribution to the overall noise level (EPA 1971):

- diesel exhaust muffler;
- diesel engine and surrounding casing, including the air intake and turbocharger (if any);
- cooling fans;
- rail interaction; and
- electrical generator.

An additional source of noise is the siren or horn, which produces noise levels 10 to 20 dBA greater than that from the other sources. This is not a continuously operated source, is a necessary operational safety feature, and is therefore excluded from the above list.

Because freight or passenger cars have no propulsion system of their own, the exterior noise produced is due mainly to the interaction between the wheels and the rails. Modern train cars with auxiliary hydraulic suspension systems in addition to the normal springs can be 10 dBA quieter than the older freight cars, which have only springs. One other major source of noise from railroads is braking operations in retarder yards, which produce a high-pitched sound at a level than can exceed 120 dBA at 15 m (50 ft) (EPA 1971).

A railroad shunting operation on a rail siding with a diesel locomotive and freight cars will produce an average SEL of 98.0 dBA at a distance of 15 m (50 ft) (EPA 1971). This railroad system dBA noise level would closely approximate noise levels anticipated to exist at the Orogrande Range Camps siding.

3.12.1.10 Community Area. Sources of potentially hazardous occupational noise were surveyed in the WSMR community area by the U.S. Army Environmental Hygiene Agency in 1973, 1976, and 1980. A majority of the noise sources surveyed were shop tools, generators, heavy equipment, woodworking equipment, climatic environmental and precision machinery, radar equipment, numerous maintenance shops, warehouses, heavy vehicle repair operations, and missile system tests on the Main Post and range areas, which generated occupational noise levels in excess of 85 dBA (U.S. Air Force 1992).

According to the U.S. Army Environmental Hygiene Agency occupational health surveys, outdoor noise levels in the WSMR Main Post area range from 55 dBA to roughly 110 dBA in the near vicinity of heavy vehicle maintenance repair areas. Pneumatic tools peak noise levels of 125 dBA were recorded adjacent to a vehicle body repair building. Noise levels at the Main Post area boundaries are estimated at 55 to 60 dBA, and at the outer boundaries noise levels are estimated at 45 to 55 dBA. Noise levels within the San Andres National Wildlife Refuge, 19 km (12 mi) north of the WSMR Main Post area, are estimated at 45 dBA (U.S. Army 1985a). During JTX, Roving Sands 93 and 94 ambient noise levels in the Refuge were measured at 45 dBA (U.S. Army Environmental Hygiene Agency 1994.)

There have been no recent studies of conventional background noise at WSMR. Typical instantaneous noise levels caused by everyday common natural and human events are listed in Figure 4-1. Noise studies have been conducted at nearby populated areas such as at Holloman AFB and in the city of Alamogordo, New Mexico. Typical of an urban setting, outdoor noise levels in Alamogordo range from 55 to 65 dBA.

The WSMR Main Post area noise levels are estimated to fall in roughly the same noise level ranges as the urban areas of Holloman AFB and Alamogordo, New Mexico. Noise experienced by personnel on post would be typical of other rural or suburban communities. Personnel on the WSMR Main Post working in areas where occupational noise levels exceed 85 dBA are required to wear ear protection earplug or headset devices. The U.S. Army hearing conservation criterion for required wearing of hearing protection is 85 dBA (AR 40-5, Preventive Medicine, 1990).

3.13 RADIATION SOURCES

This section discusses two categories of radiation: ionizing and nonionizing. Ionizing radiation can be defined as radiation that causes the formation of ions. The term ionizing radiation is used for particle radiation and high-frequency electromagnetic radiation. Nonionizing radiation does not cause ionization and refers to lower-frequency electromagnetic radiation.

3.13.1 Ionizing Radiation Sources

This section describes ionizing radiation sources at WSMR.

3.13.1.1 Nuclear Effects Directorate. The NED operates directly under TECOM. Its mission is to provide the simulated nuclear environments and technical expertise necessary to perform complete nuclear weapon effects test and evaluation programs on military systems. NED facilities are available to all branches of the Armed Services and to U.S. Army contractors. These facilities are sources of ionizing as well as nonionizing radiation and are discussed in their appropriate section. The ionizing radiation sources at NED consist of the Fast Burst Reactor (FBR), the Linear Electron Accelerator (LINAC), the Gamma Radiation Facility, and the Relativistic Electron Beam Accelerator (REBA).

Fast Burst Reactor

The FBR is designed to simulate as closely as possible the neutron radiation environment produced by a fission weapon. It is capable of producing high-yield, short duration fission pulses as well as steady-state nuclear environments.

The FBR normally provides a neutron pulse with a full width at the half-maximum point of approximately 50 microseconds. Flux density at the core surface can be varied to provide pulse exposure to test items up to 6.5 x 10^{13} neutrons per square centimeter (4.2 x 10^4 neutrons per square inch). The FBR also is routinely operated in a steady-state mode at power levels up to 8 kW. At this power level, time-integrated neutron flux levels of approximately 6.5 x 10^{13} neutrons per square centimeter (4.2 x 10^4 neutrons per square inch) are produced at the core surface every 10 minutes of operation.

In addition to its neutron output, the FBR can be used as a source of gamma radiation. With appropriate shielding, gamma dose rates as high as 1.0 x 10^{-8} rads per second are produced. The use of various moderating and shielding materials makes it possible to increase the width of the pulse to several milliseconds. Techniques and procedures also have been developed to produce modified neutron-to-gamma dose ratios. The FBR parameters and operating characteristics are flexible and can generally be customized to match the requirements of individual experimenters.

The reactor also can be operated with a modified core configuration that provides an internal irradiation of small experiments. A flux density of approximately 3.0 x 10^{14} neutrons per square centimeter (1.9 x 10^{15} neutrons per square inch) per burst can be obtained inside the cavity, which can accommodate test items up to 8.9 cm (3.5 inches) in diameter by 10.2 cm (4 inches) long. Normally, the reactor is operated in an exposure cell 15.2 m (49.9 ft) long by 15.2 m (49.9 ft) wide by 6.1 m (20 ft) high. Vehicular and large test item access to the cell is through a large shield door approximately 3.6 m (11.8 ft) wide by 4.6 m (15.1 ft) high. Neutrons reaching the walls or ceiling of the cell are attenuated by capture in a borated gypsum board lining 20 cm (7.9 inches) thick. The reactor is remotely lowered into a shielded pit following operations to allow quick access to the cell for changing or positioning of experiments as required. For experiments requiring larger test volume, the FBR is operated outside its exposure cell. Transfer to outdoor operation requires less than 90 minutes. In this configuration, source-to-target distances in excess of 1 km (0.6 mi) are available. The reactor has not been operated outdoors for many years. Environmental impacts of any project proposing such operation would be addressed in a project-specific NEPA document tiered to this EIS. The surrounding area is open, unobstructed, semiarid terrain.

Linear Electron Accelerator

The LINAC is designed to expose test items such as semiconductor devices to a high-intensity gamma spike similar to that associated with a nuclear weapon detonation. It provides a source of high-intensity, short-duration pulses of high-energy electromagnetic radiation for simulated threat level exposures. The two-section S-band accelerator is powered by a pair of 21-MW klystrons operating at approximately 2,855 MHz. A 120-kV electron beam, previously bunched into packets of electrons, is injected into the accelerator. Upon leaving the accelerator, the electron passes through a thin water-cooled aluminum window with the angular divergence of the electron beam dependent on the beam energy. The average energy can be adjusted from 2 to 48 million electronvolts. The beam diameter is approximately 1 mm (0.04 inches) at the exit window. The electrons can be impacted on a thin platinum target to create high-energy bremsstrahlung pulses with a 30-degree exit cone.

The test item may be irradiated by either the bremsstrahlung pulses or by the electron beam. The LINAC can be operated in a single-pulse mode or continuously at pulse rates from 10 to 100 pulses per second. Pulsewidths are variable from 10 nanoseconds to 10 microseconds. Beam current is variable from less than 10 microamperes to a maximum of 5 amperes for short pulses (100 nanoseconds or less) and a maximum of 1.5 amperes for longer pulses.

Peak dose rates ranging from 1.0 x 10^4 rads per second to approximately 1.0 x 10^{12} rads per second at 1 cm (0.4 inches) from the exit window are typical. With the bremsstrahlung target in place, a maximum intensity on the order of 5.0 x 10 rads per second can be achieved.

The LINAC beam is directed into a test cell approximately 6 by 8 m (19.7 by 26.2 ft) in area and 6 m (19.7 ft) high. A precision three-axis table for supporting test items and equipment is located in front of the beam port and provides a 0.9- by 1.4-m (3- by 4.6-ft) area capable of supporting 240 kg (529 lb). The table can be moved remotely on all three axes from the control console. Movement can be achieved either manually or by computer control through the LINAC digital data acquisition and processing system.

The Gamma Radiation Facility

The Gamma Radiation Facility is designed to provide the total gamma dose and residual gamma dose environments needed for nuclear effects testing. It is primarily for Transient Radiation Effects on Electronics (TREE) experiments and verification tests of systems for gamma dose survivability. However, its uses are diverse and include radiography and shielding experiments as well as calibration and operational testing of military radio instrumentation.

The Gamma Radiation Facility uses eight triply encapsulated cylindrical cobalt-60 sources with total activity near 64,000 curies to provide varying levels of gamma radiation. Cobalt-60 gamma energies are predominantly 1.17 or 1.33 MeV. The sources are transferred pneumatically from their storage position in the source room to an exposure head assembly in the test cell. The exposure head can accept the sources individually or in any combination up to a total of eight. During exposure, the sources are contained within a 0.2-m-diameter (0.6-ft-diameter) circle on the front face of the head assembly.

The exposure head is located at one end of the test cell, which provides a working volume of 12.8 by 6.1 m (42 by 20 ft) in area and 3.7 m (12.1 ft) in height. In general, system-level tests can easily be conducted inside the exposure cell. However, experiments requiring larger test volumes or that have unusual requirements can be conducted outside using the large roll-up door opposite the head. Testing has been conducted at source-to-target distances of up to 170 m (558 ft).

Any combination of eight sources may be used to achieve the desired level of exposure. Exposure time for each of the sources is controllable individually in increments of 0.1 seconds. Any desired duration may be used. Experiments requiring exposure in excess of 100 hours have been performed. Exposure rates at 1 m from the exposure head can be varied from 0.4 to 95,000 roentgens per hour.

Active monitoring of electronic experiments is accomplished by cables run through four 10-cm-diameter (3.9-inch-diameter) conduits from the exposure cell to an instrumentation room. General support instrumentation, including real-time digital data acquisition and processing, is available to experimenters upon request. Surveillance of an experiment during irradiation is possible by either closed-circuit television or by visual observation through a lead glass window. A pair of mechanical articulated arms is available for manipulation of radioactive materials and sources, with prior approval.

Four additional cesium-137 sources with total activity of approximately 4.44 x 10^{14} becquerel (12,000 curies) are available upon request. Cesium-137 gamma energies are near 0.66 MeV. These sources may be substituted for any of the four largest cobalt sources for experiments that require exposure to different gamma energies.

Relativistic Electron Beam Accelerator

The REBA is a high-energy, pulsed, field-emission, electron-beam or bremsstrahlung x-ray source. It was designed, built, and originally operated by Sandia National Laboratories to provide an energy source of short duration for determining material responses to rapid surface and in-depth energy deposition. The principal components of REBA are a Marx generator, a Blumlein transmission line, and an output tube. Stored low-voltage energy is converted to high voltage energy by the Marx generator and then transferred to the Blumlein transmission line, which serves as a fast-discharge pulse-forming, low-inductance energy source for the output tube.

The Marx generator consists basically of a bank of capacitors, which are charged in parallel and discharged in series by means of spark-gap switches. The negative voltage output of the Marx generator is placed on the coaxial Blumlein transmission line consisting of three concentric cylinders. The voltage formed by the Blumlein is impressed across the tube diode, which consists of an insulating and vacuum-holding structure, a field-emission cathode, and an anode (U.S. Army 1989b).

The anode used for the electron-beam mode of operation is a thin low-Z target which allows passage of the electrons with minimal energy loss. For the x-ray mode of operation, the anode used is a thick high-Z target, selected for maximum efficiency in converting electron-beam energy into bremsstrahlung x-radiation.

The REBA is capable of delivering six exposures per hour. In electron beam mode, the total transported beam energy is approximately 6.7 kilojoule (1.5 kilocalories). Peak beam fluence is approximately 16,736 J/m^2 (400 $calories/cm^2$). In x-ray mode, peak dose environments of 1.8×10^4 rads and peak dose rates of 2.6×10^{11} rads per second are measured. Nominal pulse widths for both modes are between 50 and 70 nanoseconds.

3.13.1.2 Thorium in Alloys. Magnesium/thorium alloys are sometimes found in drone airframes used for missile targets. The alloy is used because of its high tensile strength and resistance to heat. The thorium in this alloy is an alpha emitter with a half-life of 1.45×10^{10} years. Alloy HK-31 has a thorium concentration of 2.5 to 4 percent while alloy HM-21 has a concentration of 1.5 to 2.5 percent (U.S. Navy 1984). A typical amount of thorium in the drones would be approximately 2.3 kg (5 lb).

3.13.1.3 Depleted Uranium. Missiles carrying depleted uranium have been tested at WSMR over the history of the range. Prior to 1979, these missiles were not completely recovered from their impact site. There are 72 such sites at WSMR. Excavation at these sites is controlled by the Radiation Protection Division. Since 1979, there have been 30 to 40 more missile tests of this nature. The impact sites that resulted from these tests were excavated for any radioactive material beyond background level as determined from portable radiation detectors (Wenz, pers. com. 1994).

Depleted uranium is uranium made up of more than 99.3 percent of the Uranium-238 isotope. Uranium-238 has a half-life of 4.59×10^9 years. Alpha radiation is the predominant radiation from depleted uranium although very low gamma radiation also is present. Beta particle radiation is the radiation observed predominantly due to the subsequent decay of daughter products.

3.13.1.4 Research Rockets. Research rockets are used at WSMR by universities, private industry, the U.S. Air Force, and NASA for a variety of missions. Research rockets may contain radioactive sources for the purpose of calibrating onboard sensing devices. Only the use of sealed sources is permitted. These sources may emit alpha, beta, gamma, or neutron radiation. The radioactive sources must not leak in excess of 0.005 microcuries using standard leak test procedures. At different stages of an operation, the radioactive sources may be located at the Vehicle Assembly Building, LC-36, U.S. Navy building N-200, LC-35, the Small Missile Range, and various impact areas (U.S. Navy 1987).

3.13.1.5 Self-luminous Devices. Many types of standard military equipment contain self-luminous devices such as compasses, watches, artillery sights, vehicle gauges, dials and switches, Light Anti-Armor Weapon (LAW) rocket sights, and muzzle reference sensors. Such devices contain radioactive tritium in newer models and radium-226 in older models (Wenz, pers. com. 1994). In a few instances promethium-147 is used. Radium-226 is no longer authorized for use in military equipment. These devices typically contain 100 milliCuries or less of radioactive material, with a few containing several Curies of tritium.

Many types of standard military sights contain thorium-coated lenses such as the sights on the Line of Sight Forward-Heavy (LOS-F-H), laser designators, and on the M-1 tank. Such devices contain either thorium fluoride or thorium oxide. A few electronic tubes contain small quantities of radioactive substances (i.e., cobalt-60, radium-226).

3.13.1.6 Trinity Site. Trinity Site, 23 km (15 mi) southeast of Stallion Range, is the site of the first man-made nuclear explosion, with an estimated yield of 19 kilotons. The blast completely vaporized the 30.5-m (100-ft) steel tower and the surface of several acres of surrounding desert.

The site is currently enclosed by an outer fence at a 488-m (1,600-ft) radius from ground zero and an inner fence approximately 61 m (200 ft) on a rectangular side surrounding the spot where the tower existed and where the monument now stands. The first public tour of Trinity was in 1953, and regular annual tours began in 1960. Public tours are given semiannually.

The intense heat from the blast at Trinity fused the desert sand together with fission and activation products into a greenish, glass-like substance called Trinitite, which was found to be a major source of gamma radiation (mostly Cs-137, Eu-152, and Co-60). In 1973, local environmentalists asked the Atomic Energy Commission to issue a warning of potential radioactive danger from the so-called atomic glass to persons who tour the area and carried away pieces of Trinitite. After a study, the Atomic Energy Commission (now the Department of Energy) testified before the New Mexico State Environmental Improvement Board that the amount of radioactivity in the small Trinitite souvenirs did not constitute a significant health hazard or warrant recall or public warnings. The remaining Trininite has been evaluated at Los Alamos National Laboratory and found not to be hazardous.

3.13.1.7 Other Radiation Sources. There are approximately 750 sources of ionizing radiation composed of radionuclides (primarily permanently sealed sources), industrial equipment, and medical diagnostic X-ray machines at WSMR. The majority of the radioisotopes in use are small, sealed sources used for standards in the calibration of radiation detection equipment and dosimetry systems. A 9,000-curie Co-60 source (for calibration and studies of radiation effects) is included in the inventory.

All radiation surveys as well as receipt, control, and shipment of radioactive materials; personnel dosimetry issue, exchange, and records administration; and personnel overexposures are the primary responsibilities of the Radiation Protection Division. The health physics activity is performed in compliance with existing U.S. Nuclear Regulatory Commission and U.S. Army Regulations.

3.13.2 Nonionizing Radiation Sources

This section describes nonionizing radiation sources at WSMR

3.13.2.1 Nuclear Effects Directorate. The NED operates three facilities on WSMR, which provide nonionizing radiation sources to simulate these aspects of a nuclear detonation environment. These three facilities are the Electromagnetic Pulse Facility, the White Sands Solar Facility, and the Electromagnetic Radiation Effects Facility.

Electromagnetic Pulse Facility

The EMP Facility is a high-altitude test environment simulation of an exoatmospheric nuclear weapon detonation. The EMP is emitted into a working volume 13.4 m^2 (144 ft^2) and variable in height between 6.7 and 15.5 m (22 and 51 ft). The system uses a unique array antenna, which combines elements of both bounded waves and free field generators. The array is made of 54 antenna modules in a 3 by 18 configuration, each module consisting of double-density aluminum screens arranged to form a dihedral horn. Each horn radiates like a free field radiator, and the array as a whole provides the field uniformity and high field strengths associated with bounded wave systems. The working volume is large enough to accommodate most test systems. The EMP generates a horizontal polarized plane wave with the pointing vector perpendicular to the ground. This configuration provides the most stringent test of ground-based systems where the ground reflection is an important factor.

The facility produces a double exponential pulse with a rise time on the order of 10 nanoseconds, a 1/e decay time of 280 nanoseconds, and a pulse duration of 740 nanoseconds. The free field peak E-field amplitude is variable between 100 and approximately 50,000 volts per meter.

EMP fields within any arbitrary horizontal plane are uniform to within 5 percent of the mean field intensity except near the dihedral horns and the edges of the array. Thus, an effective test volume of 12.2 m^2 (131 ft^2) by up to 15.5 m (51 ft) high is available to the user. Test level reproducibility is within 3 percent.

Solar Facility

The White Sands Solar Facility is a focusing-type solar facility capable of providing intense thermal radiation pulses that simulate the thermal environment from a nuclear weapon detonation. The White Sands Solar Facility consists of four main components, a heliostat, attenuator, concentrator, and test chamber. The heliostat consists of an array of 356 flat mirrors arranged on a 12.2-m-wide (40-ft-wide) by 11-m-high (36-ft-high) steel structure. The heliostat automatically tracks the sun to reflect the thermal energy through the attenuator section to the concentrator. The attenuator consists of a louvered structure whose blades are used to regulate the amount of thermal energy reaching the concentrator. The concentrator consists of 180 mirrors with spherical curvature mounted on a 9.1-m^2 (98-ft^2) steel frame located 29.3 m (96 ft) south of the heliostat. Each of these mirrors is mounted to concentrate the thermal energy at the focal plane of the facility in the test chamber. A remotely controlled three-axis table is available for positioning of experiments at the focal plane.

The maximum flux available at the focal plane is approximately 4.2 MW/m^2 (100 calories per square centimeter per second), with a total usable power of 32.8 thermal kW and a blackbody temperature equivalence of approximately 5,240 °C (9,464 °F). A uniformity of 10 percent is obtainable over an exposure diameter of 5.1 cm (2 inches). The irradiance profile at the focal plane is a skewed Gaussian distribution with the 50-percent flux points occurring at a 5.1-cm (2-inch) radius from the center of the solar image. Two basic modes of thermal energy modulation, shaped (nuclear) and rectangular, are provided. Nuclear weapon thermal pulse shapes can be provided for weapon yields ranging from sub-kiloton levels up to 50 megatons. Rectangular pulse shapes with nominal rise and fall times of 30 milliseconds are available. Typical turnaround time between exposures is about one minute.

3.13.2.2 Lasers. The term laser is an acronym for Light Amplification by Stimulated Emission of Radiation. There are approximately 150 lasers in use at WSMR. Approximately 100 of these are portable. A permanent laser research facility (HELSTF) was constructed at the former MAR site.

Types of Beams

The media used to generate laser beams are solid-state, gaseous-state, and semiconductor or injector type. A common solid-state laser is the ruby capital. The synthetic ruby crystal is made of aluminum oxide in which some of the aluminum atoms are replaced by chromium atoms. The crystal is silvered at one end and partially silvered at the other. It is surrounded by a flask tube energized by a capacitor. When the flashtube flashes, it excites some of the chromium atoms, which, when they drop back to their stable energy level, give off photons. The photons are reflected between the reflecting surfaces exciting more chromium atoms to give up more photons so that a burst of photons "escape" through the partially silvered surface in a pulse of coherent light. The WSMR inventory of laser devices contains several Class 4 devices. Class 4 lasers are lasers that not only produce a hazardous direct or secularly reflected beam, but also can be a fire hazard or produce a hazardous diffuse reflection.

The gaseous-state laser operates similarly to the solid-state laser. In a helium-neon gas laser, a radio frequency or direct current excites the helium atoms, which in turn excite the neon atoms to a higher energy level and give off photons when they return to the normal state. The output beam is stimulated by the repeated reflections between the end mirrors. This results in a continuous stream of laser light emitted in a continuous wave.

Injector lasers use a semiconductor crystal with a desired lattice structure of its atoms. Light of the desired frequency will stimulate the recombination of an electron that has been excited. This emits laser energy. Because the laser beam travels in parallel lines, it does not disperse as ordinary light and, hence, the energy is confined to a small area so that the intensity of the beam remains high.

Ruby lasers emit short pulses of energy. Usually the output energy per pulse is high (200 to 500 joules) and the pulse width is between 175 and 350 milliseconds. The peak power from 500 joules delivered during a 350-millisecond pulse is over 1,400 watts, which is concentrated on a small area in laser systems.

The WSMR inventory of laser devices contains 96 Class 3 laser devices. Class 3 lasers can injure the eye if viewed directly. The danger from such a laser is the direct or specularly reflected beam.

The WSMR inventory of laser devices contains 20 Class 2 lasers. Class 2 lasers are low-power visible devices that do not have enough power to injure a person accidentally, but which may produce retinal injury when stared at for a long period. There also are an unspecified number of Class 1 laser devices at WSMR that have essentially no associated health or safety hazards.

3.13.2.3 Radars. The last major source of nonionizing radiation is radars and other microwave generators. Radars represent sources of high-power radio frequency (microwave) energy, while other sources, such as communications and data links, are generally low-power systems.

The radar units are divided into major categories of range radars (digital, analog, and surveillance radars) and project radars (advanced research projects, U.S. Air Force and Atmospheric Science Laboratory units). There are two types of radiation hazards associated with these radar units: microwave and x-ray. The microwave radiation is associated with the electromagnetic radiation emitted from the radar feed assembly and reflector or antenna (RF energy). X-rays are an inherent radiation associated with high-voltage rectifier, klystron, or other high-voltage electronic tubes. Microwaves do not possess sufficient energy to produce ionization. However, they can cause excitation of an atom with resultant production of heat. The ionizing radiation of x-rays can pose a biological hazard. However, with proper installation of shielding around electronic tubes, such as klystron, magnetron, traveling wave, and high-voltage thyratrons, normally no personnel health hazards exist. The shielding of these tubes is a well-established manufacturing practice.

Atmospheric Profiler Research Facility

Three research quality atmospheric profiling radar systems are installed in the area immediately northeast and northwest of building 23109, approximately 16 km (10 mi) east of the WSMR headquarters.

The first, a 49.25-MHz High Performance Wind and Cn2 (optical turbulence) Profiler System, is installed in a 168-by 168-m (550- by 550-ft) cleared area west of building 23109. The transmitter power rating is 250 kW peak, 12 kW average. The transmitter/receiver antenna is a collinear-coaxial phased array and forms an approximate radiating aperture of 13,632 m^2 (146,700 ft^2) (U.S. Army 1991d).

The second, a 404.37-MHz AWP system, is installed in a 19.8 by 19.8-m (65- by 65-ft) cleared area north of building 23109. The transmitter power rating is 16 kW peak, 0.8 to 1.6 kW average. The transmitter receiver antenna is a collinear-coaxial phased array and forms an approximate radiating aperture of 300 m^2 (3,229 ft^2) (U.S. Army 1991d).

The third, a 2,900-MHz FM-CW (frequency-modulated, continuous-wave) Atmospheric Doppler Radar System, is installed in a 33.5- by 33.5-m (110- by 110-ft) cleared area east of building 23109. The transmitter power is 230 W continuous. The antenna consists of two 3-m-diameter (10-ft-diameter) reflectors (one continuously transmitting, the other continuously receiving) mounted on a fixed but transportable trailer. The transmitter antenna forms an approximate radiating aperture of 7.2 m^2 (77.5 ft^2)) (U.S. Army 1991d).

Other Microwave Generators

Of the numerous microwave generators in use at WSMR, a few are microwave ovens that are in use like their domestic counterparts. The remaining microwave generator sources are used for experimental and calibration sources.

3.14 HAZARDOUS MATERIALS/HAZARDOUS WASTE

This section describes the current hazardous materials and hazardous waste use, transportation, storage, disposal, and management activities at WSMR. In addition, environmental regulations, programs, and compliance issues related to hazardous materials and waste management activities at WSMR are addressed. WSMR and NASA/WSTF manage hazardous materials and waste separately and each is discussed separately in the following sections.

3.14.1 Hazardous Materials Management

This section describes the hazardous materials used, storage locations, and base users. In addition, this section discusses the management mechanisms that these organizations use to comply with federal, military, state, and local regulations; protect their employees from occupational exposure to hazardous materials; protect the public health of the surrounding communities; and protect the environment. Many organizations at WSMR are responsible for managing hazardous materials. These organizations include NASA/WSTF, Safety and Radiation Protection Divisions of the Environmental and Safety Directorate of WSMR, U.S. Army Materiel Test and Evaluation Command, NED, U.S. Navy Naval Air Warfare Center, Directorate of Public Works, and numerous private contractors at WSMR. Environmental regulations, programs, and procedures related to general hazardous materials management at WSMR are listed in Table 3-58.

The primary responsibility for compiling hazardous materials information for WSMR, exclusive of NASA/WSTF, the Naval Air Warfare Center, and private contractors, is the Safety Division of the Environmental and Safety Directorate. It is the responsibility of each user of hazardous materials to identify the hazardous materials and report their use. The Safety Division identifies hazardous materials used at WSMR through the use of compliance audits of base users. Hazardous materials used are compiled in a data base and listed at the Safety Division. Material safety data sheets, which describe the hazards associated with a material, precautions to take in the event of a spill or fire, and how to prevent occupational exposure to the material, are kept at the use and storage site of each material and are kept on file at the Safety Division. The Safety Division currently has 100,000 material safety data sheets on file for WSMR.

The fire department and the Safety Officer are responsible for inspecting all of the hazardous materials storage facilities at WSMR, documenting the findings, verifying corrective actions, and maintaining accurate records as required by AR 420-90. The Main Post fire department maintains Emergency Contingency Plans and is responsible for inspecting hazardous material storage facilities. The Directorate of Logistics is responsible for the central receiving, storage, and dispensing facility that handles hazardous materials. WSMR Environmental and Safety Directorate personnel provide hazardous material storage, guidance, and inspections for U.S. Navy facilities at WSMR.

Each user of hazardous material is responsible for safe storage and handling of the material. These materials are shipped to each user in compliance with DOT hazardous materials regulations and all users are responsible for complying with DOT hazardous materials regulations. Releases of hazardous materials above reportable quantities are reported to the EPA. A list of reported releases as of August 1990 is presented in Table 3-59.

3.14.1.1 Underground Storage Tanks. WSMR currently has 25 USTs (Table 3-60). Most of these tanks are registered with NMED (Mendoza, pers. com. 1993). The Environmental Services Division at WSMR is responsible for managing UST regulatory compliance.

All USTs that store unleaded and leaded gasoline, and diesel have been upgraded with leak detection and spill and overfill protection in compliance with New Mexico state regulations,

Table 3-58
Hazardous material regulations and procedures applicable to WSMR

HAZARDOUS MATERIALS MANAGEMENT (General)	
29 CFR 1910 (OSHA)	Training, handling, and storage
Table 302.4 of 40 CFR 302	Reportable quantities of hazardous materials spills
49 CFR 171-179 and AR 55-355	Labeling and transportation of hazardous materials
AR 200-1	Environmental protection and enhancement
AR 420-9	Flammable material storage areas
Executive Order 12856	Federal Compliance with Right-to-Know Laws and Pollution Prevention requirements
U.S. Army 414S.19-R-I	Hazardous commodities storage Chapter 5, Section 4
Pesticides, Herbicides, and Rodenticide	
29 CFR 1910	Training and handling
40 CFR 156, 162, 165, 170, 171	Labeling, registration, disposal, storage, handling, and certification
AR 200-1, AR 200-1.5.5, AR 200-1-6.10, AR 420-74, and AR 42-76	Health monitoring, pest management plans, handling, and recordkeeping
U.S. Army 4150.7	Pest management programs
U.S. Army 4160.21-M	Disposal and recordkeeping
Polychlorinated Biphenyls (PCBs)	
40 CFR 761	PCBs requirements
AR 200-1	Handling, use storage, disposal, records, and reporting
50 FR 29170	PCB transformer fire rules
Underground Storage Tanks (USTs)	
40 CFR Part 280	UST regulations
New Mexico Statute Annotated 74-6B-1 to 74-6B-11	New Mexico UST regulations
Radioactive Materials	
Nuclear Regulatory Commission	Regulates federal agencies under the Atomic Energy Act
Petroleum, Oils, and Lubricants	
U.S. Army Manual 4140.25-M and WSMR Regulation 755-2	Waste oil recovery and recycling
HAZARDOUS WASTE MANAGEMENT	
40 CFR 260-271 (RCRA)	Hazardous Waste Management Regulations
40 CFR 370, 372 Executive Order 12856	Community Right-to-Know, applicable to federal agencies under
49 CFR 171-179 (DOT)	Transportation
AR 200-1	Environmental Protection and Enhancement
AR 420-47	Solid and Hazardous Waste Management
DEQPM 80-5	U.S. Army Hazardous Materials Disposal Policy
DEQPM 80-8	RCRA
New Mexico Statute Annotated && 74-4-1 to -13	Hazardous Waste Management

Table 3-59
Hazardous material releases reported to EPA

Release Date	Release Description	Organization	Source	Affected Area
January 13, 1987	4,000 gallons chrome VI solution	U.S. Army	unknown	unknown
June 27, 1987	103 gallons unleaded gasoline	ES-E	fixed facility	asphalt
August 29, 1987	500 gallons diesel	U.S. Army	fixed facility	land
September 20, 1987	100 gallons unleaded gasoline	U.S. Army	fixed facility	asphalt
February 27, 1988	1,500 gallons ethanol	U.S. Army	highway	land
May 5, 1988	375 pounds unsymmetrical dimethyl hydrazine; 1,107 pounds inhibited fuming nitric acid	U.S. Army	fixed facility	land
April 13, 1989	2 gallons capacitor oil	ES-E	fixed facility	land
March 16, 1990	100,00 gallons diesel	ES-E	unknown	land and groundwater
April 27, 1990	methyl chloride	ES-E	fixed facility	land
August 13, 1990	200 gallons hydroxide	ES-E	fixed facility	land

and are being equipped with overfill prevention equipment as required by 40 CFR 280.20(c). WSMR is currently developing a program to test each tank and maintain inspection records.

NASA/WSTF manages seven USTs separately from WSMR (Amidei, pers. com. 1993). The NASA/WSTF environmental compliance department is responsible for managing regulatory compliance of the seven tanks. They are in compliance with federal and state regulations.

3.14.1.2 Pesticide and Herbicide Use. Pesticides and herbicides are stored in the specially-designed pesticide storage building (building 1708) and are managed by the WSMR agronomist.

Table 3-60
USTs at WSMR

Tank ID#	Capacity L (gal)	Contents	Location
WS-1773	22,712 (6,000)	unleaded gasoline	WSMR Main Post
WS-1774	22,712 (6,000)	unleaded gasoline	WSMR Main Post
WS-1775	22,712 (6,000)	unleaded gasoline	WSMR Main Post
—*	22,712 (6,000)	diesel	WSMR Main Post
WS-1779	22,712 (6,000)	diesel	WSMR Main Post
WS-1781	22,712 (6,000)	diesel	WSMR Main Post
WS-1793	22,712 (6,000)	diesel	WSMR Main Post
WS-1874	94,635 (25,000)	diesel	WSMR Main Post
WS-1875	94,635 (25,000)	diesel	WSMR Main Post
WS-1876	94,635 (25,000)	diesel	WSMR Main Post
WS-1877	94,635 (25,000)	unleaded gasoline	WSMR Main Post
WS-1878	94,635 (25,000)	unleaded gasoline	WSMR Main Post
WS-1879	94,635 (25,000)	unleaded gasoline	WSMR Main Post
—	22,712 (6,000)	unleaded gasoline	Rhodes Canyon Range Center Station
—	22,712 (6,000)	diesel	Rhodes Canyon Range Center Station
—	94,635 (25,000)	unleaded gasoline	Rhodes Canyon Range Center Station
—	94,635 (25,000)	diesel	Rhodes Canyon Range Center Station
—	94,635 (25,000)	unleaded gasoline	Stallion Range Camp
—	94,635 (25,000)	diesel	Stallion Range Camp
—	18,927 (5,000)	diesel	Stallion Range Camp
—	18,927 (5,000)	diesel	Stallion Range Camp
S-26028	11,356 (3,000)	unleaded gasoline	HELSTF
S-24061	567,810 (150,000)	diesel	LC-38 Main Post
M4	22,712 (6,000)	unleaded gasoline	NASA/WSTF 100 Area, east of bldg 113
M5	9,464 (2,500)	regular leaded gasoline	NASA/WSTF 100 Area, east of bldg 113

* Dash indicates no data available.

Notes: L = liter
gal = gallon

Pesticides and herbicides are used in the maintenance of the Main Post facilities and the Main Post golf course, and to maintain clear zones within weapon impact areas (Mendoza, pers. com. 1993). These chemicals are applied in accordance with applicable federal and state laws and regulations as outlined in the WSMR pesticide management plan (U.S. Army 1993i). Pesticide and herbicide use for each year is outlined in pest management reports submitted to the AMC. Pesticide and herbicide containers are rinsed and the rinsate is applied as a pesticide or herbicide. Outdated products are manifested and managed as hazardous waste by the hazardous waste storage facility. The management agronomist at WSMR administers the pesticide management plan and manages the pesticide program. Each of the applicators and pesticide managers have been certified by the U.S. Army as pesticide applicators (Mendoza, pers. com. 1993).

Safe pesticide handling and application at NASA/WSTF is the responsibility of the NASA Engineering Support Office, while the facilities maintenance personnel are responsible for managing the application of pesticides and herbicides. NASA/WSTF uses very limited quantities of pesticides and herbicides. In 1993, approximately 114 to 454 L (30 to 120 gal) per year of the herbicide Roundup® is used at NASA/WSTF to control weed growth around the buildings. The herbicide is stored in a locked cabinet in building 121. Pesticides are applied monthly by an off-site pest control contractor to control rodents, flies, crickets, and ants. No pesticide products, containers, or pesticide wastes are stored at NASA/WSTF. NASA/WSTF uses less than 530 L (140 gal) of pesticides per year (Amidei, pers. com. 1993).

3.14.1.3 Polychlorinated Biphenyls. Management of PCBs at WSMR is handled primarily by two entities. Overall management is the responsibility of DPW, while much of the PCB-related work is performed by electrical shop personnel. All PCB-containing equipment at NASA/WSTF facilities has been reduced to non-PCB status.

PCBs are highly stable and have excellent insulating and fire resistant properties. They were used extensively in electrical equipment, especially transformers. The Toxic Substances Control Act banned the manufacture, distribution, and use of PCBs except in totally enclosed systems such as electrical transformers. in July 1985, the EPA passed the PCB Transformer Fire Rules (50 CFR 29170) that placed additional restrictions, on PCB transformer use in or near commercial buildings. Transformers manufactured prior to 1972 often contained PCBs in concentrations higher than 50 ppm.

PCBs primarily are contained within transformers, capacitors, and filters throughout the base as part of the WSMR electrical utility. Approximately 10 transformers containing less than 50 ppm PCBs are known to be located on the range (Table 3-61). All transformers and capacitors with PCB concentrations greater than 50 ppm in and adjacent to public use areas have been removed.

All removed transformers with PCBs are immediately transferred to a PCB-specific storage area adjacent to the WSMR hazardous waste storage facility when taken out of service. Inspections of this storage area are performed weekly by the Directorate of Logistics. Currently, the electrical shop of the DPW maintains all daily and quarterly inspection records of all known PCB transformers as required by 40 CFR 761.30(a). PCBs were previously transported and disposed of by USPCI at Grassy Mountain in Clive, Utah, and Aptus Environmental Services in Coffeeville, Kansas.

3.14.1.4 Asbestos. Asbestos-containing materials are located in most buildings constructed prior to 1980. Asbestos was found in the following building materials: floor tile, pipe fitting insulation, pipe insulation, siding, tank and vessel insulation, water and sewer lines, transit wallboard (wall and ceiling), air duct insulation, and vibration dampening materials. Asbestos management is regulated under 40 CFR 763 as amended by the Asbestos Hazard Emergency Response Act of 1986, 29 CFR 1910, 29 CFR 1926, and AR 200-1.

An active asbestos control, removal, and notification program currently exists throughout the installation. Where asbestos-containing materials exist in primary and secondary schools on sites, all school employees, organized parent groups, and parents have been informed of the location of such materials in accordance with the Asbestos Hazard Emergency Response Act. Additionally, each custodial worker has been given a copy of the EPA publication, *A Guide for Reducing Asbestos Exposure*. The Asbestos Management Program at WSMR is in compliance with AR 200-1. An inventory of asbestos in buildings is maintained by the

Table 3-61
Known PCB-containing units at WSMR

Facility	Equipment Type	Quantity L (gal)
Building 1534	1 999-kVA transformer	227 (60)
Building 21756	3 75-kVA transformers	136 (36) each
Building 21759	2 100-kVA transformers	136 (36) each
Building 21759	3 75-kVA transformers	136 (36) each
Small Missile Range	1 30-kVA transformer	572 (151)

Notes: L = liter
gal = gallon
kVA = kilovoltampere

asbestos department of DPW (Mezaneros, pers. com. 1993). WSMR is currently removing asbestos from buildings and disposing of asbestos-containing material in the asbestos landfill.

3.14.1.5 Radioactive Materials. The Nuclear Regulatory Commission has given New Mexico authority as an Nuclear Regulatory Commission "Agreement State" to regulate radioactive by-product materials, source materials, and special nuclear materials. However, the Nuclear Regulatory Commission retains licensing and regulatory authority for federal activities, including those at WSMR, in agreement states.

Radioactive magnesium-thorium metal alloys are used in airframes and engines of helicopters, missiles, and jet aircraft; depleted uranium was used in missile tests; and radium was used in instruments and on dials of instrument panels of older Army trucks and aircraft. These very low-level radioactive materials present a low radiation exposure to workers, solders, and the environment.

Radioactive alloys used in armament are normally recovered from impact areas and disposed of as radioactive waste. Magnesium-thorium alloys are used typically in older aircraft such as the Phantom F-4 and UH-1 helicopters as well as target missiles. Dials with radium are being replaced and being disposed of as radioactive waste. Radioactive materials are managed by the Radiation Protection Division at WSMR (Wenz, pers. com. 1992).

3.14.1.6 Ordnance. The Materiel Test Directorate manages and secures explosives and ordnance areas except for small ordnance storage areas at the naval facilities, which are maintained by the U.S. Navy, as described below. There are several major explosive storage magazine areas on WSMR. The main storage area is located in the technical service area (21000 Area), 4 km (2.5 mi) south of the post area in a sparsely vegetated portion of the salt flats. This storage area has three sections: one section designated for munitions storage, another for liquid propellant, and a third is used to store solid propellent, totaling 44 storage magazines. The magazines are earth covered, lightning strike protected, and are constructed to implode instead of explode in the unlikely event of a problem. Each magazine is securely locked and entry into a magazine can only be made by one of the chemical/ammo staff. The ammo storage area is secured with barbed-wire fence, lights, and an intruder detection system that is linked to the Military Police. Ordnance enters the range along one of four routes: through the El Paso entrance, the Orogande entrance, the NASA/WSTF entrance, or the Las Cruces entrance. The ordnance is preinspected/escorted and delivered to the magazine storage area. These facilities are used by the U.S. Army, its contractors, and other range users.

The U.S. Naval Air Warfare Center also maintains an ammunition storage area with seven magazines located south of LC-35, east of WSMR headquarters. Two other small ammunition storage facilities located in the hazardous test area (27000 area) 6.4 km (4 mi) north of the post are used to store detonators, fuses, and plastic explosive. Additionally, there are four Arms Ammunition and Explosive storage facilities on. the Small Missile Range.

NASA/WSTF ordnance is stored in buildings 180, 180A, 180B, 180C, and 181 in the 100 Area. These buildings are used to store trinitrotoluene, detonators, fuses, and smokeless gun powder for use in the 272 Area, LSHOE area, open detonation unit, South High Bay, and 800 Area of NASA /WSTF.

Unexploded ordnance is taken to the Hazardous Test Area and exploded by the National Range Operations team as needed. The hazardous test area has been used for approximately 20 years of ordnance disposal. On rare occasion, if an ordnance is unsafe or unstable for transportation, Explosive Ordnance Disposal will explode the ordnance in place.

3.14.1.7 Petroleum, Oil, and Lubricant. Management of petroleum, oil, and lubricant at WSMR is the responsibility of the Supply and Services Division of the Directorate of Logistics. Waste oil produced or recovered on WSMR is collected and recycled following WSMR regulation 755-2 and U.S. Army Manual 4140.25-M.

3.14.2 Hazardous Waste Management

Hazardous waste management is regulated by both the federal government (EPA) and the state of New Mexico (NM ED). Environmental regulations and procedures related to hazardous wastes at WSMR are listed in Table 3-62.

The federal RCRA contains provisions for the safe treatment, storage, and disposal of wastes and is the basic law for the regulation of hazardous waste management practices. Under this act, the EPA provides a definition of what is a hazardous waste and sets standards for transportation, treatment, storage, and disposal of these wastes. In enacting RCRA in 1976, Congress directed the EPA to develop a federal program for the management and control of hazardous wastes from "cradle to grave." States may be authorized by the EPA to develop and implement their own hazardous waste programs in lieu of RCRA. New Mexico applied for and received authorization for their own program on January 11, 1985. The Hazardous Waste Act (New Mexico Statute Annotated §§ 74-4-1 to 74-4-13) regulates hazardous waste management and control in the state of New Mexico.

U.S. Army regulations (1990d) also provide guidelines for the handling and management of hazardous waste and ensure compliance with all federal, state, and local laws regulating generation, handling, treatment, storage, and disposal of hazardous wastes.

The WSMR base users and NASA are each responsible for environmental compliance within their organizations; for independently tracking hazardous wastes; for proper hazardous waste identification, storage, transportation, and disposal; and for implementing strategies to reduce the volume and toxicity of the hazardous waste generated. The types of hazardous waste, the generators, and the process that generates the waste are listed in Table 3-63.

Table 3-62
Hazardous waste regulations and procedures applicable to WSMR

Regulations

40 CFR 260-271 (RCRA) - Hazardous Waste Management Regulations
40 CFR 370, 372 - Community Right-to-Know
49 CFR 171-179 (DOT) - Transportation
AR 200-1 - Environmental Protection and Enhancement
AR 420-47 - Solid and Hazardous Waste Management
DEQPM 80-5 - U.S. Army Hazardous Materials Disposal Policy
DEQPM 80-8 - RCRA
New Mexico Statute Annotated §§ 74-4-1 to 74-4-13—Hazardous Waste Management

Table 3-63
Major generators of hazardous waste at WSMR

Generator	Waste Generation Activity	Types of Waste
NASA/WSTF	Propulsion testing, materials testing, space-related activity, space shuttle testing, facility maintenance, and heavy equipment maintenance.	Acids/corrosives, mercury-contaminated materials, paint-related materials, petroleum-based solvents and related materials, photograph development and research, spent batteries (lead, nickel-cadmium, and lithium), waste explosives, waste solid and liquid fuel and related materials, and waste oils.
HELSTF	High-energy laser testing and facility maintenance	Acids/corrosives, chlorinated halocarbons, chlorinated solvents, chromium wastes, paint-related materials, waste oils, and various mixtures of above.
MTD	Weapons testing (missiles, aircraft, armament, vehicles, etc.), weapons research, weapon and vehicle maintenance, and facility maintenance.	Acids/corrosives, chlorinated halocarbons, chlorinated solvents, chromic acid, lithium batteries, and paint-related materials.
Naval Air Warfare Center (U.S. Navy)	Weapon and vehicle maintenance, weapons research, and facility maintenance.	Chlorinated solvents, heavy metal contaminated materials, paint-related materials (with lead, methyl ethyl ketone, toluene, and heavy metals), and petroleum solvents.
Paint Shop	Painting facility maintenance	Paint-related materials and solvents. Some materials contaminated with lead, chromium, and solvents.
DPW	Lead paint replacement.	Lead paint-related materials.
DPW	Asbestos abatement.	Asbestos-related materials.
Main Post Motor Pool	Vehicle maintenance	Lead batteries, waste solvents, and waste oil.
Dynaspan	Weapons static testing.	Lead-mercury contaminated materials and paint-related materials.

3.14.2.1 Hazardous Waste Tracking System. The Directorate of Environment and Safety manages the WSMR hazardous waste tracking system, which tracks hazardous wastes from the generator to WSMR satellite accumulation points and 90-day storage sites, continuing through the WSMR hazardous waste storage facility (building 22895). From the hazardous waste storage facility, wastes are shipped off the range (Smith, pers. com. 1993).

NASA/WSTF manages and tracks hazardous waste separately from WSMR. NASA/WSTF has an environmental staff that obtains permits and manages the hazardous waste treatment and disposal facilities. NASA/WSTF manages hazardous waste by establishing satellite waste accumulation areas and tracking wastes using the WSTF Individual Waste Profile Sheets. A profile sheet is completed for all WSTF hazardous waste streams. Profile sheets are maintained and tracked using a computer data base.

Each of the waste accumulation areas is managed by the generator of the waste. Waste within NASA/WSTF is transported by the generator to a collection point. Any further transport is by authorized personnel. Waste management practices are conducted in accordance with procedures mandated in the WSTF Waste Analysis Plan and the NASA/WSTF Hazardous Waste Operating Permit (Amidei, pers. com. 1993). There are approximately 30 satellite accumulation points at NASA/WSTF (Table 3-64). Collected wastes for off-site shipment, treatment, or disposal are stored in the Permitted Container Storage Facility in area 100.

3.14.2.2 Hazardous Waste Minimization Program. Congress specifically stated the following in the Hazardous and Solid Waste Amendments (HSWA) of 1984 to the RCRA:

> "The Congress hereby declares it to be the national policy of the United States that wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment."

Pursuant to 40 CFR 262.41, 264.75, and 265.75 of the implementing regulations for RCRA, the U.S. Army has established a requirement to implement a hazardous waste minimization program.

For the purposes of the hazardous waste minimization program, waste minimization may be defined of hazardous waste or the reduction in toxicity of hazardous waste that is generated or subsequently treated, stored, or disposed. Source reduction refers to the reduction or elimination of waste at the point of generation. Source reduction activities could include process changes, materials substitution, proper inventory procedures, employee training, and other activities. Recycling refers to the use or reuse of a waste stream by-product, or the reclamation of a waste material.

3.14.2.3 Treatment and Disposal Facilities. WSMR has no permitted or active treatment or disposal facilities with the exception of NASA/WSTF. The hazardous waste generated at WSMR proper is either disposed of or recycled at off-site facilities. RCRA permitted storage facilities are described in Section 3.14.2.1 and Tables 3-64 and 3-65. Examples of off-site treatment, recycling, and disposal facilities used by WSMR since 1990 are listed in Table 3-66 and off-site facilities used by NASA/WSTF are listed in Table 3-67. The majority of hazardous wastes shipped off-site from WSMR have been transported to treatment, storage, and disposal facilities in Texas. These Texas facilities include Alpha Omega Recycling; Disposal Systems, Inc.; ELTEX Chemical; Hydrocarbon Recovery Services; Technical Environmental Systems; and Treatment One. Other wastes have been shipped to USPCI

Table 3-64
NASA/WSTF hazardous waste accumulation points

Site	Type of Site	Area
Drafting, building 100	satellite	100
Reproduction, building 101	satellite	100
Dome, East of building 151 in Burn Area	satellite	100
Southeast of building 113, near Clean Pad	satellite	100
Northeast corner of building 113	satellite	100
Heavy Equipment Area, building 158	satellite	100
West of building 113, near Machine Shop	satellite	100
South of building 150	satellite	100
Northwest corner of building 121	satellite	100
South end of Paint Shop, building 113	satellite	100
Vehicle Service, building 151	satellite	100
Building T-253	satellite	200
Room 143, building 203	satellite	200
Room 146, building 203	satellite	200
Environmental Laboratory, Room 126, building 203	satellite	200
Vacuum Gauge Calibration, Room 137, building 203	satellite	200
Room 110, building 203	satellite	200
Room 136, building 200	satellite	200
Room 142, Chem Laboratory in Fuel Room	satellite	200
Lab Con High Bay	satellite	200
Photo Laboratory, Room 107, building 200	satellite	200
Room 151, North High Bay (2 Sites)	satellite	200
TS-302, HCU Containment Berm	satellite	300
300 Decon	satellite	300
East of building 270	satellite	200
East of building 448	satellite	400
East of building 412	satellite	400
East of Test Cells Near 800 Decon	satellite	800
Outside of Test Cells, West of 800 Decon	satellite	800

Grassy Mountain in Utah and to U.S. Ecology in Beatty, Nevada. PCBs have been shipped to Aptus, Inc., in Kansas.

NASA/WSTF has several permitted treatment facilities regulated under an approved RCRA Hazardous Waste Operating Permit (Amidei pers. com. 1993). These permitted facilities include the evaporation tank unit (200 area), waste fuel treatment unit (500 area), and open detonation unit (700 area). The quantities and types of wastes permitted to be treated by these units are listed on Table 3-68.

3.14.2.4 RCRA Corrective Action Sites. One of the major provisions (Section 3004[u]) of the HSWA requires corrective action for releases of hazardous waste or constituents from solid waste management units (SWMUs) at hazardous waste treatment, storage, or disposal facilities. Under this provision, any facility applying for a RCRA Part B permit will be subject to an RCRA Facility Assessment (RFA). An RFA is used to identify SWMUs, collect existing contaminant release information, and identify known or suspected releases at SWMUs requiring further information. An RFA was conducted at WSMR for EPA Region

Table 3-65
Satellite and 90-day hazardous waste accumulation points

Site	Type of Site
Building 1870	90-day
Navy-Main Post (building 1460)	satellite
Cortez III (south of Main Post)	90-day
HELSTF	90-day
Navy USS Desert Ship (building 23270)	satellite
Lockheed (building 1550)	satellite
Cortez III (building 1534)	satellite
Cortez III-GTO	satellite
Print Plant (building 153)	satellite
Raytheon—LC-38	satellite
Main Motor Pool (building 1785)	satellite
Paint Shop (building 1742)	satellite
PM Shop (building 1754)	satellite
Heavy Equipment Shop (building 1753)	satellite
MTD Lab (building 1530)	satellite
Audio/Visual (buildings 1621 and 1512)	satellite
Stallion Range Center	satellite
Atmospheric Sciences Laboratory (building 1622)	satellite
Vulnerab. Assess. Laboratory (buildings 1624 and 1626)	satellite

Table 3-66
Examples of off-site treatment and disposal facilities used by WSMR, 1990 to 1993

Site	Type of RCRA Wastes Accepted
Alpha Omega Recycling, Longview, Texas (Recycling)	D000, D001, D003
Aptus, Coffeeville, Kansas (Disposal)	PCBs
Disposal Systems, Inc., Deer Park, Texas	D000 to D009, F001 to F003, F005, F007, U220
ELTEX Chemical, Houston, Texas	D002 to D009, D011, F001 to F003, F005, P030, Corrosives
ENSCO, El Dorado, Arizona	D001, D007, D008, F003
Hydrocarbon Recovery Services, San Antonio, Texas	D000 to D002, D006 to D008, D035, F001 to F003, F005, U228
Technical Environmental Systems, Inc., La Porte, Texas formerly known as Laidlaw Environmental Services	D001 to D004, D008, D009, D011, D018, D022, D035, F001 to F003, F005, U044, U220
Treatment One, Houston, Texas	D001, D002, D007, D008, F003, F005, U122
U.S. Ecology, Beatty, Nevada (Disposal or Treatment)	D007, D008
USPCI Grassy Mountain, Clive, Utah (Disposal)	D000 to D002, D006 to D009, DO11, PCBs

Table 3-67
Examples of off-site treatment, recycling, and disposal facilities used by NASA/WSTF, 1992 to 1993

Site/Vendor	Type of Waste Accepted	Approximate Yearly Quantity (1993)
Safety Kleen (Disposal/Recycling)	petroleum naptha	3,053 kg (6,732 lb)
	waste carburetor cleaner	196 kg (432 lb)
Holloman AFB DRMO (Recycling)	spent batteries (D008)	2,268 kg (5,000 lb)
	photo fixing solutions with silver (D011)	2,271 (600 gal)
	silver oxide batteries (D011 Waste)	30 units
ENSCO, Dalton, Georgia (Recycling)	NiCad batteries (D006 Waste)	145 kg (320 lb)
	lithium batteries (D003)	< 12 kg (< 27 lb)
	lead-acid batteries (D008)	31 kg (68 lb)
Quicksilver, Brisbane, California (Recycling)	mercury wastes (D009)	92 kg (203 lb)
Rollins Environmental Services (Incineration)	waste paint (liquid) (D001, D006, D007, D008, D009)	567 L (150 gal)
	waste paint (solid) (D008, D009)	508 kg (1,120 lb)
	oil sludge/contaminated oils (F001, F005, D035, D019, F003)	2,646 L (700 gal)
	fuel-contaminated soft goods (P068, U099, U133)	756 L (200 gal)
	organic solvents (D001, D009, F001, F003, F005, D035)	189 L (50 gal)
	chromate wastes (D006, D007)	187 L (50 gal)
	debris (F001, F003, F005, D008, D009, F035)	378 L (100 gal)
Kinsbursky Bros., Anaheim, California (Recycling)	NiCad batteries (D006)	382 kg (842 lb)

Notes: gal = gallon, kg = kilogram, L = liter, lb = pound

Table 3-68
NASA/WSTF storage and disposal facilities

Treatment Site	Annual Quantities	Wastes Treated
Open Detonation Unit	136 kg (300 lb) 100 grams (0.22 lb)	waste explosives A, B, and C antimony pentafluorine
Evaporation Tanks	105,991 L (28,000 gal) 1,893 L (500 gal) 15,142 L (4,000 gal) 946 L (250 gal) 1 L (0.26 gal)	solvents (D001, F001 to F005) liquid oxidizers (D001) liquid corrosives waste fuel (P068, U099, U133) neutralized cyanide (D003)
Waste Fuel Treatment Unit	Not available	hydrazine fuel
Container Storage Unit	Maximum 71,828 k (158,350 lb) or 9,993 L (2,640 gal)	solvents contaminated soft goods waste paints contaminated vacuum pump oil Toxic Substances Control Act
waste		nonhazardous waste

Notes: kg = kilogram
lb = pound
gal = gallons
L = liter

VI in August 1988 and identified 138 SWMUs at WSMR. Subsequent and more accurate mapping of the SWMUs was undertaken in 1995-96.

Owners and operators of SWMUs must institute corrective actions at any SWMUs that may have had releases of hazardous wastes or hazardous constituents that present a potential hazard to human health or the environment. After completion of the RFA, a Part B permit may be issued by the EPA with compliance schedules for corrective actions. WSMR submitted the Part B permit application in 1984 and the EPA issued the permit in October 1989 (EPA 1989).

EPA Region VI has entered into a compliance agreement with WSMR for corrective action at SWMUs. RFIs are used to verify releases and characterize the nature, extent, and rate of migration for releases of concern. The state of New Mexico is authorized by the EPA to conduct a hazardous waste program under RCRA. However, the authorized waste program does not include the provisions of HSWA and promulgated regulations. Therefore, the EPA implements and enforces the HSWA regulations.

WSMR's Hazardous and Solid Waste permit requires that an RCRA Facility Investigation (RFI) be conducted at WSMR SWMUs in four phases: Phase I (Appendix I SWMUs), Phase II (Appendix II SWMUs), Phase III (Appendix III SWMUs), and Phase IV (Appendix IV SWMUs). The focus of the RFI for a given SWMU is to determine whether a risk to human

Table 3-69
SWMUs requiring further assessment or corrective measures

SWMU	Description	Concern	Appendix/ Phase
21	Old Fire Fighting Training Area	Petroleum hydrocarbons and lead in soil	I
22	Abandoned Pit	Petroleum hydrocarbons and lead in soil	I
79	Sludge Beds (STP)	Cyanide and other metals in sludge	I
80	Waste Pile (STP)	Cyanide, lead, and chromium in sludge	I
82	Former Drainage Ditch (STP)	Chromium in soil	I
83	Former Drainage Ditch (STP)	Chromium in soil	I
8	Waste-oil Tank	Petroleum hydrocarbons in soil	II
38 and 39	Inactive HELSTF Landfills	Volatile organics and solvents in soil	III
92 to 100	LPSA Neutralization/ Evaporation Pits	Benzidine in soil	III
121 to 123	SRC Subgrade Tanks	Petroleum hydrocarbons in soil	III
132	Orogrande Waste Stabilization Pond	Petroleum hydrocarbons in soil	III
142	Cleaning Facility Sump	Diesel floating on groundwater, chlorinated solvents in groundwater	IV
143	Chromate Spill Site	Chromium and chlorinated solvents in groundwater	IV
154	Systemic Diesel Spill at HELSTF	Diesel floating on groundwater, diesel in soil	IV

Note: STP = sewage treatment plant

health or the environment is posed by that SWMU. In so doing, the RFIs address surface water groundwater, surface and subsurface soil, and structures associated with each SWMU. The purpose of these investigations is to verify the presence or absence of contaminants at the SWMUs. These investigations will provide information to determine if corrective measures are needed for any of the SWMUs. The SWMUs that require a further assessment or corrective measures in order to determine appropriate remediation measures are listed in Table 3-69 (COE 1992g, 1992h) and shown on Figures 3-36 through 3-38.

NASA/WSTF has several treatment and disposal facilities, including sewage treatment lagoons in the industrial 100 area and the 200 area. Surface impoundments in the 300, 400, and 600 areas were closed as landfills in 1988 under approved NMED closure plans. The NASA/WSTF SWMUs (Table 3-70) are investigated separately from WSMR SWMUs and as part of a Consent Order issued by the EPA. Four underground storage tanks were removed from the 200 Area as part of the Consent Order. A plume of contaminated groundwater extends from beneath NASA/WSTF onto BLM property under the EPA Consent Order. NASA/WSTF currently is conducting remedial investigations to assess contamination at the site.

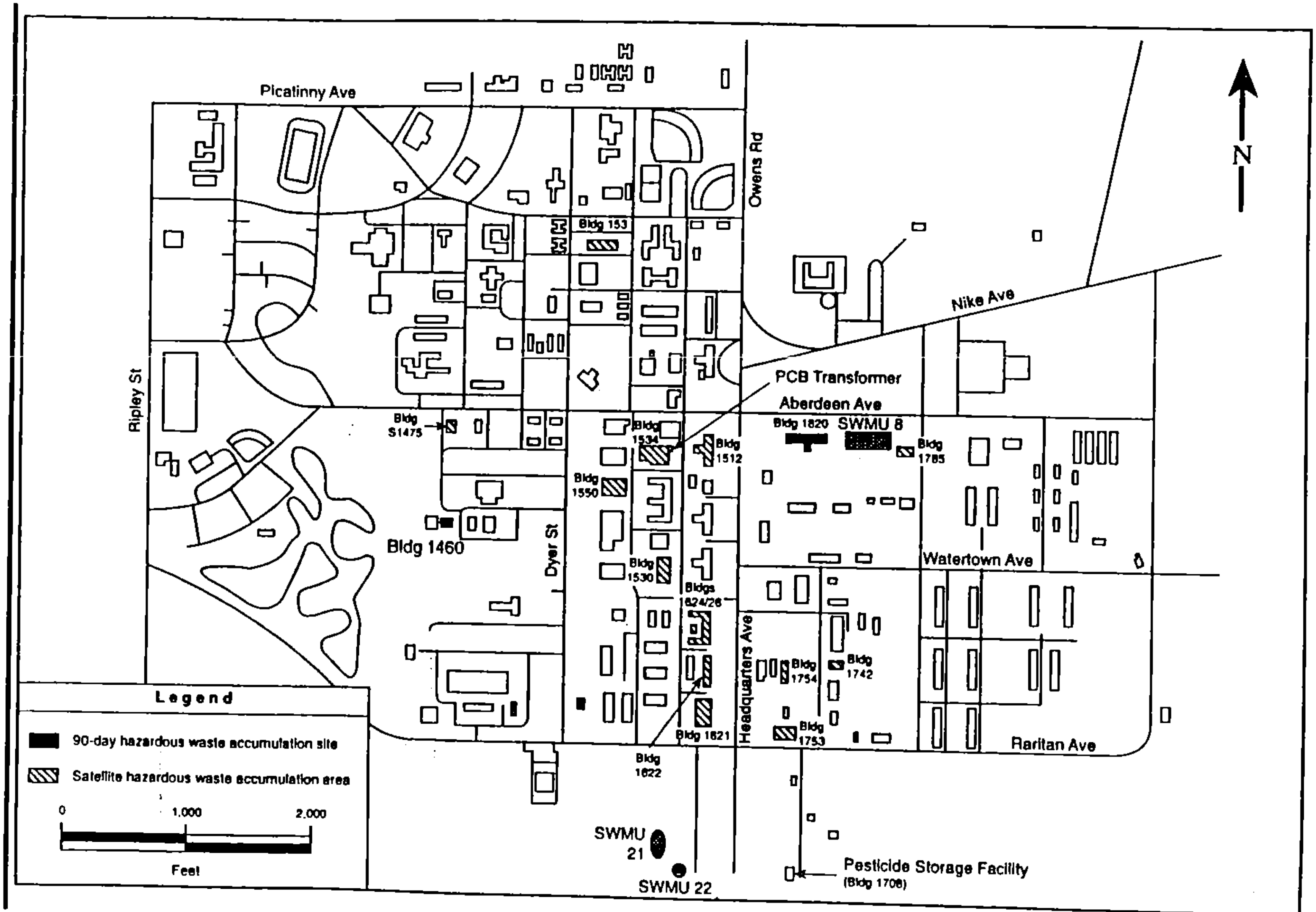

Figure 3-36. Locations of hazardous material/waste facilities, Main Post

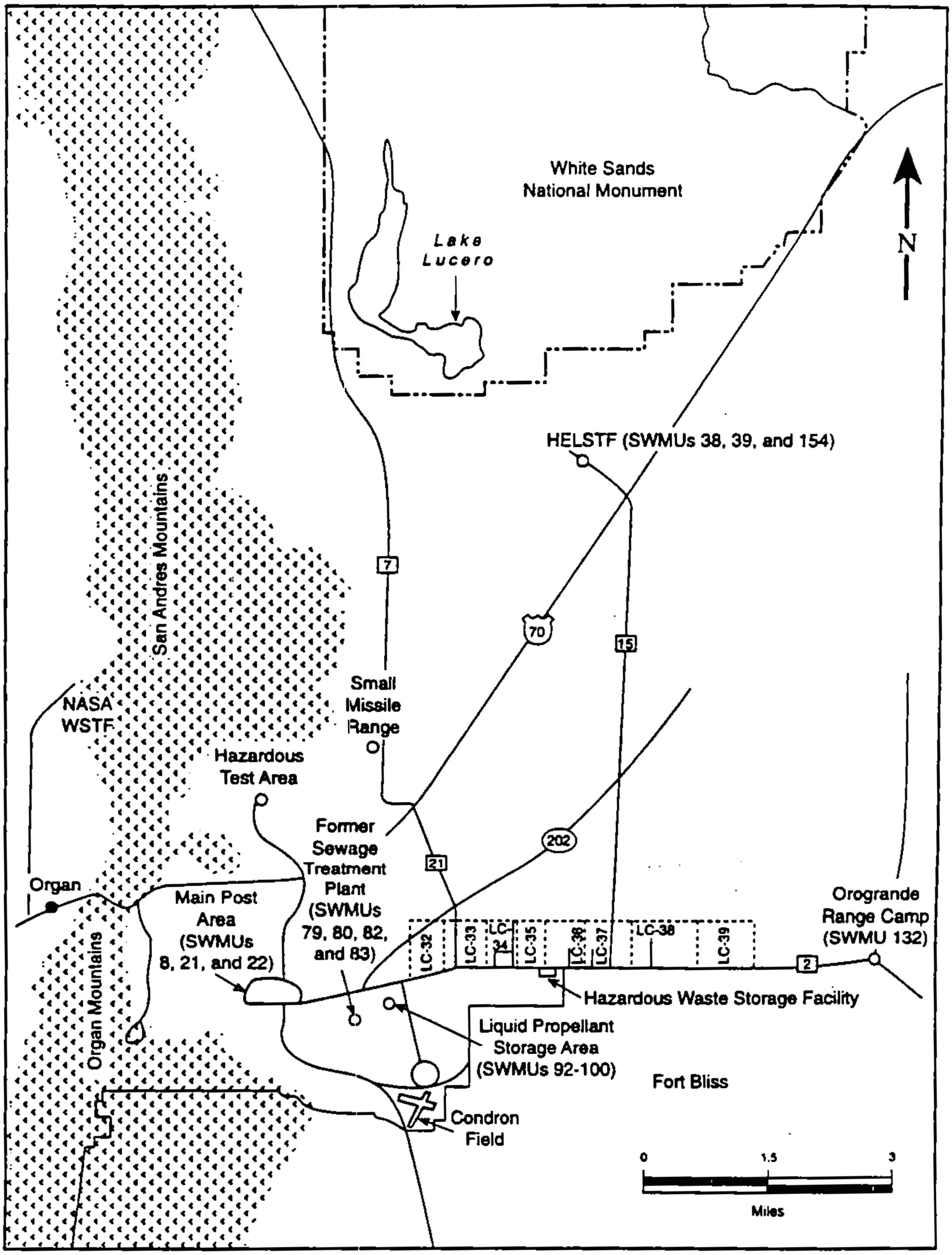

Figure 3-37. Location of SWMUs – southern portion of WSMR

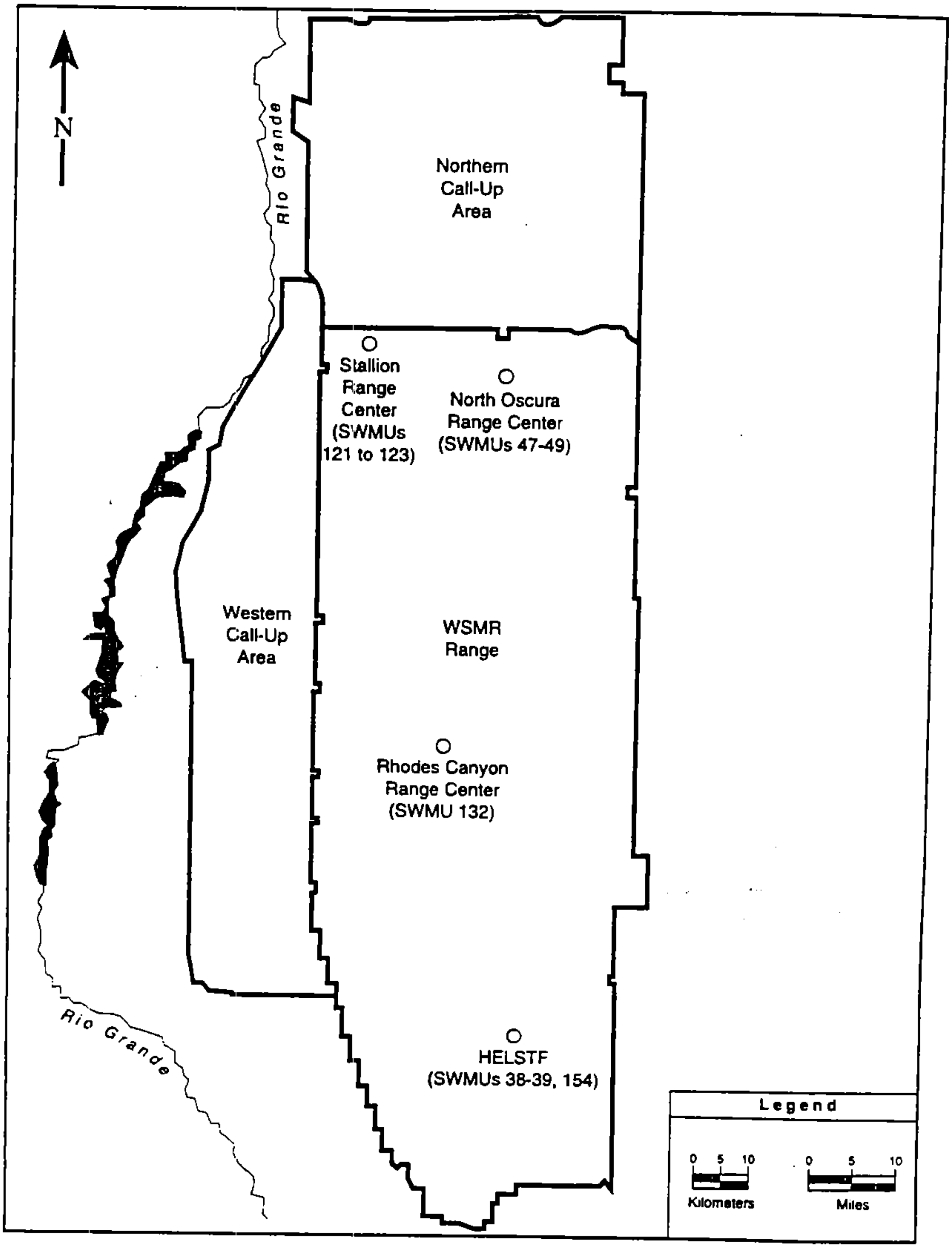

Figure 3-38. Solid waste management unit locations

Table 3-70
NASA/WSTF solid waste management unit sites

SWMU Number	Unit Description	
1	100 Area	burn pit
2	100 Area	container storage area
3	100 Area	PCB container storage area
4	100 Area	sewage lagoons
5	200 Area	clean room discharge pipe
6	200 Area	scape room discharge pipe
7	200 Area	building 203 discharge pipes
8	200 Area	south high bay discharge pipes
9	200 Area	sewage lagoons
10	200 Area	burn pit
11	200 Area	underground tanks
12	200 Area	evaporation tanks
13	300 Area	USTs/surface impoundments
14	300 Area	oxidizer burner
15	400 Area	USTs/surface impoundments
16	400 Area	oxidizer burner
17	400 Area	aspirator discharge pipes
18	600 Area	abandoned burn pit
19	600 Area	test areas
20	600 Area	sewage sludge
21	700 Area	sanitary landfill
22	700 Area	open burning/open detonation area
23	700 Area	remote test area
24	800 Area	UST
25	800 Area	oxidizer burner

3.15 HEALTH AND SAFETY

For this EIS, the evaluation of health and safety covers current operational facilities and potential facilities associated with the proposed action and the no action alternative. Criteria considered include risk of explosion or release of hazardous substances; emergency response and emergency management plans; and threats to health and safety of workers, the local population, and the environment.

Identification of harmful chemicals and other contaminants that are required to be handled, stored, applied, and disposed of properly is discussed in Section 3.14, Hazardous Materials/ Hazardous Waste, which covers the management and tracking of hazardous materials and the treatment and disposal of hazardous wastes. Radiation concerns are discussed in Section 3.13.

The primary focus of this section is to discuss the resources and procedures from local communities and the major WSMR site programs that are available for response and mitigation of effects from a hazardous material (HAZMAT) accident or other multihazard events. Section 3.15.1, Public Health and Safety, describes local resources and plans for public response to an emergency; and Section 3.15.2, WSMR Site Health and Safety, includes WSMR resources and plans.

3.15.1 Public Health and Safety

Protection of public health and safety is the primary function of numerous local, state, and federal agencies. Most obvious and visible are law enforcement and fire protection facilities.

In addition, other public groups dealing with health and safety include environmental, emergency management, transportation, public health, and public service agencies. Contiguous agencies and facilities such as White Sands National Monument, Ft. Bliss, and Holloman Air Force Base also can be called upon to provide assistance with safety, fire control, and law enforcement. Other groups also may be involved with health and safety such as the Red Cross, utility companies, local industry, and industrial associations. In the past several years, federal laws have tasked local and state agencies with the coordination of emergency planning for HAZMAT incidents among themselves, local industry, volunteer groups, and other related groups. As discussed below, an evaluation of health and safety resources is available from the reports and plans produced from these coordinated groups, called local emergency planning committees (LEPCs).

3.15.1.1 Public Health and Safety Functions. A number of public officials involved in emergency management, planning, and response, through LEPCs or other job functions involving public health and safety were interviewed to provide the information that follows.

Local Emergency Planning Committees

Under authority of Title III, Emergency Planning and Community Right-To-Know: Superfund Amendments and Reauthorization Act of 1986, the Governor of each state must designate a State Emergency Response Commission (SERC). Functions of each SERC include designation, supervision, and coordination of activities for the LEPCs. Each LEPC must establish rules, give public notice of activities, and establish procedures for handling public requests for information. An Emergency Operations Plan (EOP) must be developed by October 17, 1988, and be reviewed annually by the LEPCs.

Local Emergency Planning Committee Membership

LEPCs include representatives from a diverse group of agencies and organizations within each emergency management planning area. Typically, the LEPC includes representatives from emergency management, city and county government, fire protection, local industry, and volunteer relief organizations. The LEPC is a dynamic body and membership is subject to change at any time. LEPC membership is listed below.

- Doña Ana County/Las Cruces: Las Cruces City Council, American Red Cross, Las Cruces police department, Sheriff's department, New Mexico State University Safety Office, New Mexico state police emergency response officer, National Guard, NMED, Doña Ana County Commission, Las Cruces fire department, New Mexico Motor Transport Division, Messilla fire department, Salvation Army, City of Las Cruces Safety Office, BLM, New Mexico State Department of Forestry, and Memorial Medical Hospital Safety Office.

- El Paso: City fire department, City/County Emergency Management Office, City police department, City Equipment and Services, City Traffic and Transportation, and El Paso Community College.

- Local Industries: Marion Laboratories, Inc., Safety–Kleen Corp., Helena Chemical Company, Chevron U.S.A., Swift–Eckrich, Inc., ASARCO, Phelps

Dodge, Siemans, El Paso Natural Gas Company, Van Waters & Rogers, El Paso Refining, Ltd., Baltimore Spice, McGill Manufacturing Co. Inc., Hanley Paint, Big Three industries, Levi Strauss, Chrysler Corporation, Millipore, Featherlite Building Products, Frito–Lay, Inc., Baxter Healthcare & Pharmaceutical, Bordon, El Paso Times/Herald Post, Levi Strauss & Co., GETS, American Minerals, Inc., Rollins Leasing Corp., and Texas Engineering Products.

- Otero/Alamogordo (The Alamogordo EOP reportedly is not funded by the Federal Emergency Management Agency {FEMA}, so no LEPC organization listing is required by FEMA.): Holloman AFB, NMED, City Public Safety, Mescalero Bureau of Indian Affairs, Dog Canyon fire department, U.S. Forest Service, EmergiCare, NPS, Red Cross, and Gerald Champion Hospital.

- Sierra/Truth or Consequences: Elephant Butte Lake State Park, Emergency Management Office, New Mexico state police, County Administrative Assistant, Emergency Medical Service, Red Cross, City Safety Officer, and Volunteer fire department.

- Socorro: New Mexico Institute of Mining & Technology, Bureau of Mines & Mineral Resources, New Mexico Institute of Mining & Technology Research & Development, Eagle Pitcher Industries, Socorro fire department, San Antonio fire department, and Socorro Office of Civil Emergency Preparedness.

- Torrance: Emergency Management Coordinator for the county Emergency Management Office, Sheriff's department, Volunteer fire department chiefs, Mountainair police chief, Moriarty police chief, Red Cross, Hoinstine Oil Co., and a private citizen (Castillo, pers. com 1994).

Emergency Operations Plan

The National Response Team *Hazardous Materials Emergency Planning Guide* NRT-1 (National Response Team 1987) was the guidance document available to LEPCs during the time when Title III EOPs were first prepared. The NRT-1 document is used extensively to describe the components included in EOP sources in this EIS. Typically, the LEPC plans covering HAZMAT incidents are included in more comprehensive disaster planning documents called multihazard plans, which cover hazardous materials, floods, tornadoes, and other disasters. The 14 federal agencies that constitute the National Response Team have major responsibilities in environmental, transportation, emergency management, worker safety, and public health areas. These agencies include the following:

- Department of Agriculture,
- Department of Commerce,
- Department of the Interior,
- U.S. Army,
- Department of Energy,
- Department of State,
- Department of Labor,

- Department of Justice,
- DOT,
- Department of Health and Human Services,
- FEMA,
- Nuclear Regulatory Commission,
- EPA, and
- U.S. Coast Guard.

Some of the EOPs for counties (and for some of the larger cities in the respective counties) that were reviewed follow.

- Doña Ana County/Las Cruces (Otero 1994)
- El Paso (Soteriou 1992)
- Lincoln (Bohks 1992)
- Ruidoso (Hall 1990)
- Sierra/Truth or Consequences (Ball 1993)
- Socorro (Anaya 1993)
- Torrance (Castillo 1984).

Using information obtained from on-site and telephone interviews with city and county emergency managers and LEPC chairs, and reviews of EOPs, an overview of public emergency response functions in the counties around WSMR was compiled. EOP emergency response functions in the following section headings are essential planning elements for an LEPC according to the NRT-1 document. This information found for local community EOPs is presented below.

Initial Notification

Prompt communications are critically important during an emergency; in particular, a 24-hour emergency response hotline (i.e., a 911 emergency number for all localities). Emergency 911 calls go to a central dispatch office. The dispatcher follows with subsequent notifications to emergency service organizations and, as needed, nearby municipalities and counties. For volunteer responders, such as volunteer fire fighters, personal pagers and home telephones are used. Each of the emergency planning offices contacted had an enhanced 911 system, although some systems had been installed recently. The enhanced 911 system allows the dispatcher to receive a video display of the originating address of the 911 call, saving valuable seconds in response time. All appropriate local, state, and federal officials and agencies should be notified, depending on the nature and severity of the incident. For some events, it also is important to notify special facilities such as schools, nursing homes, day care centers, and industries.

A summary of initial notification plans from EOPs is included below.

- Doña Ana County/Las Cruces: An enhanced 911 system is in place.

- El Paso: An enhanced 911 system is in place with a central dispatch system that directs calls to the city or county, as appropriate. Pagers are used for volunteer fire fighters.
- Lincoln/Ruidoso: An enhanced 911 system was installed in the fall of 1993.
- Otero/Alamogordo: An enhanced 911 system has been in place for approximately one year.
- Sierra/Truth or Consequences: A 911 system is being used. Enhanced 911 equipment will be installed in the near future.
- Socorro: An enhanced 911 system is in place.
- Torrance: An enhanced 911 system has been in place for approximately one year.

Direction and Control

Response to a hazardous incident will likely involve many participants such as law enforcement, fire fighters, emergency medical services, and health and environmental personnel. Furthermore, there may be more than one organization present and capable of performing the same service, such as local police, county sheriff, and state police. Coordination is needed among these various agencies to determine in advance who is in charge. in the EOP, this is presented through a clearly delineated chain of command that also designates who activates the emergency operating center and the on-scene command post, and who serves as an advisor during an incident. in the state of New Mexico, specially trained members of the state police will assume command as an emergency response officer. Until the emergency response officer arrives, the on-scene authority is typically the ranking fire department officer, although police or other officers can assume control under some EOPs, depending on the type of incident. The incident commander or the emergency response officer also sets up the on-scene command post. EOPs include provisions for an emergency operating center, which typically is activated by the emergency management office when needed.

The emergency operating center is a central point of coordination and communications during an incident. Radios, telephones, and ham radios may be used for communications. The emergency operating center may be wired for independent phone lines, some having up to 20 independent phone lines.

EOPs for direction and control are summarized below.

- Doña Ana County/Las Cruces: The EOP specifies incident command and the emergency response officer. The emergency operations center is located in the emergency management office, which contains independent phone lines and ham radio stations.
- El Paso: The emergency response agency having primary responsibility assumes command. The emergency operations center is located in the basement of the El Paso City Hall and is equipped with emergency power, 20 independent phone lines, and ham radios.
- Lincoln: The standard EOP, modeled after the state plan, includes direction and control.

- Ruidoso: The standard EOP, modeled after the state plan, includes direction and control.
- Otero/Alamogordo: The EOP specifies incident command and the emergency response officer. The county emergency operating center is located at the sheriff's department, and is being upgraded. Per the EOP, an emergency operations center and an alternate location designation are needed for Tularosa, Cloudcroft, and Mescalero Apache Indian Reservation.
- Sierra/Truth or Consequences: Initial incident command by first responders. The state police emergency response officer is notified immediately to assume control. Two phone companies currently provide service in the county, complicating communications. The emergency operating center is located in the county commissioners' meeting room. Portable radios and walkie talkies are the primary means of communication. Plans are ongoing to enhance the current radio equipment. It is recognized that independent phone lines are needed.
- Socorro: Initial incident command is assumed by first responders from the fire department. State police are notified to send an emergency response officer. The emergency operating center is located at the fire department, but may be changed to the police department.
- Torrance: initial incident command is assumed by first responders. The state police emergency response officer is notified immediately to assume control. The emergency operating center is located in the commissioners' room near the emergency planning office.

Communications Among Responders

Provision for directing responses and exchanging information among agencies and organizations is important to ensure accurate and efficient communications. Typically, communications are by radio and telephone. This may include an "on-scene" command radio frequency that all responders can use. Also, the EOP may specify who uses a radio unit.

EOP provisions for communications among responders are indicated below.

- Doña Ana County/Las Cruces: The EOP includes communications. Radio and telephone communications are used.
- El Paso: There are plans to use a standard common frequency for responders including fire, police, emergency medical service, and sheriff departments.
- Lincoln: Portable and mobile radios are used. An emergency services frequency is being considered.
- Ruidoso: Communications by radio.
- Otero/Alamogordo: The EOP includes communications. An standard operating procedure (SOP) for radio communications during emergencies is reportedly in place.
- Sierra/Truth or Consequences: Radios and pagers are the primary means of communication.

- Socorro: Radios are reportedly the primary means of communication among responders.
- Torrance: The sheriff's office serves as central dispatch after receiving 911 calls. Radio and telephone are used to contact responders.

Warning Systems and Emergency Public Notification

EOPs include means for alerting the public as soon as word of the actual or anticipated disaster is received. Disseminated information can include essential directions such as precautions to be taken by the public, evacuation routes, shelters, and sources of aid. Means for alerting the public include commercial radio and television announcements, the Emergency Broadcast System, mobile and fixed sirens, telephone fan-outs, door-to-door warnings, and mobile public address systems. The National Warning System may be used to give notice of wartime disasters, or of peacetime disasters such as tornadoes and floods.

EOP provisions are indicated below.

- Doña Ana County/Las Cruces: A public warning system and notification are included in the EOP.
- El Paso: A public warning system and notification are included in the EOP.
- Lincoln: Television notification will come from Albuquerque stations.
- Ruidoso: Warning sirens are planned for the city of Ruidoso in April 1994. There is a radio station in Ruidoso for broadcasting emergency notifications.
- Otero/Alamogordo: A public warning system and notification are included in the EOP. A repeater system is available to enhance the quality of radio communications.
- Sierra/Truth or Consequences: A public warning system and notification are included in the EOP. A siren is being considered for installation on the water tower in Truth or Consequences.
- Socorro: A public warning system and notification are included in the EOP.
- Torrance: Albuquerque radio and television are used for public notification.

Public Information/Community Relations

In order to help the public plan and prepare for disasters, it is important to provide accurate information to the public, both before and during an incident. Radio and television are particularly useful as these media can disseminate information quickly. Newspapers can provide detailed information to enhance public understanding of emergency incidents, spills, and actions for containment and cleanup. The county or city public information officer, as applicable to the situation, is the typical spokesperson serving as the central media contact.

A summary of public information/community relations plans from EOPs is included below:

- Doña Ana County/Las Cruces: Local radio, television, and newspapers are used to disseminate information.
- El Paso: Special newsletters, brochures at city hall for distribution, and presentations to civic groups are used for public information.

- Lincoln: Standard provisions follow the EOP.
- Ruidoso: The city public information officer is the spokesperson. Periodic reports are communicated through the local Ruidoso newspaper and radio.
- Otero/Alamogordo: Local radio and newspapers are used to disseminate information.
- Sierra/Truth or Consequences: Local radio and newspapers are used to disseminate information.
- Socorro: Local radio and newspapers are used to disseminate information. The city reports a public information officer as part of their incident command system.
- Torrance: Periodic announcements are run in a weekly newspaper. The Red Cross is active in conducting classes on emergency response actions for citizens, notably senior citizens.

Resource Management

EOPs include information on the identification, location, and availability of resources needed to respond to an emergency, such as heavy equipment, vehicles, and personal protective equipment. Many local communities typically are overwhelmed by the prospect of providing ample funding for these resources, therefore, the EOP may involve cooperative agreements with private industry, construction companies, or other localities. In particular, the state resources marshalled by the emergency response officer are valuable resources to localities. When needed, helicopter support is available from the National Guard or medical facilities, notably the military installations at Holloman AFB and Fort Bliss. Funds for use of resources are chargeable to the party responsible for the incident.

Resource management provisions in EOPs are indicated below.

- Doña Ana County/Las Cruces: Resource management is part of the FOP.
- El Paso: Resource management is part of the FOP.
- Lincoln: Resource management is part of the FOP.
- Ruidoso: Resources include assistance from the U.S. Forest Service, New Mexico Forest Service, Bureau of Indian Affairs, Ruidoso Downs fire department, the Mescalero Apache Reservation, and state-funded Search and Rescue.
- Otero/Alamogordo: The city/county emergency management personnel work closely with Holloman AFB to provide support for major disasters. For example, Holloman AFB may be called to assist in containment of a large HAZMAT spill. In addition, state and local highway departments serve as resources. Helicopter resources include those at Fort Bliss and Holloman AFB.
- Sierra/Truth or Consequences: Resource management is part of the EOP.
- Socorro: Resource management is part of the EOP. A list of resources is kept in the county Civil Emergency Preparedness Office, and includes

National Guard, BLM, Santa Fe Railroad, New Mexico Department of Transportation, New Mexico Environmental Improvement Department, New Mexico State HAZMAT Team, and city and county road departments.

- Torrance: Resource management is part of the EOP. The emergency management office maintains lists of contractors and county and state road department contacts.

Health and Medical Services

EOPs include the identification of medical resources. Ambulance service is summoned through the 911 response system. Ambulance service may be contract services or operated by a local agency. Helicopter medical transport service is available as an emergency services resource. In addition to transporting the injured, needed services may include disposal of the dead. Some emergency management offices report that hospital and emergency services personnel have HAZMAT training in order to better cope with chemical decontamination scenarios for injured persons. Health and medical services are listed below.

- Doña Ana County/Las Cruces: Health and medical services are included in the EOP. Some health and medical personnel receive HAZMAT training to better understand decontamination actions. Ambulance service is provided by a private company.
- El Paso: The ambulance service is owned and operated by the city. There are several hospitals in the city and at least two have a decontamination room.
- Lincoln: A volunteer ambulance service is used.
- Ruidoso: Ambulance service is available through the Lincoln County Medical Center Hospital.
- Otero/Alamogordo: There is an agreement for a city/county ambulance service and paramedic service run by EmergiCare. Some of the other towns in the county also have limited ambulance service. Hospitals include those in Alamogordo, Holloman AFB, and the U.S. Public Health Service Indian Hospital.
- Sierra/Truth or Consequences: Ambulances are available through the county emergency medical services. The volunteer fire departments have limited ambulance service.
- Socorro: Health and medical provisions are in the EOP.
- Torrance: Ambulance service is funded by the county to a private service, EmergiCare. Some fire departments have rescue units with emergency medical technicians. A helicopter service is available from Albuquerque, with a five to six-minute response time.

Response Personnel Safety

Safety equipment (called personal protective equipment), must be identified and available for use by HAZMAT response personnel. This equipment may include such items as respirators, special protective clothing, and other equipment that protects the head, eyes, face, ears, hands, arms, and feet. Equipment selection is dynamic; it may be modified as the response site is reevaluated, and updated as information becomes available. The specific equipment used varies according to the hazard.

Responders also should be trained in the use of safety equipment. Training resources include EPA courses for HAZMAT personnel and the New Mexico State Fire Training Academy in Socorro. The New Mexico State Police also offer training to local response personnel. In some instances, the situation may dictate that no entry is allowed for local responders due to a lack of training or equipment. For these situations, the response is relegated to the responsible party, and sometimes to state and federal specialists.

EOP provisions follow.

- Doña Ana County/Las Cruces: Personnel are offered HAZMAT training from federal and state organizations. A roster of trained personnel and current training status is maintained in the Emergency Civil Preparedness planning office.
- El Paso: There is an "entry" HAZMAT team that is trained and equipped to Technician Level A. In addition, there are three "decontamination teams" trained to support the HAZMAT team. The primary function of the HAZMAT team is to neutralize and contain. The responsible party is responsible for final cleanup. Personnel in all stations are trained as first responders. Sources of training include the EPA and state training division. The fire department HAZMAT Coordinator keeps a roster of trained personnel. Procedures are in place for entry, a buddy system, and contamination control.
- Lincoln: Some fire fighters and emergency medical technicians reportedly have HAZMAT training.
- Ruidoso: HAZMAT response is referred to the emergency response officer for action. Ruidoso fire fighters have had first responder HAZMAT training, primarily through State Police Academy training.
- Otero/Alamogordo: Alamogordo and volunteer fire departments report basic HAZMAT training. Some Alamogordo fire fighters have advanced HAZMAT training, and some disposable personal protective equipment for HAZMAT work is readily available. Holloman AFB has an advanced HAZMAT response team.
- Sierra/Truth or Consequences: HAZMAT response is referred to the emergency response officer for action. Volunteer fire fighters have some HAZMAT training. Some personal protective equipment and HAZMAT equipment are available for handling chlorine cylinders.
- Socorro: City fire fighters receive HAZMAT training. A roster of training status is kept in the city fire department office.
- Torrance: HAZMAT response is referred to the emergency response officer for action. In 1994, training on radiation and HAZMAT response is anticipated for county personnel. Some personnel have had radiological materials training from a federal facility.

Personal Protection of Citizens

In the event of especially hazardous situations, such as a toxic chemical cloud, the local responder incident commander or the emergency response officer may direct special protective actions for citizens. Decisions relating to the personal protection of the public, including protective actions to be followed during the incident by citizens, will be communicated through the notification means specified above.

If there is a potential for contamination of soil or water that can cause a chronic problem, the warning and notification may address actions related to water supply and sewage and garbage disposal.

In many cases, the emergency response officer may determine that the public is better served by staying put during an incident; this is called in-place sheltering. Staying outdoors may expose citizens to toxic clouds and increased risk of accidents from being transported away from the site of an incident. If indoor isolation is a preferable alternative, the EOP may specify certain procedures, such as closing windows or shutting off heating and air conditioning systems vent fans, fireplaces, and clothes dryer vents.
The EOPs also include information on evacuation as a course of action. Provisions for transporting citizens from residences, schools, hospitals, nursing homes, and other public facilities should be considered. Most emergency management offices consider school, public, and private buses to be the transportation resource. EOPs that were reviewed included provisions for in-place sheltering and evacuation, which followed the plans from state and federal sources.

EOP provisions for personal protection of citizens are summarized below.

- Doña Ana County/Las Cruces: In-place sheltering, evacuation procedures, and reception and care facilities are included in the EOP.
- El Paso: In-place sheltering, evacuation procedures, and reception and care facilities are included in the EOP. It was reported verbally that an MOU is in place with Doña Ana County, New Mexico, for evacuation resources.
- Lincoln: Provisions are included in the EOP.
- Ruidosa: Provisions are included in the EOP.
- Otero/Alamogordo: in-place sheltering, evacuation procedures, and reception and care facilities are included in the EOP.
- Sierra/Truth or Consequences: In-place sheltering, evacuation procedures, and reception and care facilities are included in the EOP. A trailer with supplies to support citizen evacuation is being contemplated.
- Socorro: Provisions are included in the EOP.
- Torrance: Provisions are included in the EOP.

Fire and Rescue

Fire services include both volunteer and paid fire departments. As expected, the larger cities typically have paid fire departments and a relatively greater resource base compared to smaller communities. The smaller towns and rural areas typically have volunteer fire departments, where even the fire chief may be a volunteer position.

EOPs specify the chain of command among fire fighters. Usually, the highest ranking fire officer is the incident commander until the emergency response officer (per New Mexico State Plan) arrives on the scene. The spirit of cooperation among fire departments during emergency situations was reported as good during the EOP review interviews.

Most fire departments, both paid and volunteer, reportedly receive HAZMAT training, although the relative percentage of trained fire fighters appeared to vary considerably among departments. Likewise, the amount of personal protective equipment for HAZMAT work varies greatly among the fire departments.

El Paso has some significant differences from the New Mexico communities. The El Paso fire department reports a fully functional HAZMAT response team. El Paso is a sizeable metropolitan area with numerous industries. It is separated by many kilometers (miles) from other significant state of Texas resources; therefore, the El Paso fire department and community have a high degree of self-sufficiency and a well-equipped and fully functional HAZMAT team.

Fire departments also typically have personnel trained as emergency medical technicians or paramedics who can provide lifesaving measures even before ambulances arrive on the scene. Some fire departments reportedly assisted emergency services ambulances in transporting injured persons. HAZMAT training also was reported for some ambulance and medical personnel.

Provisions in local plans follow.

- Doña Ana County/Las Cruces: Both paid and volunteer fire departments exist in the county. All are available on 24-hour dispatch and offer mutual assistance for incidents.
- El Paso: The El Paso fire department has over 600 personnel. Fire departments agree that units will travel to offer mutual aid for distances that are "out of distance." The El Paso fire department has assisted Fort Bliss with range fires.
- Lincoln: Standard provisions are in the EOP. The county is serviced by volunteer fire departments.
- Ruidoso: Mutual aid agreements were reported with volunteer fire departments. Mutual aid also involves fire departments from the Mescalero Apache Reservation.
- Otero/Alamogordo: Fire departments include a paid department in Alamogordo and 18 volunteer fire departments. Fire departments also are located at Holloman AFB and the Mescalero Apache Indian Reservation.
- Sierra/Truth or Consequences: Volunteer fire departments provide fire protection.
- Socorro: City fire fighters receive HAZMAT training. The New Mexico Fire Fighters Training Academy is located in Socorro.
- Torrance: The ranking fire officer serves as incident command. The state police emergency response officer is called to the scene to take charge.

Law Enforcement

Counties contain several law enforcement departments, including city and village police, county sheriff, and state police. The Plan and Procedures Manual from the New Mexico Hazardous Materials Emergency Response Program (New Mexico State Police 1990) gives authority to the New Mexico State Police Chief to designate an emergency response officer to serve as an on-scene coordinator for a HAZMAT emergency. Each New Mexico state police district designates one or more emergency response officers who are trained in HAZMAT emergency management. The local EOPs designate an on-scene incident commander, typically under control of the law enforcement agency normally responsible for the incident scene area, to serve before the emergency response officer arrives to assume authority.
Note that the emergency response officer serves the state of New Mexico. El Paso, Texas, provides the incident commander for that city and county.

EOP provisions follow.

- Doña Ana County/Las Cruces: In addition to city, town, and sheriff law enforcement officials, the county has the New Mexico State University Police Department. The incident command system is followed and is a training course available for response personnel.
- El Paso: Law enforcement tasks and responsibilities are included in the EOP.
- Lincoln: The incident command reportedly is dependent on the jurisdiction.
- Ruidoso: Standard provisions are in the EOP.
- Otero/Alamogordo: Several municipalities have law enforcement agencies. Also, law enforcement personnel in the county include the military (federal) police, county sheriff, Indian reservation police, and state police.
- Sierra/Truth or Consequences: Municipal police and county sheriff provide law enforcement services.
- Socorro: Law enforcement provisions in the EOP are subject to the upcoming revision.
- Torrance: Several towns have paid police departments. Otherwise, county sheriff and state police have responsibility.

Ongoing Incident Assessment

In the event of a HAZMAT incident, conditions must be monitored continuously to assess the release and impacts, both on- and off-site. Conditions to be assessed include size, concentration, and movement of leaks, spills, and releases. In the event of a toxic cloud, this may include air monitoring. These assessments are needed to make decisions necessary for response personnel safety, citizen protection (including in-place sheltering), evacuation areas (if any), food and water usage in the impacted area, and containment and cleanup actions.

Provisions in local plans follow.

- Doña Ana County/Las Cruces: Available resources for incident assessment include WSMR, NASA, the environmental division of the Doña Ana

County Health Department, the New Mexico Air Control Board, and the Federal Regional Response system.

- El Paso: The fire department has two air monitoring specialists. Equipment available includes colorimetric tubes and electronic toxic gas detectors. Photoionization instruments are planned future purchases. A special study (showing negative results) was conducted on turn-out gear used by responders at an asbestos incident.
- Lincoln: There are no direct capabilities. They are dependent on outside resources and the emergency response officer.
- Ruidoso: There are no direct capabilities. They are dependent on outside resources and the emergency response officer.
- Otero/Alamogordo: Capabilities include those with the HAZMAT team from Holloman AFB and the state environmental department. Fire fighters have some HAZMAT training, which aids in incident assessment.
- Sierra/Truth or Consequences: There are no direct capabilities. They are dependent on outside resources and the emergency response officer.
- Socorro: There are few direct capabilities by first responders. Assessment is highly dependent on outside resources and the emergency response officer. The local college (New Mexico Institute for Mining & Technology) and on-scene computer modeling were reported as resources.
- Torrance: There are no direct capabilities. They are dependent on outside resources and the emergency response officer.

Human Services

An incident may impact an area such that human services tasks become necessary. If evacuation is required, citizens may need assistance with heat, clothing, blankets, food, water, temporary housing, cleaning and repair, or moving and storage. Welfare and food stamps may be needed for citizens losing regular housing or employment because of the incident. Loans for businesses or ranches may be needed. Some persons may need counseling, particularly in the event of serious injuries or deaths.

Provisions in local plans follow.

- Doña Ana County/Las Cruces: Human services provisions are included in the EOP.
- El Paso: Red Cross, Salvation Army, United Way, Goodwill Industries, Southern Baptist Convention Disaster Relief, and local churches were mentioned as resources. The cohort of nonEnglish speaking persons will require bilingual interpreters during disaster relief.
- Lincoln: Human services provisions are included in the EOP.
- Ruidoso: A state human services office is located in Ruidoso.
- Otero/Alamogordo: Human services provisions are included in the EOP.

- Sierra/Truth or Consequences: Human services provisions are included in the EOP.
- Socorro: Human services provisions are included in the EOP.
- Torrance: Human services provisions are included in the EOP.

Public Works

Various public works personnel may have important tasks during and after an incident. Street and highway personnel may be called upon to clear debris from impacted areas. During and after the incident, traffic routes will need to be established and restored. Public works resources may be needed for building dikes and removal, transport, and disposal of solid and liquid contaminants. The EOPs typically rely on county and state highway departments for assistance and equipment.
Community sanitation must be maintained or reestablished as quickly as possible. Public water supplies may need quick action to prevent contamination, which may include discontinuing water service for a period of time. Follow-up action may include restarting a water supply facility in a manner that provides uncontaminated water, which may involve flushing lines prior to consumption. The National Guard may be called upon to provide tanker trucks with potable water.

Likewise, a HAZMAT spill into a sewage treatment may call for a rapid discontinuation of sewage to prevent chemical contamination of a waterway. Garbage pickup and landfilling may be discontinued temporarily. Interim disposal can be problematic from the standpoint of public health.

Provisions in local plans follow.

- Doña Ana County/Las Cruces: Public works resources are included in the EOP.
- El Paso: Provision of portable toilets has been a recognized activity from past experiences.
- Lincoln: Public works resources are included in the EOP.
- Ruidoso: The Ruidoso Street and Water Department provides support.
- Otero/Alamogordo: Public works resources are included in the EOP.
- Sierra/Truth or Consequences: Public works resources are included in the EOP. City and county road departments are available.
- Socorro: Public works resources are included in the EOP.
- Torrance: Public works resources are included in the EOP.

Other Planning Elements

Other elements may be induded in a multihazard EOP. In particular, EOPs reviewed for this project typically include procedures to be followed in the event of a nuclear attack. Discussion in the EOPs show that this geographical area is a "high-risk area subject to blast overpressures greater than 2 pounds per square inch" due to WSMR being identified in the Nuclear Attack Planning Base (NAPB-90). El Paso also is included in the high-risk area.

Some other noteworthy aspects of the EOPs follow.

- Doña Ana County/Las Cruces: The Doña Ana County/city of Las Cruces emergency management program has been recognized for its organizational, planning, and functional excellence. It is considered a model program by other communities in the region. In 1990, Doña Ana County/Las Cruces received a Special Achievement Award from the EPA. The Doña Ana County/Las Cruces program also has received a Best Emergency Management Program award from the state of New Mexico.

- El Paso: El Paso is in an unusual situation because it is close to an international boundary. The El Paso Emergency Management Coordinator has established a working relationship with the Juarez Emergency Coordinator. This communication is important as both El Paso and Juarez are sizeable metropolitan areas with significant industries handling toxic chemicals. For example, there is a hydrofluoric acid plant in Juarez that ships railcars through Texas.

- Lincoln/Ruidoso: The town reports a working relationship with emergency services from the Mescalero Apache Indian Reservation.

- Otero/Alamogordo: A good working relationship with Holloman AFB adds greatly to the available community resources for responding to a HAZMAT incident or other disaster.

- Sierra/Truth or Consequences: Actual experiences with a natural gas pipeline leak and a serious theater fire in the downtown area, which caused responder consideration for evacuation of a sizeable housing facility, have offered real-life experiences to emergency planners for future planning and conduct of operations within the community during major emergencies.

- Socorro: The local resources are enhanced by two local facilities – the New Mexico Institute for Mining and Technology, and the New Mexico Fire Fighters Training Academy. A section on radiological incidents was added to the EOP in September 1990.

- Torrance: Being a small county, resources are limited. The Emergency Coordinator also serves as County Fire Marshall, although the job will probably become separated in 1994. Industrial facilities are extremely limited. Material Safety Data Sheets and EPA Tier I and Tier II reports go to the Emergency Coordinator and are primarily for service stations, telephone company battery acid, and gas and oil pipeline companies.

Containment and Cleanup

For a hazardous chemical spill, local responders will emphasize protection of life and property. Initially, this will typically involve containment and stabilization, which may include earthen dikes or berms, oil absorbents, and sand or straw bale barriers. The degree of response for initial containment is dependent on resources and proper training of local responders, typically fire fighters. State agencies, as coordinated by the New Mexico State Police emergency response officer, focus on additional measures and resources for containment and actual cleanup of spills. Cleanup costs and responsibility typically will be assessed upon the responsible party causing the incident. The cleanup can be conducted by the responsible party or by specialists designated by the emergency response officer, with costs being charged back to the responsible party. When no responsible party is identifiable, costs come from public funds.

The standard action in New Mexico EOPs for a HAZMAT incident is to call the New Mexico State Police for an emergency response officer. This ensures additional support and availability of HAZMAT response equipment coordinated through the emergency response officer. Additionally, the EOP typically contains information on availability of heavy equipment and sources for HAZMAT support, such as the State Highway Department. Techniques for spill containment and cleanup may be simple, such as using a shovel to form a dike around a spill or using sandbags around a manhole to prevent chemical flow into a sewer system. Special oil-absorbent material may be readily available to spread on a gasoline or oil spill. These simple techniques may be used by local responders.

Specially trained HAZMAT teams from the private or public sector may be called in by the emergency response officer or the responsible party to support first responders. The teams are trained and equipped to use additional, more sophisticated techniques to contain a spill such as plugging a leaking chlorine cylinder. HAZMAT teams are available from various state and federal government groups, railroads, and private contractors.

Provisions in local plans follow.

- Doña Ana County/Las Cruces: Planners include railroad HAZMAT teams as cleanup resources on railway right-of-ways. The Doña Ana County Health Department, in conjunction with the state police, takes an important role in site restoration.
- El Paso: The fire department HAZMAT team performs containment and neutralization. Drum overpaks and vacuum trucks may be used by the HAZMAT team. The responsible party is responsible for final cleanup.
- Lincoln: They are dependent on the emergency response officer and outside resources.
- Ruidoso: They are dependent on the emergency response officer and outside resources.
- Otero/Alamogordo: A good working relationship with Holloman AFB adds greatly to the available community resources for responding to a HAZMAT incident. The Alamogordo fire department has some special disposable clothing (personal protective equipment) for HAZMAT response.
- Sierra/Truth or Consequences: Some limited resources are available, including sandbags, absorbent material, and chlorine cylinder response equipment.
- Socorro: Kirtland AFB in Albuquerque was reported as a resource for HAZMAT incidents. This is believed to be a resource initiated by the emergency response officer.
- Torrance: They are dependent on the emergency response officer and outside resources.

Testing and Updating the EOP

FEMA requires periodic testing of the EOP. This is accomplished through tabletop, functional, and full-scale exercises. Exercises that have been performed in the last several years include a simulated plane crash in the mountains west of Alamogordo (with high school drama students acting the parts of injured victims) and a space shuttle crash with an associated plutonium spill on WSMR. This latter exercise included close cooperation with Holloman AFB. Local emergency planning agencies participated and coordinated responses during these exercises. All parties reported that this was a valuable experience resulting in a better understanding and implementation of the EOPs. As expected, modifications are made in EOPs to improve the plans after the exercises. The EOPs are dynamic documents and are updated periodically to reflect new or changing conditions in the local area.

Provisions in local plans follow.

- Doña Ana County/Las Cruces: Regular tabletop, functional, or field simulation exercises are conducted.
- El Paso: A full-scale exercise was conducted in 1992 involving a simulated refinery fire and over 300 personnel. A simulated aircraft accident exercise was conducted in 1993 with over 400 personnel involved.
- Lincoln: Periodic exercises are conducted.
- Ruidoso: Periodic exercises are conducted, specifically for the city.
- Otero/Alamogordo: An exercise was held where local and Holloman AFB responders were involved in a simulated aircraft crash in the mountains. Local high school drama students acted the parts of victims.
- Sierra/Truth or Consequences: Periodic exercises are conducted. In addition, two actual incidents have occurred-a natural gas pipeline break and a tire at a movie theater-that enabled an evaluation of response resources and procedures.
- Socorro: Periodic exercises are conducted. An exercise in 1989 simulating a space shuttle crash using planners from Socorro, the Stallion facility, and other surrounding counties.
- Torrance: Emergency planning has been tested in exercises and actual incidents. Several years ago, a 137-cm (54-inch) snowfall resulted in declaration as a disaster area. Monies were obtained from disaster relief agencies to repair seriously damaged gravel roads. In a second incident in February 1993, a truck carrying radioactive material crashed in the east lane of Interstate Highway 40 and closed the highway for 26 hours. The emergency response officer worked on the scene with county personnel and the responsible party HAZMAT crew came from Dallas to clean up the site.

3.15.2 WSMR Site Health and Safety

This section discusses the major facilities and sites on WSMR. The range is large, approximately 8,288 km- (3,200 mi^2). Hence, the individual facilities may be separated by many kilometers (miles) from one another and from various support facilities. Each WSMR facility has organizations and processes in place designed to reduce the possibility of a serious incident from occurring. Various programs also are in place that are designed to aid personnel in understanding and responding to HAZMAT incidents. This includes provisions for transporting and treating injured personnel. An overview of the health and safety procedures and programs at the WSMR facilities is presented below.

3.15.2.1 Nuclear Effects Directorate Large Blast/Thermal Simulator Site. The LBTS is a facility new to WSMR located in the northern part of the range. The facility was designed to simulate nuclear blasts of several magnitudes. These simulations are used to evaluate the survivability of military equipment and systems. Final construction of the LBTS will be complete in early 1994. NED runs the facility, and the operations and maintenance facility operator is Lockheed. A small staff of 30 government and contractor personnel will operate the facility.

Applicable Safety Operating Procedures

SOPs are currently in the process of being written for the LBTS. A draft system safety program plan describes the tasks and activities of system safety management and system safety engineering to identify, evaluate, and eliminate or control hazards. Each of the subsystems will have an SOP, which will conform with AMC-R 700-107, Preparation of SOP for Ammunition Operations With TECOM Supplement and WSMR-R-385-18, Command Safety Program. SOPs for the LBTS will be completed by spring of 1994.

Health and Safety Programs

Training programs for employees are currently being written. Employees will be trained in HAZMAT spill response procedures, hazard communication, including Material Safety Data Sheet usage, and confined space entry.

Emergency Response/Evacuation Plans

In the event of an emergency, the Stallion fire department will be the first responders for the LBTS. The Stallion fire department is located approximately 6.4 km (4 mi) from the LBTS facility. Injured LBTS personnel will be transported via the Stallion ambulance to the Socorro Memorial Hospital. An LBTS facility disaster control plan has not yet been written; however, a draft is due by the summer of 1994 (MIlls, pers. com. 1993).

3.15.2.2 High Energy Laser System Test Facility. The HELSTF has extensive plans and procedures to handle an emergency. HELSTF has been operation since 1980 and is operated by the U.S. Army Space and Strategic Defense Command (USASSDC, formerly the USASDC). HELSTF currently has approximately 250 employees. Other groups at HELSTF include the U.S. Army, U.S. Navy, Hughes Aircraft, TRW, Massachusetts Institute of Technology, Rockwell, Wally J. Schaffer Co., and AFA (Brown, pers. com. 1994). AFA Aerotherm Corporation is the largest contractor with 150 employees.

The testing schedule has fluctuated over the years. During periods of heavy testing, a full health, safety, and environmental staff existed. This staffing included a fire department and a nurses aid station. The current test schedule does not require a staffed fire department. Fire protection of the site is provided by a WSMR fire station with an approximate 20- to 30-minute response time. The nurses aid station is staffed by a full-time nurse and an emergency medical technician during normal working hours, during high energy laser testing, and during hazardous fluid transfers (fluorine). In the event of an emergency, prior arrangements have been set up with Holloman AFB Hospital, the WSMR McAfee Clinic, and the Las Cruces

Memorial Hospital to accept and communicate with the HELSTF ambulance (Campbell, pers. com. 1994). A full-time Safety Officer also is on site to oversee hazardous fluid transfers and laser testing.

Applicable Safety Operating Procedures

Over the years, HELSTF has developed extensive SOPs to cover all laser operations and hazardous fluid transfers. The SOPs are updated annually.

Health and Safety Programs

The HELSTF Safety Office trains site employees on the hazardous chemicals kept at the site (hazard communications), confined space entry, and HAZMAT spill response in case of an emergency. The Safety Office also maintains the Material Safety Data Sheet files for the site. The Material Safety Data Sheets are available for employees to review at any time. Hazardous chemicals maintained at HELSTF are monitored 365 days a year, 24 hours a day, by a site surveillance team as well as a highly sophisticated Hazardous Atmospheric Monitoring System. In the event of an emergency, site surveillance personnel follow written procedures to alert appropriate personnel and to correct the emergency situation. Emergency procedures are updated annually (Paterson, pers. com. 1993).

Emergency Response/Evacuation Plans

The HELSTF Facility Disaster Control Plan was last updated December 23, 1993. The plan presents potential accident or emergency conditions that could occur at HELSTF and the procedures to be followed in the event of such an occurrence. The primary considerations in dealing with accident or emergency conditions are presented in the Disaster Control Document. Individuals responsible for handling an emergency situation, including an emergency that could affect the public, also are described in the Disaster Control Plan.

3.15.2.3 Temperature Test Facility. The Temperature Test facility is located 4 km (2.5 mi) from the Main Post east on Nike Avenue. The Material Test Directorate operates and runs the Temperature Test facility, which has six full-time government employees. The facility has three test chambers that are used for extreme temperature testing and can produce a wide range of weather simulations including jungle heat and humidity, dry desert, fog, arctic cold, and salt-saturated atmospheres. In 1992, the Temperature Test facility eliminated the use of methylene chloride as a heat transfer agent, which significantly reduced the potential for hazardous waste occupational risk to employees. The facility now uses Syltherm® fluid as the primary heat transfer fluid. Syltherm® has significantly lower environmental and workplace hazards associated with it than methylene chloride.

Applicable Safety Operating Procedures

SOPs address testing in the three test chambers in addition to testing of live rounds and other test articles at the Temperature Test facility.

Health and Safety Programs

The Temperature Test facility Safety Officer trains employees on the hazardous chemicals kept at the site (hazard communication), confined space entry, and HAZMAT spill response. Personnel at the Temperature Test facility are trained in the use of self-contained breathing apparatus for work inside the test chambers. Temperature Test facility personnel also are trained in the use of oxygen deficiency and lower explosion limit detector meters to check Temperature Test facility chamber conditions. A sophisticated fire protection system that uses ultraviolet detection has been installed.

Emergency Response/Evacuation Plans

In the event that outside emergency help is needed, the Temperature Test facility would call the WSMR McAfee Clinic located 4 km (2.5 mi) west of the facility. Emergency plans are updated for the facility every two years.

3.15.2.4 NASA Safety and Staff. NASA and the WSTF site support contractor have personnel responsible for health and safety procedures, as well as dissemination, implementation, and revision of the procedures. A safety manager responsible for security and emergency services, three safety engineers, and an industrial hygienist are employed by the site support contractor. WSTF also has an industrial hygienist (NASA 1993a). NASA research rockets are also under the control of NASA at WSTF.

Health and Safety Programs

Documents that call out the site health and safety requirements and determine site procedures include the *NASA Safety Policy and Requirements Document* and the *Johnson Space Center Safety Manual* and local WSTF management instructions. These manuals contain provisions for training and certification, and address issues such as safety committee meetings.

The sites support contractor's certification plan is required to make provisions for certification, which is required for personnel directing or performing certain tasks at WSTF. Such tasks are considered critical because human error in these areas could result in injury to personnel, damage to the environment, legal liability to WSTF, equipment damage, or irretrievable loss of test data. The certification plan outlines operations requiring certification for such operations as propulsion testing, laboratories, emergency services, special processes, special equipment/systems, environmental regulations/compliance, and hazardous materials and dangerous goods transportation.

Emergency Response/Evacuation Plans

NASA safety and other documents such as the WSTF chemical release plan address emergency response issues.

Fire Protection

WSTF maintains its readiness to detect and respond to fire emergencies with an on-site contractor-operated fire department, an automatic fire alarm system, and fire suppression systems. The fire department also trains personnel in the use of fire extinguishers and how to respond to a fire.

The WSTF fire department is equipped with three pumper units, two 63 L/s (1000 gal/min) pumpers (one of which is specially outfitted for rescue), one 47 L/s (750 gal/min) pumper, two ambulances, and one patrol vehicle. The quarters in the Emergency Center, Building 104 include alarm rooms, a classroom, kitchen, offices, sleeping quarters, and three bays for equipment.

The department operates 24 hours a day with sufficient manpower to respond to a one-alarm fire. In the event of greater emergency, 20 auxiliary firemen from on-site contractor personnel will provide assistance. If necessary WSMR will respond with additional firemen and equipment through an agreement with the WSMR Fire Department located 32 km (20 mi) from WSTF.

Involvement in Future Programs

NASA Safety currently has plans to combine the NASA, JSC, and WSTF safety manuals into a single document (NASA 1993a).

3.15.2.5 Navy Launch Complexes. The U.S. Navy has 65 military staff and 85 civilians stationed at WSMR. The U.S. Navy at WSMR launches commercial, NASA, U.S. Army, and U.S. Air Force missiles from its six launch complexes located approximately 16 km (10 mi) east on Nike Avenue. The U.S. Navy prepares and launches 50 to 60 major missile systems and tests another 200 smaller missions per year at WSMR. In addition to the launch complexes on Nike, the U.S. Navy also conducts firing missions (missiles, targets, gun firings) from WC-50, Sulf site, Pony site, BAM, SQUIRT, and RENT sites. At each of the six launch complexes, there is at least one block house to protect essential personnel and visitors at the time of missile firing. Navy Safety is responsible for missile preparation and assembly before launch and site safety at the launch pad. WSMR Missile Flight Safety makes decisions regarding areas of WSMR to be evacuated for each mission and regarding in-flight missile termination in the event of missile failure. Most of the missiles fired from WSMR use solid propellant and require little special equipment; however, in the last three years the U.S. Navy has built a new liquid propellant handling facility.

Applicable Safety Operating Procedures

The U.S. Navy has written and maintains SOPs for U.S. Navy operations. Most U.S. Navy SOPs are handled internally. U.S. Navy SOPs cover the launch complexes and normal maintenance procedures for the U.S. Navy facilities at WSMR.

Health and Safety Programs

The U.S. Navy trains their personnel in hazard communications and Material Safety Data Sheets, confined space entry, and hazardous materials handling. Material Safety Data Sheets are available to employees to review at any time. U.S. Navy personnel are in a medical surveillance program to ensure fitness for work

Emergency Response/Evacuation Plans

The U.S. Navy has written emergency disaster plans and evacuation plans to be implemented in an emergency. In the unlikely event of a catastrophic missile failure in which the missile lands outside the WSMR boundary, the incident would be handled by the WSMR Emergency Control Center. The U.S. Navy would render technical advice to the center. HAZMAT spills would be handled by the WSMR HAZMAT Response Team headed by the WSMR fire department. An accident at the U.S. Navy launch pads would be handled by the WSMR fire department and WSMR McAfee Clinic. If the accident occurs uprange (near Stallion), injured personnel would be evacuated to either Socorro Memorial Hospital or the Holloman AFB Hospital depending on which hospital is closer to the accident.

3.15.2.6 Aerial Cable. Aerial Cable, located in the northern part of the range, is a facility new to WSMR. Construction of the Aerial Cable site was completed in 1994. The National Range runs the facility, and Lockheed Engineering & Sciences Company is the operations and maintenance contractor. A staff of 20 government and contractor personnel will operate the facility.

Applicable Safety Operating Procedures

SOPs have been completed for the Aerial Cable facility. A system safety program plan describes the tasks and activities of system safety management and system safety engineering to identify, evaluate, and eliminate or control hazards. Each subsystem has applicable SOPs, which conform with AMC-R 700-107, Preparation of SOP for ammunition operations and WSMR-R-385-18, Command Safety Program.

Health and Safety Programs

Training programs for employees are currently being written. Employees will be trained in hazard communication and Material Safety Data Sheet usage, confined space entry, and HAZMAT spill response procedures.

Emergency Response/Evacuation Plans

In the event of an emergency, the Stallion fire department will be the first responders for the Aerial Cable site. The Stallion fire department is located approximately 42 km (26 mi) from the Aerial Cable Facility. Injured Aerial Cable personnel will be transported via the Stallion ambulance to the Socorro Memorial Hospital. If needed, injured personnel will be air evacuated to Holloman AFB Hospital. An Aerial Cable facility disaster control plan has not yet been written, but a draft is due by the summer of 1994 (Hoffman, pers. com. 1994).

3.15.2.7 Ground Electro-optical Deep Space Surveillance. The U.S. Air Force operates the GEODESS, which is located in the northern part of the range and is a tenant organization on WSMR. The site is staffed by 23 personnel who operate multiple telescopes and other instrumentation on the site.

Applicable Safety Operating Procedures

The GEODESS site uses the US. Air Force Safety, Occupational Health, and Industrial Hygiene program as a model for the site. The site maintains extensive safety programs. The Safety, Occupational Health, and Industrial Hygiene documents are updated yearly by the site contractor, PRC, and the site is inspected yearly by the US. Air Force.

Health and Safety Programs

PRC trains their personnel in hazard communications and Material Safety Data Sheet usage, confined space entry, and hazardous materials handling. Material Safety Data Sheets are available to employees for review at any time. PRC personnel are in a medical surveillance program to ensure fitness for work Employees are trained in CPR (cardio-pulmonary resuscitation) and first aid. A weekly safety meeting is conducted, and documentation on training topics and attendees is maintained by the site Safety Officer.

Emergency Response/Evacuation Plans

In the event of an emergency, the Stallion fire department will be the first responders for the GEODESS site. The Stallion fire department is located approximately 1.6 km (1 mi) from the site. Injured GEODESS personnel will be transported via the Stallion ambulance to Socorro Memorial Hospital. A GEODESS facility disaster control plan has been submitted to the WSMR Emergency Control Center at the Main Post.

3.15.3 WSMR Health and Safety Resources

The primary focus of this section is to discuss the facilities available within the base having resources and procedures that provide health and safety services to the major WSMR sites identified in the preceding section. The WSMR health and safety resources include missile flight safety, the WSMR Emergency Control Center, the WSMR Main fire department, the Stallion fire department, WSMR McAfee Clinic, and the WSMR Ground Safety Office. The responsibility that each of these resources has for health and safety support to the major sites is discussed below.

3.15.3.1 Missile Flight Safety. Missile Flight Safety is part of the National Range Directorate. Missile Flight is staffed with 11 employees, 5 of whom are authorized and qualified to terminate a missile in flight. A Missile Flight Safety Officer acting during a real-time missile flight test works under the direct authority of the Commanding General and does not answer to anyone but the Commanding General. Missile Flight Safety priorities are to protect the general public, range personnel, and expensive equipment, in that order. The object is to ensure that the public is not exposed to risks greater than those normally experienced during the conduct of normal daily life.

Extensive planning, risk analysis, missile and target subsystems checkout, and flight simulation are practiced before each mission. In the unlikely event of a missile flight malfunction, the Missile Flight Safety Officer has authority to terminate the flight. The Flight Safety Office at WSMR uses many different tracking methods to monitor missile flight tests. These methods include multiple radar, optical, and telemetry systems. Redundant computer systems are used to process tracking information and to predict the instantaneous impact position of the missile during flight. The Flight Safety Officer uses the instantaneous impact position to choose the best place to terminate the missile flight.

Applicable Standing Operating Procedures

The Missile Flight Safety Office has extensive Standing Operating Procedures (SOPs) and has refined safety procedures over the last 45 years. Missile Flight Safety oversees the testing of 60 to 80 large missiles and up to 400 smaller test missiles each year. Each new program is accompanied by a thorough safety review, a risk analysis, and preparation of SOPs. The documentation is reviewed by the individual project directors and by Missile Flight Safety. Missile firings cannot be scheduled or conducted without the final approval of the Missile Flight Safety Office at WSMR. Missile failures are investigated by the Missile Flight Safety Office and subsequent testing cannot continue until satisfactory corrective action is taken. The Commander's WSMR Flight Safety program is strictly enforced in keeping with U.S. Army instructions and the policies and procedures established in WSMR Regulations.

Health and Safety Programs

Missile Flight Safety trains their personnel in hazard communications, Material Safety Data Sheet use, and hazardous materials handling. Material Safety Data Sheets are available to employees for review at any time. Missile Flight Safety personnel are in a medical surveillance program to ensure fitness for work.

Emergency Response/Evacuation Plans

WSMR Missile Flight Safety personnel decide what areas of the range will be evacuated and which roads will be blocked for each mission. The information is posted and published so that range personnel can plan for any inconveniences caused by missile testing. The public also is notified of scheduled roadblocks through public announcements (e.g., commercial radio). Roadblocks normally last less than one hour. If the WSMR extended area is required to be evacuated, ranchers are sent written notices a week in advance to plan for the evacuation. Roadblocks and evacuated areas are enforced by the military police.

3.15.3.2 WSMR Emergency Control Center. The Emergency Control Center is located in the basement of building 100 (headquarters) and the staff functions directly under the Commanding General. The Emergency Control Center staff maintains control room equipment and prepares disaster control plans for WSMR. The Emergency Control Center has disaster control plans for all of the major WSMR facilities. In the event of a disaster at WSMR, the Emergency Control Center would be activated. A representative from each cognizant organization would be sent to the Emergency Control Center to help coordinate the disaster. An active Emergency Control Center would normally consist of environmental, missile flight safety, fire department, public affairs, Judge Advocate General, and relevant project personnel. The Commanding General has the final decision on all Emergency Control Center actions.

Applicable Standing Operating Procedures

The Emergency Control Center has numerous SOPs that are to be used in the event of an emergency. The Emergency Control Center reviews project facility disaster control plans to ensure completeness in case the plans have to be implemented.

Health and Safety Programs

The Emergency Control Center continuously trains and drills its members so that it will be prepared if an emergency occurs. The Emergency Control Center has a current HAZMAT inventory of the WSMR facilities.

Emergency Response/Evacuation Plans

Emergency response plans have been written for scenarios that could occur on WSMR. The Emergency Control Center would coordinate any public evacuations with the local authorities. The Emergency Control Center has agreements with Socorro Memorial Hospital, Holloman AFB Hospital, and WSMR McAfee Clinic to accept injured personnel if necessary. The Emergency Control Center maintains an up-to-date contact list of project and facility personnel, hospital contacts, and WSMR key staff that could be called upon during an emergency.

Future Programs

The Emergency Control Center will plan and institute drills with the public emergency team members as a continuing effort to support the community.

3.15.3.3 WSMR Main Fire Department. The *White Sands Missile Range Disaster Control Plan* lists parties to be contacted by Emergency Control Center personnel. For both duty and nonduty hours, the fire department is part of the Installation Response Team. The installation Response Team is capable of performing cleanup efforts at the scene of an oil or hazardous substance discharge on or near WSMR. The equipment for the installation Response Team is located at Environment-Safety and consists of the following: one 3/4-ton truck, one grader, one D-8 dozer, two centrifugal pumps, two 3,785-L-tanks (1,000-gal-tank) trucks, 25 bales of straw (absorbent), one vacuum truck, 10 shovels and rakes, and one 5-cubic-yard dump truck (Vallez, pers. com. 1994).

The fire department has SOPs in place for handling special hazard situations, such as fuel spills or fire fighting operations in Symbol 1 buildings (Symbol 1 is a category of explosive described in DAPAM 385-64).

Fire department personnel have undergone extensive training to handle special hazard situations. Course titles include Hazardous Materials Response for First Responders, Hazardous Waste Workers Course (40 hour), Radiation Monitoring, and Ammunition Explosive Certification Training. The fire department has access to additional sources for hazardous materials information, including the Cameo HAZMAT Information Data Base, CHRIS HAZMAT Manual, Hazardous Materials Guide for Fire Protection, and the Occupational Safety & Health Guide for Hazardous Waste (Vallez, pers. com. 1994). The fire department also operates the HAZMAT bus to respond to emergency situations involving hazardous materials. The HAZMAT bus is used to respond to HAZMAT spills and leaks. Beyond the protective gear for personnel, the bus contains absorbent materials and a 284 L (75-gal) decontamination pump system.

3.15.3.4 Stallion Fire Station. The Stallion fire station (Station 3) is responsible for fire protection in the range north of Rhodes Canyon. A total of six employees per shift with a minimum of four per shift work around the clock, 365 days a year. The Stallion fire department is equipped with two brush tanker trucks, a rescue ambulance, a structural truck, and two first responder vehicles. Station 3 provides support for the uprange programs to include the LBTS, Aerial Cable, PHETS, BAT, Sulf site, North Oscura Peak, and Rhodes Canyon. The fire department provides site support at project sites during testing periods. If an accident or a fire were to occur, the fire department is on hand to respond. Each fire fighter at Station 3 is a trained emergency medical technician.

Station 3 conducts semiannual building inspections to ensure fire safety compliance at the project sites. Station 3 also responds to the numerous brush fires that occur from natural causes on the north range. HAZMAT spills are handled by the Main Post HAZMAT response team. Travel time for the HAZMAT team takes as long as two hours depending upon the location of the spill. The Stallion fire department would contain the spill until help could arrive.

Applicable Standing Operating Procedures

The fire department maintains and updates SOPs for Station 3 operations.

Health and Safety Programs

The fire department trains their personnel in hazard communications and Material Safety Data Sheet usage, confined space entry, and hazardous materials handling. Material Safety Data Sheets for each project are available for fire fighters to review at any time. Fire fighters are in a medical surveillance program to ensure fitness for work.

Emergency Response/Evacuation Plans

Station 3 has written emergency plans in the event of an accident in the north range area. Station 3 will respond with an ambulance to any project that requires assistance. Station 3 has a verbal agreement with the Socorro Memorial Hospital, which will accept injured range personnel in the event of an accident. Station 3 phones the Socorro Memorial Hospital ahead of time to alert them to an incoming patient. At that time, the Socorro Memorial Hospital dispatches an ambulance to meet the Station 3 ambulance half way and transfer the patient. To date, the Station 3 ambulance and the Socorro ambulance do not have direct radio communication between the two units. The Holloman AFB Hospital is used if an air evacuation is required. Verbal agreements between WSMR and Holloman AFB have been made so that a WSMR patient will be accepted into the Holloman AFB Hospital.

3.15.3.5 WSMR McAfee Clinic. WSMR McAfee Clinic has an outpatient treatment room whose primary purpose is to stabilize and transport patients to another urgent care facility such as Fort Bliss Hospital or Holloman AFB Hospital. The WSMR Radiation Protection Division and Industrial Hygiene Office are located at WSMR McAfee Clinic.

Applicable Standing Operating Procedures

WSMR McAfee Clinic has written and maintains SOPs for U.S. Army operations. The Safety Office reviews and maintains the SOPs at a central location in building 124 on the Main Post.

Health and Safety Programs

An extensive education and training program is in place at WSMR McAfee Clinic, which is the primary location on WSMR for the distribution of health information. The hospital also arranges blood drives on WSMR. Active duty personnel receive medical examinations and medication at the clinic. First aid and CPR training in conjunction with the Red Cross also are available through WSMR McAfee Clinic. The hospital has a Safety Office that maintains the hospital HAZMAT inventory and hazard communication training records.

Emergency Response/Evacuation Plans

In the event of a disaster at WSMR, a McAfee representative would be sent to the Emergency Control Center building 100. Upon instruction from the Emergency Control Center, an ambulance team would be sent to the incident site. The ambulance is equipped with a radio and keeps in constant contact with WSMR McAfee Clinic. The hospital ambulance team would report to the on-scene commander for instruction. WSMR McAfee Clinic has a MediVac helicopter pad to receive patients transported by air.

WSMR McAfee Clinic is in the process of developing plans to work more closely with the Emergency Control Center to identity the different hazards that are on WSMR. This process enables hospital staff to be better prepared to handle emergencies. At present, WSMR McAfee Clinic can support projects with an ambulance, nurse, and two medics. WSMR McAfee Clinic also has two U.S. Army doctors on staff who can provide assistance.

3.15.3.6 WSMR Ground Safety Directorate. The WSMR Environmental and Safety Directorate, Safety Division has Standard Occupational and Safety and Health inspections of all Army facilities annually. Hazardous operating areas are inspected as required. During each of these inspections, the Hazardous Materials Inventory list is spot-checked to ensure that Material Safety Data Sheets are in place for each hazardous material listed. An annual wall-to-wall inventory is accomplished with one copy of the inventory sent to the safety division were it is maintained. A copy of the inventory is included in WSMR 385-18 per OSHA requirements.

WSMR Safety Division personnel attend mandatory certification training annually. The Safety Division personnel conduct monthly HAZCOM training to WSMR Personnel. Asbestos CPR training is also provided on an as-needed basis. CPR training is also available and provided by the Safety Division certified CPR instructor.

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CHAPTER FOUR
ENVIRONMENTAL CONSEQUENCES

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ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential environmental consequences of the proposed action and the no action alternative prior to implementation of mitigation measures. The analysis is organized into the same 15 resource categories described in Chapter 3, Affected Environment. The intent is to provide the reader with a general understanding of the kinds of environmental impacts associated with activities at White Sands Missile Range (WSMR). By identifying the major issues of concern in the various categories of activities, the preparation of future environmental documents tiered to this Environmental Impact Statement (EIS) will be expedited. The project-specific impact discussions are examples rather than an exhaustive list. This analysis examines potential cumulative impacts, generic mitigation measures, and relationships between short-term and long-term productivity of the site. Implementation of the mitigation measures identified for adoption in the proposed action would reduce, mitigate, or eliminate the adverse impacts identified for the no action altemaitve and any proportionally greater impacts anticipated or identified as part of mission changes.

This section describes the potential impacts on geology and soils at WSMR from implementation of the proposed action and the no action alternative. Current WSMR activities, past WSMR activities, and resulting environmental consequences were used to assess potential future consequences.

4.1.1 Proposed Action

Geology and soils only slightly affect the orientation, construction, or operation of facilities at WSMR. Recovery operations, construction operations, and missile impacts associated with test programs may cause soil compaction or erosion, as described below.

4.1.1.1 Recovery Operations. Recovery operations may involve off-road travel to locate and remove debris. Increased soil compaction and defoliation would occur as a result of off-road travel using wheeled and tracked vehicles, with the greatest soil impacts caused by tracked vehicles. WSMR personnel experienced in recovery operations report that most soil disturbances are caused by recovery operations rather than debris impacts (Postlewait, pers. com. 1991). The amount of off-road travel depends on the phase of research and development, and the ability to locate the munition or debris. When a munition system is being researched and developed, all components must be recovered. This requires large search teams, which create more disturbance than small teams used outside the research and development phase.

Several factors influence soil compaction, including soil moisture content, the type and speed of traffic, and soil texture. Variation in "compactibility" exhibits three stages of compaction resistance with increasing moisture content: (1) the soil becomes more resistant to compaction as the moisture content increases from dry to a low value; (2) as the moisture content increases further, the soil becomes less resistant to compaction until an intermediate ("optimum") moisture content is reached for maximum compaction; and (3) the resistance to compaction increases as the moisture content increases above the optimum. These factors are characteristic for soils excluding pure clays and sands (Webb and Wilshire 1983).

The second factor affecting soil compaction is the number of vehicle passes. The greatest soil compaction and related soils property changes would occur during the first few passes from vehicles or other transients. Another factor affecting soil compaction is the weight of the vehicle. Lighter vehicles would cause less compaction than heavy vehicles. Foot traffic would cause the least amount of soil compaction (Webb and Wilshire 1983).

Soil texture is the major factor determining the magnitude of compaction under applied loads. Soils composed of equal-size particles, such as sands or clays, will not compact as much as soils composed of different-sized particles (Webb and Wilshire 1983). It has been determined empirically that the maximum compaction occurs when the sand component is 80 percent and the soil is a loamy sand. Soil mixtures with more sand or more clay do not compact as much. Soils that compact the most are composed of many different-sized soil particles (Webb and Wilshire 1983).

The main factor affecting wind and water erosion is the density of the vegetation cover. Vegetation acts as a wind block and roots hold soils together during rain events. Increased soil erosion could result from devegetation of areas during off-road operations. Repeated off-road travel by wheeled or tracked vehicles would decrease the vegetation density, increasing the severity of soil erosion. Once the vegetation is removed from an area or from a route into a recovery area, the same route should be used in order to minimize damage throughout the area. The greatest damage to vegetation would result from tracked vehicles and the least amount of damage would result from foot traffic.

Erosion problems also occur as a result of soil compaction. Numerous investigations have reported increased rain runoff and severe erosion problems in soil compacted by vehicles (Webb and Wilshire 1983). The most important contributor to increased erosion is the decreased infiltration rate of rain in soils, which is caused by compaction on vehicle trails (Webb and Wilshire 1983). As the soil becomes more compact, the infiltration rate decreases, causing increased runoff during rain events. This increased runoff then leads to increased erosion. The eroded soil can cover vegetation that was not initially disturbed by vehicles. Once the vegetation is covered, it dies, increasing erosion by additional devegetation of the area.

4.1.1.2 Construction Operations. Construction operations include new buildings, roads, aircraft landing areas, and construction on old sites where existing buildings have been removed. The greatest soil disturbances would occur during the construction of facilities in previously undisturbed areas. Soil compaction from construction vehicles, worker parking, and roads used to gain site access would result in soil compaction. Devegetation of the area resulting from construction activities also would occur. Construction of buildings, roads, and aircraft facilities would require associated drainage controls. This would include the construction of small drainage ditches and large man-made arroyos to handle the greater flow of water. Cyclonic effects by permanent structures would need to be addressed with landscaping or building design. Construction on existing disturbed areas would not cause new soil disturbances unless facilities were expanded beyond the footprint of the former facility. All land-disturbing construction activities can potentially damage or destroy cultural resources. Indirect impacts can also occur. For example, runoff water channeled by culverts can cut into cultural deposits.

4.1.1.3 Effects of Missile Impacts. Repairing areas damaged by missile impacts would cause soil compaction and devegetation when accessing the site and filling in the depressions. The amount of soil disturbed by missile impacts depends on several variables (Moore 1976):

- The effect of the angle of impact on crater size. For impact angles lower than 15 degrees from the horizontal, a furrow or chain of depressions may be produced. A high angle of impact may result in smaller apparent depressions in certain target materials, especially porous materials.
- The relationship of the size of the depressions to impact energy. Linear dimensions of the craters are proportional to the kinetic energy of the missile.
- The compressibility of impact area material. The soils dispersed from the depression upon missile impact are composed of sheared and compressed soil. Soils have been found that have twice the density of their natural state.
- The effect of water on the impact area material. Missile impact depressions in water-saturated gypsum lake beds and in moist gypsum lake beds have two features in common: their ejecta includes little or no sheared or compressed target material, and depressions tend to be larger than those in drier material.

Secondary impact depressions may be produced when surface materials, such as sand, have little cohesion. Missile impact ejects debris that creates additional depressions. Where surface materials are cohesive no secondary depressions would be produced, but the surface may be littered with fragments (Moore 1976).

Other programs including National Aeronautics and Space Administration (NASA) and space programs, equipment component or subsystem programs, research and development, and special tasks, are not expected to impact geology or soils because they have no direct physical effects on geology or soils. Specific projects, however, will be required to address any potential impacts in their associated NEPA documents.

4.1.2 No Action Alternative

Consequences to geology and soils resulting from the no action alternative may be fewer than those resulting from the proposed action. This is so because the no action alternative prohibits additional construction, or testing of programs employing radically new technologies. Under the proposed alternative any projects proposing such developments will be required to address potential impacts on geology and soils in their associated environmental documents.

4.2 HYDROLOGY/WATER RESOURCES

This section describes the potential impacts on hydrology and water resources at WSMR from implementation of the proposed action and the no action alternative. In this assessment, current and past WSMR activities and resulting environmental consequences were used to assess potential future consequences of activities at WSMR.

Continued monitoring of groundwater levels and water quality characteristics are particularly important for assessing possible impacts of ongoing and future water supply development and waste disposal practices at WSMR. As an example, specific monitoring requirements for White Sands Test Facility (WSTF) are given in Table 4-1. Similar requirements are required for the WSMR Main Post and other permanent facilities such as SMR, HELSTF, and SRC. Because the details of future programs cannot be anticipated at present, only a general programmatic framework of water resources impacts can be provided in this document. Impacts associated with specific projects would be analyzed in project-specific NEPA documents tiered to this EIS.

The following activities were considered as criteria for identifying water resources impacts:

- water supply needs, as identified by each program activity along with permanent and temporary personnel associated with that program (direct as well as support, if warranted);
- wastewater disposal (sewage and any program activity residuals potentially affecting nearby water resources); and
- characterization and impacts of any other program aspects affecting water demands, wastewater disposal, or potentially affecting nearby water resources.

Regarding nearby water resources impacts, it should be kept in mind that for many areas of the WSMR site, surface water resources are nonexistent and groundwater resources are at some depth below land surface and often are too saline for direct potable water supply purposes (see Section 4.8.1.5).

For assessing programmatic water resources-related impacts of each major program category, the following significance criteria were considered. Impacts to water resources would be adverse if any of the following occurred (U.S. Navy 1993):

- the program required development of new sources of surface water or ground water supply, or necessitated construction of a new or expanded water treatment facility;
- the program caused changes in either soil percolation rates or the amount of impervious cover resulting in a change in the rate of surface water runoff;
- the program altered the natural drainage system of an impacted area;
- peak runoff flows in excess of pre-development (currently observed or estimated) peak flows would be caused by program implementation;
- structures or facilities would be located within a Federal Emergency Management Agency (FEMA)-delineated 100-year floodplain or in areas prone to localized flooding;
- the program would cause excessive turbidity or sedimentation in natural water bodies or stream courses;
- the program would impair the designated beneficial uses of surface water or groundwater resources within the affected area, due to changes in water quality, water depth; or

Table 4-1
WSTF monitoring for drinking water and wastewater

Variables	Sample Frequency	Sample Location
Drinking Water		
Chlorine Content Hardness	monthly	tap water at major facilities (100, 101, 120, 200, 300, 400, 800), U.S. Air Force guard shack, and TDRSS buildings
Volatile Organic Compounds	monthly	water wells I and J
Coliform	quarterly	tap water at major facilities (100, 101, 120, 200, 300, 400, 800), U.S. Air Force guard shack, and TDRSS buildings
Inorganics (health standards)	annually	water supply wells I and J
Nitrate	every four years	water supply wells I and J
Wastewater		
pH	weekly	overflow lagoons (100 and 200 areas)
Dissolved Oxygen		
Temperature		

Source: NASA 1989.

- program implementation would reduce spring runoff or result in Localized area(s) of pre-development water levels that would decline below root depths of riparian vegetation or dry up or diminish the flow of natural springs.

In evaluating potential water-related impacts, consequences of anticipated major program activities were categorized as follows:

- not adverse if there is no potential to exceed the impact criteria listed above,
- potentially adverse but mitigable if there is a potential to exceed the impact criteria listed above but all potential consequences could be readily reduced through accepted engineering procedures or by mitigative measures, or
- potentially adverse if there is a potential to exceed certain of the impact criteria listed above and the anticipated impacts cannot be mitigated readily.

4.2.1 Proposed Action

The major program activities considered in this EIS are listed in Table 4-2. This table summarizes relevant aspects of 34 major program activities with regard to water resources. Potential impacts at the WSMR site are discussed separately from possible off-site impacts.

4.2.1.1 WSMR Site. This section describes potential impacts on water resources within the boundaries of WSMR. Impacts are summarized by program category.

Water Resources Impacts by Major Program Category

Air-to-Air/Surface Programs – Because no construction projects have been described for this category, no construction-related water resources impacts are expected. Fixed-wing aircraft affiliated with these programs would take off and land at Holloman Air Force Base (AFB). Missiles for these programs are mounted on aircraft and typically use solid fuel propellants. Pollutants of concern impact principally high-altitude air space and would not be expected to impact water resources locally. Targets include unmanned aircraft and ground-based vehicles. Debris from missiles and targets on the ground surface generally are retrieved. Some activities in air-to-air/surface programs would require portable generators. Fuel spills might occur and potentially could adversely impact water resources; however, such cases are mitigable and can be included in contingency spill prevention or clean-up remedial actions.

No detailed water resources information is available to date for the 1020 ADP, the Advanced Medium Range Air-to-Air Missile (AMRAAM) (U.S. Air Force 1992), or the Bright Eyes programs. Because personnel requirements have not been estimated (Table 4-2), demands for potable water and portable toilet facilities cannot be estimated at this time. However, overall water-related impacts of these three programs are judged to be relatively minor compared to other identified major programs.

This assessment of impacts is based upon a recently completed Environmental Assessment (EA) for the Brilliant Anti-Armor Submunition (BAT) Program (U.S. Army 1993j). Permanent WSMR based personnel involved in this program total 50; for a given mission, a total of 100 field and support personnel may be involved (Table 4-2). No perennial streams or springs of significant size are known to be located within or near BAT Program operational sites or within designated possible impact areas (U.S. Army 1993j). Thus, no adverse surface water impacts are expected as a result of this proposed program activity. Likewise, the potential for adverse impacts on groundwater resources is anticipated to be insignificant (U.S. Army 1993j). Groundwater quality in most BAT impact areas is relatively saline and, hence, inferior or nonpotable. The estimated groundwater yields from aquifers underlying BAT Program operational sites greatly exceed the anticipated needs (U.S. Army 1993j).

Presuming a worst-case, per-person consumptive use of 3 x 10 m^3/s (70 GPD) of potable water (Baca, pers. com. 1992), the anticipated work force of 30 personnel would require 92 x 10 m^3/s (2,100 GPD) (U.S. Army 1993j). It is anticipated that all potable water needs will be fulfilled through trucking water to the BAT sites. According to Baca (1992), the water for this and similar programs would be trucked by two 18.9-m^3 (5,000-gal) tankers from the Stallion Base water source. All potable water usage would constitute a consumptive use, as defined by the New Mexico State Engineer Office; this use would be within existing water rights held by WSMR.

All BAT Program operational sites would include portable toilet facilities. These would be installed, serviced, and replaced on an as-needed basis (U.S. Army 1993j).

Table 4-2
Summary of water resources aspects of major programs at WSMR

Program Category	Program Name	NUMBER OF PERSONNEL Permanent	Per Mission	Construction	Source of Water for Each Mission	Additional Water Requirements
Air-to-Air/Surface	1020 ADP	—*	—	—	—	—
	BAT	50	100	—	Two 18,925-L (5,000-gal) tankers from Stallion.	Portable toilets will be used.
	Bright Eyes	—	—	—	—	—
	AMRAAM	—	—	—	No water required.	None.
Subtotals		50	100			
Dispenser or Bomb Drop	U.S. Air Force TCT TNG	0	unknown	unknown	N/A	None.
Subtotals		0				
Equipment Component or Subsystem	JSE Optical Guided Weapon	30	10	—	19-L (5-gal) containers.	Portable toilets will be used.
	LORAINS	3	—	—	—	—
	DIRT/BICT	—	—	—	—	—
Subtotals		33	10			
High-energy Laser	ALPHA	—	—	—	—	—
Subtotals						
NASA and Space	Space Shuttle Program Support	—	—	—	All water trucked in.	WSSH has its own septic tank. Water used to condition the runways.
SSTC (SS Trainer)		17	—	—	Same as Space Shuttle.	Same as Space Shuttle.
Subtotals		17				

(table continues)

Table 4-2 (continued).

Program Category	Program Name	NUMBER OF PERSONNEL Permanent	Per Mission	Construction	Source of Water for Each Mission	Additional Water Requirements
Research and Development	GBR	25	0	unspecified	70 GPD (max) hauled to sites from WSMR supply.	R-409 site: septic holding tank. LC-39 and IFC-25: portable latrines. Soakage pits for other domestic w/w.
Subtotals		35	20			
Special Tasks	U.S. Air Force special tasks	—	—	—	—	—
	Recovery and EOD	(EOD) 20 (Recovery) 25	12	N/A	Individual responsibility.	None.
	U.S. ARMY special tasks	—	(Once per 2 yr) 150 (Once per yr) 8	—	—	—
	DNA HE PHEN	—	—	—	—	—
	Range tests	—	—	—	—	—
	RTDS	—	—	—	—	—
Subtotals		45	95			
Surface-to-Air	ERINT	(ERINT) 5 (ETS) 8	(ERINT) 30 (ETS) 12	unspecified	Import potable water. Source unspecified.	Portable toilets.
	FAADS	a "few"	300	none	Trucked to ORC from Carrizozo (600 quarts per day)	Three to five portable toilets per mission.

(table continues)

Table 4-2 (continued).

Program Category	Program Name	NUMBER OF PERSONNEL Permanent	Per Mission	Construction	Source of Water for Each Mission	Additional Water Requirements
	HAWK	30	20	N/A	Trucked to sites. (2,100 GPD)	ORC: existing septic tank. Others: portable toilets.
	NCTR	20	50	N/A	Potable water trucked to site.	None.
	NLOS	none	none	unspecified	2,271 L (600 gal) per test day from post supply.	WSMR sewage system.
	PATRIOT	undetermined	20	N/A	Unspecified.	Portable toilets.
	RAM	15	none	none	170,325 L (45,000 gal) per year; source not specified.	Septic tank and leach field at RAM site.
	STORM	—	—	—	—	—
	THAAD	50	150	75	LC-37: WSMR supply STRONG site: trucked.	Unspecified.
Subtotals		115	555	95		
Surface-to-surface	ATACMS	—	—	—	LC-33: Local supplies Deerborn: trucked.	Rinsing trucks and other equipment (no soap).
	LOSAT	unspecified	unspecified	unspecified	346,729 L (91,606 gal) per year.	Stationary sewerage at Small Missile Range.
	Navy Gun	4	15	20	Potable water trucked to site.	None.
Subtotals						

(table continues)

Table 4-2 (continued).

Program Category	Program Name	NUMBER OF PERSONNEL Permanent	Per Mission	Construction	Source of Water for Each Mission	Additional Water Requirements
Target Systems	XQUH-1B	1	20	—	Trucked in using 19-L (5-gal) containers.	Portable toilets.
	QS-55	—	—	—	—	—
Subtotals		1	20			
Meterological and upper atmosphere probes		—	—	—	—	—
Subtotals						
GRAND TOTALS		311	800	95		

Source: U.S. Army 1993g.

* Dash indicates no data available.

Notes: gal = gallon
GPD = gallon per day

Aircraft Dispenser or Bomb Drop Programs – No detailed information is available about TAC TNG or related programs. Aircraft based at Holloman AFB are involved in program missions. Dispensers, bombs, and explosives are dropped from these aircraft, and certain residuals from these munitions may impact local remote areas. However, impact areas are quite isolated (section 4.3.1.4), and potentially adverse water resources impacts from explosive detonations in bomb-drop missions should be considered mitigable.

Equipment, Component, or Subsystem – No water resources information is available for the DIRT/BICT or the LORAINS(/INER) programs (Table 4-2). Testing of optically-guided weapons and sensors will require 30 permanent employees for the JSE Optical Guided Weapon Program. These personnel are presumed to be supplied with water from the WSMR water supply system. For each mission, an additional 10 personnel will be supplied with water from 18.9-L (5-gal) containers. A presumed consumptive use of 18.9 L per day (5 GPD) per person or 189 L per day (50 GPD) per mission would be required. There are no additional requirements for water. Portable toilets would be used for sewage disposal.

High-energy Laser Programs – No detailed water resources information is available for the ALPHA Program. Because no personnel requirements have been estimated (Table 42), demands for potable water and portable toilet facilities cannot be estimated at this time. However, these overall impacts are judged to be relatively minor compared to other identified major programs.

NASA and Space Program Support – All the missions listed in the data base for the Space Shuttle Program consist solely of paperwork activities within the range. Because this program coincides with the Shuttle Trainer Program, its impacts are included in that program; the same 17 personnel staff both programs. White Sands Space Harbor (WSSH), which receives water by truck from existing WSMR supply sources, operates two shifts per day for shuttle pilots practicing approaches and landings in the Shuttle Training Aircraft. Assuming a per-capita water consumption of 37.9 L per day (10 GPD) on a year-round basis, approximately 379 m^3 (100,000 gal) per year of water is consumed for potable purposes at the WSSH site. Water also is used to condition the runways for practice landings. This conditioning involves wetting the natural soils for compaction and dust control. The quantity of water currently used for this purpose is unknown but is estimated at over 3,785 m^3 (1,000,000 gal) per year. The water is trucked to the site from existing two non-potable water supply sources at WSMR. WSSH has its own septic tank which is drained by WSMR and is disposed of at the Main Post wastewater treatment plant.

The WSTF Wells I and J were drilled in 1963. Pumping and water level records indicate static water levels have not changed much since then, when they were 96 and 108 m (315 and 355 ft), respectively, below ground level. Static water levels are now 96 and 102 m (315 and 335 ft) for Wells I and J. Well K, drilled in 1993, is located between Wells I and J in the same aquifer and has a static water level of 97 m (317 ft). Pumping at a rate of 470 gpm (30 L/s) for up to 12 hours, the drawdown below static water level for Wells I and J has remained constant at about 4.6 m (15 ft) since 1963. Well K, pumping at a rate of approximately 47 L/s (750 gpm), has a drawdown of approximately 18 m (58 ft). Present water consumption at WSTF if approximately 11.4 mL (3 million gal) per month and does not impose an overdraft on either the present wells or the basin water resources. It is probable that present facilities could easily satisfy from three to four times the present demand.

Research and Development – The Theater Missile Defense (TMD) Ground Based Radar (GBR) Program is expected to last three years and require approximately 21 to 25 personnel. It is anticipated that water supplies for selected TMD-GBR test sites would be transported to each site by truck (U.S. Army Space and Strategic Defense Command (USASSDC) 1993a). Movable water supply bladders may be placed at required locations and filled with water from existing WSMR supply sources. Estimated maximum daily usage at a selected TMD-GBR test site would be 265 L (70 gal) per person. For the estimated 25 people involved in the tests, the daily maximum water usage would be 6,624 L per day (1,750 GPD). However, a more reasonable average water use may be approximately 95 L (25 gal) per person presuming that water use is primarily for drinking and sanitary utilities and not for bathing. Thus, the average daily water use for 25 persons involved in a selected test would be 2,366 L per day (625 GPD).

Wastewater would be disposed of in portable latrines and a septic tank system. At the R-409 site, a septic holding tank would be used. At the Launch Complex (LC)-39 and IFC-25 sites, portable toilet facilities would be used. Wastes from these portable latrines and septic holding tanks would be pumped periodically by licensed contractors and taken to the wastewater treatment plant at the Main Post. Other domestic wastewaters (gray water) would be disposed of in soakage pits using approved procedures. No surface waters are known to occur at any TMD-GBR alternative site, and groundwater resources are estimated to occur several hundred feet below the ground surface at these sites. In addition, groundwater underlying the alternative sites is, for the most part, relatively saline and of inferior quality.

Special Tasks – Insufficient information is available to assess the potential water resources impacts of the following special task missions projected for the proposed action: Air Force Special Tasks, Army Special Tasks, Defense Nuclear Agency HE PHEN, Range Tests, and RTDS. For a field training exercise such as that described for the Richardson Ranch Training Complex (RRTC) (Section 4.3.1.11) or for Army Special Tasks, potable water and portable toilet facilities would be needed for 60 to 150 field personnel, respectively. Water impacts are expected to be minimal. Water resources impacts of specific special task missions would be assessed in project-specific NEPA documents tiered to this EIS.

The level of activity for the Army Recovery and Explosive Ordnance Disposal (EOD) associated with the proposed action is presumed to be at the level for the no action alternative. Water requirements are the responsibility of each individual activity. An estimated 12 personnel are involved in a given mission (U.S. Army 1993g); overall, this total water demand is judged to be relatively small in comparison with other major programs. For the permanent personnel (20 involved in EOD and 25 in recovery, Table 2 [U.S. Army 1993g]), it is presumed that their water needs, when not in the field, are provided by existing Post Headquarters sources.

Surface-to-Air Programs – A number of programs in this category have EAs describing the affected environment of each program, as discussed below. Of the major programs covered in this category, only the Theater High Altitude Area Defense (THAAD), Non Line of Sight (NLOS), and Extended Range Intercept Technology (ERINT) programs include proposed construction activities. Launch complex and building structures are planned to support these projects. In general, construction would take place at the beginning of a program and would be completed within several weeks or months. Land disturbances during construction are considered distinct from those occurring during planned operational activities. It is presumed that good engineering practices would be implemented to minimize erosion and other water related construction impacts.

At launch sites, solid fuel rockets characteristic of surface-to-air missiles may impact nearby surface water resources. Any fuel spills would require quick response from WSMR personnel through implementation of its Installation Spill Contingency Plan (U.S. Army 1993b). This plan is designed to minimize impacts on both surface water and groundwater resources of an area impacted by a spill. Because rocket motor exhaust typically would disperse hydrogen chloride, carbon monoxide, and particulates (such as aluminum oxide), these substances may affect the nearby land surface and associated vegetation. Depending upon the occurrence of precipitation events, runoff or water percolating through underlying soils might be impacted locally. However, inasmuch as surface water bodies are rare in the region and runoff or subsurface percolation due to precipitation occur infrequently, localized monitoring of such effects would be needed. It is judged that water-related impacts of these substances would not adversely affect regional groundwater resources over the long term.

Water-related impacts of the ERINT Program are described in U.S. Army Strategic Defense Command (USASDC 1991c). The number of personnel required for ERINT Program construction activities is unspecified (U.S. Army 1993g). Personnel requirements are summarized in Table 42. For field aspects of this program, potable water would be imported; however, the source, means, and amounts remain unspecified. Portable toilet facilities are to be provided for field personnel supporting each mission. Also, the ERINT EA should be referred to regarding potential environmental impacts of the STORM (UDS 11) major program (USASDC 1991c).

The Forward Area Air Defense System (FAADS) and FAADS C21 programs are considered in combination for the purposes of this impact assessment. An EIS has been prepared for the basic FAADS Test and Evaluation Program (U.S. Army 1993b). Impact areas generally are located between the Oscura Range Center (ORC) to the southeast and the North Oscura Range Center (NORC) to the northwest (U.S. Army 1993b). Drainage ways generally are ephemeral streams. Several ephemeral springs occur in the Oscura Mountains and Garden Spring Canyon area, and intermittent storm-related streamflows in Salt Creek occur southeastward into the Tularosa Valley. Underlying groundwater resources are highly saline (U.S. Army 1993b).

An estimated 300 personnel may be required for program activities (Table 4-2); however, only a "few" permanent personnel are specified. Potable water would be trucked to the ORC from Carrizozo (Figure 1-1); quantities are estimated at 568 L per day (150 GPD). The Carrizozo public water supply has the capacity to produce 852,000 L per day (225,000 GPD) (U.S. Army 1993b); thus, no adverse effects on water supplies are expected from this program. Between three and five portable toilets would be required in the field per mission (Table 4-2). However, other test personnel and observers at the ORC would be using stationary, permanent sewerage facilities at that location. In summary, the FAADS and FAADS C21 programs field operations should result in no significant adverse water-related impacts. However it should be noted that the FAADS program outlines a single full-scale FAADS test, including use of aircraft, missiles, ground activity, and obscurants. Detonation of explosives or live warheads used within the FAADS Program has the potential to ignite ground fires (Section 4.3.1.2). If this were to occur, standard WSMR range safety and fire suppression procedures would be implemented. In the event of a wildfire, particulates, volatile organics, and nitrogen oxides would be among the substances generated, and these might affect water resources locally. The time-schedule intensity of this program has a very minimal potential to impact water resources in the immediate area; however, any potentially adverse impacts should be mitigable.

Water-related impacts of the Homing All the Way to Kill (HAWK) (HIP) Program are discussed in the EA for the HAWK Missile Program (WSMR Environmental Services Division 1993a). Groundwater resources impacts are judged to be very minimal. Groundwater depths range from approximately 73 m (220 ft) to more than 98 m (300 ft) below ground surface

(WSMR Environmental Services Division 1993a). In most cases, groundwater quality underlying impact areas is highly saline, thus, nonpotable.

An estimated 7,949 L per day (2,100 GPD) would be trucked to staffed HAWK Program operational sites. This estimate presumes a daily water requirement of 265 L (70 gal) per person (20 personnel per mission), which is judged to be worst case. The estimated 30 HAWK Program permanent staff are assumed to be located at Post Headquarters. Any HAWK Program personnel located at the ORC would use existing septic tank facilities; otherwise, portable toilet facilities would be provided as needed (WSMR Environmental Services Division 1993a).

The Phased-Array Tracking to Intercept of Target (PATRIOT) Air Defense System is described by the U.S. Army (1982b). PATRIOT system testing at WSMR is located at LC-38 (Baca, pers. com. 1992; U.S. Army 1993g). No known system-specific environmental documentation has been completed. Up to 20 personnel per test have been identified (Table 4-2); however, permanent staffing dedicated to this major program is not specified. Additional water requirements are unknown; portable toilet facilities are indicated for use in the field, as needed (Table 3-3).

The Rolling Airframe Missile (RAM) Program has been covered by an EA (U.S. Army 1993g). Permanent personnel total 15 (Table 4-2). Potable water requirements are specified at 4,259 L per day (1,125 GPD) for 40 days per year, or approximately 170 m^3 (45,000 gal) per year (U.S. Army 1993g) and would be met from existing WSMR water supply sources. The RAM Program areas encompass LC-50 and LC-34. A septic tank and leach field system would be used at the RAM Program location (Table 4-2).

An EA for the THAAD Program has been completed by the USASSDC (1993b). Some construction-related activities are included and a 75-person work force is estimated (Table 4-2). Certain test activities at Holloman AFB would take place at existing facilities and would not be expected to affect the use of ground water resources or the existing water resources of Holloman AFB. The WSMR site is involved in test site development and flight preparation (USASSDC 1993b); however, no water resources-related impacts are anticipated. An estimated 50 permanent personnel are involved in the THAAD Program; 150 additional personnel would be involved in a given flight test. The LC-37 and STRONG sites would be used during flight testing at WSMR. At LC-37, the Post Headquarters water supply would be used; potable water would be trucked to the STRONG site from existing WSMR water sources. No adverse impacts are anticipated regarding water quality as a result of flight tests (USASSDC 1993b).

Surface-to-Surface Programs – An EA has been completed for the Army Tactical Missile System (ATACMS) Program (U.S. Army 1991e). One or more conflagration tests are planned for this program (Section 4.3.2.3). For such a test, 13,250 L (3,500 gal) of jet fuel are burned around a test missile. Up to 10 target vehicles may be involved in a given test, and power generators are proposed for use- at the RATSCAT and Deerhorn sites. Hence, possible fuel spills would be handled under provisions of the Installation Spill Contingency Plan. The available Post Headquarters water supply would be used for potable water at LC-33; at the Deerhorn site, potable water would be trucked in from existing sources. Volume requirements are not specified at this time; however, the amounts are not anticipated to adversely impact the WSMR water supply (U.S. Army 1991e). Additional water use would include rinsing trucks and other equipment; no use of soap has been specified (Table 4-2). It is presumed that rinse water would be collected for treatment at LC-33, but not at the Deerhorn site.

Several warhead impact tests have been specified, and Phase I and Phase II impact areas potentially may affect nearby water sources. These include Mound Spring, Malpais Spring, a nearby stock tank, and Salt Creek adjacent to the ABC-1 Warhead Impact Target (WIT) (U.S. Army 1991e). In order to minimize the potential impacts to these sensitive habitats, WSMR (U.S. Army) and Holloman Air Force Base (U.S. Air Force) have entered into a cooperative agreement with the WSNM (National Park Service), the USFWS and the NMDGF. This agreement commits to the creation of limited use areas around the White Sands pupfish habitat as well as a variety of other measures to avoid harm to this species. In addition to the cooperative agreement, a White Sands pupfish management and recovery plan is being developed by WSMR. This plan will further define specific management prescriptions for the protection and enhancement of this species.

Relevant information regarding the Line of Sight Anti-Tank (LOSAT) Program is obtained from the U.S. Army (n.d.a). Program personnel requirements have not been specified. The Small Missile Range would be used for program testing. The water supply at this facility is slightly over 346 m^3 (91,600 gal) per year, and there are stationary, permanent sewerage facilities at this location.

Potential Navy Gun Program impacts have been evaluated in an EA (U.S. Navy 1993). Tests could begin in 1994 and run through the year 2010. Approximately 100 projectiles per year could be fired in up to five WSMR impact areas. A short-term increase in water demand is anticipated for construction-related activities, such as dust suppression and supply for the construction work force (20 personnel). This small increase could be accommodated by the existing water supply system; thus, this is not considered an adverse impact. Rough grading of the proposed facilities would modify the natural topography possibly increasing soil erosion rates in unprotected areas over the short term. Storm runoff diversions from construction sites to natural drainageways during construction might result in very limited adverse downstream impacts, such as channelization and entrenchment due to the erosive power of high, sediment-laden flows (U.S. Navy 1993). Also, construction activities could result in accidental spills of diesel fuel, lubricants, or other potentially toxic construction materials, negatively impacting surface waters and, potentially, underlying aquifers. However, based upon the general lithologic conditions (including hardpan) and the general depth to the water table (commonly exceeding 30.5 m [100 ft] below ground surface throughout most of the program area), the potential for negative groundwater resources impacts resulting from a spill is considered minimal. No new water supply sources or treatment facilities would be needed.

Based upon depths to groundwater commonly exceeding 30.5 m (100 ft) below ground surface, no adverse impacts from an accidental release of potentially hazardous materials into the soil and underlying groundwater would likely occur (U.S. Navy 1993).

A total of 20 construction workers have been projected for the Navy Gun Program (Table 4-2); 15 personnel per mission are indicated. However, the Navy Gun Program EA indicated that 30 employees would be needed for the testing programs (U.S. Navy 1993). All potable water needs are to be fulfilled through water trucks supplied from existing WSMR sources; no daily consumptive water use has been estimated.

No known environmental documentation has been completed for the NCTR Program. Permanent personnel total 20, and up to 50 personnel would be required for a given mission (Table 4-2). Potable water would be trucked to the field site(s) from existing WSMR supply sources, and no additional water supplies are judged to be required.

The U.S. Army (1992c) has prepared an EA for the NLOS Program. No additional project-related personnel requirements have been identified for this EIS (Table 4-2). The EA (U.S. Army 1992c) indicates that between 25 and 50 project-related personnel may require potable water. Potable water will be provided by the "low-level" WSMR water supply system at the Post Headquarters; a requirement of approximately 2,271 L per day (600 GPD) is projected for each test day. The projected total water use during NLOS testing is 45,425 L (12,000 gal), which is approximately 0.002 percent of total annual WSMR Post Headquarters use. This water requirement is judged to be minimal. The WSMR Post Headquarters wastewater system would be used for sewage. This system also services the LC-50 site (U.S. Army 1992c). No portable latrine facilities would be established unless current facilities were found to be inadequate (U.S. Army 1992c). Should portable latrines be necessary, they would be provided at a 1:20 latrine:personnel ratio and scheduled maintenance would be performed by an approved contractor. Regarding wastewater and garbage disposal facilities, the proposed project activities are not expected to increase their use to a point that would jeopardize their integrity. Should it become obvious that these systems are overloaded, additional facilities would be provided by the project to ensure that existing facilities do not cause environmental degradation.

Target-Systems Programs – For the XQUH-1B Program, a full-scale UH-1 helicopter at a rotary-wing drone target is used. This type of target then is used for testing Stinger, Chaparral, and HAWK missiles. A single (equivalent) personnel staff oversees this program. For a given test application, up to 20 WSMR staff may be involved (Table 4-2). For field operations, potable water is trucked in using 18.9-L (5-gal) containers and portable toilet facilities are used.

4.2.2 No Action Alternative

Criteria used in addressing potential impacts of the no action alternative are described above. In cases where substantially different levels of activities are indicated for the no action alternative than for the proposed action, specific descriptions of potential impacts are discussed below. Otherwise, it is suggested that the degree of impacts on water resources would be proportional to the differing levels of activity.

4.2.2.1 WSMR Site. Water resources-related impacts in these subsections have been developed for the no action alternative based on detailed information and data regarding currently planned major project activities as described in Key Program Descriptions, WSMR Range-wide EIS (U.S. Army 1993g). This information, compiled for 34 identified major program activities, was compiled in October 1993. The major program category delineations have been maintained in these subsections.

Water Resources Impacts by Major Program Category

Air-to-Air/Surface Programs – As indicated in Section 4.2.1.1, no construction projects have been described for this category. Thus, no construction-related water resources impacts are expected. Fixed-wing aircraft affiliated with WSMR air-to-air/surface programs would take off and land at Holloman AFB. The missiles in these programs are mounted on aircraft and typically use solid fuel propellants. Pollutants of concern impact principally high-altitude air space and would not be expected to impact water resources locally. Targets include use of unmanned aircraft and ground-based vehicles. Debris from missiles and targets on the ground surface generally are retrieved if readily located. Some activities in air-to-air/surface programs will require portable generators. Fuel spills might occur and could be potentially adverse; however, such cases are mitigable and can be included in contingency spill prevention or cleanup remedial actions. Fuel or chemical spills in White Sands pupfish habitat could be devastating to the species and may not be mitigable. As per the 1994 Cooperative Agreement for the Protection and Maintenance of White Sands pupfish between the U.S. Army. U.S. Air Force, WSNM, USFWS, and the NMDGF, White Sands pupfish habitats will be designated limited use areas to preclude access and avoid the potential of spills at these sensitive sites. This agreement also includes a variety of management prescriptions to prevent impacts to the pupfish habitat.

As indicated in Section 4.2.1.1, no detailed water resources information is available for the 1020 ADP, the AMRAAM, or the Bright Eyes programs. Because no personnel requirements have been estimated (Table 42), demands for potable water and portable toilet facilities cannot be estimated at this time. However, these overall impacts are judged to be relatively minor compared to other identified major programs.

Based upon a recently completed EA for the BAT Submunition Program (U.S. Army 1993j), the impacts of the no action alternative would be lower than those under the proposed action, which was considered not significant in the EA's Finding of No Significant Impact (FONSI).

Dispenser or Bomb Drop Programs – No detailed information has been provided about the TAC/TNG or related programs. As discussed above, aircraft based at Holloman AFB are involved in program missions. Dispensers, bombs, and explosives are dropped from these aircraft, and certain residuals from these munitions may impact local remote areas. However, impact areas are quite isolated (Section 4.3.1.4), and potentially adverse hydrologic-related impacts from explosive detonations in bomb-drop missions should be considered mitigable.

Equipment, Component, or Subsystem – No water resources information is available for the DIRT/BICT or the LORAINS(/INER) programs (Table 4-2). Testing of optically guided weapons and sensors will require 30 permanent employees in support of the JSE Optical Guided Weapon Program. These personnel are presumed to be supplied with water from the WSMR water supply system. An assumed consumptive use of 18.9 L per day (5 GPD) per person or 189 L per day (50 GPD) per mission would be required. There are no additional requirements for water. Portable toilets would be used for sewage disposal.

High-energy Laser Programs – No detailed water resources information for the ALPHA Program is available to date. Because no personnel requirements have been estimated (Table 4-2), demands for potable water and portable toilet facilities cannot be estimated at this time. However, these overall impacts are judged to be relatively minor compared to other identified major programs.

NASA and Space Program Support – As would be the case for the proposed action, all the missions listed in the data base for the Space Shuttle Program consist solely of paperwork (administrative activities) within the range. Because this program coincides with the Shuttle Trainer Program, its impacts are included in that program and the same 28 personnel staff both programs. WSSH, which is supplied by truck from existing supply sources, operates two shifts per day for shuttle pilots practicing approaches and landings in the Shuttle Training Aircraft. Approximately 227 m^3 (60,000 gal) per year of water is consumed for potable purposes at the WSSH site. Non-potable water is used to condition the runways for practice landings. This conditioning involves wetting the natural soils for compaction and dust control. The quantities of water used for this purpose is unknown, but are estimated at over 3,785 m^3 (1,000,000 gal) per year, which is trucked to the site from existing sources. WSSH has its own septic holding tank which is drained by WSMR and its contents disposed of at the Main Post wastewater treatment plant.

Research and Development – No missions are planned for the GBR Program in the no action alternative; hence, no environmental impacts would be associated with this program.

Special Tasks – Insufficient information is available to adequately assess potential water resources-related impacts of the miscellaneous special task missions projected for the no action alternative. Water resources impacts of specific special task missions would be assessed in project-specific NEPA documents tiered to this EIS. For the no action alternative, the level of the Army Recovery and EOD key function is presumed to be at the same level as the proposed action. Each activity is assigned the responsibility to procure water; overall, total water demand is relatively small in comparison with other major programs.

Surface-to-Air Programs – The overall activity level of this major program category for the no action alternative is approximately 35 percent that projected for the proposed action (U.S. Army 1993g). Any specified significant impacts should be scaled accordingly (Section 4.2.1).

Water-related impacts of the ERINT (UDS 12) Program are described in USASDC (1991c). The number of personnel required for ERINT Program construction activities is unspecified (Baca, pers. com. 1992; U.S. Army 1993g). Personnel requirements are summarized in Table 42. For field aspects of this program, potable water would be imported; however, the source, means, and amounts remain unspecified. Portable toilet facilities are to be provided for field personnel supporting each mission.

The FAADS and FAADS C21 programs are considered in combination, for purposes of this assessment. An EIS has been prepared for the basic FAADS Test and Evaluation Program (U.S. Army 1993b). It should be noted that this program outlines a single full-scale FAADS test, including use of aircraft, missiles, ground activity, and obscurants. The time schedule intensity of this program has the potential to minimally impact water resources in the immediate area in the short term; however, any potentially adverse impacts should be mitigable. Also, the ERINT EA should be referred to regarding potential environmental impacts of the STORM major program (USASDC 1991c).

Water-related impacts of the HAWK (HIP) Program are discussed in the EA for the HAWK Missile Program (WSMR Environmental Services Division 1993a). Any impacts of the no action alternative, including potable water and wastewater disposal needs, should be scaled according to any changes in the number of HAWK missions.

No known environmental documentation has been completed for the NCTR Program. Permanent personnel total 20, and up to 50 personnel would be required for a given mission (Table 4-2). Potable water would be trucked to the field site(s), and no additional water supply would be required.

The U.S. Army (1992c) has prepared an EA for the NLOS Program. Any impacts of the no action alternative, including potable water and wastewater disposal needs, should be scaled according to any changes in number of NLOS missions.

The PATRIOT Air Defense System is described by the U.S. Army (1982b). PATRIOT system testing at WSMR is located at LC-38 (Baca, pers. com. 1992; U.S. Army 1993g). An EA for PATRIOT is being prepared simultaneously with this EIS. Any impacts of the no action alternative, including potable water and wastewater disposal needs, should be scaled according to any changes in number of PATRIOT missions.

The RAM Program has been covered by an EA (U.S. Army 1993g). Water resources impacts, if any, should be scaled according to the number of missions that may be conducted under the no action alternative.

An EA of the THAAD Program has been completed by the USASSDC (1993b). The FONSI for the program states that no significant adverse impacts are anticipated as a result of THAAD project flight testing activities.

Surface-to-Surface Programs – An EA has been completed for the ATACMS (U.S. Army 1991e). Relevant information regarding the LOSAT Program is obtained from the U.S. Army (n.d.a). Program personnel requirements for these projects have not been specified. The Small Missile Range is to be used for program testing. Under the no action alternative, the level of program activity is approximately 16 percent that of the proposed action. Water resources-related impacts should be scaled accordingly.

The Navy Gun Program has been evaluated in an EA (U.S. Navy 1993). Any impacts of the no action alternative, including potable water and wastewater disposal needs, should be scaled according to any changes in number of Navy Gun missions.

4.3 AIR QUALITY

The air quality of an area is influenced by two major factors: the characteristics of the air pollution sources in or near the area of interest and the defining meteorology of the area. The climate and meteorology of the Tularosa Basin is discussed in detail in Section 3.3.1. Generally, the weather conditions at WSMR promote excellent air quality. Wind speeds typically are sufficient to disperse air pollutants horizontally. Atmospheric mixing depths and turbulence usually provide mechanisms for vertical transport of pollutants. This section discusses the other variable in the air quality formula, the air pollution sources that are proposed or existing as part of the WSMR programs.

The ROIs for evaluating air quality impacts are the local and regional vicinities. A local area of interest for air quality is the immediate vicinity or within a few kilometers of an air pollution source. Local impacts may have specific and cumulative effects on other developments and land uses within the area. On a larger scale the possible effects of WSMR activities on the air quality of the regional airshed, the Tularosa Basin, are considered. In some cases, potential effects on a global scale are examined. However, relevant long-term meteorological baseline data are expected to be inadequate to effectively assess global climate and meteorological impacts.

For each programmatic category, the following criteria are used to identify potential air quality impacts.

- National and state of New Mexico ambient air quality standards for criteria pollutants. Ambient air quality standards are discussed and listed in Section 3.3.3.

- Applicable health guidelines for hazardous air pollutants.

- For stationary sources, a potential emission rate greater than 9.1 metric tons (10 tons) per year of any regulated air contaminant for which there is a national or New Mexico ambient air quality standard (State of New Mexico

Air Quality Control Regulation No. 703.1) (State of New Mexico Health and Environment Department n.d.).

- For stationary sources, a potential emission rate of a toxic (hazardous) air pollutant that exceeds the emission level specified in Appendix A of State of New Mexico Air Quality Control Regulation No. 752 (State of New Mexico Health and Environment Department n.d.).
- Creation of offensive odors that would impact the area.
- Alteration of air movements, moisture, temperature, or other feature of local or regional climate.

In addition, WSMR will assess the cumulative impact of WSMR and WSMR-related activities on air quality. Cumulative impacts are discussed in Section 4.16 of this document.

In evaluating the potential air quality impacts of the programmatic activities, consequences are categorized as:

- not adverse if no potential to exceed the impact criteria listed above is determined,
- potentially adverse but mitigable if a potential to exceed the impact criteria listed above is determined but all potential consequences could be readily reduced through standard procedures or by measures recommended in this and previous environmental documentation, or
- potentially adverse if a potential to exceed the impact criteria listed above exists and the predicted impacts cannot be readily mitigated.

4.3.1 Air Quality and Visibility

As described in Section 3.3, baseline visibility conditions at WSMR are being monitored through an automatic camera system. The camera has been placed in the Main Post area on the roof of the 100K site building with a fixed range at approximately 77 to 78 degrees north. The target vista is uprange, offering the longest viewscape possible within WSMR.
Pictures are being taken of the target vista automatically, three times per day for one year. Observance of identified landmarks at known distances from the camera location provides a quantitative evaluation of the visual range, recorded in a series of photographs. The primary use of this technology for future aesthetic and visual resource impact evaluations will be the calibration of Geographic Information System (GIS)-generated viewscapes and subviewscapes (i.e., foreground, midground, background) thus greatly reducing the time and complexity of confirming these images in the field.

4.3.2 Proposed Action

The air quality impacts of the proposed action are examined for each programmatic category. The air quality impacts of the no action alternative are evaluated in Section 4.3.3.

4.3.2.1 Air-to-Air/Surface Missile Programs. The air quality impacts from air-to-air/surface missile programs would not be significantly different between the proposed action and the no action alternative.

Two important sources of air pollutants from air-to-air/surface missile program activities are exhaust emissions from aircraft and rocket engines. The types and numbers of aircraft involved with these programs are variable. F-15 and F-16 aircraft are typical. Likewise, the duration of complete flight cycles (idle - taxi out - take off - flight - landing - taxi in - idle) are highly variable among programs and among missions. Under the assumption that two F-15 and one F-16 aircraft are assigned to each mission and that they fly a standard landing-take off cycle (Seitchek 1985), engine exhaust emissions of fixed-wing aircraft associated with air-to-air/surface missile programs for one year are estimated and reported in Table 4-3.

Fixed-wing aircraft affiliated with WSMR air-to-air/surface missile programs will take off and land primarily at Holloman AFB. Although Holloman AFB programs and activities are not included among the programs evaluated in this EIS, these WSMR-related aircraft emissions are released into the Tularosa Basin airshed. Considering the relatively few flights per day and the vast volume of the airshed, however, any air quality impacts would be minimal. In-flight emissions would be released at high altitudes and would have only a minimal impact on ground-level air quality.

Not all aircraft flights will actually fire test missiles. For example, a description of the AMRAAM program outlines plans for six missile firings per year (U.S. Air Force 1992). Air-to-air/surface missiles typically use solid fuel propellants. Pollutants of interest generated by the combustion of solid propellants usually include hydrogen chloride, carbon monoxide, and aluminum oxide. Missile firings would most frequently occur at high altitudes where the release of small amounts of pollutants is not expected to result in adverse air quality impact at Hydrogen chloride released by these small missiles into tropospheric altitudes, less than 15 km (10 mi), would be removed by natural precipitation. Hydrogen chloride emitted by these small missiles at higher altitudes would not result in any measurable impact on stratospheric ozone levels. Hydrogen chloride is not an ozone-depleting chlorine compound (Bennett et al. 1991).

Missions involving live missile firings require targets. Unmanned target aircraft whose flight patterns are controlled remotely by radio contact with a ground operator are called drones. Drones can be full-scale or subscale, fixed- or rotary-wing aircraft. The air quality effects of drone engine exhaust are discussed in Section 4.3.2.5. For normal test missions, when a missile strikes a target drone aircraft the aircraft is damaged but not destroyed. The target aircraft typically is returned to a WSMR landing strip designated for the program mission. For normal tests, debris consists primarily of the test missile and possibly pieces of the drone target aircraft. Ground impact of the debris momentarily generates a burst of fugitive dust.

Ground target vehicles, probably diesel-powered tactical vehicles such as tanks and personnel carriers, generate pollutants typical of engine exhaust: nitrogen oxides, carbon monoxide, hydrocarbons, sulfur oxides, and particulate matter (Environmental Protection Agency [EPA] 1985a). Ground targets usually are limited to no more than a few dozen per mission. Heavy-duty diesel vehicles in these numbers would not adversely impact air quality, even in the immediate vicinity of the test area.

Some projects in the air-to-air/surface missile programs require portable generators for power supplies at remote sites. Generators can be fueled by diesel or gasoline. Diesel combustion products are nitrogen oxides, carbon monoxide, hydrocarbons, particulate matter, and sulfur oxides. Gasoline combustion products are carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter, and sulfur oxides (EPA 1 985b). Exhaust emissions from generators, whether diesel or gasoline, are not anticipated to result in air pollutant concentrations that exceed national or state ambient air quality standards. However, the Notice of Intent (NOI) requirement of the State of New Mexico (AQCR 703.1, Part 2, A.1.) applies to a portable air

Table 4-3
Estimates of landing and take off emissions from fixed-wing aircraft associated with WSMR air-to-air/surface missile programs*

Pollutant	Proposed Action (260 missions per year)	No Action Alternative (200 missions per year)
Carbon Monoxide (CO)	9.4 (10.3)	7.2 (7.9)
Hydrocarbons	1.2 (1.3)	0.91 (1.0)
Nitrogen Oxides (NO_x)	3.4 (3.7)	2.6 (2.9)
Particulate Matter	0.028 (0.031)	0.022 (0.024)
Sulfur Oxides (SO_x)	0.64 (0.70)	0.49 (0.54)

Source: Seitchek 1985.

* Reported in metric tons (tons) per year.

Notes: Estimates are based on two F-15 and F-16 aircraft for each mission. Emissions are calculated to altitudes of 914 m (3,000 ft) AGL.

AGL = above ground level

m = meter

ft = foot

pollution source, which has a potential emission rate at its maximum capacity in the absence of air pollution control equipment greater than 9.1 metric tons (10 tons) per year. in the absence of air pollution control equipment, permits are required for stationary sources (including portable sources) that have a potential emission rate at maximum capacity greater than 4.5 kg (10 lb) per hour or 23 metric tons (25 tons) per year (AQCR 702, Part 2, A.1.a.[1]) (State of New Mexico Health and Environment Department n.d.). Diesel generators rated above 54 kW require an NOI; those above 136 kW require a permit because of emissions of nitrogen oxides. Virtually all gasoline generators require an NOI and a permit because of carbon monoxide emissions. Therefore, any adverse air quality impacts of most power generators associated with the programs is determined to be mitigable. The preventive mitigation measure is compliance with the New Mexico Air Quality Bureau regulations.

No construction projects involving land disturbance have been described for these programs. Therefore, no construction fugitive dust is expected as a result of proposed air-to-air/surface missile programs.

There are many sources of air pollutants within the air-to-air/surface missile programs. This is the case with most of the programmatic categories evaluated in the WSMR EIS. Most sources are minor and often mobile, such as missiles, mobile targets, and aircraft, and would not result in an adverse impact on the air quality of WSMR. Many small stationary sources, typically power generators, would have an adverse air quality impact that is mitigable.

4.3.2.2 Surface-to-Air Missile Programs. The air quality impacts from surface-to-air missile programs would not notably be different between the proposed action and the no action alternative.

Missiles launched at ground level represent an important potential source of criteria and hazardous air pollutants. The missiles described in these programs all rely on solid fuel rocket motors. Of principal concern are the combustion products of solid fuel propellants: hydrogen chloride, carbon monoxide, and aluminum oxide. Aluminum oxide has a very low toxicity but it is released as fine particulate matter, which as a category is a criteria pollutant. Sometimes other constituents in solid fuel rocket motor exhaust are toxic. These vary with the formulation of individual solid fuels and are emitted in small quantities. For example, the NLOS missile releases 96 g (0.21 lb) of lead (U.S. Army 1992c). A significant fraction of solid rocket motor exhaust is composed of chemicals that are not hazardous to human health or the environment.

These include water; nitrogen; carbon dioxide; hydrogen; and miscellaneous hydrogen, hydroxide, chloride radicals, and aluminum chloride compounds. The quantities and composition of rocket motor exhaust from selected missiles in the surface-to-air missiles' programs are presented in Table 4-4.

The actual effect on the ambient air quality in the locality of these missile launches depends on a number of variables. Certainly the size of the missile rocket motor is very important. The weather conditions at the time of launch play a critical role in the dispersion of air pollutants. At WSMR, wind speeds and atmospheric mixing promote the dissipation of the exhaust emissions of the rocket motors. Although a higher concentration of exhaust emissions occurs near the launch pad because of initial missile acceleration, the combustion products are emitted along the flight path of the missile. A missile trajectory is completed within a few minutes, if not seconds, and at high altitudes, so only a part of the exhaust products emitted during a normal flight will have any effect on ground-level air quality. The potential for this small portion of missile exhaust products to exceed the air quality impact criteria is small.

Air dispersion modeling techniques are used to estimate the effects of air pollution sources on ambient air quality. Modeling techniques and the associated assumptions for air dispersion of rocket motor emissions are not standardized by any regulatory agency such as the EPA. The number of available candidate models that would be applicable to a rocket launch scenario is limited. Usually, a puff model is selected because a rocket launch acts like a sudden release of emissions that lasts a few seconds. Examples are the puff algorithms within the EPA TSCREEN model and a commercial version called TRPUF. Conservative assumptions are applied in these modeling exercises. These assumptions usually include the largest rocket motor in a particular program, release of the entire inventory of combustion products at low altitudes, low wind speeds, and low atmospheric mixing heights.

Air dispersion modeling of some of the missiles in the surface-to-air missile programs have indicated potentially significant but mitigable air quality impacts. For example, modeling of a normal launch of the SR-19-AJ-1 first-stage rocket motor from the HERA target missile (TMD program) showed negligible impacts to ground-level ambient air quality. That is, no exceedances of ambient air quality standards or guidelines were predicted. In modeling for a missile accident scenario, ambient air quality standards for carbon monoxide and particulate matter were not exceeded. In another example, modeling for a normal launch of a HAWK missile indicated possible exceedances of ambient air quality standards for carbon monoxide and fine particulate matter near the launch site. Hydrogen chloride concentrations were predicted to exceed a short-term public exposure guideline for several miles downwind from the launch site of a HAWK missile. The public is not allowed in these areas. Ambient air quality impacts for the HAWK program were therefore determined to be minimal (WSMR Environmental Services Division 1993a).

Table 4-4
Combustion products of selected missiles planned for surface-to-air missile programs at WSMR*

Missile Designation	Total Quantity	Hydrogen Chloride	Carbon Monoxide	Aluminum Oxide	Other Constituents
SR19-AJ-1 Booster (possible first stage of HERA missile)	6,296 (13,851)	1,402 (3,084)	1,327 (2,919)	1,767 (3,866)	1,800 (3,982)
Sergeant Missile (first stage(6,526) of STORM)	2,960 (1,327)	602 (518)	235 (0)	0 (4,681)	2,123
PATRIOT Missile	815 (1,797)	170 (374)	176 (388)	308 (679)	161 (356)
ERINT Booster/ Sustainer Motor	114 (251)	24 (52)	26 (58)	41 (90)	23 (51)
HAWK Booster	150 (330)	31 (68)	34 (75)	48 (106)	37 (81)

Sources: USASDC 1991c, 1993; WSMR Environmental Services Division 1993a.

* Reported in kilograms (pounds).

Analyses of missile launch scenarios associated with surface-to-air missile programs conclude that short-term air quality effects near a launch location can be expected. Exposure of human, animal, and plant receptors to high levels of pollutants could occur under certain circumstances, such as proximity to a launch site, very low wind conditions, or missile failure on a launch pad. However, missile launches within the programmatic descriptions of the proposed action are characterized by a short duration (on the order of seconds) and infrequency (days, weeks, and months between events). The public is excluded from the test area until WSMR staff determine that conditions are safe. These programmatic characteristics typically reduce any ambient air quality impacts from missile launches at WSMR.

Some of the missiles in these programs, such as THAAD, use small quantities of hypergolic liquid fuels in the delivery vehicles. Hypergolic fuels are liquids that ignite upon contact, and they are extremely toxic. The THAAD missile attitude control system requires 1 L (0.3 gal) each of monomethylhydrazine and nitrogen tetroxide. Fuel handling takes place inside buildings or in Secure areas under very controlled conditions. Actual combustion of these fuels occurs at high altitudes.

Ground traffic associated with individual programmatic activities ranges typically from 10 to 30 vehicles per test day. This is not enough to adversely impact air quality from either engine emissions or fugitive dust on unpaved roadways.

The Section 4.3.2.1 discussion of emissions from power generators assigned to air-to-air/surface missile programs applies to the power units in the surface-to-air programs as well. Potentially adverse air quality impacts would be mitigable. Complying with the air quality control regulatory requirements may apply as standard preventive mitigation measures. In general, the only aircraft associated with surface-to-air missile programs at WSMR on a regular basis are helicopters assigned to debris recovery tasks. As discussed in Section 4.3.2.11, air quality impacts from helicopters would be minimal.

The number and size of construction projects proposed for these programs is insufficient to impact air quality to any measurable degree. Of the major programs in this surface-to-air missile category, the THAAD, NLOS, ERINT, and Navy Advanced Gun Weapon System Technologies (Navy Gun) programs require construction activities. Launch complex and building structures are planned to support these projects. Construction takes place at the commencement of a program and is completed within several weeks or months. Construction land disturbances are not on-going activities. Fugitive dust will be generated from earth moving work at the construction sites and may impact air quality in the immediate vicinity. Because the areal impact would be limited, the air quality impacts of these few construction activities would be minimal. No cumulative air quality effects due to construction activities are expected. Mitigation of fugitive dust from nonpoint sources includes timely application of ample water or chemical dust suppressants, minimization of new roads, and the reclamation (including revegetation) of old roads and cleared areas.

The FAADS program is somewhat different from other programs in the surface-to-air missile program category. Most of the programs, such as PATRIOT and HAWK missile tests, involve firing one missile at a time. In contrast, a single full-scale FAADS test with maximum activity will include aircraft, missiles, ground activity, and obscurants. This intense activity has the potential to impact air quality in the immediate locale. The predominant impact would be fugitive dust from the ground activities, including test vehicles, support vehicles on unpaved roadways, impacting targets and missiles, obscurants, and fires. Emissions from the engines of aircraft and ground vehicles or from diesel and gasoline generators are not sufficient to be significant contributors to air quality deterioration. The EA for the FAADS program concluded that air quality impacts are expected to be minimal. This conclusion applies to the regional scale of the Tularosa Basin. At a FAADS test site, ambient air quality standards or guidelines could be exceeded. However, because the extent of the impact is confined and remote and the possibility of public exposure is extremely unlikely, the air quality impact of a FAADS mission and the FAADS program is categorized as potentially adverse but mitigable.

Detonation of explosives or live warheads used within a test activity such as a FAADS mission can ignite ground fires. Standard range safety procedures require fire suppression personnel and equipment to be present at test sites to reduce the chance of an uncontrolled fire. In the event that a wildfire does break out, the air quality impact would be potentially adverse. The degree of impact would depend on the duration and extent of the uncontrolled ground fire as well as the fuel type and fuel loading. Air pollutants resulting from wildfires include particulate matter, carbon monoxide, volatile organics, and nitrogen oxides.

In summary, the mission activities of the surface-to-air missile programs have the potential to adversely impact the air quality in the immediate vicinity of the tests. Solid fuel rocket motor exhaust typically includes hydrogen chloride, carbon monoxide, and particulate matter (as aluminum oxide). Ambient concentrations of these pollutants could temporarily exceed ambient air quality standards or health guidelines. Any hazardous air pollutants generated by FAADS-related activities are expected to dissipate to levels that do not affect sensitive animal populations in the region, such as bighorn sheep in the San Andres Mountains. Intense usage of obscurants, such as burning diesel, flares, or fog oil, could adversely impact air quality in the test area. Uncontrolled ground fires ignited by detonation of explosives or other causes associated with tests would impact air quality. Because tests are generally brief and relatively infrequent, areal impacts of pollutants are limited, atmospheric conditions at WSMR tend to disperse air pollutants, and public exposure to these air pollutants is very unlikely, making the air quality impacts of the surface to-air missile programs within the proposed action potentially adverse but mitigable.

4.3.2.3 Surface-to-Surface Programs. In the proposed action, the number of activities included in surface-to-surface programs, at the most 260 per year, represents an increase of 4 percent over no action alternative levels. This translates to minor differences between the two alternatives with respect to the potential air quality impacts of surface-to-surface missile programs. Four projects (LOSAT, ATACMS, Copperhead, and Multiple Launch Rocket System [MLRS]-Basic) constitute 90 percent of the activities within this category. The LOSAT and Copperhead missions would increase while the ATACMS and MLRS-Basic missions would decrease under the proposed action. LOSAT is examined as a representative project of the surface-to-surface missile programmatic activities within the proposed action. ATACMS is reviewed in Section 4.3.3.3 as a representative project within the no action alternative.

The possible air quality impacts of the LOSAT program are extensively studied in the EA for the Kinetic Energy Missile (KEM) System (U.S. Army n.d.a). Sources of air pollutants are the combustion products from fuels burned by internal combustion engines of mobile sources, dust raised by vehicles on unpaved roadways, use of obscurants, and missile exhaust. The EA calculates the emissions of nontactical vehicles, tactical vehicles, and aircraft internal combustion engines for a total four-year program period that would encompass 14 flight test missions. The mobile source inventory examined in the EA includes over 32,000 operational hours for nontactical vehicles, 226 operational hours for tactical vehicles, and 2 hours of a pole-mounted helicopter target. These mobile sources were estimated to generate approximately 44 metric tons (49 tons) of carbon monoxide, 4 metric tons (4 tons) of hydrocarbons, and 6 metric tons (7 tons) of nitrogen oxides over the entire four years. Most of these emissions come from gasoline powered nontactical vehicles that support the LOSAT project.

The EA's FONSI states that the fugitive dust from unpaved roads is insignificant. Several LOSAT field tests use obscurants and battlefield simulators. Air pollutants from fog oil, graphite, silicon dust, flares, white phosphorus, and open burning of 208-L (55-gal) drums of diesel fuel would adversely impact the air quality in the immediate vicinity of the LOSAT tests. The ignition of phosphorus releases phosphorus pentoxide, phosphorus trioxide, and phosphoric acid. Fog oil generation and burning diesel produce hydrocarbon aerosols and particulate matter. These air quality effects would impact areas within 1 km (0.62 mi) of a test site for periods of less than one to several hours.

When evaluated according to the air quality impact criteria of this EIS, the air quality effects of obscurants are considered potentially adverse but mitigable. Obscurants are airborne particulates on materials used to duplicate battlefield smoke or other optics-confusing conditions. Obscurants of many types would generate airborne concentrations of particulate matter, both solids and liquid aerosols, such as graphite, silicon dust, hydrocarbon particles, fog oil and smoke. These concentrations are likely to exceed ambient air quality standards and health guidelines for particulate matter. The American Conference of Governmental Industrial Hygienists publishes workplace exposure guidelines for numerous chemical substances (American Conference of Governmental Industrial Hygienists 1990). The American Conference of Governmental industrial Hygienists occupational guidelines are not directly applicable to the general public. Nevertheless, they do offer some help in assessing air quality impacts. For particulates not otherwise classified, the American Conference of Governmental Industrial Hygienists 8-hour threshold limit value-time weighted average (TLV-TWA) is 10 mg/m^3. It is very possible that in the immediate vicinity of obscurant sources, ambient concentrations of particulate matter could exceed the TLV-TWA value. This distinct possibility of exceeding ambient air quality standards or health guidelines makes the air quality impact of obscurants potentially adverse but mitigable. The standard mitigation measure is to exclude the public from the vicinity of the tests. Exclusion of public access is a standard range safety procedure during all WSMR field tests.

The KEM used in the LOSAT program contains 57 kg (125 lb) of solid propellant. Prior to a KEM launch, two CRV-7 missiles would be launched to validate the system. A CRV-7 missile uses 4.5 kg (10 lb) of solid propellant. Among the KEM exhaust constituents are 0.57 kg (1.25 lb) of lead and approximately 20 kg (43 lb) of carbon monoxide. CRV-7 exhaust products include approximately 1.4 kg (3 lb) of hydrogen chloride and 1.4 kg (3 lb) of carbon monoxide.

The impacts on air quality resulting from the activities of the surface-to-surface missile programs within the proposed action would be potentially adverse but mitigable. Within the immediate area of missile testing and target impacts, air quality would deteriorate. Tests take place in isolated areas distant from public access, which mitigates the impacts. These events would be short in duration, typically only a few hours. WSMR site and atmospheric conditions would reduce any local air quality effect.

4.3.2.4 Aircraft Dispenser and Bomb Drop Programs. Examples of aircraft involved in these missions include the F-4, F-117, T-38, HH-60, and B-52. Landing and take-off are expected to take place at Holloman AFB. The discussion of aircraft engine emissions in Section 4.3.2.1 is applicable here. Although Holloman AFB programs and activities are not included among the programs evaluated for this EIS, estimates of landing and take-off emissions from WSMR-related aircraft based at Holloman AFB will be evaluated for potential cumulative impacts. Because the numbers and types of aircraft participating in dispenser and bomb drop programs is variable from year to year, the estimates of aircraft engine emissions presented in Table 4-5 are presented in units of 100 missions. Any air quality impacts from aircraft dispenser and bomb programs are expected to be minimal. Cumulative impacts to air quality, including estimates of the total emissions from all existing WSMR and WSMR-related activities, are discussed in Section 4.16 of this document.

In-flight aircraft engine emissions are not expected to have an adverse impact on air quality due to the high speed of the aircraft and the short duration of the event.

Ground impacts of dispensers, bombs, and explosives that are dropped from aircraft would result in bursts of fugitive dust. Pinnick et al. (1983) conducted measurements of the sizes and concentrations of dust particles resulting from the detonation of high explosives in three types of soils, including sandy soils near Orogrande, New Mexico. Peak dust concentrations within 10 to 50 m (33 to 164 ft) of detonation are 0.05-10 g/m^3. Irrespective of soil type, all dust size distributions exhibit a bimodal character with mass mean radii of approximately 7 microns and 70 microns. The larger particles contribute most to mass loading. Smaller particles are transported farther than larger particles, which settle gravitationally within a few hundred meters of a detonation site.

Air pollutants resulting from explosives include carbon monoxide and nitrogen oxides and sometimes methane, hydrogen sulfide, sulfur dioxide, ammonia, hydrogen cyanide, ethane, and ethylene, depending on the composition of the explosive. It is possible that airborne

Table 4-5
Estimates of landing and take-off emissions from selected aircraft associated with WSMR dispenser and bomb drop programs*

Pollutant	F-4 C/F Aircraft	T-38 Aircraft
Carbon Monoxide (CO)	2.3 (2.5)	4.0 (4.4)
Hydrocarbons	0.44 (0.48)	0.61 (0.67)
Nitrogen Oxides (NO_X)	0.39 (0.43)	0.060 (0.066)
Particulate Matter	0.079 (0.087)	0.00022 (0.00025)
Sulfur Oxides (SO_X)	0.10 (0.11)	0.035 (0.039)

Source: Seitchek 1985.

* Reported in metric tons (tons) per 100 missions.

concentrations of hazardous air pollutants could exceed health guidelines, making the air quality impact potentially adverse . Given the isolated setting of the impact areas away from public areas, the air quality effects from explosive detonations in bomb drop missions are considered mitigable.

4.3.2.5 Target Systems. A significant fraction (approximately 70 percent) of target system missions is attributable to TMD testing. The TMD program proposes to launch its targets from off-range sites-the Green River Launch Complex, Utah; and the Fort Wingate Depot, New Mexico. The potential air quality impacts of TMD target launches at these locations are discussed in the EIS for the TMD program (USASDC 1993). Excluding TMD target tabulations, the numbers of target missions in the proposed action are roughly equivalent to those in the no action alternative.

Approximately 22 percent of the proposed action target missions are assigned to XQUH-1 H rotary-wing drone targets. Engine exhaust emissions from XQUH-1 H helicopter drone activities are not expected to exceed 0.3 metric tons (0.3 tons) per year for any criteria pollutant for 100 missions. These quantities of pollutants would have a minimal impact on air quality. On infrequent occasions, such as in LOSAT testing, a helicopter drone is affixed to a pole. Emissions from the operating engine are not enough to degrade air quality. For example, approximately 3 kg (6 lb) of carbon monoxide per hour are estimated from a typical helicopter landing-take off cycle, and quantities of other criteria pollutant emissions are less. The only other target system in notable numbers is the QS-55 helicopter drone. The QS-55 drone is proposed in numbers about one fourth the magnitude of XQUH-1H target numbers. No emissions information for the QS-55 helicopter engine is published in the mainstream literature.

However, the minimal emissions from the operating engine of the QS-55 drone are expected to be comparable to those from the XQUH-1H engine

4.3.2.6 Meteorological and Upper Atmospheric Probes. Most of these missions would be balloon launches, which would have no impact on air quality. The rockets required to carry meteorological instruments to high altitudes are very small and would present a minimal impact to air quality, even in the immediate area of the launch.

4.3.2.7 NASA and Space Program Support. NASA WSTF is a research and development facility specializing in the test of space flight materials and propulsion systems. NASA WSTF is located on the east side of the San Augustin and San Andres mountains, approximately 10 km (6 mi) north of U.S. Highway 70. The ongoing activities of NASA WSTF are discussed in Section 4.3.3.7 as components of the no action alternative.

NASA is responsible for missions associated with the Space Shuttle and the Shuttle Trainer programs which take place at the WSSH. A major activity at the WSSH is the maintenance of landing strips at Alkali Flats. During these operations, fugitive dust would be generated by the maintenance equipment. Emission factors specific to the roadway maintenance activities of site preparation are general and depend on a number of factors. The quantity of dust emissions from construction-related work, such as airstrip maintenance, is proportional to the area of land being disturbed and the level of construction activity. It also depends on soil composition and soil moisture. The EPA (1985b) suggests an approximate general emission factor for such construction activities of 1.1 metric tons (1.2 tons) of total suspended particulate matter (particles less than 30 microns in diameter) per acre per month. Since the two Alkali Flats landing strips are each 10,700 m (35,000 ft) long by 275 m (900 ft) wide or approximately 587 hectares (1,450 acres) total area, airstrip maintenance work could generate as much as 1,800 metric tons (1,700 tons) of fugitive dust per month. The resulting air quality impact in the immediate areas would be potentially unacceptable. Of course, only a small fraction of a landing strip is worked at any one time. The application of water as a dust suppressant to the landing strips at Alkali Flats is an acceptable way to mitigate the air quality impacts from airstrip maintenance and other construction-related activities. Maintenance of the landing strips is expected to have a mitigable impact on the air quality in the vicinity of the WSSH. Approximately eight times a year during shuttle flights, WSSH provides NASA with climatic data and other services. These eight mission-support activities do not impact air quality.

A number of power generators are used at the WSSH (Vickers, pers. com. 1993). As discussed in Section 4.3.2.1, the air quality impact of generators is potentially adverse but mitigable by complying with the state of New Mexico air quality control regulations. Project proponents, tenants, and contractors are responsible for all regulatory compliance.

The Shuttle Trainer is the other major activity at the WSSH. The Shuttle Training Aircraft are two modified Gulfstream II aircraft housed in NASA facilities at the El Paso International Airport. The Shuttle Trainer does not actually touch down at the Alkali Flats landing strip. The action is a simulated touch-and-go within 5 m (15 ft) of the ground. Training takes place four to five days per week, with approximately 10 touch-and-go maneuvers per week. Other aircraft, the NASA Super Guppy and the shuttle carrier, assigned to the Shuttle Trainer mission do not fly in WSMR airspace (Vickers, pers. com. 1993).

The DC-X (Delta Clipper) test program is a component of the Single Stage Rocket Test (SSRT) test program. Flight tests are planned at the WSSH Columbia site east of Highway 7 and north of Range Road 10. The exhaust product of the liquid hydrogen-liquid oxygen propulsion system of the DC-X vehicle is basically water. No adverse impacts to air quality from exhaust emissions for launch activities are anticipated. Minimal construction activities are required in the launch landing area; therefore, impacts to air quality from construction activities are anticipated to be minimal (Strategic Defense Initiative Organization 1992).

Table 4-6
Estimated annual emissions from rotary-wing aircraft associated with the JSE Optical Guided Weapon program*

Pollutant	Proposed Action (150 missions per year)	No Action Alternative (70 missions per year)
Carbon Monoxide (CO)	0.8 (0.9)	0.4 (0.4)
Hydrocarbons	0.5 (0.5)	0.2 (0.2)
Nitrogen Oxides (NO_x)	0.5 (0.6)	0.3 (0.3)
Particulate Matter	0.08 (0.09)	0.04 (0.04)
Sulfur Oxides (SO_x)	0.08 (0.09)	0.04 (0.04)

Source: EPA 1985a.

* Reported in metric tons (tons) per year.

Note: UH-1H engine exhaust emission rates are supplied as surrogate for unavailable AH-64 engine exhaust emission rates. Presumes two hours per mission.

4.3.2.8 Equipment, Component, or Subsystem Programs. The JSE Optical Guided Weapon and LORAINS are representative projects of this programmatic category. The sources of air pollutants from the JSE Optical Guided Weapon tests are aircraft and countermeasures. The principal aircraft involved would be AH-64 helicopters. Some fixed-wing aircraft would participate. Engine exhaust emission rates are not available for AH-64 helicopters, and UH-1H helicopters are substituted to estimate annual air emissions for the JSE Optical Guided Weapon project (Table 4-6). The aircraft engine emissions would have minimal impact on ambient air quality. Wind-blown dust would be produced at any helicopter touchdown location. This fugitive dust would not be expected to disperse downwind to any great distance.

Countermeasures would be used in roughly one third of the tests. Countermeasures include burning barrels of diesel fuels, smoke and phosphorus grenades, flares, chaff, and fog oil, and are intended to challenge the optical system that is tested. The potential air quality impacts of obscurants are discussed in Section 4.3.2.3. The emissions of these obscurants and battlefield simulators would impact areas within 1 km (0.62 mi) of a test site for periods of less than one to several hours. When evaluated according to the air quality impact criteria of this EIS, the air quality effects of obscurants are considered potentially adverse but mitigable. Tests take place in isolated areas distant from public access, which mitigates the impacts.

LORAINS is an on-board guidance system for aircraft, usually C-12 aircraft but also F-111 and B-1 aircraft. Flights originate from Holloman AFB and are estimated to last one hour per mission. Estimates of the potential air quality impact of the alternative aircraft flown in conjunction with LORAINS testing are shown in Tables 4-7 and 4-8. Emissions are calculated for a landing-take off period lasting approximately 34 minutes and an in-flight time of one hour. Engine emissions produced during landing and take off patterns within 914 m (3,000 ft) above ground level (AGL) are more likely to impact ground-level air quality than in-flight emissions. Landing-take off emissions are calculated for flights within 914 m (3,000 ft) AGL while in-flight emissions are released at high-altitudes. In-flight emissions are less per unit of

Table 4-7
Aircraft engine exhaust emissions estimates for LORAINS activities, presuming full-time use of B-1A aircraft*

	PROPOSED ACTION (96 missions per year)			NO ACTION ALTERNATIVE (70 missions per year)		
Pollutant	Landing-Take Off	In-flight	Total	Landing-Take Off	In-flight	Total
Carbon Monoxide (CO)	15.7 (17.3)	1.33 (1.46)	17.1 (18.8)	11.4 (12.6)	0.96 (1.06)	12.4 (13.7)
Hydrocarbons	2.26 (2.49)	0.0697 (0.0768)	2.33 (2.57)	1.65 (1.82)	0.051 (0.056)	1.71 (1.88)
Nitrogen Oxides (NO_x)	2.88 (3.17)	0.401 (0.442)	3.28 (3.61)	2.10 (2.31)	0.292 (0.322)	2.39 (2.63)
Particulate Matter	0.0571 (0.0629)	0.00349 (0.00384)	0.0605 (0.0667)	0.0417 (0.0459)	0.0025 (0.0028)	0.0442 (0.0487)
Sulfur Oxides (SO_x)	0.566 (0.623)	no data	0.566 (0.623)	0.412 (0.454)	no data	0.412 (0.454)

Source: Seitchek 1985.

* Reported in metric tons (tons) per year.

Notes: Landing-take off emissions are calculated to and from 914 m (3,000 ft) AGL. In-flight emissions are based on one-hour period with aircraft engine in military mode. B-1A aircraft uses four F101-100 engines.
m = meter
ft = foot
AGL = above ground level

fuel than landing-take off emissions because, during flight, aircraft engines are in a high-thrust setting and fuel burns more efficiently. In-flight emissions are generally released over wide areas.

The air quality impact of the aircraft engine emissions would be minimal because of the huge volume of the airshed and because the flights occur on a relatively infrequent schedule, on the average of one flight every 3.8 days.

In summary, equipment, component, and subsystems missions of the proposed action present a potentially adverse but mitigable air quality impact. Aircraft engine emissions would not cause an adverse ground-level impact, but the use of battlefield obscurants and simulators potentially would. The standard mitigation measure is the exclusion of the general public from the test areas and, therefore, from exposure to the potential air pollutant levels resulting from those tests.

Table 4-8
Aircraft engine exhaust emissions estimates for LORAINS activities, presuming full-time use of F-111A aircraft*

	PROPOSED ACTION (96 missions per year)			NO ACTION ALTERNATIVE (70 missions per year)		
Pollutant	Landing-Take Off	In-flight	Total	Landing-Take Off	In-flight	Total
Carbon Monoxide (CO)	4.4 (4.8)	0.07 (0.08)	4.4 (4.9)	3.2 (3.5)	0.05 (0.06)	3.3 (3.6)
Hydrocarbons	3.4 (3.8)	0.003 (0.003)	3.4 (3.8)	2.5 (2.8)	0.002 (0.002)	2.5 (2.8)
Nitrogen Oxides (NO_x)	0.71 (0.78)	1.1 (1.2)	1.8 (2.0)	0.52 (0.57)	0.76 (0.84)	1.3 (1.4)
Particulate Matter	0.09 (0.10)	0.04 (0.04)	0.13 (0.14)	0.067 (0.074)	0.03 (0.03)	0.09 (0.10)
Sulfur0.12 Oxides (SO_x)	no data (0.13)	0.12	0.084 (0.13)	no data (0.093)	0.084	(0.093)

Source: Seitchek 1985.

* Reported in metric tons (tons) per year.

Notes: Landing-take off emissions are calculated to and from 914 m (3,000 ft) AGL. In-flight emissions are based on one-hour period with aircraft engine in military mode. F-111A aircraft uses two TF30-3 engines.
m = meter
ft = foot
AGL = above ground level

4.3.2.9 High-energy Laser Programs. ALPHA and High Energy Laser System Test facility (HELSTF) special projects account for most of the activity in these programs. Information from a U.S. Army Application for Permit (1982c), two other communications between the U.S. Army and the State of New Mexico Air Quality Bureau (Ferrari, pers. com. 1984; Duran, pers. com. 1984), and a USASDC (1992) report concerning WSMR HELSTF air permits provide the basis for this discussion of air quality impacts.

Several pieces of combustion equipment are in place at HELSTF. These include five smaller industrial- and commercial-size heating units, pumps, and scrubber ejector that have the total potential to use 440,600 L (116,400 gal) of No. 2 fuel oil per year. Combined potential emissions from these units are approximately 0.26 metric tons (0.29 tons) of carbon monoxide, 0.05 metric tons (0.06 tons) of volatile organic compounds, 1.05 metric tons (1.16 tons) of nitrogen oxides, 0.11 metric tons (0.12 tons) of particulate matter, and 0.36 metric tons (0.40 tons) of sulfur dioxide per year. Four propane heaters produce negligible emissions.

No effects, adverse or beneficial, of lasers on air quality have been identified (Shively, pers. com. 1994, Garcia, pers. com. 1994; Dick-Peddie, pers. com. 1994). In the event that high-energy laser programs increase in the future, project proponents will address this issue in supporting environmental documentation.

Hazardous air pollutants are released into the ambient air in conjunction with laser tests and manufacturing process steps. These hazardous air pollutants include nitrogen trifluoride, fluorine gas, hydrogen fluoride, deuterium fluoride, carbon tetrafluoride, nitric acid, hydrochloric acid, and sodium dichromate. Inert or nonreactive gases also are emitted from testing or process activities. Some of these are argon, nitrogen, helium, deuterium, and ethylene.

In 1984, air quality analyses on nitrogen trifluoride emissions associated with laser development activities indicated that under conditions carefully monitored by HELSTF there would be no adverse public health effects, primarily because of ambient air monitoring during and after laser testing and public exclusion until safe entry levels are determined. This analysis was accepted by the New Mexico Air Quality Bureau. if the activities of HELSTF remain the same as those reviewed in 1984 and earlier permit application reviews, the resulting air quality impact is categorized as potentially adverse but mitigable by HELSTF standard operating procedures (SOPs).

4.3.2.10 Research and Development Programs. The only research and development program activities within the proposed action are GBR demonstration and validation projects associated with the TMD program. The GBR program would require few, if any, missile or aircraft targets or support aircraft that are not affiliated with other TMD-programmatic activities, such as ERINT and THAAD. Potential environmental impacts of those programs are assessed in other sections of this document. Air quality impacts from fugitive dust associated with site preparation activities for GBR locations would be minimal due to the short duration of the activities and because construction dust is composed primarily of large particles that settle close to the site. Emissions of two large diesel-powered generators that support GBR equipment during testing and from transport and commute vehicles are not expected to result in exceedances of any ambient air quality standards. Air pollution permits for the two generators would be required. Nuclear effects testing, identified as the Nuclear Effects Directorate (NED), is one of the research and development programs at WSMR. Existing research and development programs do not affect air quality.

4.3.2.11 Special Tasks. U.S. Army special tasks include a variety of training activities. Air pollution sources associated with some of these U.S. Army special tasks consist of engine exhausts from gasoline and diesel-powered vehicles and from fixed- and rotary-wing aircraft, explosives detonation, and fugitive dust. These sources are not expect to adversely impact air quality.

An example of a U.S. Army special task mission that presents a potential air quality impact is an annual training exercise at the RRTC. During this exercise, approximately 60 people participate in simulated combat activities for a period of six hours. Impacts on air quality from activities before and after a training exercise at RRTC would be similar to impacts from comparable construction and traffic activities in a rural setting with an arid climate. The air quality impacts would not be minimal. During a training exercise, the air quality at RRTC and immediately downwind would temporarily deteriorate, primarily due to fugitive dust generated by multiple sources, including ground troop movements, ground vehicles, helicopters landing and taking off, inert rocket and bomb impacts, and the detonation of explosive charges. The amount of dust produced during these intense periods of training could be intense locally.

However, the impact on ambient air quality would not continue beyond the duration of the exercise and would be confined to the immediate vicinity. Numbers of mobile sources, both ground vehicle and aircraft, are expected to be relatively few. Detonation of explosive charges would produce, besides fugitive dust, carbon monoxide, nitrogen oxides, and very small quantities of methane, hydrogen sulfide, hydrogen cyanide, and ammonia. The area is isolated and distant from civilian populations. Consequently, no adverse air quality impacts to the general public would occur.

In addition to the special tasks total are approximately 285 U.S. Army recovery and EOD missions per year. Sources of air pollutants associated with a typical recovery mission include one UH-1H helicopter, four to six gasoline-powered ground vehicles (pick-up trucks), possibly one piece of diesel excavation equipment (backhoe or bulldozer), and off-road travel. Total emissions from 285 hours of helicopter flight time, which is an annual approximation, are broadly estimated at 2 to 3 metric tons (2 to 3 tons). Air quality impacts from a recovery mission are minimal.

4.3.2.12 Summary of the Air Quality Impacts of the Proposed Action. Many of the project activities within the programs of the proposed action may result in potentially adverse but mitigable air quality impacts when evaluated with the impact criteria defined in Section 4.3. Surface missile launches and use of obscurants and battlefield simulators would possibly elevate airborne concentrations of criteria and hazardous air pollutants above ambient air quality standards and applicable health guidelines in the vicinity of launches and field tests. The ground areas near these sites are excluded from public access at critical times. This mitigation measure, which is a standard range policy, reduces the air quality impact of these activities. Many of the power generators that support field activities and some testing facilities such as HELSTF, have potential emission rates that exceed the minimum emission levels specified in New Mexico Air Quality Control Regulations for requiring source registration and permits. These levels indicate a categorization of potentially adverse but mitigable impact. The standard preventive mitigation measure is compliance with applicable air quality control regulatory requirements for pieces of equipment that fall within the jurisdiction of the regulations. Emissions from aircraft and mobile ground vehicles are not expected to result in unacceptable air quality impacts either locally or regionally. Construction activities are not expected to result in adverse air quality impacts. Cumulative impacts to air quality are discussed in Section 4.16 of this document. A follow-on cumulative impacts analysis is proposed to supplement the findings of this EIS (Appendix D, Commitment Management Summary). No program activities have been identified as sources of offensive odors. Mitigation of fugitive dust from nonpoint sources includes timely application of ample water or chemical dust suppressants, minimization of new roads, and the reclamation (including revegetation) of old roads and cleared areas. Finally, none of the program activities or projects present the potential to impact local or regional weather.

4.3.3 No Action Alternative

This section evaluates the potential air quality impacts of the no action alternative. Reference is frequently made to discussions of these programs within the proposed action. Usually only the numbers rather than the specific projects are different between the two alternatives.

4.3.3.1 Air-to-Air/Surface Missile Programs. A maximum 200 missions per year are projected for the air-to-air/surface missile programs in the no action alternative. The air quality impacts from air-to-air/surface missile programs within the no action alternative would be similar to those within the proposed action, in which a maximum of 260 missions per year is forecast. A comparative estimate of the annual emissions from aircraft associated with these programs is presented in Table 4-3 in Section 4.3.2.1. Emissions from other air-to-air/surface missile programmatic sources, such as rocket motors, ground targets, and generators in the no action alternative also would be proportionally less than in the proposed action. The resulting differences in ambient air quality impacts of the two alternatives would not be measurable.

The mobile sources associated with the air-to-air/surface missile programs in the no action alternative would result in a minimal impact to the air quality of WSMR. Many stationary sources, typically power generators, would have an air quality impact that is potentially adverse but mitigable. The standard preventive mitigation measure is the timely compliance with the New Mexico Air Quality Bureau regulations.

4.3.3.2 Surface-to-Air Missile Programs. In the no action alternative, the maximum number of surface-to-air missile program activities would be 674, compared with the proposed action maximum of 1,100. The air quality impacts resulting from the surface-to-air missile programs in the no action alternative would be similar to the impacts of those same programs in the proposed action. The program activities are discrete events separated in time (usually on the order of days or weeks) and space (in scales of miles). Atmospheric conditions at WSMR promote the dispersion of pollutants with the result that any air quality impacts are very localized and do not last.

4.3.3.3 Surface-to-Surface Missile Programs. Within the no action alternative, the ATACMS program is representative of the maximum 234 missions in the surface-to-surface missile category. The ATACMS activities and associated environmental impacts are described in the EA for the program (U.S. Army 1991e). The rocket motor exhaust emissions of the ATACMS are typical of solid propellants. Aluminum oxide (261 kg [576 lb]), hydrogen chloride (154 kg [340 lb]), and carbon monoxide (151 kg [334 lb]) are the constituents of concern in the 728 kg (1,605 lb) of combustion products for the ATACMS (USASDC 1993). These amounts of pollutants are sufficient to cause potentially adverse air quality impact immediately downwind from the launch site. The impacts are mitigable by excluding public access from remote launch sites.

Several dozen nontactical ground vehicles, mostly gasoline and some diesel, would support each test. Engine emissions from these vehicles would have a minimal impact on air quality. Several impact areas are designated for the ATACMS projects, including the Stallion, North, 649, and Rhodes WITs. Fugitive dust from missile and payload ground impacts would be very brief, and the dust would settle and disperse quickly.

One or more conflagration tests are planned for the ATACMS project. A conflagration test involves exposing a test missile to fire conditions induced by combustion of 13,200 L (3,500 gal) of jet fuel. Burn time is approximately 30 minutes, and smoldering time is another hour. A conflagration test is conducted only during low wind speed conditions. Personnel are not allowed to re-enter the test area for 24 hours. During the test burning, the visual effect of the smoke plume would be definite and dramatic. Although the test would take place within an hour and a half, pollutant short-term average concentrations (1 hour and less) would possibly be high enough to result in exceedances of longer-term average concentration (8-hour and 2-hour) ambient air quality standards and health guidelines. Federal and state ambient air quality standards apply to outdoor areas accessible to the public. Because the public does not have access to the conflagration test area or downwind, ambient air quality standards and health guidelines do not directly apply to conflagration test areas.

As many as 10 target tactical vehicles (e.g., tanks, trucks, or self-propelled launchers) would operate in the target area during a test. Sometimes they would be stationary; during other tests they would be moving. For any one test, the targets would be operating for one to two hours. The maneuvering target tanks would generate quantities of fugitive dust that would deteriorate local air quality for the duration of the test. Consequently, the air quality impact would be potentially significant but mitigable.

Power generators proposed for RATSCAT and Deer Horn sites to support the program are small (60 and 100 kW). Their air quality impact is categorized as potentially adverse but mitigable by complying with the New Mexico Air Quality Bureau regulations as a standard preventive mitigation measure. Any construction-related land disturbance in preparation for the ATACMS program, such as the construction of a bunker at the Denver WIT, would result in a minimal impact on air quality.

This discussion of the possible air quality impacts of ATACMS, a representative project of the no action alternative surface-to-surface missile programs, along with the review in Section 4.3.2.3 of the LOSAT air quality analysis, concludes that the air-quality impacts would be potentially adverse but mitigable. Although for short periods of time, ambient pollutant concentrations might exceed the levels designated for air quality standards and health guidelines, the public is excluded from the testing areas and hence not exposed to these pollutant levels. Mission activities are relatively infrequent, and atmospheric conditions promote pollutant dispersion. Compliance with air pollution control regulation requirements for stationary sources would serve as a standard preventive measure to mitigate the potentially adverse effect of power generators.

4.3.3.4 Aircraft Dispenser and Bomb Drop Programs. Within the no action alternative, a maximum of 45 dispenser and bomb drop sorties per 24-hour period would take place. Air quality impacts resulting from these missions would not be qualitatively different from the impacts of identical missions under the proposed action. Because dispenser and bomb drop missions would occur less frequently, the overall air quality impacts would be somewhat less with the no action alternative. The emissions associated with aircraft would be minimal. Fugitive dust and hazardous air pollutant levels resulting from dispenser bomb impacts and explosions would result in potentially adverse air quality impacts that are mitigable by the public exclusion procedures at WSMR test sites.

4.3.3.5 Target Systems. Within the no action alternative, fixed- and rotary-wing drone aircraft account for all 300 target system tabulations. Like manned aircraft, drone aircraft disperse emissions over a wide flight-path area, often at altitudes above 305 m (1,000 ft).

An example of a fixed-wing drone aircraft is the MQM-107, which is propelled by a solid fuel rocket motor booster to launch the vehicle and a turbojet engine for the duration of the flight. Booster exhaust emission products are typical of solid propellants: aluminum oxide, carbon monoxide, and hydrogen chloride. Even though they are released relatively close to ground level when the drone is launched, the booster exhaust products are in sufficiently small amounts (approximately 27 kg [60 lb] total for all chemical species) and for such a short duration (approximately two seconds) that pollutant levels are not high enough to adversely impact air quality. Because drones are launched singly, there is no combined effect. The turbojet engine burns a high quality kerosene fuel. In-flight pollutant emissions from the drone engine (nitrogen oxides, carbon monoxide, hydrocarbons, and particulate matter) are released at high altitudes and hence would minimally impact ground-level air quality.

The discussion of rotary-wing drone aircraft presented in Section 4.3.2.5 also is applicable to the no action alternative. Air quality impacts to the WSMR airshed due to target systems within the no action alternative would be minimal.

4.3.3.6 Meteorological and Upper Atmospheric Probes. Within the no action alternative, the level of activity is essentially the same as the proposed action. Air quality impacts would be minimal.

4.3.3.7 NASA and Space Program Support. NASA WSTF is a research and development facility specializing in the testing of space flight materials and propulsion systems. NASA WSTF is located on the west side of the San Augustin and San Andres mountains, approximately 10 km (6 mi) north of U.S. Highway 70. The NASA WSTF property and buildings are grouped into five "areas" for purposes of program management.

NASA WSTF has prepared a 1992 inventory of air emissions (NASA 1993b). The information in this inventory is summarized in Table 4-9.

The largest single air pollution source at NASA WSTF is the 400 Area Steam Altitude System. The 1992 inventory tabulates annual emissions from this one source: 155 metric tons (171 tons) of carbon monoxide, 196 metric tons (216 tons) of isopropyl alcohol, 27 metric tons of volatile organic compounds (20 metric tons [22 tons] of methane and 7 metric tons [8 tons] of ethane). According to the air quality impact criteria, the 400 Area Steam Altitude System presents the potential for an adverse air quality impact by exceeding 9.1 metric tons (10 tons) per year of carbon monoxide and volatile organic compounds (isopropyl alcohol, methane, and ethane). (It should be noted that methane is negligibly reactive photochemically and hence does not contribute to ozone formation.)

The component service unit and the evaporation tanks in the 200 Area emit 14 metric tons (15 tons) of isopropyl alcohol per year. Hence, the 200 Area also has the potential to adversely impact air quality.

There are a number of important sources of hazardous air pollutants at WSMR WSTF, notably the 200, 300, 400, and 800 Areas. in general, the quantities of annual emissions of the hazardous air pollutant listed in the 1992 inventory appear to be below levels required by Regulation 752 for registration with the New Mexico Air Quality Bureau. Possible exceptions include hydrazine emissions in the 200 and 800 Areas, ammonia in the 300 Area, and isopropyl alcohol in the 400 Area.

NASA WSTF submitted registration information to the New Mexico Air Quality Bureau in 1990 accounting for monomethylhydrazine emissions in the 200 and 400 Areas, and isopropyl alcohol emissions from the 400 Area (Tillett, pers. com. 1990). NASA WSTF submitted a Permit Application for ammonia emissions from the 300 Area Altitude Simulation System (Colonna, pers. com. 1992a) and supplemental information of the 302 Test Stand (Colonna, pers. com. 1993). Air dispersion modeling in support of the 1992 Permit Application indicated that ammonia concentrations at the property boundary were less than the New Mexico Air Quality Bureau health guidelines. WSTF is restricted from public access by fence lines at the facility boundaries.

The New Mexico Air Quality Bureau has issued an Air Quality Permit to NASA WSTF for a 31.32-million Btu per hour boiler in the 302 Area (Williams, pers. com. 1992; Colonna, pers. com. 1992b). Permit emissions imitations are 4.4 tons per year of sulfur dioxide, 2 tons per year of nitrogen oxides, and 0.4 tons per year of carbon monoxide.

According to the criteria applied to evaluate air quality impacts, ongoing activities at NASA WSTF have the potential to adversely impact air quality. Information supporting a Permit Application for ammonia emissions from the 300 Area indicates that those impacts are mitigable

Table 4-9
Summary of 1992 air emissions inventory for NASA WSTF

Air Emission	100 Area (lb/yr)	200 Area (lb/yr)	300 Area (lb/yr)	400 Area (lb/yr)	800 Area (lb/yr)	Facility Total (lb/yr)	Facility Total (ton/yr)	Facility Total (metric ton/yr)
Criteria Pollutants								
Carbon Monoxide (CO)	118	445	2,532	352,774	194	356,033	178.02	161.60
Sulfur Dioxide (SO_2)	4	13	0	0	1	18	0.01	0.01
Nitrogen Oxides (NO_x)	589	2,223	472	1,127	251	4,662	2.33	2.12
Volatile Organic Compounds (VOC)	47	178	0	60,216	18	60,459	30.23	27.44
Inert and Low Reactive Gases								
Nitrogen (N_2)	0	18,859	75,143	288,230	0	382,232	191.12	173.49
Helium (He)	0	0	5,601	3,074	0	8,675	4.34	3.94
Hydrogen (H_2)	0	0	136	28,793	0	28,929	14.46	13.13
Oxygen (O_2)	0	0	0	1,010,668	0	1,010,668	505.33	458.73
Water (H_2O)	0	50,000	2,034	7,983,741	10,000	8,045,775	4,022.89	3,651.86
Carbon Dioxide (CO_2)	0	60,000	1,536	2,323,566	18,000	2,403,102	1,201.55	1,090.73
Hazardous Air Pollutants								
Isopropyl Alcohol	0	30,008	0	432,000	0	462,008	231.00	209.70
Ammonia	0	0	17,800	300	20	18,120	9.06	8.22
Chlorofluorocarbon Compounds (CFCs)	0	14,005	0	0	0	14,005	7.00	6.36
Aluminum Oxide (Al_2O_3)	0	0	0	959	0	959	0.48	0.44
Hydrogen Chloride (HCl)	0	0	0	620	0	620	0.31	0.28
Methylene Chloride	0	450	0	0	0	450	0.22	0.20
Monomethyl Hydrazine	0	108	5	111	0	224	0.11	0.10

(Table continues)

Table 4-9 (continued)

Air Emission	100 Area (lb/yr)	200 Area (lb/yr)	300 Area (lb/yr)	400 Area (lb/yr)	800 Area (lb/yr)	Facility Total (lb/yr)	(ton/yr)	(metric ton/yr)
Hazardous Air Pollutants (continued)								
Methanol	0	210	0	0	0	210	0.10	0.10
Chloroform	0	175	0	0	0	175	0.09	0.08
Acetone	0	65	0	0	0	65	0.03	0.03
Hydrazine	0	34	1	0	5	40	0.02	0.02
Toluene	0	30	0	0	0	30	0.02	0.01
1-Propanol	0	20	0	0	0	20	0.01	0.01
Acetylene	0	< 5	0	0	0	< 5	< 0.01	< 0.01
Atomic Chlorine (Cl)	0	0	0	< 5	0	< 5	< 0.01	< 0.01
Butyl Acetate	0	< 5	0	0	0	< 5	< 0.01	< 0.01
Hydrogen Cyanide (HCN)	0	0	0	< 5	0	< 5	< 0.01	< 0.01
Cyclohexanone	0	< 5	0	0	0	< 5	< 0.01	< 0.01
Ethylene Glycol Monoethyl Ether	0	< 5	0	0	0	< 5	< 0.01	< 0.01
Methyl Isobutyl Ketone	0	< 5	0	0	0	< 5	< 0.01	< 0.01
N-Nitrosodimethylamine	0	< 5	0	0	0	< 5	< 0.01	< 0.01
Tetrahydrofurfural Alcohol	0	< 5	0	0	0	< 5	< 0.01	< 0.01
1,1,1-Trichloroethane	0	< 5	0	0	0	< 5	< 0.01	< 0.01
Xylene	0	< 5	0	0	0	< 5	< 0.01	< 0.01

Source: NASA 1993b.

by restriction of public access. WSMR is in the process of compiling emissions data for regulated air pollutants and hazardous air pollutants in order to comply with the requirements of Title V of the Clean Air Act.

The NASA and space program support missions of the no action alternative would have the same air quality impacts as those of the proposed action. Aircraft emissions would not present a significant air quality impact. Maintenance activities of the unpaved landing strips at Alkali Flats would result in potentially adverse but mitigable air quality impacts.

4.3.3.8 Equipment, Component, or Subsystem Programs. As with the proposed action, the chief impact to air quality is anticipated to occur only in the immediate vicinity of a ground activity, such as a target area where battlefield simulators are employed. The overall assessment of the impact of equipment, component, and subsystems missions in the no action alternative would be potentially adverse but mitigable. The standard mitigation measure is the exclusion of the general public from the test areas and, therefore, from exposure to the potential air pollutant levels resulting from those tests.

4.3.3.9 High-energy Laser Programs. The high-energy laser program missions under the no action alternative are not appreciably different from the proposed action. The air quality impact of these activities would be potentially adverse but mitigable. Laser testing activities can emit hazardous air pollutants in concentrations that possibly exceed health guidelines. SOPs at HELSTF, including air monitoring and exclusion of the public, mitigate the air quality effects. The amounts of these emissions of hazardous air pollutants possibly exceed emission levels specified in Appendix A of State of New Mexico Air Quality Control Regulation No. 752, which also categorizes the air quality impact as potentially adverse but mitigable. By reviewing current operations and air permits for compliance with regulations and requirements that have been promulgated since the inception of these programs and then filing the necessary NOI and permit forms, as applicable, HELSTF operators would institute a standard preventive mitigation measure advised by the impact criteria.

4.3.3.10 Research and Development Programs. Within the no action alternative, no research and development program activities affecting air quality would take place. Consequently, no impacts to the air quality of WSMR would occur.

4.3.3.11 Special Tasks. A qualitative assessment of an example of a U.S. Army special tasks activity, a training exercise at the RRTC, is presented in Section 4.3.2.11. Air quality impacts of these exercises are potentially adverse but mitigable.

4.3.3.12 Summary of the Air Quality Impacts of the No Action Alternative. The primary air quality-related difference between the proposed action and the no action alternative is the level of activity in each. Consequently, the air quality impacts of the no action alternative are substantively the same as those of the proposed action. The air quality impacts of many project activities within the no action alternative would be potentially adverse but mitigable. Within limits, the number of launches of a particular surface missile, the number of times that a conflagration test is conducted, or the number of occasions that a battlefield simulation exercise take place is less important than the intensity of short-term air quality effects of the discrete activity. Under neither the proposed action nor the no action alternative is the schedule of programmatic activities planned so frequently that air quality effects would coincide, overlap, or compound. Near launch sites of some surface missiles and near the locations of some field activities, it is expected that ambient levels of criteria and hazardous air pollutants might exceed air quality standards and applicable health guidelines. To mitigate this potentially adverse impact, the public are routinely excluded from the vicinity of these activities. Certain equipment, notably power generators and stationary sources of hazardous air pollutants, have the potential to emit pollutants at emission rates that the State of New Mexico has deemed necessary for source registration and permitting. Complying with the air quality control regulatory requirements serves as a standard preventive measure to mitigate the potentially adverse air quality impact of these sources. Aircraft and mobile ground sources would minimally impact air quality on either local or regional scales. No odor sources have been identified. Mitigation of fugitive dust from nonpoint sources includes timely application of ample water or chemical dust suppressants, minimization of new roads, and the reclamation (including revegetation) of old roads and cleared areas. WSMR activities are not on a scale to alter local or mesoscale weather patterns.

4.4 BIOLOGICAL RESOURCES

This section discusses the types of impacts on biological resources that may result from the implementation of the proposed action and the no action alternative. The method used to evaluate impacts also is discussed. The biological resources analyzed include vegetation, wildlife, threatened and endangered species, and sensitive habitats. The significance of specific impacts of future projects cannot be assessed here and will be addressed in project-specific NEPA documents tiered to this EIS. Similarly, the Endangered Species Act requires that consultations be conducted with state and federal agencies concerning the potential impacts of specific projects on sensitive species when project-specific documents are prepared.

4.4.1 Assessment of the Significance of Potential Impacts

A systematic matrix-based analysis was made to assess the potential for impacts associated with the proposed action and the no action alternative. Three matrices were developed to facilitate the analysis of programs conducted at WSMR. A review was made of the programs associated with this EIS as described in Chapter 2. This resulted in a matrix of programs and activities required to implement them (Table 4-10). The activities were analyzed to determine what effects they may have on the WSMR environment and an activities/effects matrix was produced (Table 4-11). Each project effect was then analyzed to determine what impact it may have on the biotic resources of WSMR or on nonbiotic resources that affect biotic resources. An effects/impacts matrix was developed from this analysis (Table 4-12).

Tables 4-10 through 4-12 present impact analysis matrices with common elements that allow the analyst to start with a WSMR program and derive a list of impacts that may result from the implementation of a program (rows) or from programs requiring similar activities. This is done by first selecting a program in the programs/activities matrix (Table 4-10). The activities associated with the program can then be read from the marked columns. For example, road building may be associated with any program implemented on WSMR. Next, in the activities/effects matrix (Table 4-11), each of the selected activities appears as a row. The effects these activities may have can be read from the marked columns. The relationship between the effects caused by a program activity and the impacts the effect may have on biotic resources is presented in the effects/impacts matrix (Table 4-12).

Impacts on some portions of the biota may in turn affect other biological resources. For example, vegetation provides cover, forage, nest sites, and other values for wildlife species. When vegetation is lost or damaged, wildlife species dependent on it also are affected. Interactions between various affected components of the biota are taken into account in an impact analysis.

Table 4-10
Matrix of programs and activities

Programs	Activities																																			
	Falling Debris	Explosions	Unexploded Ordanance Disposal	Road Construction	Road Maintenance	Recovery Operations	Off-road Travel	On-road Travel	Herbicide / Pesticide Management	Laser Use	Electro-magnetic Radiation	Radiation (Nuclear)	Brush Management	Refuse Disposal	Aircraft Flights	Target Flights	Missile Flights	Simulated Chemical Attacks	Utilities	Sewage Disposal	Pond Construction	Water Well Drilling	Building Removal	Parking Lot Construction	Construction Material Laydown	Storm Water Management	Road Construction / Maintenance	Fencing	Pyrotechnic Flares	Release of Obscurants	Night Operations	Landfill Construction / Maintenance	Exhaust Emissions	Parachute and Bladder Drops	Mountainerring	Small Arms Fire	Surface Water Withdrawal
Construction				●	●			●					●	●	●				●	●	●	●	●	●	●	●	●	●				●	●				●
Air-to-Air / -Surface Missile	●	●	●	●	●	●	●	●		●	●		●			●	●	●	●	●				●	●			●		●	●		●				
Surface-to-Air	●	●	●	●	●	●	●	●		●	●		●			●	●	●	●	●				●	●			●			●		●				
Surface-to-Surface	●	●	●	●	●	●	●	●		●	●		●				●	●	●	●				●	●			●		●	●		●				
Dispenser or Bomb Drop	●	●	●	●	●	●	●	●			●		●					●	●	●				●	●			●	●	●	●		●				
Target Systems	●			●	●	●	●	●			●		●			●			●	●				●	●			●		●			●				
Meteorologic/Upper Atmosphere Probes	●			●	●	●	●	●			●		●				●		●	●				●	●			●			●		●				
NASA & Space Program Support	●			●	●	●	●	●	●		●		●	●			●		●	●				●	●			●			●		●				
Equipment, Component, or Subsystem				●	●		●	●		●			●						●	●				●	●			●	●	●	●		●				
High Energy Laser	●	●	●	●	●	●	●	●		●	●		●			●	●		●	●				●	●			●					●				
Research and Development	●			●	●	●	●	●			●		●			●	●		●	●				●	●			●	●	●	●		●				
Special Tasks		●	●	●	●	●	●	●	●				●						●	●				●	●			●					●	●	●	●	
Ongoing Management Practices				●	●				●				●	●					●	●		●		●	●	●	●	●				●	●				

Table 4-11
Matrix of activities and effects

Activities	Effects																																
	Ground Disturbance	Fire	Noise	Overhead Motion	Blast Overpressure	Induced Wind	Cratering	Ejecta	Ground Motion	Launch Emissions	Explosion By-Products	Fugitive Dust	Physical Disintegration	Trenching	Excavation	Spills	Drift	Deposition	Residuals	Off-Site Transport of Chemicals	Human Presence	Release of Toxic Substances	Entrapment	Modification of Vertical Habitat	Surface Water Distribution	Habitat Fragmentation	Wildlife Corridor Disruption	Reduced Visibility	Increased Lighting	Radiation (Nuclear)	Electro-magnetic Radiation	Release of Radionuclides	Habitat Removal
Falling Debris	●	●					●	●		●	●		●			●											●						
Explosions	●	●	●		●	●	●	●	●		●	●	●			●						●			●		●						●
Unexploded Ordnance Disposal	●	●	●		●		●	●			●	●	●			●					●	●			●		●						●
Road Construction	●		●									●	●		●	●				●	●			●	●	●	●						●
Road Maintenance	●		●									●	●			●				●	●			●	●	●							
Recovery Operations	●		●									●				●											●		●				
Off-road Travel	●	●	●									●			●	●					●						●		●				
On-road Travel																●																	
Herbicide/Pesticide Management																●	●	●	●	●	●												
Laser Use	●	●	●	●	●		●			●										●	●												
Electro-magnetic Radiation																														●	●		
Radiation (Nuclear)																														●	●		
Brush Management	●		●									●									●	●		●		●	●						
Refuse Disposal																						●											
Aircraft Flights			●	●																													
Target Flights			●	●						●																							
Missile Flights			●	●						●																							
Simulated Chemical Attacks																●	●	●	●	●		●											
Utilities	●		●									●		●	●						●		●				●		●				

Table 4-11 (continued)

	Effects																																
Activities	Ground Disturbance	Fire	Noise	Overhead Motion	Blast Overpressure	Induced Wind	Cratering	Ejecta	Ground Motion	Launch Emissions	Explosion By-Products	Fugitive Dust	Physical Disintegration	Trenching	Excavation	Spills	Drift	Deposition	Residuals	Off-Site Transport of Chemicals	Human Presence	Release of Toxic Substances	Entrapment	Modification of Vertical Habitat	Surface Water Distribution	Habitat Fragmentation	Wildlife Corridor Disruption	Reduced Visibility	Increased Lighting	Radiation (Nuclear)	Electro-magnetic Radiation	Release of Radionuclides	Habitat Removal
Sewage Disposal	●													●	●	●									●								
Pond Construction	●		●									●			●						●				●		●						
Water Well Drilling	●		●																		●				●		●						
Building Removal			●									●									●	●		●									●
Parking Lot Construction	●		●									●			●												●						
Construction Material Laydown	●		●									●			●	●					●	●		●	●		●		●				
Storm Water Management																											●						
Road Construction / Maintenance	●		●									●	●	●	●					●	●	●		●	●	●	●						●
Femcomg	●		●												●						●		●			●	●						
Pyrotechnic Flares		●		●																		●	●				●		●				
Release of Obscurants		●	●	●								●				●	●	●	●	●	●	●					●	●					
Night Operations																											●						
Landfill Construction / Maintenance	●		●									●		●	●	●						●			●		●		●				
Exhaust Emissions																																	
Parachute and Bladder Drops	●			●									●			●				●	●	●					●		●				
Mountaineering			●										●								●						●		●				
Small Arms Fire			●																		●	●					●						
Surface Water Withdrawal			●													●									●		●						

Table 4-12
Matrix of effects and impacts

	Impacts																																		
Effects	Loss of Vegetation/Habitat	Direct Mortality	Reduction of Cover for Wildlife	Reduction of Prey/Forage	Modify Drainage Patterns	Increased Competition	Modify Vertical Habitat Structure	Increased Stress	Decreased Growth	Increased Growth	Startling Behavior	Temporary Hearing Loss	Permanent Hearing Loss	Lower Reproductive Fitness	Physical Injury	Interrupt Nesting / Breeding	Ground Nest / Burrow Destruction	Avoidance/Displacement	Respiratory Problems	Reduce Photosynthesis	Entrapment of Wildlife	Change Biomass Production	Decreased Diversity	Decrease Mobility	Abandon Den/Nest	Increased Predation	Change in Vegetation Types	Soil Compaction	Crushing of Vegetation	Disruption Soil Profile	Erosion	Sedimentation	Bioaccumulation	Tissue-heating	Ground Water Table Alteration
Ground Disturbance	●	●	●	●	●	●	●	●	●	●					●	●	●	●		●		●	●		●	●	●	●	●	●	●	●			
Fire	●	●	●	●		●	●	●	●	●	●				●	●	●	●	●	●					●	●	●				●	●			●
Noise								●	●		●	●	●	●		●		●							●										
Overhead Motion								●	●		●				●	●		●							●										
Blast Overpressure	●	●	●	●			●	●			●	●	●	●	●	●	●	●							●										
Induced Wind	●	●	●	●			●	●			●				●																				
Cratering	●	●	●	●	●		●										●										●			●	●	●			●
Ejecta	●	●	●	●	●		●	●			●				●		●								●		●		●	●					
Ground Motion								●			●						●																		
Launch Emissions	●	●	●	●				●							●		●																		
Explosion By-products										●												●													
Fugitive Dust							●	●							●				●								●								
Physical Disintegration	●	●	●	●	●		●		●							●	●								●				●	●	●	●			
Trenching	●	●	●	●	●		●	●							●	●	●	●			●	●		●			●	●	●	●	●	●			
Excavation	●	●	●	●	●		●	●							●	●	●	●				●			●		●	●	●	●	●	●			
Spills	●	●	●	●	●		●	●	●	●							●		●			●	●		●		●				●	●	●		
Drift	●	●	●	●			●	●	●					●		●			●	●		●	●	●	●		●						●		

Table 4-12 (continued)
Matrix of effects and impacts

	Impacts																																		
Effects	Loss of Vegetation/Habitat	Direct Mortality	Reduction of Cover for Wildlife	Reduction of Prey/Forage	Modify Drainage Patterns	Increased Competition	Modify Vertical Habitat Structure	Increased Stress	Decreased Growth	Increased Growth	Startling Behavior	Temporary Hearing Loss	Permanent Hearing Loss	Lower Reproductive Fitness	Physical Injury	Interrupt Nesting / Breeding	Ground Nest / Burrow Destruction	Avoidance/Displacement	Respiratory Problems	Reduce Photosynthesis	Entrapment of Wildlife	Change Biomass Production	Decreased Diversity	Decrease Mobility	Abandon Den/Nest	Increased Predation	Change in Vegetation Types	Soil Compaction	Crushing of Vegetation	Disruption Soil Profile	Erosion	Sedimentation	Bioaccumulation	Tissue-heating	Ground Water Table Alteration
Deposition		●	●					●	●						●				●	●															
Residuals								●	●													●				●							●		
Off-Site Transport of Chemicals	●	●						●	●					●					●	●		●	●				●						●		
Human Presence	●	●						●			●				●	●	●	●							●		●	●	●						
Release of Toxic Substances	●	●	●	●			●	●						●	●	●			●	●		●	●		●		●						●		
Entrapment		●						●			●			●	●	●		●						●		●									
Modification of Vertical Habitat							●																												
Surface Water Distribution	●	●	●	●	●		●	●										●				●	●	●	●	●	●				●	●			
Habitat Fragmentation		●						●						●	●			●			●		●	●		●	●								
Wildlife Corridor Disruption		●		●		●		●	●					●	●	●		●			●		●	●	●	●									
Reduced Visibility		●						●							●			●						●		●									
Increase Lighting								●			●				●											●									
Radiation (Nuclear)	●	●	●	●			●	●	●					●	●							●	●				●								
Electro-Magnetic Radiation		●						●			●				●			●																●	
Release of Radionuclides		●												●	●																		●		
Habitat Removal	●	●	●	●		●		●										●					●			●	●								

The activities, effects, and impacts associated with the operation and maintenance of WSMR are related to specific programs. The determination of impacts depends on the availability of adequate information about the program activities and effects. The matrix presented in this EIS is generic and is based on the information currently available on WSMR programs. As new programs are instituted and more information on WSMR programs becomes available, new activities and effects may be identified. For this reason, each new program must be analyzed carefully during the environmental review process to determine what impacts on biotic resources may result from its implementation.

Identified impacts may then be evaluated for significance. The determination of significance includes considering the intensity, extent, and context in which the impact occurs. Intensity refers to the severity of the impact, and the following should be considered in evaluating intensity of impact on biological resources:

- impacts may be either beneficial when they result in the creation, restoration, or enhancement of natural habitat, or adverse, when they result in the loss or degradation of natural habitat;
- unique characteristics of the geographic area such as proximity to park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas;
- the degree to which the impacts are likely to be controversial;
- the degree to which the possible impacts are highly uncertain or involve unique or unknown risks;
- the degree to which the action may establish a precedent for future actions with adverse effects;
- whether the action is related to other actions with individually minimal, but cumulatively adverse , impacts;
- the degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973; and
- whether the action threatens a violation of federal, state, or local law.

Extent is based on the relative amount of the change in the area/quantity and/or duration of recovery from the impact. Context may be defined at the site-specific, local, regional, or national scale.

As a result of that evaluation, consequences are assigned to one of three categories: not adverse, adverse and mitigable, or adverse but unmitigable. The potential significance of impacts is evaluated for one or more of the following components of the biotic environment: vegetation resources, wildlife resources, sensitive species, and sensitive habitats. If consequences existed that could not be mitigated readily, the activity would be determined to present potentially adverse environmental impacts. Consequences would be deemed adverse but mitigable if concerns existed, but it was determined that all potential consequences could be readily mitigated through standard procedures or by measures recommended in this and previous environmental documentation.

4.4.2 Proposed Action

The following section presents the results of the environmental analyses conducted for the proposed action.

4.4.2.1 Vegetation. WSMR includes more than 809,400 hectares (2,000,000 acres) of habitat (Table 3-23). Hence, the total acreage of individual WSMR vegetation types tends to be large. Current mapping indicates that sizes vary from approximately 9,956 hectares (24,600 acres) of closed-basin scrub (arroyo riparian and wetland) vegetation to approximately 221,780 hectares (548,000 acres) of Chihuahuan desert scrub (creosote bush) (Table 4-11). The descriptions of these vegetation types are general and are appropriate at the base-wide scale of analysis. The ongoing mapping of biological resources on the WSMR will be accomplished at the level of the habitat types. This will result in a more detailed mapping, providing information on the plant associations encountered at the scale of the individual project site.

Most of the vegetation types on WSMR also are well represented in other portions of the region, although the state-wide and regional acreage of the habitat types occurring on WSMR is not known. However, many of these habitat types are well represented locally and regionally and even fairly large losses of the common types would not result in adverse impacts to the habitat types. Other habitat types occur in smaller amounts. Losses of even relatively small acreage of scarce habitat types may adversely impact sensitive species.

The loss of vegetation is an impact that may lead to secondary impacts including but not limited to direct mortality of wildlife, reduction of available cover for wildlife, reduction of prey and forage, displacement, increased competition, increased stress, and increased erosion and sedimentation. The significance of vegetation loss may vary depending on the sensitivity of the habitat it represents, the degree to which sensitive species would be affected by its loss, and other factors.

4.4.2.2 Wildlife. Various impacts on wildlife could result from program activities included in the proposed action. These impacts and their significance are largely project specific. Although specific impacts cannot be discussed in detail, the types of impacts that are commonly considered are reviewed. WSMR currently implements management practices for the conservation of sensitive natural resources, including wildlife, endangered species, and wetlands. These management practices will continue to be applied to all sensitive natural resources within WSMR.

Direct Mortality

Direct mortality of wildlife as a result of the implementation of the proposed action could result in adverse impacts. Direct mortality is a specific impact that may result from numerous activities related to the proposed action such as vehicle traffic, debris impact, and electrical wire installation among others (Tables 4-10 through 4-12).

Wildlife prone to this type of impact may be those that are restricted to specific habitats such as aquatic invertebrates, fish, or wildlife that use burrows for long periods through the year such as amphibians, reptiles, or small mammals. Big-game, medium-sized mammals, and birds may be able to avoid direct mortality impacts of such activities. Concerns also have been raised on WSMR over raptor mortality due to electrocution and collisions resulting from the construction of electrical transmission lines.

Habitat Loss/Fragmentation/Disruption of Migration Corridors

Impacts from habitat loss, habitat fragmentation, and disruption of migration corridors could result in potential impacts on wildlife. Habitat loss and fragmentation on WSMR may occur, from effects such as ground disturbance, fire, debris impact, fencing, and construction activities among others (Table 4-12).

Habitat loss for wildlife species could result in displacement, which could cause other ecological effects such as reduction of cover, reduction of prey and/or forage, increased predation, increased competition, among others. Loss of habitat heterogeneity and disruption of wildlife corridors may Impact a species that requires two or more habitat types and make it impossible to move between habitats (Wilcove et al. 1986). Loss of White Sands pupfish habitat, desert bighorn sheep habitat, deer fawning areas, and winter forage areas and their associated migration corridors may result in adverse impacts.

Noise/Overpressure

Impacts from noise related to construction and program operations on WSMR could result in potential impacts on wildlife. Noise effects on wildlife could result in impacts such as startling behavior, temporary or permanent hearing loss and abandonment of nest or den sites (Table 4-12). These impacts could also affect other ecological interactions such as predator-prey, parasite-host, plant-pollinator, and mutualism (Wilcove et al. 1986).

The significance of noise impacts on wildlife should include considerations such as hazardous decibel levels, intensity, frequency, and duration. Noise levels that exceed 90 dB may affect mammals adversely (U.S. Fish and Wildlife Service [USFWS] 1988b). Calculations of reactions of pronghorn to helicopter noise in New Mexico ranged from no reaction at 60 dBA to a strong reaction at 77 dBA (USFWS 1988b). Low-altitude jets and sonic booms (82 to 114 dBA) have been known to cause "noticeably alarmed" responses in raptors, and helicopter appearance over the top of a cliff caused panic and frantic escape behavior (USFWS 1988b). The Mojave fringe-toed lizard exhibited hearing loss after exposure to 95 dB for one hour and the desert iguana experienced a shift in hearing threshold and permanent hearing loss after exposure to off-road vehicle noise of 114 dB for 1 hour and 10 hours, respectively (USFWS 1988). Couch's spadefoot toad is known to prematurely emerge from its hibernation burrow when exposed to off-road vehicle sounds of 95 dBA (USFWS 1988). It is proposed that the impacts of noise on invertebrates needs to be further explored (Appendix D).

Concern over effects of aircraft noise and sonic booms on raptor nesting success has been expressed and studied by many (USFWS 1988; U.S. Air Force 1990b; Donahoo, pers. com 1986; U.S. Forest Service 1979). Potential impacts of noise could result from sonic booms, low-flying aircraft, and other sources. If persistent, these sources of auditory stimuli could adversely affect the survival or reproduction of listed species, resulting in temporary or permanent hearing loss, abandonment of the nest or den site, disruption of breeding activity, or abnormally heightened levels of physiological stress. Most studies of free-ranging wildlife indicate, however, that a wide range of mammalian and avian species acclimate readily to infrequent aircraft noise (Lamp 1989). These potential adverse effects can be avoided or mitigated by limiting aircraft overflights to areas when sensitive wildlife or nesting birds do not occur and restricting aircraft activity in areas of critical wildlife habitat to 610 m (2000 ft) above ground level. The potential impacts of the no-action alternative could be proportionally fewer than those of the proposed action, depending on the specific nature of the proposed future projects. According to the U.S. Air Force (1990b), analysis of previous studies did not rule out the possibility that aircraft overflights would have subtle effects on reproductive output.

Lasers

Laser use on WSMR in various programs could result in physical injury to wildlife. Some of the programs that use lasers during operations require protective eye gear for humans working in the vicinity of the project (Krehoff and Cavallaro 1989, Directed Energy Directorate 1989, U.S. Army 1985b). According to a study done in 1980 by the U.S. Army (U.S. Army 1980b) regarding laser activity at WSMR, there have been negligible cumulative impacts on wildlife populations. Big game species in mountainous areas were not affected at all and open range species such as quail and coyotes were only slightly impacted.

Radars

Concern for impacts to wildlife due to radar use on the WSMR is mainly rooted in the potential for energy absorption. A recent analysis of potential impacts on wildlife in the CBR Family of Strategic and Theater Radars Environmental Assessment (USASSDC 1993c) found no adverse impacts to wildlife as result of the project. Operation of radar generates electromagnetic radiation. High-intensity electromagnetic fields must be evaluated for compliance with applicable standards. Prolonged exposure to direct electromagnetic radiation could result in mortalities. Hazardous levels of high microwave power densities and energy absorption rates by wildlife species would need to be determined for projects involving the generation of high levels of electromagnetic radiation.

Entrapment of Wildlife

Entrapment of wildlife is most likely to occur during construction activities such as trenching and excavation (Table 4-12). Entrapment of wildlife could lead to mortalities from suffocation, dessication, starvation, or increased predation. These activities are generally site specific and not likely to be adverse on a range-wide scope.

Toxic Chemicals

Sewage lagoons may be attractive to waterfowl and other birds in the area where potable surface water is scarce. For waterfowl and shorebirds, lagoons are unusual habitat because the water is often deep and the edges lack emergent vegetation and, in fact, may be covered with rock, rubber, or other hard-surfaced materials (Swanson 1977). The attractive component of sewage lagoons seems to be the abundance of invertebrate food supplies available in nutrient-enriched ponds (Uhler 1956, 1964). Sewage environments, however, may promote avian diseases (Moulton et al. 1978), feather-wetting from detergent accumulations (Choules et al. 1978), or poisoning from blue-green algal toxins (Olson 1964). Therefore, within the confines of their primary purpose, sewage lagoons may pose a variety of management concerns for wildlife resources on WSMR. Other sources of toxic substances in WSMR programs are spills of liquid fuels, rocket propellants, and explosive constituents. Release of these substances into the White Sands pupfish habitat could have severe consequences for this species due to its limited distribution.

4.4.2.3 Threatened and Endangered Species. The proposed action may involve activities resulting in the direct or indirect loss of sensitive species or their habitat. The significance of impacts on sensitive species depends on the intensity and extent of the impacts and the context in which they would occur. If the activity results in the take of a species listed as endangered or threatened by the USFWS, New Mexico Forestry and Resources Conservation Division, or New Mexico Department of Game and Fish (NMDGF), the impact would be adverse. The ESA Act defines "take" as: "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or to attempt to engage in any such conduct." The definition of "harm" has been further defined by court decisions to include the degradation of habitat, including any habitat destruction or modification that presents an endangered species population from recovering. If an impact were sufficiently intense or extensive enough to result in a change in status of a species from candidate to listed, it would be adverse. This could occur if an activity reduced the habitat or numbers of individuals of a species sufficiently to justify regulatory concern. In addition, potential impacts on candidate species must be addressed because listing may occur at any time. WSMR will review the action and implement surveys as needed for listed species, sensitive species, and other species of concern within proposed activity areas. Wherever practicable, habitats occupied by listed species or other species of concern will be protected. If protection is not practicable, then mitigation measures, developed in cooperation with management agencies, will be implemented to offset the impact of the project.

The determination of impacts on sensitive species is made on a case-by-case basis. Knowledge of the distribution of biotic resources on WSMR, particularly the distribution of sensitive species, is incomplete. While the effects of project activities on some habitat types are more likely to result in unacceptable impacts to sensitive species than on others, this determination often will require site-specific field surveys. Project activities occurring on established WSMR facilities including launch sites, WITs, and existing buildings and roads, are less likely to result in adverse impacts to sensitive resources. Project activities that take place on areas outside of established WSMR facilities, but for which surveys indicate that no sensitive species are present, are likely to have only minimal impacts on sensitive species. It is WSMR policy to maintain threatened and endangered species and critical habitat at existing levels. Ground surveys for threatened and endangered species will be undertaken at all activity sites within WSMR to ensure that projects do not have adverse impacts on threatened and endangered species. If threatened or endangered species are located within an activity site, WSMR will consult with the USFWS and NMDGF to determine an appropriate course of action.

4.4.2.4 Sensitive Habitats. Program activities occurring in or on sensitive habitats may result in impacts on important resources. Activities that result in the filling or dredging of wetlands require permits issued by the COE. The intensity, extent, and context within which impacts on sensitive habitat occur would determine the significance, if any, of the impact.

As with threatened and endangered species, the determination of impacts on sensitive habitats is made on a case-by-case basis. Knowledge of the distribution of these habitats on WSMR is incomplete, and the significance determination often will depend on site-specific field surveys. Project activities occurring on established WSMR facilities are less likely to result in adverse impacts on sensitive resources. Project activities that take place outside of established WSMR facilities, but for which surveys indicate that no sensitive habitat is present, are unlikely to have adverse impacts on sensitive habitat. Project activities may affect portions of WSMR on which recent field surveys have not been conducted. If a reasonable likelihood exists that a sensitive habitat may be affected, surveys would be required. Project activities may directly or indirectly result in the loss or degradation of biotic resources on portions of WSMR. A variety of sensitive habitat types have been identified at WSMR (Table 3-27). Currently, WSMR maintains a GIS database that includes data on these sensitive areas. These data have been derived from past surveys and will be updated with each new survey. Data from the GIS will be incorporated into the Integrated Natural Resources Management Plan, which will address the needs of specific habitats and species. WSMR is committed to avoiding impacts to sensitive habitats. If impacts are unavoidable, WSMR will work with the management agencies to develop suitable and appropriate mitigation measures to avoid irreparable harm to the resource.

Wetlands

The proposed action contains several elements that potentially could impact wetland areas. Future construction, including roads, parking areas, buildings, or launch pads, could adversely impact wetlands. Whenever possible, construction activities will avoid wetlands and areas directly adjacent to wetlands, thereby avoiding direct impacts to wetland sites. In addition to the direct impacts associated with land conversion, indirect impacts can affect wetland sites. Additionally, changes to wetland areas may occur as a result of stormwater management activities. These activities could alter surface drainage and divert water from playas or other wetland areas. Effects would be adverse if wetlands were reduced in areal extent or degraded by pollutant or sediment inputs.
Weapons testing also may impact wetland areas. Weapon and target debris may fall into wetlands and alter their character. Depending on the weaponry used, a direct hit on a wetland could alter its character significantly. Also, vehicle traffic from positioning targets and launch vehicles would disturb any wetlands over which the vehicles drive. Likewise, target recovery activities could disturb existing wetland areas.

Activities associated with the proposed action could increase the withdrawal of water from some of the springs and wells. If the increased withdrawal significantly alters the amount of water available in the wetland areas, the wetlands could be affected adversely. Wetland area could be lost or the type of wetland could be altered. For each project, the location and type of wetlands within the projected area of impact will be determined and impacts of specific activities analyzed.

Wherever possible, jurisdictional wetlands will be avoided. For example, careful selection of final storm water retention sites to avoid wetlands would reduce or eliminate impacts on wetland habitats. In addition, the proposed actions could enhance wetland values by creating wetlands in storm management areas. If avoidance of wetlands is not possible, then WSMR, working in coordination and consultation with the COE, USFWS, and EPA, will implement measures to mitigate impacts and minimize harm to wetland sites. The goal of these mitigative measures will be to meet a criterion of no net loss of wetland. These mitigative measures will be site specific and developed on a case-by-case basis. The measures may include enhancement or enlargement of existing wetlands or potentially the creation of new wetlands.

The no action alternative would have the potential for similar impacts on wetlands. However, the magnitude of the impacts would be less as the no action alternative would involve fewer activities but of the same type as the proposed action.

4.4.3 No Action Alternative

Impacts on biological resources associated with the no action alternative is expected to be lower than those of the proposed action. Impacts of projects in previously surveyed areas would need to be assessed using project-specific information. Impacts of projects in previously unsurveyed areas would need to be assessed using project-specific information as well as surveys of the area.

4.4.3.1 Vegetation. Impacts on vegetation resources could result from the implementation of the no action alternative. The impacts are expected to be fewer and in some cases less intense than those associated with the proposed action due to the smaller number of programs. These impacts are not anticipated to be significant.

4.4.3.2 Wildlife. Various impacts on wildlife could result from the no action alternative. The significance of these impacts would be largely project-specific. Common impacts associated with the proposed action also are expected to occur for the no action alternative. The level of impacts is expected to be lower and in some cases less intense than the proposed action, due to the lower level of activity.

4.4.3.3 Threatened and Endangered Species. Impacts. on sensitive species could result from the no action alternative. Impacts are expected to be fewer and in some cases less intense than those associated with the proposed action due to the smaller number of programs.

4.4.3.4 Sensitive Habitats. Impacts to sensitive habitats could result from the no action alternative. The impacts are expected to be fewer and in some cases less intense than those associated with the proposed action due to the smaller number of programs.

4.5 SOCIOECONOMICS

This section discusses potential socioeconomic impacts of the proposed action and the no action alternative.

4.5.1 Proposed Action

Socioeconomic conditions in the WSMR region can be characterized by a number of variables. These include the level and distribution of population, employment, income, housing, and public services.

The proposed action is separated into two components: the first being continuation of current project activities, operations, and services; the modemization and improvement of outdated services; and the second being changes to project programs, site usage, and services. This section describes potential effects on socioeconomic conditions in the region from implementation of any of these two components.

Employment and population are the key components of project-related socioeconomic impacts. Changes in the level of employment can lead to an inflow or an outflow of population (workers and their dependents) to or from a region. This, in turn, affects the distribution and availability of income, housing, and public services in the region. This effect can be even more pronounced in a small regional economy where employment is focused on a few key sectors (e.g., manufacturing, government) that support may of the other jobs (e.g., retail trade, services). WSMR is an important component of the regional economy.

Continuation of current project activities, operations, and services would not result in any socioeconomic impacts on the local communities adjacent to the installation, or on the region as a whole. Employment and expenditure levels at WSMR would remain roughly the same as would the overall level of WSMR-related population in the area. WSMR operations would continue to be an important economic asset to local communities like Las Cruces. No deficiencies have been identified in terms of the ability of the local community to provide ad equate levels of housing or public services (e.g., education, public safety) to WSMR personnel and their dependents. This level of activity under the proposed action is the same as the no action alternative (see Section 4.5.2).

The modernization and improvement of outdated services would probably lead to an increased level of WSMR-related economic activity. Additional construction and expenditures for equipment that is procured locally would exert a positive influence on the regional economy. Increased construction employment opportunities may lead to the immigration of workers and dependents to the region, but could likely be accommodated by the existing labor force. With the modernization and improvement of outdated services, permanent operations staffing levels at WSMR would not change substantially from existing levels. Local communities would be able to provide adequate levels of housing and public services for this potentially small influx of population.

Changes to project programs, site use, and services may lead to a substantial alteration in the level of employment and expenditures at WSMR and may therefore result in socioeconomic impacts on adjacent communities. Any substantial program changes that lead to a large increase or decrease in WSMR-related employment and a concomitant immigration or outmigration of population, could impact local support communities like Las Cruces. If these program changes occur within a short time frame that does not allow communities to adequately plan ahead, these changes may impact socioeconomic conditions in the region.

4.5.2 No Action Alternative

The no action alternative would continue project activities, operations, and services that currently exist at WSMR. This would involve roughly the same level of staffing levels, payrolls, and other expenditures that currently exist from WSMR-related activities. These activities would continue to exert a positive economic influence on the regional economy of the multicounty area. Communities adjacent to the installation, especially Las Cruces, would continue to host the predominant share of WSMR-related personnel and dependents and provide housing and public services to this population. Adequate levels of public service provision and infrastructure are available locally to accommodate this population.

4.6 CULTURAL RESOURCES

Current and future activities at WSMR have the potential to affect properties included in, or eligible for inclusion in, the National Register of Historic Places (NRHP). These activities include a wide variety of training, testing, construction, and maintenance programs that cause differing degrees of disturbance and whose effects are numerous, complex, and often undertaken with high national defense priorities under accelerated schedules. Impacts would vary based on the type of cultural resources being discussed, dependent to some extent upon the cultural-temporal period to which resources belong. Potential impacts also would vary according to the type of activity planned. Potential impacts can be direct, causing physical destruction and alteration of a cultural property, or they may be indirect, such as isolating a property from its natural setting; creating visible, audible, or atmospheric elements that are in conflict with the character of the property and its setting; or neglect of the property that results in deterioration or destruction.

4.6.1 Proposed Action

This section describes the potential impacts of the proposed action on cultural resources.

4.6.1.1 Criteria Sources of Impacts on Cultural Resources. The following describes the terms used to define projects and effects related to cultural resources. These definitions are derived in large part from the Historic Preservation Plan for WSMR (U.S. Army 1981).

An "undertaking" means any project, activity, or program that can result in changes in the character or use of historic (or prehistoric) properties, if any such historic properties are located in the area of potential effects. Undertakings include new and continuing projects, activities, or programs and any of their elements not previously considered under Section 106 (Code of Federal Regulations 36 CFR 800.2). Historic and prehistoric sites are buildings, structures, and objects, determined to be greater than 50 years old. Historic properties may include Cold War or other properties less than 50 years old that have been determined significant.

The "criteria of effect" apply to all federal and federally assisted or licensed undertakings, including new and continuing projects, programs, and any of their elements not previously considered under Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended). An undertaking has an adverse effect on a historic property when the following two criteria are both met:

- the undertaking may alter characteristics of the property, including relevant features of its environment or its use, which qualify the property for inclusion on the National Register; and
- the alteration may diminish the integrity of the property location, design, setting, materials, workmanship, feeling, or association.

Effects on historic and prehistoric properties include, but are not limited to:

- physical destruction, damage, or alteration of all property;
- alterations of the character of the property's surrounding environment where that character contributes to the property's qualification for the National Register;
- introduction of visual, audible, or atmospheric elements out of character with the property or altering its setting;
- neglect of a property resulting in its deterioration or destruction; and
- both effects caused by the undertaking that occur at the same time and place and effects caused by the undertaking that are later in or far removed in distance, but are still reasonably foreseeable.

4.6.1.2 Examples of Impacts. Potential impacts can be described under five general categories, as follows:

- Surface disturbance associated with general land use activity on WSMR:
  - off-road vehicle travel in sensitive site areas,
  - creation of access to previously inaccessible areas, and
  - unauthorized removal of cultural properties or vandalism.
- Surface and subsurface ground disturbance caused by missile and other impacts:
  - contamination by chemicals or duds that effectively remove or limit access to scientific information, and
  - cumulative shock or vibration damage to structures.

- Chemical use for vegetation suppression, as obscurants, and other chemical contamination:
  - alteration of surface cover due to herbicidal vegetation suppression, leading to potential erosion; and
  - contamination of archaeological materials with potential for radiometric dating.
- Construction effects and landscape alteration:
  - reuse or removal of structural materials from existing buildings,
  - alteration of drainage or erosional patterns,
  - creation of new wetlands or ponding,
  - damage from earth moving and heavy equipment, and
  - visual impact.
- Surface disturbance caused by firefighting, missile, test vehicle, and other forms of ordnance test recovery and retrieval procedures:
  - damage from earth moving and heavy equipment:
  - visual or landscape alteration of habitat;
  - creation of access to previously inaccessible areas;
  - damage due to off-road vehicle traffic;
  - damage due to helicopter landing;
  - damage due to firefighting equipment, trucks, and activity;
  - detonation of unexploded charges at site of impact; and
  - unauthorized removal of cultural artifacts.

4.6.1.3 Cumulative Impacts. When an impact is repetitive it can produce cumulative effects and damage. Impact types that may require consideration and, in some cases, may call for mitigation specifically to stem cumulative effect include but are not limited to:

- helicopter and other aircraft vibrations,
- ground surface and subsurface compaction pressure from intensive surface usage, and
- vandalism.

Resonant shaking, ground velocity, acceleration patterns, and fatigue effects of vibrations from helicopter activity may cause damage to standing cultural resources. Resonant shaking is a function of the range of frequencies generated by the helicopter blade. Damaging effects from resonant frequency would have to fall into a specific range based on the type of building material. Generally, this range has been identified as being between 35 to 60 Hz for mud-wall ruins of the American Southwest (COE 1990).

Compaction and pressure generated from the surface by the traffic of heavy equipment, including tanks and large trucks, can affect the integrity of subsurface archaeological resources. Pottery and architecture are especially prone to damage from soil compaction and soil stresses. The level of initial failure stress (or the point at which pottery would fracture in a clay-type soil) appears to be between 52,400 to 109,530 Pa (7.6 to 15.9 psi). Even at a much higher stress level 172,400 to 517,000 Pa (25 to 75 psi), when damage and fracture have occurred, pottery artifacts may still be identifiable and reconstructible. Variables affecting severity of damage include vessel size, shape, and soil type (COE 1990).

Vandalism is the removal of acts or the defacement and destruction of properties. The motivation may be commercial (for monetary gain), noncommercial (curiosity, personal collection), or simply destructive. Effects can be repeated digging at sites, creation of roads where no access previously existed, disturbance of grave sites, and destruction of uncollected artifacts, sites, or structures that might otherwise have scientific value (COE 1990).

4.6.1.4 Types of Projects and Related Impact Potential. Ground disturbing impacts with the potential to damage cultural resources could result from activities in a number of program categories. Tables 4-13 through 4-21 summarize impact types associated with projects in these categories and indicate whether a survey has been conducted. The threat posed to cultural resources depends on the specific details of the project in question. Newly proposed projects will each require NEPA review and individual archaeological evaluation. Thus, any ranking of types of potential impacts on WSMR serves to illustrate, not evaluate, anticipated impacts. In general terms, installation undertakings that have the potential to damage cultural properties, ranked from most to least damaging, include, but are not limited to:

- ground maneuver training;
- facilities construction;
- high explosive missile impacts;
- drone and tow target impacts;
- fire fighting, fire break construction;
- missile recovery operations;
- other ordnance impacts;
- transportation and utilities; and
- unauthorized collecting by range personnel.

Ground maneuver training on a large scale is relatively rare on WSMR. Experience confirms that complete avoidance can be achieved with proper constraints. In a free-play tactical mode, extensive mitigation will be necessary to avoid impacts on cultural resources should free-play be approved on WSMR.

Facilities construction is usually limited to Post Headquarters and range camp areas, although isolated facilities are often expanded or added throughout the range. These activities should be preceded by an archaeological review. Mitigation of any potential impacts on historic properties would be by relocation of the project to avoid significant properties, fencing, or if no alternative is available, by data recovery or other approved treatment designed to protect values for which the property is considered significant.

Table 4-13
Air-to-Air/Surface Missile program potential impacts and archaeological survey status

Project Name	Area of Impact[a]	Potential Impact	Survey[b]
AMRAAM	Midrange (SALT and 50-mile Area)	solid fuel, debris recovery	+
BAT	North Range (Zumwalt)	solid fuel, off-road vehicles, debris recovery	+
BRIGHT EYES	Midrange (50-mile Area)	solid fuel	unknown
1020 ADP	unspecified	unspecified	unknown

[a] Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity.

[b] A positive sign (+) indicates that archaeological survey in the project areas has been completed as of this writing.

Table 4-14
Dispenser/Bomb Drop Program potential impacts and archaeological survey status

Project Name	Area of Impact*	Potential Impact	Survey
U.S. Air Force TCT TNG	North range (Red Rio, Oscura)	construction, debris recovery, surface disturbance	unknown

[a] Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity.

Table 4-15
Equipment component or subsystem program potential impacts and archaeological survey status

Project Name	Area of Impact*	Potential Impact	Survey
JSE Optical Guided Weapon	south range (Largo, AMRAD)	debris recovery, liquid fuel, helicopter	unknown
LORAINS	all range	transponder placement	unknown
DIRT/BICT	unspecified	unspecified	unknown

[a] Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity.

Table 4-16
NASA and space program support projects potential impacts and archaeological survey status

Project Name	Area of Impact[a]	Potential Impact	Survey
Space Shuttle	Space Harbor	unspecified	unknown
SSTC	Space Harbor	unspecified	unknown

[a] Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity.

Table 4-17
Research and development program potential impacts and archaeological survey status

Project Name	Area of Impact[a]	Potential Impact	Survey
GBR	south range (R-409)	petrol products, construction	unknown
Research Rockets	south range (LC-36)	solid fuel, debris recovery	unknown

[a] Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity.

High-explosive missile impacts are usually directed at specific targets, and potential misses are usually destroyed while airborne. Most impact targets would be subjected to archaeological survey, followed by avoidance or data recovery. Ordnance recovery efforts may end with the detonation of unexploded ordnance at the impact site which has the potential of additionally impacting cultural resources. Explosives generate a shock wave with a positive pressure phase and a negative pressure phase. Effects on standing architecture can be substantial. Shock waves due to surface or subsurface explosions are transmitted through the earth, affecting buried cultural resources and surface structures. Other impacts include incendiary effects, fragmentation of casings, and landscape alteration. Impacts of missiles and explosions create shallow crater-like depressions, furrows in soil and vegetation, carbon deposits, mounded and cracked ground surfaces with underlying cavities (camouflet), and subsurface accumulations of carbon monoxide. The depth of ground penetration of an explosive missile determines the extent of cratering and surface or subsurface damage (U.S. Army 1981).

Drone and tow target impacts are usually planned for specific areas, but actual mission constraints may require premature releases of drones and tow targets. These types of potential impacts could be reduced by designation of large approved release areas that have been surveyed.

Solid fuel debris can cause ground fires. Firefighting and firebreak construction usually require off-road vehicle travel, often with heavy equipment. Preplanned firebreaks will be surveyed

Table 4-18
Special tasks program potential impacts and archaeological survey status

Project Name	Area of Impact[a]	Potential Impact	Survey[b]
U.S. Air Force Special Tasks	all range	unspecified	N/A
U.S. Army Special Tasks	north range	live ammo, off-road vehicles, personnel	N/A
EOD/Recovery	all range	off-road vehicles, debris recovery, personnel	N/A
Range Tests	unspecified	unspecified	N/A
RTDS	unspecified	unspecified	N/A
Defense Nuclear Agency HE PHEN	unspecified	unspecified	

[a] Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity.
[b] N/A indicates not applicable.

and rerouted to avoid resources. Those built during a fire fight pose a threat to cultural resources that cannot be avoided completely. Prior survey and marking could reduce these types of impacts substantially, and the WSMR Environmental Services Division would inform firecontrol personnel of site probability and locations within fire suppression areas. To the extent possible, the WSMR Environmental Services Division would monitor firebreak construction during fire fights.

Missile and other recovery operations are essential proceedings for reasons of security, data collection, and containment of potentially hazardous materials. Recovery usually involves offroad vehicle travel to locations that cannot always be anticipated. Detonation of unexploded ordnance often is required at the site of test impact, resulting in additional impact. Firefighting activity also is associated with testing and recovery procedures and may involve construction of fire breaks, heavy equipment, and large numbers of personnel. Landscape alteration, visual impacts on local areas, access to previously inaccessible areas, and the potential for unauthorized removal of cultural properties are all possible effects of the recovery process. Extensive recovery operations would be coordinated through the WSMR Environmental Services Division to identify any sensitive resources already identified in the recovery vicinity. Recovery operations within sensitive areas would be monitored by the WSMR Environmental Services Division personnel whenever possible.

During any recovery action in an unsurveyed area, proposed entry routes and project-related disturbance areas will be reviewed through the GIS data base and surveyed in advance, if required. In the event that overriding project or other environmental requirements prohibit an adequate survey, an archaeologist or other qualified representative of the WSMR Environmental Services Division will accompany the recovery team, when practicable. This individual will assist in the selection of the entry path that will minimize the potential for adverse impacts and will identify and assist in avoiding or otherwise record any activity with potential impacts on cultural resources.

Table 4-19
Surface-to-Air Program potential impact and archaeological survey status

Project Name	Area of Impact[a]	Potential Impact	Survey[b]
ERINT	north range (Sulf site), south range (LC-50)	debris recovery, chemical simulant	unknown
FAADS	north range (FAADS Valley, Oscura, Red Rio)	warhead, debris recovery, radioactivity, personnel, off-road vehicles	+
HAWK	all range	solid fuel, debris recovery	+
NCTR	south range (LC-31)	N/A	N/A
NLOS	south range (LC-50, targets)	solid fuel, warheads, debris recovery, petrol products	
PATRIOT	all range	vehicles, debris recovery, warhead, personnel	+
RAM	south range (LC-34, LC-50)	solid fuel, warhead, debris recovery, personnel	+
STORM	unspecified	unspecified	unknown
THAAD	south range (LC-37)	liquid fuel, warhead, solid fuel, chemical simulant	+

a Areas of impact include launch complexes, target sites, recovery areas, and any area of project-related activity

b A positive sign (+) indicates that archaeological survey in the project areas has been completed as of this writing, and an N/A indicates not applicable.

Table 4-20
Surface-to-surface program potential impacts and archaeological survey status

Project Name	Area of Impact*	Potential Impact	Survey
ATACMS	south range (LC-33, Rhodes)	solid fuel, debris recovery, warhead	unknown
LOSAT	south range (Small Missile Range)	solid fuel, debris recovery, warhead	unknown
Navy Gun	south range (LC-37)	N/A	N/A

a Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity

Table 4-21
Target system program potential impacts and archaeological survey status

Project Name	Area of Impact[a]	Potential Impact	Survey
XQUH-1B	south range (GAM, ROWL)	liquid fuel, debris recovery, warhead	unknown
QS-55	unspecified	unspecified	unknown

[a] Areas of impact include launch complexes, target sites, recovery areas, and any areas of project-related activity.

Other ordnance is used on a continuing basis in secured training ranges. While this ammunition is generally nonexplosive, the cumulative impact on cultural resources could be substantial. Review of target locations, based on archaeological survey, would allow complete mitigation or avoidance of sensitive sites in these types of areas.

Erosion control measures may need to be implemented in areas. It is doubtful that herd and grazing activity have greatly affected archaeology sites on WSMR (Breternitz and Doyel 1983).

The vast size and dispersed nature of facilities on WSMR require an extensive transportation, communications, and utilities network. While much of this network is deployed along existing roads, a great deal also is routed crosscountry. It would be preferable for conservation of cultural resources to locate all utilities along existing roads. Archaeological surveys of proposed easements followed by mitigation and/or avoidance (which is highly feasible cross-country) would eliminate impacts to cultural resources.

Unauthorized collection of cultural materials by range personnel does occur, although to a lesser extent than on other publicly accessible federal lands. Expeditious enforcement of federal archaeological regulations, with an emphasis on deterrent penalties, combined with a positive program of public education, would substantially reduce these impacts. Therefore, these impacts are not expected to be adverse.

4.6.2 No Action Alternative

This section describes the potential environmental impacts of the no action alternative.

Consequences to cultural properties under this alternative fall primarily into categories of neglect-associated impacts. The main effects of concern also would occur under the proposed action alternative as well, but may occur to an exaggerated extent under the no action alternative. Effects include natural degenerative processes and vandalism.

- Natural degenerative processes:
  - general debilitating effects of time and climate;
  - impact due to livestock, burrowing animals, and insects; and
  - unimpeded natural degeneration due to neglect of property.

- Vandalism:
  - commercial and noncommercial gain, and
  - willful defacement and destruction.

Livestock (including feral horses or large herds of wild ungulates) can affect exposed and unexposed cultural resources. Ceramic and lithic artifacts at the surface level, as well as any standing architecture, can be displaced, damaged, or destroyed by livestock. Direct damage may be due to the presence of animals, while secondary damage can occur as a result of erosion caused by the decrease in vegetative biomass due to grazing (COE 1990).

Natural climatological processes are myriad, and gradually obliterate the scientific value of cultural resources. Frost heaving is an example of a repeated natural effect that can result in damage to cultural resources. Soil stratigraphy, generally used for dating sites and artifact constellations within a site, may be disturbed by cycles of thawing and freezing. These cycles tend to result in the vertical movement of objects within the soil. Objects may eventually move to the surface and be dispersed from there. Movement due to frost heaving varies with soil type, soil moisture content, overburden pressure, and rate of frost penetration (COE 1990).

Vandalism is a problem ubiquitous to all antiquities sites and it is likely to occur under both the proposed action and the no action alternative. Mitigation of potential vandalism effects can occur directly through law enforcement actions, or indirectly through improving public awareness and posting signs (COE 1990).

4.6.3 Cultural Properties Discovered During Construction or Operations

Procedures that apply to properties discovered, uncovered, or affected in an unanticipated manner during construction or ground disturbing operations are specified in 36 CFR 800.11. If undiscovered properties appear likely to exist after, or on the basis of, a cultural resource inventory or survey the WSMR Environmental Services Division would identify the need for preparation of a specific contingency plan for treatment in accordance with standards set forth in 36 CFR 800.8.

If historic properties are discovered in the absence of such a plan, the WSMR Environmental Services Division would be informed immediately and the historic properties will be avoided. The WSMR Archaeologist would assess the potential adverse effects and consult with the State Historic Preservation Office (SHPO) to determine an appropriate course of action in compliance with the terms of the Programmatic Memorandum of Agreement (PMOA) concerning consultations, and Native American Graves Protection and Repatriation Act (NAGPRA) when appropriate.

Every effort would be made to avoid, minimize, or mitigate harm to such a property until consultation and treatment requirements can be met as specified in 36 CFR 800.11 and Army Regulation AR 420-40, paragraph 3-6.

4.6.4 Consultation With Native Americans

Consultation with representatives of indigenous Native American groups would be initiated to determine sites of religious significance to be avoided during any undertaking. Previous projects (Human Systems Research, Inc. 1991) have employed informal consultations and field surveys in the vicinity of the Oscura Range to assess the presence of such sites, or Traditional Cultural Properties.

NAGPRA requires consultation in the case of ancestral grave sites that may be disturbed, either by design or by inadvertent discovery, during any proposed action. Prior to any undertakings, an Memorandum of Understanding (MOU) between possibly affected tribal organizations and WSMR should be drafted. The act specifically requires that, unless appropriate consultation and MOUs have been made with Native Americans regarding grave sites, work must be halted for 30 days upon discovery of a burial site.

4.7 LAND USE

This section discusses the potential impacts of the proposed action and the no action alternative on land use at WSMR.

The land areas used for future missions at WSMR include all existing facilities and use areas, as well as potential new developments in currently unused areas. As the mission goal for WSMR is diverse, involving large-scale research, testing, and development activities, it is impossible to predict specific future land use needs for the base. These issues will need to be discussed on a case-by-case basis incorporating the needs and scheduling of project proponents and WSMR.

WSMR has exclusive use of approximately 809,400 hectares (2,000,000 acres) within its boundaries for military purposes. Agreements for temporary and periodic use of White Sands National Monument (WSNM), San Andres National Wildlife Refuge, the Jornada Experimental Range (JER), and the Call-Up areas to the north and west of the range boundaries have been established and are expected to be maintained. These use agreements encompass approximately 178,120 hectares (440,125 acres) of land including small off-site instrument locations within New Mexico.

4.7.1 Proposed Action and ROIs

This section describes the potential environmental impacts of the proposed action. The following is a description of specific regions of land use that come under influence in the proposed action. The three mission goals for installation support are as follows:

- to promote the most efficient and cost-effective land use plan dealing with facility location and function;
- to plan and coordinate development to ensure compatible land use for future growth and change on the range and the post; and
- to enhance and preserve the visual, aesthetic, and natural resources of the installation.

The goals are to be accomplished by integrating complementary architectural designs with natural landscapes, integrating environmental protection and preservation activities, and minimizing adverse impacts from future development activities by implementing a real estate management plan.

WSMR would continue to support existing and future research, development, and test and evaluation missions. Its facilities and equipment would be used, and the potential for new projects is high. Structural building, improvement, and demolition are scheduled throughout the range, with an emphasis on the Main Post and Cantonment area. Future project areas may be established as required by individual proponent specifications.

4.7.1.1 Main Post and Cantonment. This land parcel of almost 809 hectares (2,000 acres) is likely to remain as WSMR primary headquarters. The majority of operational support is centralized here, including (but not necessarily limited to) administrative, industrial, community support, family and troop housing, maintenance and supply, and storage.

4.7.1.2 South Range Launch Complex and Support Areas. These areas support ground-to-ground and ground-to-air missile firings. Each complex hosts firings based on need, safety criteria, instrumentation coverage, and range scheduling. Six additional launch complexes have been set aside for future development.

4.7.1.3 South Range Land Use Area South of U.S. Highway 70. Condron Airfield features two large runways and is used for a variety of transports, maneuvers, and procedures. LC-33 is listed in the NRHP, is a National Historic Landmark, and will continue to hold this status. The Nuclear Effects Laboratory provides a simulated nuclear environment used for research purposes. The magazine area houses explosive ordnance, missile engines, and weapons and will continue to have importance as a major ordnance warehouse.

4.7.1.4 South Range Land Use Area North of U.S. Highway 70. This is a high-use area conducting diverse activities. Weapon testing and ordnance disposal areas are situated here.

The Small Missile Range provides technical support for testing programs. The HELSTF facility also is a regularly used high-energy laser weapons system testing area. WSSH provides landing and flight support for the space shuttle program. The publicly used WSNM also is located here, and receives approximately 600,000 visitors per year with a projected increase of 2 to 5 percent each year.

4.7.1.5 Southwestern Range Area. WSTF is an 24,605 hectares (60,800 acres) site that maintains storage, administrative, and test facilities, and would continue to provide these services as required under current and upcoming programs. The expansion of WSTF facilities is not currently proposed. Any future expansion would be addressed in appropriate environmental documentation. All undertakings with potential to impact species protected within the adjacent San Andres National Wildlife Refuge are subject to review.

4.7.1.6 Central Range Land Use Area. ORC is an operational Support center for testing activities in the northern sector of the range. It also is a technical support area for communications and instrumentation. Rhodes Canyon Range Center (RCRC) is a permanent operational area that supports missile missions. A variety of other test and weapons impact areas exist in the central range area and would be used frequently under the proposed action.

4.7.1.7 North Range Land Use Area. Stallion Range Center (SRC), NORC, RRTC, and the FAADS valley sites provide operational support headquarters, mission support, maintenance, security, communications, missile tracking, support personnel and equipment, and instrumentation areas for programs assigned to the north range. Programming would place increased emphasis on these resources under the proposed action.

The Trinity site encompasses 14,763 hectares (36,480 acres) in the north range area and is a National Historic Place and a National Historic Landmark. Public visitation is offered on a regularly scheduled semiannual basis.

4.7.1.8 WSMR-controlled and Joint-use Area. Joint-use areas including FIX, Aerobee, ABRES 4A, and ABRES 4AX are adjacent to the north and west boundaries of

WSMR. These co-use Call-Up areas are leased from 40 to 50 individual landowners, including the Bureau of Land Management. Total land area at present exceeds 607,050 hectares (1,500,000 acres). Lease agreements are likely to continue as a means of preserving flexibility in scheduling projects that require these areas.

The JER is maintained under an agreement between the U.S. Army and the Crops Research Division of the Agricultural Research Service. This agreement is likely to continue. MOAs or MOUs between government agencies would continue to be observed and developed as necessary for Call-Up areas in adjacent states.

4.7.1.9 Non-WSMR-controlled and Nonjoint Land Use. Fort Bliss shares joint-use areas with WSMR. Agreements between the two agencies pertain to shared firing and maneuver areas, and are expected to continue. Holloman AFB is situated on the northeast boundary of WSMR. This is a non-WSMR-controlled multi-use facility, maintaining its own directive of operations.

4.7.1.10 Minerals. All mining claims on WSMR have been acquired by the U.S. Army. Future mining operations are not anticipated.

4.7.1.11 Grazing. With the exception of a small co-use area on the JER and limited activities near the Main Post, livestock grazing is not permitted on the range. Implementation of a larger grazing program could conflict with the military testing and security mission of WSMR and be exceedingly hazardous to livestock.

4.7.1.12 Hunting. Fourteen seasonal open-hunting and trapping areas have been designated on WSMR. These may be hunted under provisions set forth in WSMR regulations. Alterations or impacts on the current status of hunting and trapping regulations at WSMR are not foreseen at this time.

4.7.2 Building Schedules

As a federal landholding agency, WSMR is obligated to report all unutilized, underutilized, excess, and surplus real properties (including land, buildings, and fixtures) to Housing and Urban Development. This regulation is a requirement under Title V of the Stewart B. McKinney Homeless Assistance Act. HUD collects this information on a quarterly basis and uses it to determine if properties are suitable for use by the homeless. WSMR must report all buildings scheduled for demolition to HUD. As WSMR is isolated from any urban areas, this has not proven to be a problem.

WSMR maintains a no-growth policy with regard to scheduled building construction. If a facility is scheduled for construction, then a building of like size (square foot for square foot) must be demolished, either at WSMR, or at another U.S. Army Test and Evaluation Command (TECOM) facility. This policy is structured to regulate the demolition of out of date, unusable, or unoccupied buildings throughout TECOM, while monitoring the structural growth of the facilities. Facilities scheduled for demolition at WSMR are monitored by the Master Planning Division (MPD). The Real Property Planning Board (RPPB) reviews all proposed construction activities on WSMR. It uses the Space Utilization report to make decisions on reshuffling and moth balling existing facilities, based on the downsizing of the U.S. Army and a lack of maintenance funds (U.S. Army 1993k). Historic preservation procedures are reviewed prior to the demolition of any structure. In accordance with these procedures, WSMR is attempting to preserve a set of historic structures on post that. illustrate an important era of range history.

The RPPB is developing a building permit procedure to handle the requirements of different types of construction projects. This will cover all footprint areas (any project that alters land). RPPB Siting Action Guidelines are currently in the draft stage. This action will direct all individuals and organizations intending to construct real property facilities on WSMR and its Call-Up areas on the policies, responsibilities, and procedures for RPPB actions. Requests for facilities support is through the Engineering and Housing Directorate (U.S. Army 1993k).

Decisions made by the MPD will affect future generations at WSMR. Planning should be undertaken in a deliberate fashion involving both project proponents and personnel who are committed to community planning. Locations like the Cantonment area must be planned with logic, cohesion, coherence, and rationale. Facilities should be located in convenient areas with aesthetics in mind. WSMR has an Installation Design Guide that helped the base win the U.S. Army Community of Excellence award in 1992. This guide should be used in conjunction with other planning activities undertaken by the Directorate of Public Works. A good example of recent zoning and planning work on the post is the new shopping district. This area consists of a new commissary, PX, shoppette, and theater, and is an asset to the base community as it attracts customers by centering people working together with related function in a common location (U.S. Army 1993k).

4.7.3 No Action Alternative

Consequences to land use and development of the no action alternative may be fewer than those resulting from the proposed action. This is so because the no action alternative prohibits additional construction, or testing of programs employing radically new technologies. Under the proposed alternative any projects proposing such developments will be required to address potential impacts on land use and development in their associated environmental documents.

4.8 UTILITIES AND INFRASTRUCTURE

This section describes the potential impacts of the proposed action and the no action alternative on WSMR utilities and infrastructure. Included in the analysis are those facilities and systems that provide WSMR with electrical service, telephone service, natural gas, mobility fuels, water, and sanitary and solid waste handling. It is noted that the existing infrastructure is adequate for all programs and operations under the proposed action.

4.8.1 Proposed Action

Under the proposed action, WSMR would continue its present testing and training activities using current range capabilities to support existing programs. WSMR also would expand its mission capabilities beyond its present level in order to test future missile systems.

4.8.1.1 Electrical Service. Any increase in WSMR project electrical requirements resulting from the proposed action would create an increased demand for the load area servicing the new project. As described in Section 3.8.1, electricity to the load areas is currently provided to WSMR from four sources: El Paso Electronic Company (94 percent), and from Otero County Electric Cooperative, Sierra Electric Cooperative, and Socorro Electric Cooperative (6 percent combined total). In fiscal year 1991 (October through September), WSMR consumed 109,041 MWh of electricity. The majority of the facilities at WSMR are serviced from 345 and 115-kV transmission lines and 14.4 and 24.9-kV distribution lines. It is anticipated that new facilities could be added to these existing lines without major changes.

The implementation of the proposed action would result in modifications or additions to the WSMR electrical system. There are currently four ongoing or planned programs that would

Table 4-22
Annual electrical consumption of WSMR planned programs

Program	Anticipated Consumption (kWh)	Affected Load Area
BAT/Zumwalt Test Track	9,000	load area #2
Large Blast/Thermal Simulator	5,356,800	load area #3
Aerial Cable (Murray Well)	60,000	load area #3
Aerial Cable (PHETs East Park)	302,000	load area #3

Note: kWh = kilowatthour

require additions to the WSMR electrical distribution facilities. These programs and their anticipated annual usages are presented in Table 4-22. All impacts related to ground disturbances created by the installation of new transmission line corridors and poles from the proposed action are potentially adverse but mitigable and would be addressed by project-specific NEPA documentation.

4.8.1.2 Communications Systems. In some cases, telephone services can be provided to a new program by reactivating an inactive telephone connection. New telecommunication lines required as a result of the proposed action would occur, along existing roadways where available.

Under the proposed action, existing systems may need to be modified or rebuilt. All copper cable used in telecommunications on the base would be replaced by fiber optic cable. When completed, this new cable would form a loop around the entire range. The first 145 km (90 mi) of this loop have been replaced already. The existing Dial 1 stations (previously discussed in Section 3.8.1.2) would be used as central offices for the system. In addition, fiber optics would be run to each of approximately 115 optic van sites scattered throughout the range to allow vans collecting test data to plug in at each site. The following is the general chronological and priority order of these modifications.

- Main Post to Stallion Gate (145 km [90 mi]). Status: complete.
- King I to Oscura Range (72 km [45 mi]). Status: ongoing; to be completed by 1998.
- Junction 9 to Rhodes Canyon (40 km [25 mi]). Status: planned; to be completed in 1998 to 2003 after the completion of King I to Oscura Range.
- Main Post. Status: planned; all wire is to be replaced in a star configuration with technical area 123 as the central office leading to all other buildings; to be completed in 1998 to 2003.
- Optic van sites (115 sites). Status: planned; no schedule available.

4.8.1.3 Natural Gas and Other Heating Gas Systems. The natural gas/heating system on the Main Post should have no difficulty absorbing loads imposed by construction of facilities included in the current U.S. Army military construction program. New projects within

the environmental test area may require natural gas service and will require a resolution to meet this need. Getting natural gas to the environmental test area could cause a pressure loss to the Main Post system. If the environmental test area required gas, it could tie directly into the 7.6-cm (3-inch) El Paso/Alamogordo transmission line. There would be no adverse effects to the Main Post system from this option, and it would provide the potential for expansion of this new system to other areas outside the Main Post.
The existing WSMR natural gas distribution system is undergoing rehabilitation to replace leaking and aged pipes and to install a cathodic protection system to detect leaks (COE 1992e). Major additions to the distribution system segments are not considered to be necessary for the foreseeable future. New access to the existing steam lines required by the proposed action would require only minor modifications and additions.

A 1992 (COE 1992d) analysis of the WSMR natural gas/heating system found that there should be no problems with the WSMR natural gas supply for the foreseeable future. This COE report suggests that there are no limits to the existing system and that the supply is adequate. The consumption of natural gas has decreased over the past several years resulting in an actual increase in the efficiency of the system.

Only one major U.S. Army military construction project is planned to upgrade the existing gas/heating system (COE 1992d). The central heating and cooling plant project is intended to serve the technical area and other buildings in the immediate vicinity. In addition, gas/heating system additions would be required to support individual U.S. Army military construction projects.

4.8.1.4 Mobility Fuels. There are no new facilities planned for the storage and distribution of mobility fuels at WSMR. The current system is adequate to Support the proposed action. New program requirements would require assessment on a project-specific basis.

WSMR intends to upgrade one of the two delivery tankers currently used at SRC to deliver aviation fuel (Jet Propulsion Fuel No. 8). The 7,571 L (2,000-gal) tanker will be replaced with an 18,927 L (5,000-gal) tanker in 1994.

4.8.1.5 Water Systems. A variety of programs have been implemented in-house to upgrade the water system, both in the Main Post area and elsewhere on WSMR. These projects include replacement of water lines and storage tanks, upgrading of the fire flow loop in the Main Post technical area, and major repairs to pumps on a rotating basis. Major additions to, or replacement of, system components are not anticipated in the foreseeable future. Exceptions include the continuing replacement of corroded/encrusted cast iron and concrete reinforced steel cylinder lines and a well development and storage project at Soledad Canyon (see Section 3.2.5.12).

The existing program of routine well maintenance and repair, periodic line replacement, and new well and storage development would provide adequate water supply for the foreseeable future. However, U.S. Army findings (COE 1992) document that the entire system on the post should be reevaluated in more detail in the event of major facility development or expansion beyond 13,000 persons, and the SRC system must be evaluated due to new facilities requirements.

With the exception of a requirement for upgrading in the technical area, the distribution network in the Main Post area is adequate to support current and foreseeable future populations (COE 1992). In 1992, the COE determined the SRC distribution system to be adequate.

4.8.1.6 Sanitary Waste Disposal Systems. The Main Post waste collection system generally is in good condition and operates at only 25 percent of its maximum capacity during peak-flow periods. It serves a current population of 5,000, but has supported over 13,000 in the past. The Main Post wastewater treatment plant originally was designed to provide a 4.4 x 10^{-2}-m^3/s (1-MGD) operating capacity. The system currently is operating at approximately 50- to 60-percent capacity. The proposed action is not expected to result in significant changes to the WSMR sanitary waste disposal systems. Both the Main Post and SRC collection and treatment systems could support a considerable increase in population (up to 100 percent) without significant changes.

The majority of the WSMR septic tank systems are in good condition and suitable for their intended and continued use. The proposed action may result in new or expanded septic tank and leach field systems.

4.8.1.7 Solid Waste Handling Systems. These systems include new or expanded landfills and the transport of wastes.

New or Expanded Landfills

The Main Post landfill currently occupies an area of approximately 10 hectares (25 acres). Under the proposed action, operations are anticipated to continue until the year 2000 when the total area of the landfill is expected to be approximately 32 hectares (80 acres).

The contractors' area of the Main Post landfill currently occupies approximately 2 hectares (5 acres) for disposal of construction/demolition wastes. As this disposal area fills, new cells will be opened to the north. This portion of the landfill is anticipated to occupy a total area of 6 hectares (15 acres) before this site is closed in the year 2000 (Battelle Environmental Management Operations 1990).

Under the proposed action, operations at the SRC landfill are anticipated to continue at the present site for 10 years (Battelle Environmental Management Operations 1990). In addition, there is room for expansion immediately south of the present landfill and adjacent to the fence line. Impacts to utilities and infrastructure are not expected to be adverse.

Transport and Handling of Solid Wastes at Range Centers and Remote Sites

Potential consequences to the solid waste transportation system from the implementation of the proposed action include increased transportation from existing and new sites. The proposed action would increase the amount of waste collected and transported to both the Main Post and SRC landfills. The current transportation systems at WSMR are adequate to support the proposed action.

4.9 TRAFFIC AND TRANSPORTATION

This section describes potential impacts on the traffic/transportation network on and adjacent to WSMR. In this assessment, current and past WSMR activities and resulting environmental consequences were used to assess potential consequences of the proposed action and the no action alternative.

4.9.1 Proposed Action

This section describes the potential environmental impacts associated with the proposed action. Given the programmatic nature of this EIS, no attempt was made to predict impacts to the traffic/transportation network surrounding WSMR on a quantitative basis. Rather, the impacts are discussed qualitatively.

4.9.1.1 Program Support Modification. Many of the proposed construction projects would require the building of additional roads. Planning roads to meet the needs of multiple projects could result in a beneficial impact on WSMR by increasing the available transportation network. However, existing roads would experience increased use, resulting in increased traffic and additional maintenance costs.

4.9.1.2 Future Programs. Changes in the number of missions for all categories of future programs would impact the traffic/transportation network supporting WSMR. The number of roadblocks on U.S. Highway 70 affecting civilian motorists traveling between Las Cruces and Alamogordo, New Mexico, would change directly with the change in the number of future missions conducted. An increase in the number of future missions for any category of programs has the potential to increase the number of roadblocks on U.S. Highway 70. These roadblocks are conducted as mission safety precautions.

In addition to the potential for more roadblocks on Highway U.S. 70, a change in the types of programs conducted at WSMR may result in the necessity for WSMR to change their agreement with the state of New Mexico regarding the duration of roadblocks. Increasing the duration of roadblocks would result in additional delays and inconveniences to motorists on U.S. Highway 70.

An increase in the number and duration of roadblocks on WSMR may necessitate the construction of widened areas to handle backed-up traffic and areas with facilities for stranded motorists. Although this would positively impact the WSMR transportation network, additional expenses to the public would be incurred.

An increase in the number of missions would result in increased traffic flow on surrounding highways and roads. Potential impacts may include necessary road expansions (such as the recent expansion of U.S. Highway 70 at San Andres Pass) and an increased level of maintenance and repair to these roads. Increasing future missions on WSMR may result in a higher use rate of airstrips and helipads located on WSMR. This would result in increased repair and maintenance costs.

A change in the number of missions on WSMR has the potential to impact traffic flow on surrounding highways and roads. The majority of the range roads on WSMR operate at levels well below their maximum allowable capacities. WSMR activities would have to increase four to five times current levels for any measurable impacts to occur on these roads.

Any reduction in activities at WSMR would have a positive impact on the traffic flow at the Las Cruces access gate to WSMR. An increase in activities would result in increased traffic congestion at the Las Cruces gate; traffic is already over capacity. The existing traffic congestion has already prompted WSMR to make plans for expanding Range Road 1 to two lanes in each direction. Although this would positively affect the transportation network serving WSMR, increased construction, maintenance, and repair costs would be incurred.

Roads on and surrounding WSMR have a maximum allowable weight capacity of 18,000 lbs per single-axle loading (Diaz, pers. com. 1993b). This maximum allowable capacity is based on the use of dual tires for large trucks and equipment. Given these standards, WSMR roads can handle vehicles of any size or weight meeting these regulations. In recent years, a super-radial tire has been developed to replace the need for dual tires. While these tires are more cost effective for the operation of these vehicles, their impacts on roads are quite destructive. The concept of dual tires allows the weight to be distributed among the two tires. With the single super-radial tire, the impact of the weight being distributed on the single tire is equivalent to the impact of 9,600 lbs per axle (Diaz, pers. com. 1993b).

A large number of project-related vehicles on WSMR are using these super-radial tires. The increased use of these tires has forced WSMR to increase the thickness of pavement used to construct and repair roads from 2 to 3 inches (Diaz, pers. com. 1993b). An increase in the number of missions or a change in the types of missions on WSMR has the potential to increase the use of the super-radial tires. The increased construction, maintenance, and repair costs would be negative impacts. Impacts to traffic and transportation would be minimal.

4.9.2 No Action Alternative

This section describes the potential environmental impacts and consequences associated with the no action alternative. With regard to future programs, the transportation network, traffic volumes, and roadblocks would remain at current levels. Periodic maintenance and repair of roads, airstrips, helipads, and other facilities still would be required. The existing transportation/traffic network would not be adversely affected.

4.10 RECREATION

This section discusses the potential recreation impacts resulting from the proposed action and the no action alternative.

4.10.1 Proposed Action

The recreation opportunities on the base and in the surrounding vicinity are numerous and varied. Recreation uses range from significant historic and geologic features to national and state forests and parks, and from on-base uses such as hunting, golf, and athletics to nearby skiing, camping, and nature viewing. This section describes the potential impacts the proposed action would have on recreation facilities and opportunities.

Recreation at WSMR is managed by the Community Recreation Division. The Community Recreation Division maintains recreation facilities and opportunities per AR 215-2, Chapter 6 (U.S. Army 1990e). The objectives of the Community Recreation Programs are to assist commanders in maintaining morale, esprit de corps, and mental and physical fitness of the soldiers (U.S. Army 1990e). As recreation demand for new or improved facilities increases at WSMR, the Community Recreation Division shifts resources to meet that demand. The recreation opportunities at WSMR are, therefore, planned and designed to accommodate as many base personnel as possible. Although recreation trends change over time, the demand for recreation uses at WSMR and in the surrounding area would not change substantially under the continuation of the current activities.

Surrounding off-base recreation facilities do not have the flexibility, requirement, or desire that WSMR has to stay abreast of recreation trends. These facilities offer specialized recreation Opportunities (i.e., camping, sightseeing, skiing, boating) in which demand and patronage are fairly constant annually. Therefore, the continuation of the current activities at WSMR would not adversely impact surrounding recreational facilities and opportunities.

Modernization and improvement of outdated services at WSMR also would not adversely impact recreation use on the base or in the surrounding area. These improvements have been occurring at WSMR over time and would not substantially increase or decrease recreation demand or opportunities on the base or in the surrounding area.

The changes to project programs, site usage, and services proposed over the next 10 years could impact recreation demand at WSMR and, to a lesser extent, in the surrounding area. Should any of the new programs or program changes require a substantial increase or decrease in the number of personnel at WSMR, base and nearby recreation demands and services could be affected. Recreation demands and services could be degraded due to possible overcrowding, facility overuse, reduction of facilities, and subsequent access restrictions. Any one of these results would make the affected recreation facilities less attractive and less enjoyable.

Such a large change in the number of personnel, however, is not anticipated. Recent base histories have not included any dramatic changes in the number of base personnel (Eckles, pers. com. 1993b). Less dramatic increases in personnel can be accommodated on the base by shifting resources to meet the increased demand. The Community Recreation Division would be aware of all new or changed programs. Therefore, the Community Recreation Division can anticipate the increased personnel and their arrival dates and can make appropriate changes to accommodate the new recreation demand (Reinhart, pers. com. 1993).

Overall, the proposed action could be adequately accommodated by the base command, and would not result in adverse recreation impacts.

4.10.2 No Action Alternative

The no action alternative would involve the continuation of the current WSMR activities. This would result in the same level of recreation opportunities on the base and in the surrounding area as currently exists. Periodic improvements and upgrades to existing recreation facilities would still be required. The existing recreation facilities and opportunities would not be adversely affected.

4.11 AESTHETICS AND VISUAL RESOURCES

This section describes potential impacts of the proposed action and the no action alternative on the visibility and aesthetics qualities at the sites delineated in Section 3.11.

4.11.1 Proposed Action

Consequences to aesthetics and visual resources under the proposed action include the following.

- Potential to degrade the quality of the aesthetic and visual resource panorama by increasing vehicle traffic, increased missile launches, increase of buildings and structures to support the proposed action, and more frequent closure of U.S. Highway 70 due to increased activity at WSMR.

- With increased activity at WSMR, more visitations to sites that provide aesthetic and visual value, including Trinity site, would take place and could potentially degrade their quality.

- increased activity at WSMR may have a negative impact on wildlife, specifically in the Bosque del Apache National Wildlife Refuge and the

Jornada del Muerto Wilderness Study Area as wildlife is a major attraction at these areas.

- Any buildings to be constructed must adhere to NHPA and minimize their impact on viewscapes from buildings that have been included in the NHPA listings.
- Increase in countermeasure types of operations could produce levels of smoke or dust that may negatively affect the viewscapes in and around WSMR.
- Increase in air traffic and missile flights could degrade, on a short-term basis, the serenity of scenic vistas if the flight patterns interrupt the views.
- Buildup of housing in the Las Cruces area to support an increase in activity at WSMR could lead to an increase in carbon monoxide and other combustion gases, which would have a deleterious and somewhat continuous degradation on visibility.
- Increased activity at WSMR could require increased outdoor lighting, causing adverse impacts on astronomical observatories in the area. These impacts could be reduced by using yellow sodium vapor lights or fitting lights with glare shields.
- Increases in construction resulting from the proposed action may result in structures visible from the White Sands National Monument. Impacts to the viewshed could be reduced by integrating natural colors and contours in the structure design.

4.11.2 No Action Alternative

The no action alternative would reduce impacts on the aesthetic and visual resources. However, there would continue to be potential adverse impacts to the resources under the following circumstances.

- Replacements for existing buildings that have outlived their usefulness are located within viewscapes of areas listed in Section 3.11 or buildings larger than those presently existing are constructed.
- Launch locations are moved into areas that are within viewscapes of those areas listed in Section 3.11.
- Light pollution would continue from major existing facilities such as the Main Post and NASA WSTF. These impacts could be mitigated by the use of lower emission lights and glare shields.

4.12 NOISE

This section describes noise effects in general, and the potential environmental impacts of noise associated with the proposed action and the no action alternative.

4.12.1 Noise Background

Noise (sound) is defined by the physical characteristics of intensity and audio frequency. intensity is measured in units of decibels (dB) based on a logarithmic scale. Sound measurement can be additionally represented by the use of an "A-weighted" decibel scale, emphasizing the audio frequency response curve, which is audible to the human ear in the region between 1,000 and 6,000 cycles per second (Hz). A-weighted sound pressure levels correlate well with subjective loudness. In most cases, decibel measurements used in this EIS are general-use A-weighted and identified by the use of the units dBA (Harris 1991). Typical dBA noise levels of familiar sources are shown in Figure 4-1. Day-night average sound level measurements (L_{dn}), will be used for some multiple aircraft activities. L_{dn}s represent a 24-hour equivalent continuous level in dBA where 10 dB are added to nighttime noise levels from 10 p.m. to 7 a.m. Sound Exposure Level (SEL) measurements are used to represent that constant level in dBA which, lasting for one second, has the same amount of acoustic energy as a given A-weighted noise event. L_{max}, a single-event maximum metric sound level, is the highest A-weighted sound level measured during a noise event. It provides no duration or amount of sound energy information but is used to assess possible effects on animals (U.S. Air Force 1993b).

Noise effects on humans are physiological (hearing loss and nonauditory effects), behavioral (speech interference, sleep interference, and performance effects), and subjective (annoyance). The human auditory system has difficulty in detecting slight changes in loudness. In most situations, a 2-dBA change is not noticeable unless the two noise events occur within a matter of seconds. Usually, a 5-dBA change is necessary to be registered by the human ear. As an example, when the sound level is doubled as measured with a sound meter resulting in a 3-dBA increase, the human individual experiences only a 23-percent increase in perceived sound level. Similarly, a tenfold increase in sound level (10-dBA increase) is necessary for a human individual to experience a doubling in perceived sound level (WSMR Environmental Services Division 1993d).

The potential impact on wild and domestic animals of sound produced by subsonic, low altitude aircraft flight operations concerns farmers and ranchers whose livelihood depends on their livestock, federal and state regulatory agencies who are responsible for protecting our wildlife resources, and the American public. Particular attention is given to sensitive species that require special management techniques. These animal groups include threatened and endangered species, some waterfowl, and various large game animals (U.S. Air Force 1993b).

Many reported observations rather than systematic evaluations are available on the short-term effects of subsonic, low-altitude aircraft noise on wild or domestic animals. However, there is a scarcity of experimental data regarding the long-term effects. Numerous reports of animal panic or startle reactions to low-flying aircraft shows that there is a potential for adverse noise impact. The current research is inconclusive. It has not produced a generally accepted SEL above which it can be expected to cause detrimental effects in animals. Though current studies make it difficult to reach conclusions with confidence, it is thought that observable effects start to appear in some animals at roughly L_{max} 85 to 90 dBA (U.S. Air Force 1993b).

A dramatic and intrusive source of noise is the sonic boom created by a supersonic object (e.g., aircraft, space vehicle, missile) moving through the air. As any body moves through the air, the air must part to make way for that body and then come together again once the body has passed. In subsonic flight, pressure signals (precursor waves that travel at the speed of sound) move ahead of the body and the parting of the air (the passage of the body) is a smooth process. In supersonic flight, precursor waves cannot precede the body and the parting process

Public Response	dBA	Familiar Sources
Injury	150	
	145	
Physically Painful	140	Sonic Boom
Extremely Loud	135	
	130	EPA/USAF Aerospace Medical Research Laboratory - "No Serious Health Problems"
	125	
Threshold of Physical Discomfort	120	Jet Takeoff (near runway)
	115	
	110	Rock Music Band (near stage)
	105	Piledriver at 50 Feet
Very Loud	100	
	95	Freight Train at 50 Feet; Ambulance Siren at 100 Feet
Hearing Damage Critieria for 8-hour Workday	90	
	85	Inside Boiler Room or Printing Press Plant
Most Residents Highly Annoyed	80	
	75	Garbage Disposal Inside Car at 50 MPH Freight Train at 100 Feet
	70	
Loud - Acceptable Limit for Residential Development	65	Acceptable for Residential Land Use
	60	
Goal for Urban Areas	55	Inside Department Store
	50	Daytime Suburban Background
	45	
	40	Bird Calls; Normal Levels Inside Home
	35	Library
No Community Annoyance	30	Quiet Rural Area
Quiet	25	
	20	Inside Recording Studio
	15	
	10	Leaves Rustling
	5	
Threshold of Hearing	0	

Source: WSMR Environmental Services Division 1993c

Figure 4-1. Typical noise levels of familiar sources, and public response

is abrupt. A bow shock wave parts the air, which expands as it passes around the body, and then a trailing shock wave recompresses the air as it closes behind the body. These waves travel through the atmosphere as pressure waves and are called sonic boom because of the abrupt noise they generate when passing an observer. This general pattern of bow shock wave, expansion region, and recompression shock is commonly associated with the sonic boom. The phenomenon occurs for all supersonic flight. The duration of the wave depends mostly on the size of the object that produces the sonic boom. A medium-size aircraft such as the SR-71 or the Concorde transport produces a wave lasting approximately 0.2 seconds. A space vehicle (shuttle) will produce waves of similar duration.

The abruptness of the pressure change is responsible for much of the public's concern about sonic booms. It gives it the startling audibility and dynamic characteristics of an explosion. Even at great distances from the supersonic vehicle where pressure levels produced are physically harmless, some public complaints are received. Sonic booms are likely to be of concern in Space Shuttle operations because segments of the trajectories followed during ascent and descent involve supersonic flight within the atmosphere over populated land areas.

The characteristics of the shock pattern at its source are influenced by flight path characteristics (e.g., altitude, speed, angle of attack, flight path curvature, and accelerations either along or transverse to the flight path) and body characteristics (e.g., bluntness, weight, exhaust plume, and volume). The pressure signature that reaches the ground is subject to the additional factors of air turbulence, winds, and temperature variations of the atmosphere traversed by the pressure wave in addition to certain flight path characteristics.

Maneuvers associated with aircraft flight can result in focusing of the shock waves over small areas of the surface where overpressures may be greater than they would be for level flight. This focusing cannot be accurately predicted. Available flight test data for supersonic aircraft indicate that the pressures can be as much as two to five times higher in the shock wave focusing area than outside. Focusing occurs briefly during the boost (ascent) phase of a space vehicle launch.

Extensive knowledge of these factors gained by past studies of conventional supersonic aircraft provides much of the basic information required for the prediction of sonic boom pressure patterns (footprints that may extend up to 185 km [100 nautical miles] in any direction) for a space vehicle. It was necessary, however, to extend this basic knowledge by additional studies and experiments so that it would apply to a space vehicle shape and the extremely high speeds and altitudes at which it operates. Successful studies and testing of sonic booms from an Apollo spacecraft demonstrated that predicted and measured booms are in agreement.

Sonic booms are an impulse noise, defined as a discrete noise of short duration (fractions of a second) in which the sound pressure level rises very rapidly to a peak level. The most important parameter for characterizing impulsive noise are the peak sound pressure level, the effective duration, the rise time, and the number of repeated impulses.

The impulse noise of a sonic boom is not unique. Man-made explosions have many of the characteristics of a normal sonic boom. A natural phenomenon that bears a striking resemblance to a sonic boom is the thunder produced by lightning strikes. The overpressure and spectral content of thunder from lightning strikes (up to a distance of 1 km [0.6 mi]) are almost indistinguishable from those of sonic booms (NASA 1978).

Sonic booms tend to be unexpected. Impulsive noises that are novel, unheralded, or unexpectedly loud can startle people and animals. Even very mild impulsive noises can awaken sleepers. Because startle and alerting responses depend largely on individual circumstances and psychological factors unrelated to the intensity of the sound, it is difficult to make any generalization about acceptable values.

A high degree of behavioral habituation, even to intense impulse noises such as gunfire, is normally seen in animals and human beings when the exposure is repeated, provided that the character of the stimulus is not changed. Transient overpressures of considerable magnitude can be experienced under certain circumstances without significant discomfort. For example, the overpressures inside a car when the door is slammed (windows raised) are up to 19 kg/m^3 (4 psf) for standard sedans and station wagons and up to 42 kg/m^3 (8.5 psf) for compact cars. Overpressures of 59 kg/m^3 (12 psf) have been measured in public viewing areas during firework displays (NASA 1978).

Concern over increasing human activities and the increasing noise levels resulting from these activities has led to the promulgation and establishment of numerous noise criteria and limits for the purpose of human hearing conservation. Some of these criteria have received national or international acceptance or standardization, and some have been embodied in state and federal legislation (WSMR Environmental Services Division 1993d). The Occupational Safety and Health Administration (OSHA) of 1970 (Public Law 91-596) was established to "assure safe and healthy working conditions for working men and women." It delegated implementation and enforcement of the law to the OSHA of the United States Department of Labor. Title 29 CFR 1910.95 pertains to the protection of workers from potentially hazardous occupational noise exposure. OSHA regulations establish a maximum noise level of 90 dBA for a continuous eight-hour exposure during a working day and higher sound levels for shorter exposure time (Table 4-23). The relationship allows a 5-dBA increase in level for a 50-percent reduction in exposure time. In actual use, this effect is a continuous function up to a limit of 115 dBA, which is generally considered the sound level at which humans will experience pain. Protection against effects of noise exposure must be provided when sound levels exceed those in Table 4-23. Under OSHA regulations, exposure to impulse or impact noise should never exceed a 140-dB peak sound pressure level (WSMR Environmental Services Division 1993d). For missile and rocket launches (firings), the OSHA standard of 115 dBA within a 15-minute duration applies. This would include all such firings at WSMR.

The Noise Control Act (1972) was enacted for the purpose of promoting an environment free from noise that jeopardizes public health and welfare. This act designated the EPA as coordinator for all federal noise control programs. However, EPA discontinued their noise pollution program. Noise standards are now under the control of a variety of federal, state, and local agencies (WSMR Environmental Services Division 1993c).

The National Academy of Science/National Research Council Committee on Hearing, Bioacoustics, and Biomechanics has developed criteria for impulse noise, including an upper tolerance limit. Impulse noise levels that exceed the Committee on Hearing, Bioacoustics, and Biomechanics limit can produce inner ear damage and hearing loss. The Committee on Hearing, Bioacoustics, and Biomechanics limit for one impulse per day lasting 200 milliseconds (corresponding to a sonic boom) is a sound pressure level of approximately 145 dB without hearing protection (NASA 1978).

The acceptability to the public of sonic booms below the Committee on Hearing, Bioacoustics, and Biomechanics impulse noise limit is very complex and involves not only the physical stimulus, but also various characteristics of the environment and the experiences, attitudes, and opinions of the population exposed. Information bearing on this question was developed in a comprehensive study of sonic boom exposure of a large community conducted in Oklahoma City in 1964. Interpretation of the data relative to the Space Shuttle is difficult because the

Table 4-23
Permissible noise exposures

Duration (hours) per day	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 to 1.5	102
1	105
0.5	110
0.25 or less	115

Source: WSMR Environmental Services Division 1993c.

Note: dBA = "A" weighted decibel level

community was exposed to as many as 15 sonic booms per day. The estimated effect of a single sonic boom, derived from evaluating the multiple sonic boom data, was that a peak overpressure not exceeding 34 Pa (0.7 psf) will not annoy the public (NASA 1978).

Additionally, an evaluation of the Oklahoma City study was made by the International Civil Aviation Organization. In reviewing the effects of sonic booms produced by supersonic aircraft during normal flight operations, the ICAO derived the following findings:

- The probability of immediate direct injury to persons exposed to sonic boom is essentially zero.
- The percentage of persons queried who rated sonic booms occurring 10 to 15 times daily as annoying increased with increasing overpressures. For overpressures of less than 24 Pa (0.5 psf), no one rated the boom as annoying; 10 percent considered 48-Pa (1-psf) sonic booms annoying; and nearly all considered 144-Pa (3-psf) sonic booms annoying.
- Primary (loadbearing) structures meeting acceptable construction standards or being in good repair showed no sign of damage up to overpressures of 958 Pa (20 psf). Nonprimary structures such as plaster, windows, and bric-a-brac sustained some damage at overpressures ranging from 48 to 144 Pa (1 to 3 psf) (NASA 1978).

Noise impact on birds varies with detonation size, range from ground zero, and time of year. Studies on the impact of sonic booms on the birds of the California Channel islands indicate that there is little impact from such noise. Some birds are startled into leaving their nest, creating the possibility of dislodging eggs or raids by birds of prey. The studies showed that most nesting birds were quite careful not to disturb their hatchlings or eggs and only left the nest briefly when startled. Some nesting birds, within approximately 10 km (6.2 mi) of a 7,076- or 14,515-metric-ton (8,000- or 16,000-ton) detonation, probably would be startled into very briefly leaving their nests. However, there should be only minimal loss of eggs or impact on hatchlings. Birds nesting in areas where overpressures exceed 240 Pa (5 psf) would probably lose their eggs from breakage due to movement of the nest itself. Depending on the type of nest construction, some egg or hatchling loss could occur to a decreasing extent at ranges beyond these values (McMullan et al. 1987).

4.12.2 Proposed Action

Other than the minor ranching activities in the northern and western Call-Up areas, the WSMR Main Post community, and remote testing facilities, the range land areas are essentially void of personnel. There is minor movement of range support personnel throughout all areas of the range. Possible minor noise impacts on personnel can be anticipated to occur in one of the populated areas.

The three areas on WSMR that are considered noise sensitive are the San Andres National Wildlife Refuge in the southwest corner of the range, the Bosque Del Apache National Wildlife Refuge on the northwest side of the range, and White Sands National Monument, including the headquarters area on the eastern edge of the range. There are other spot locations such as the Oscura Mountains where raptors have been sighted.

WSMR generally schedules programs at near the maximum daily-use capability. Therefore, changes in WSMR mission capabilities in order to test future weapon systems should not increase appreciably the total level of range activities being supported on a daily, monthly, or yearly basis. As new programs are introduced to the range, older programs would complete testing, terminate activities, and leave the range. With a relatively constant level of activity on the range in the future, noise amounts and maximum levels are anticipated to stay roughly the same well into the next century.

The primary noise sources of concern are sonic booms, aircraft or helicopter operations, missile or rocket weapon system tests, and high explosive testing. These areas along with several less intrusive noise sources are described in Section 3.12. The major WSMR programs selected for discussion in Chapter 3 are representative of the worst case for noise generation in their respective categories. Other range programs in each category that were not addressed individually would produce noise at lower decibel levels resulting in less or no environmental impact.

In Section 3.12, nine major noise sources on WSMR were identified: space system vehicles (sonic boom), low-level aircraft operations, helicopters, drones, exercises, missile/rocket weapon systems, high-explosive tests, highway/rail transportation systems, and community area. Each area represents continuing activity under the proposed action that has the potential to impact human health. Potential impacts of noise on wildlife are discussed in Section 4.4.

In addition to the range activities discussed in Section 3.12, WSMR supports other test programs and training operations located throughout the range. For the most part, these activities entail the use of some of the same major noise source areas (space system vehicles, aircraft operations, missile/rocket weapon systems), yet would not produce any higher levels of noise. Since these programs would produce noise at the same or lower levels, they are not expected to cause greater noise impacts on wildlife or humans.

Under the proposed action, range programs may increase or decrease their levels of scheduled activities. Though the number of programs desiring WSMR support or the level of support for an individual program may change, the total activity the range can handle on a day-today basis will continue to be dictated by scheduling support limitations. Range scheduling limitations will allow for only minimal, short duration surge increases in operations. The potential cumulative effect for noise under the proposed action is anticipated to be low considering schedule limits, the extensive range area over which the major noise sources are scattered, and the limited population exposed to range noise.

Effects on human health with respect to space system vehicle noise levels are not anticipated to be adverse. Space vehicle and test rocket launches will produce short duration (less than one minute) noise levels of approximately 65 dBA, 6.4 km (4 mi) from the launch site. Launch site test stands and sound buffer zones should limit main engine propulsion system testing levels to 70 dBA. Test Support personnel not under protective cover supporting a launch or launch test will be required by WSMR safety regulations to use hearing protection devices. Personnel under cover would be afforded proper sound mitigation through sound attenuation building construction. Sonic boom noise footprints are anticipated to occur over unpopulated areas many miles uprange and downrange from the launch or recovery location during space system vehicle launch and reentry. The low intensity and extreme infrequency of these sonic booms is not expected to produce effects other than a startle reaction in those people who hear the boom. The relatively long duration of a space system vehicle sonic boom pressure wave also may rattle loose windows.

Effects on human health with respect to aircraft flight operations noise levels are not anticipated to be adverse. Flight operations include subsonic and supersonic jets; helicopters; hill-scale drones; and propeller aircraft involved in test support, in training, and in military exercises. Subsonic jet aircraft and jet drones operating as low as 152 m (500 ft) AGL typically will produce from 95.7 to 115 dBA at ground level with attenuation to less than 65 dBA at a distance of 6.4 km (4 mi). The L_{dn} noise level for the roughly 600 yearly Red Rio Range low-level gunnery flights and the roughly 200 yearly Oscura Range low-level gunnery flights are expected to be less than 70 dBA at a distance of 2 km (1.25 mi) from the target site areas.

Supersonic aircraft operations are restricted by WSMR to two supersonic airspace areas (Figure 3-35). The 49th Fighter Wing area limits supersonic flight to above 1,829 m (6,000 ft) AGL. The 46th Tactical Group area allows operations down to 91 m (300 ft) AGL. Both are over unpopulated areas of the range. A recent study at WSMR established that a supersonic aircraft could generate a maximum SEL greater than 115 dBA. However, it was determined that the L_{dn} noise level varied from 54.2 dBC in the center of the WSMR-designated Supersonic Airspace to below 40 dBC at the edge of the range. At these levels, there is no expected human hearing loss and little population annoyance.

There are infrequent propeller aircraft operations on WSMR. The U.S. Army C-12, at 305 m (1,000 ft) AGL, produces a 71.8 dBA noise that is well below the 88 dBA average for up to four-engine propeller aircraft. Helicopters would operate throughout the range airspace area producing noise levels as high as 97.3 dBA (at 61 m [200 ft] AGL) in remote areas or during landings to roughly 85 dBA while transiting the range. Though a single aircraft overflight may exceed the OSHA standard of 115 dBA at which humans experience pain, such events would not exceed the maximum time limit of 15 minutes for exposure above 115 dBA. Additionally, these events would not exceed the OSHA limit of 140 dB for human exposure to impulse or impact noise (Section 3.12). Aircraft noise over WSMR would last no longer than a few seconds as the aircraft passes overhead. Noise of such short duration at 152 m (500 ft) AGL over the range is not anticipated to impact the human environment adversely.

Effects on human health with respect to extremely short duration impulse noise levels (lasting several seconds) are not anticipated to be adverse. These extremely short duration noise activities (discussed in Section 3.12) can be grouped under jet-assisted takeoff launched subscale target aircraft drones, missile and rocket weapon systems, and high-explosive charges. Several-second noise levels of up to 127 dBA at 100 ft would be produced by jet-assisted takeoff launched drones. The range BQM-34 and MQM-107 series of drones are launched from hardened launch complexes along Nike Road. Following jet-assisted takeoff burnout at 1,000 ft, these target subscale drones produce noise levels lower than light civil aircraft. Most missile and rocket ground-launched weapon systems operate from hardened launch sites along Nike Road or on the Small Missile Range. Several missiles (e.g., HAWK, MLRS) launch from remote, unpopulated sites uprange. Several-second single-event noise levels up to 149.8 dBA at 100 ft have been recorded for missile ground launches. Air-launched missiles produce lower noise levels. Missile launch noise levels of 97 dBA are expected at 1,524 m (5,000 ft) AGL and missile impact noise levels of 120 dBA are expected at 152 m (500 ft).

High-explosive tests in the north range at the Permanent High Explosive Test Site (PHETS) are of special concern for noise impact. A fraction of a second impulse noise level for high-explosive testing at PHETS would expose test personnel to noise levels up to 152 dB. This exceeds the OSHA impulse noise limit of 140 dB. Personnel not protected by noise-insulated PHETS facilities are required to wear hearing protection devices at the facilities listed in Table 3-58. Range programs that produce short duration impulse noise have been located on WSMR to avoid noise sensitive areas and to reduce exposing personnel (populated areas) to potential hearing loss. WSMR drone, missile, and rocket launch, and explosive test activities are monitored to ensure OSHA and U.S. Army regulation compliance. OSHA Permissible Noise Exposure levels (Table 423) apply and are followed for WSMR weapons firings. Safety zones and hazardous noise areas are established with noise level meters and warning signs are posted to reduce the risk of human hearing loss. Personnel required to operate in noise hazard areas are required to wear hearing protective equipment (earplugs and noise muffs). Test personnel are administered periodic audiograms to document hearing deterioration in compliance with U.S. Army hearing conservation programs.

Effects on human health with respect to range transportation systems or community area noise levels are not anticipated to be adverse. The WSMR road network is used by automobiles, light to heavy trucks, buses, and large vans. Traffic on the range remote, unpopulated area roads is categorized as extremely light and registers median traffic noise levels of 75 to 80 dBA 30.5 m (100 ft) from roadways attenuating to less than 65 dBA 305 m (1,000 ft) away. Traffic on the WSMR Main Post is considered urban traffic and is estimated at a noise level of 45 dBA. Traffic speed in the Main Post residential areas is 9 m/s (20 mph), which contributes to this acceptable low noise level. Noise levels at or below 65 dBA are classed as acceptable for residential land use (Figure 4-1). The only rail activity on the range is a shunting operation (rail siding) located more than 8 km (5 mi) from any populated areas. Diesel locomotives pulling freight cars on the siding would produce noise levels of 98.0 dBA 15 m (50 ft) away. At 457 to 610 m (1,500 to 2,000 ft), this would attenuate to approximately 65 dBA. Hearing protection devices are required for personnel supporting rail loading or unloading activities.

The WSMR Main Post community (residential) area noise level is estimated to fall in roughly the same noise level range that is typical of other suburban communities close to the range. Outdoor noise levels measured in Alamogordo, New Mexico, vary from 55 to 65 dBA. Workshop facilities on the Main Post generate occupational noise levels that exceed 85 dBA and a peak of 125 dBA was recorded for the vehicle maintenance building pneumatic tools. In all work areas where noise levels exceed 75 dBA, personnel are required to wear ear protection earplugs or noise mitigating headsets.

WSMR complies with all noise emission standards and regulations, and directs an aggressive noise control and noise mitigation procedures program.

- A comprehensive Hearing Conservation Program is in effect for all range operations. Noise hazard areas are identified and posted. Range medical personnel periodically update existing areas to ensure new noise-producing operations are incorporated in the program. Engineering and administrative measures are used for possible elimination or control of noise sources. Hearing protection devices are required and provided personnel exposed to noise levels exceeding 85 dBA. Audiometric testing is required for those working in noise hazard areas. Personnel are instructed in protection procedures and noise health hazards associated with their work stations.

- The WSMR environmental staff works closely with the USFWS for the management, control, and protection of all wildlife communities (including threatened and endangered species) on the range. The staff participates in all federal, state, and civil wildlife noise impact studies conducted on WSMR. Results of these studies are used in managing testing and training activities to reduce or eliminate animal noise impact.

- The ranching community located in the Call-Up areas is coordinated with periodically and actions are implemented to reduce impacts on domestic animals.

- WSMR testing, training, and exercise operations are planned and located on the range in an effort to control and mitigate noise emissions that could be a problem. Activities and test facilities are not conducted or located close to offrange population areas. Additionally, on-range operations are conducted in remote areas to the maximum extent possible. Aircraft routes are designed to avoid noise sensitive areas (to include wildlife refuges) and if noise impact is experienced, routes are moved for mitigation.

- An active WSMR Public Affairs Program exists. Efforts are made to work closely with communities in proximity to the range. Advanced information on high noise events reduces community noise concern and annoyance.

- Noise levels at the NASA WSTF are monitored for continued compliance with the NASA Health Standard on Hearing Conservation. NASA also participates in the Range Hearing Conservation Program.

The overall environmental consequences of noise on human health and wildlife due to WSMR testing and training activities are considered to be potentially adverse but mitigable. For a detailed discussion of these consequences, see Ellis (1981) and Krausman et al. (1993). Each of the major noise source areas, assessed individually, is either not adverse or mitigable by providing hearing protection to WSMR personnel and avoiding sensitive wildlife. As a result, any cumulative effects of noise also are anticipated to be minimal. Any decrease in program numbers would produce corresponding decreases in noise impacts.

4.12.3 No Action Alternative

Under the no action alternative, WSMR would continue operations at current levels. WSMR mission support and off-range launch capabilities would not be expanded beyond existing levels and the testing of future weapon systems employing radically new technology would not be undertaken. Test facility improvements or facilities construction for new customers would not be made. Tactical training would not be increased above currently authorized levels. Major military exercises supported by the range would continue at the rate of one per year. Small-scale exercises would continue at roughly two per year.

Initially, for the no action alternative, the on-range noise levels and quantity presently being experienced by humans and wildlife would continue. As existing weapon systems under testing at WSMR near or reach their life expectancy and are eventually phased out of the U.S. Army arsenal, they would leave the range, no longer requiring support. As the overall activity level decreases, there would be a corresponding noise decrease. Peak levels for individual noise sources (e.g., aircraft, weapons, single sonic booms) would continue for some time.

At current activity levels, WSMR would continue to comply with applicable noise emission standards and regulations. The range noise control and noise mitigation procedures programs contribute to the mitigation of noise impacts. Continuing to follow WSMR noise control and mitigation procedures under the no action alternative, the degree of noise impact on humans and wildlife would cause no greater environmental consequences than those of the proposed action, which are considered not adverse or potentially adverse but mitigable.

4.13 RADIATION SOURCES

Radiation exposure can be the result of external exposure or internal exposure from sources inhaled, ingested, or absorbed into the body. Irradiation of a cell can cause damage to the cell. Typically, cells can repair damage unless the damage is to the cell nucleus. If this occurs, the cell can be destroyed or the chromosomes in a reproductive cell may be altered, resulting in a mutation of the daughter cell.

Acute exposure is a large dose of radiation received over a short period of time. Radiation exposure received during an accident could be such an instance. Chronic exposure refers to relatively low doses received over a long period of time. An example of this would be the dose we receive from the sun over a lifetime.

This section describes the potential environmental impacts of the radiation environment at WSMR in the same order as the radiation sources were identified in Section 3.13. The section has been broken down into two categories of radiation – ionizing and nonionizing radiation.

4.13.1 Ionizing Radiation Sources

Ionizing radiation refers to radiation that has enough energy to remove electrons from atoms as it passes through the material being irradiated. Alpha and beta particle radiation fall into this category. An alpha particle is the nucleus of a helium atom. A beta particle is an energetic free electron.

Gamma radiation and high-frequency electromagnetic radiation, such as x-rays, also are termed ionizing radiation. Gamma radiation and other high-frequency electromagnetic radiation share much of the same energy region and differ only by their source.

4.13.1.1 Nuclear Effects Directorate. Because the ionizing radiation facilities at NED are separate and isolated from one another, the radiation fields produced by the facilities do not overlap in any way that would create a high radiation area outside a controlled area. Because each facility and its exposure areas are separate, environmental synergistic effects are minimal.

Fast Burst Reactor

There has been no detection of significant amounts of particulates or radio-iodines being released to the environment from the FBR. Release of radioactive gases (principally argon-41) amount to less than 4 milliCuries per 10^{16} fissions occurring in the FBR. This, coupled with the relatively short half-lives of these radioactive gases, constitutes an insignificant release to the environment.

Direct irradiation of animal and plant life can be deemed negligible due to the distances from the reactor that animal and plant life are allowed. The FBR has a chain-link fence at a 91-m (300-ft) radius from the reactor. The area within this fence is a gravel lot with no vegetation. The maximum level of radiation at this fence is below 1 rad per day, which is considered protective of nonhuman organisms (e.g., National Council on Radiation Protection and Measurements 1991).

Linear Electron Accelerator

There would be no adverse residual activity after an operation because accelerators that produce electrons having energies less than 10 megaelectronvolts typically do not activate material.

Gamma Radiation Facility

Outside of the Gamma Radiation facility cell, the greatest exposure rates are in the area surrounded by the 2.1-m (6.9-ft) chain-link fence. This is an exclusion area and entry into the area is controlled by the chain-link fence with the gates locked and interlocked during operation, such that if the interlocks are broken the gamma sources are immediately sent back to storage. Exposure rates in this area range from 400 roentgen per hour next to the west roll-up door to less than 0.001-roentgen per hour in the pedestrian walkway on the east side of the building (U.S. Army 1988b). Small birds and rodents have been observed in this area. The animals are generally moving through the area into the desert habitat outside the fence. It is possible for these small animals to stay in a position where they could receive a lethal dose of radiation. Considering the few operations that would produce worst case conditions (four or five per year) and the fact that the animals seldom stay in the exclusion area for extended periods, the possibility of more than one or two animals per year receiving doses of this magnitude is extremely small.

During the 15-year operational history of the GRF, all personnel entering the area have been strictly monitored for radiation exposure. Film badges and/or thermoluminescent dosimeters and also pocket ionization chambers are worn by each individual entering the area. During this 15-year period, the incremental radiation exposure caused by the GRF has not been distinguishable from variations in the radiation exposure that all personnel in this geographic area receive from the natural environment. The natural radiation environment produces doses to humans of approximately 150 mrem per year. Over this same time frame, there has been no known injury to animal or plant life from the GRF radiation.

Relativistic Electron Beam Accelerator

A survey was made in December 1988 by the Health Physics Division and the Dosimetry Section, Operations and Support Division of NED to characterize the levels of radiation released to the environment and to establish the radiation areas. These measurements used calcium fluoride thermoluminescent dosimeters. The levels of radiation produced outside of the building per pulse are as follows: immediately outside the roll-up door of the exposure room, 85 mrem; on top of the roof directly above the exposure cell, 62 mrem; and at the base of the antenna tower, 15 mrem (U.S. Army 1989b).

The level of radiation released to the environment by operations of Relativistic Electron Beam Accelerator (REBA) is low. The dose received by any animal or plant in the area would not be enough to cause any immediate or obvious harm. A worst case of operating the REBA for eight pulses per day, 5 days per week, 52 weeks per year would result in an exposure of 31 rem per year at the antenna base, 130 rem per year on the roof, and 176 rem per year outside the roll-up door of the exposure room. However, this worst case would never occur because the radiation is emitted in a pulse that lasts less than 1 second and the chances of an animal being in the area at the exact time of the exposures, day after day, week after week, is very remote. If it were possible for this worst case to occur, the highest level of radiation that is generated by REBA outside of the building would be 680 mrem for a total of eight exposures immediately outside the roll-up door of the exposure room.

There would be no adverse residual activity after an operation because accelerators that produce electrons having energies less than 10 megaelectronvolts do not typically activate material.

4.13.1.2 Thorium in Alloys. An investigation of possible thorium-232 contamination at the SC-SO and Hayfield areas was carried out by Los Alamos National Laboratory. Soil was sampled by laboratory personnel in each 400- by 400-m (1,312- by 1,312-ft) target area along a 50-m^2 (538-ft^2) grid that was surveyed by the WSMR Defense Mapping Agency (Buhl et al. 1987). Approximately 200 soil samples were collected and analyzed for thorium using neutron-activation analysis.

In addition to soil sampling for thorium, the area was scanned using sensitive search meters mounted on the laboratory environmental surveillance van. Four in-situ gamma spectra were taken in the two target areas to measure the components of the gamma ray field and to determine the thorium-series contribution.

Aside from thorium alloy fragments in the centimeter size range that are still present in small amounts at both sites, no detectable contamination was found in either area. The average surface thorium-232 concentration at the Hayfield site was 0.04 ± 0.002 becquerels per gram (1.077 ± 0.042 picoCuries per gram) (quoted uncertainty is twice the standard error of the mean), and is indistinguishable from the background value of 0.039 ± 0.007 becquerels per gram (1.06 ± 0.18 picoCuries per gram). At the SC-50 site, the average thorium-232 concentration was 0.023 ± 0.002 becquerels per gram (0.626 ± 0.062 picoCuries per gram), less than but statistically indistinguishable from a background concentration of 0.027 ± 0.004 becquerels per gram (0.742 ± 0.098 picoCuries per gram). The results of the search meter scan and the in-situ measurements agree with these findings.

The thorium concentrations were indistinguishable from background levels at both sites, and the environmental impact from the thorium deposition is therefore deemed negligible. Further, a Standard Operating Procedure (SOP) is in place to assure that recovery of alloys containing thorium is in concurrence with WSMR Regulation 40-8.

4.13.1.3 Depleted Uranium. Before 1979, the bulk of depleted uranium was not recovered from missile impact sites. However, surface deposition of depleted uranium was recovered. Depleted uranium sites resulting from tests after 1979 have been excavated for any radioactive material found to be beyond background level.

Further analysis of the depleted uranium sites is proposed to be undertaken in a supplemental document to follow the EIS.

4.13.1.4 Research Rockets. The radioactive sources found in some research rockets may emit alpha, beta, gamma, or neutron radiation. Only sealed sources that do not leak in excess of 0.005 microCuries (using standard leak test procedures) may be used (U.S. Navy 1987). The use of specific sources must be approved in advance by the WSMR Radiation Protection Officer.

The sources themselves do not typically constitute a serious radiation hazard to personnel. Safe handling, monitoring, and recovery procedures are in place to prevent hazards to personnel or the environment.

4.13.1.5 Self-luminous Devices. The use of self-luminous devices is a long-standing, safe practice. Of the various material used in these devices, the primary concern is with radium-226. Radium-226 is an alpha emitter with a half-life of 1,622 years. As with all alpha emitters, the main radiation hazard concern is from ingestion and inhalation.

Radium-226 is no longer authorized for use in military equipment. However, there are still many devices in use with radium-226. The radium was used in a paint to make various instrument readouts self-luminescent. Over time, the binding agent in the paint deteriorates and flakes, creating a contamination hazard. Whenever an instrument is identified to contain radium-226, it is collect by the Radiation Protection Officer for proper disposal.

4.13.1.6 Trinity Site. The semiannual public tours offered at Trinity site do not constitute a health hazard to the public. The remaining trinite is not considered a hazard, as described in Section 3.13.1.6.

4.13.1.7 Other Radiation Sources. Other radiation sources are mainly sealed sources. These sources have met leak test guidelines and do not constitute a hazard to the environment. Guidelines are in place to prevent hazards to personnel.

4.13.2 Nonionizing Radiation Sources

The electromagnetic energy spectrum of nonionizing radiation is very broad. Ultraviolet (UV), visible, and infrared (IR) radiation are recognized as having adverse effects on biological systems. At the lower end of the nonionizing spectrum below the radio frequencies, recent studies have suggested biological effects are not related to tissue heating, but to the magnetic fields at extreme low frequencies.

4.13.2.1 Ultraviolet Radiation. The UV spectrum is between visible light and x-rays. For purposes of discussion, the spectrum is divided into three regions as follows:

- near UV (400 to 300 nm),
- far UV (300 to 200 nm), and
- vacuum (200 to 4 nm).

For biological effects, the UV region between 409 and 300 nm is called UV-A. This is the region responsible for pigmentation of the skin, or suntan.

Between 320 and 280 nm, the region is referred to as UV-B. This is the region of harmful UV from natural sources. The radiation in this region is absorbed by the cornea of the eye with no immediate effects but cataracts as result of UV absorption by the cornea have been reported.

The UV-C region, between 280 and 220 nm, is associated with germicidal effects. Germicidal lamps contain UV in this wavelength region, as do some welding arcs.

The severity of the effects depends on the length of exposure, the wavelength, and the energy density. These factors determine the safe distance from the source for unprotected eyes and the necessary protection to prevent damage to those persons working with UV sources, such as germicidal lamps or welding arcs. Particular attention is given to UV radiation in the 170- to 220-nm range because damage to the eyes can occur before discomfort is felt, and because effects begin to appear four to six hours after exposure.

UV in the 400- to 360-nm range causes sunburn, which is associated with skin cancer. The effects are highly dependent on skin conditions, the wavelength of the radiation, and its intensity over an extended period.

An important consideration in terms of biological effects of nonionizing radiation is the range of its penetration. The depth of penetration depends on the wavelength of the radiation.

The factors that affect the severity of the flash burn are duration of the exposure, the wavelength of the UV produced, and the energy level of the luminance and radiance during welding. These factors are in turn dependent on parameters such as the amperage and the welding rod material and thickness.

4.13.2.2 Visible Energy. The possible effects of visible radiation from White Sands Solar Facility are confined to the test chamber where the radiation is focused at the test volume. Welding goggles are required as eye protection when viewing the focal plane during focusing of the beam. because the intense radiation is confined to the test chamber, there are no potential adverse effects on plant or animal life associated with the operation of the White Sands Solar Facility. There also are no anticipated adverse effects on the operations of other facilities in the area as a result of operations at White Sands Solar Facility.

4.13.2.3 Microwaves and Radio Waves. Microwave radiation refers to electromagnetic radiation whose frequency extends from 10 to 300,000 MHz. This radiation is normally from antennas associated with television transmitters, frequency-modulated (FM) transmitters, radar transmitters, and microwave sources used in industry, science, and medicines. Power intensities are given in units of watts per square centimeter. Areas in which the power intensity is 10 mW/cm^2 should be avoided.

It is WSMR policy to limit interference with adjacent land uses where and when at all feasible. WSMR analyzes the potential for spectral electromagnetic (SEM) interference on a project-specific and ongoing basis. Coordination beteween NRAO and WSMR has been a regular part of the analysis of SEM environment effects. This coordination will be enhanced as needed for specific projects to minimize harmful interference.

Some harmful power densities (HPD) can affect the VLA and VLBA radio telescopes in the allocated Radio Astronomy (RA) bands. The thresholds are extremely low because of the very low noise and highly sensitive radio receivers used on the antennas. The Harmful Effective Isotropic Radiated Power (HEIRP) at a WSMR transmitter site above which the HPD for the VLA is exceeded can be quite low, especially if the emitter is airborne. If the WSMR primary or harmonic radiation exceeds the VLA HPD in a RA band, data will be corrupted, an adverse impact on VLA observations. The HEIRP is lowest when the transmitter is line-of-sight to the VLA. A 10-Watt transmitter in an RA band can cause harmful interference at the VLA at ground level for WSMR locations on the northwest corner of the range and at altitudes above

8000 feet ASL at other locations. Emissions in the RA band in excess of a microwatt will cause harmful interference at most northern locations above 11,000 feet altitude. The VLA and VLBA receiver have a tuning range wider than the radio astronomy bands to make important passive use of adjacent bands where the interference environment permits. WSMR emissions that exceed the harmful peak power density (HPPD) anywhere in an adjacent band can cause gain compression in the receiver, resulting in corrupted data even if the observations are within a protected band. The impact to the data is an adverse impact on VLA observations.

One of the applications of UV is in fluorescent lamps to produce visible light. The lamps contain a small amount of mercury vapor. An electrical discharge through the vapor produces UV, which is absorbed by the phosphor coating inside the fluorescent tube. The longer wavelength light is produced and emits little or no UV radiation. Although a considerable amount of UV is produced inside the tube, it is essentially all absorbed in the glass and the fluorescent coating.

Germicidal lamps and electric welding arcs are. the most common high-level sources of UV in industry. Other uses of UV are in entertainment; advertising; crime detection; photo engraving; sterilization of air, water, and food; and therapeutic applications.

Probably, the most important UV source in terms of effects is electric arc welders, which affect more workers indoors than any other source. The common effect known as welder's flash, or flashburn, is a corneal conjunctival irritation.

The absorption of electromagnetic energy in the microwave region occurs primarily by the water and the dissolved ions contained in the system. The absorption of the energy generally results in heating of the absorbing medium. Microwave radiation of sufficient intensity can cause heating by body tissue and organs, which may result in irreversible damage. An increase in temperature of the biological system will not occur as long as the absorbed energy does not exceed the organism's ability to dissipate the heat. Based on these considerations, the suggested limits of microwave exposure have been based on a power density of 10 mW/cm^2 and an energy density of 1 mWh/cm^2 during any 0.1-hour period.

The ANSI C95.1 1982 protection guides for different bands of frequency specify intensities in two different ways: the permitted electric and magnetic field strengths (actually expressed as squares of field strength) and the power densities that would be associated with plane waves having the same electric and magnetic field strengths (plane wave equivalent power density).

4.13.2.4 Lasers. Almost all lasers are potential hazards to the eyes. All produce extremely high intensity light radiation of a single frequency (or a narrow band of frequencies). Proper filtering protection depends on the frequency of the laser involved and the optical density needed to prevent damage to the retina of the eye. Light coming from a conventional light source radiates in all directions. Light waves of varying lengths reinforce or cancel each other. Nondirectional light of varying wavelengths is said to be incoherent. Light from a laser beam vibrates in a single plane, travels in only one direction and is nonchromatic so it is coherent light. These characteristics of laser beams result in the beam having such extremely high intensity and energy.

Laser beams are not limited to the frequency of visible light. A laser unit produces only one wavelength or frequency but can be designed over a wide range of frequencies. These are lasers in the IR, visible, UV, and microwave frequency ranges.

The effects of laser radiation are unique because the very high intensities typically produced by lasers are of magnitudes that could previously be approached only by the sun, nuclear weapons, or arc lamps. This is one of the important properties that makes lasers potentially hazardous. Laser radiation is either reflected, transmitted, and/or adsorbed, depending upon the properties of the surface upon which the energy falls.

Adverse thermal effects on human skin resulting from exposure to radiation from the 400- to 1,400-nm wavelengths may vary from mild redness to blistering and charring, depending on the exposure rate, dose, and conduction of heat away from the absorption site. Adverse effects on the skin from shorter UV-B and -C vary from redness to blistering.
In almost all considerations, the human eye is the organ most vulnerable to injury. The short UV (UV-B and C) is absorbed primarily at the cornea and can produce symptoms similar to those seen in arc welders such as severe acute inflammation of the eye. This energy does not reach the retina. The far-IR regions (IR-B and -C) are also primarily absorbed at the cornea with the production of heat. Near UV (UV-A) is primarily absorbed in the lens of the eye while near-infrared is refracted and absorbed in the ocular media and retina. Visible light is refracted and absorbed at the retina.

In addition to the hazards associated with the viewing of the primary and reflected laser beams, other potential hazards include contact with cryogenic materials, electrical shock, exposure to gasses such as ozone, and the possibility of explosions at capacitor banks, optical pumping systems. A medical surveillance program is applied to personnel routinely using lasers in research, development, testing, and experimentation efforts as well as operating and maintenance personnel. Use of all laser devices is monitored by Radiological Health to ensure that hazardous conditions are avoided and environmental impact is minimized.

4.13.2.5 Nonionizing RF Sources. The electromagnetic pulse facility located at the NED, approximately 6.4 km (4 mi) south of the Main Post and about 14.5 km (9 mi) south of U.S. Highway 70, is used to simulate the electromagnetic pulse associated with the high-altitude detonation of nuclear weapons. The pulse produced by the facility simulates the electromagnetic pulse from a high-altitude nuclear detonation. The White Sands EMP System Test Array produces intense radio waves with a pulse width of 10^{-6} seconds. The short, intense pulse has a wide radio frequency spectrum, but because of the bounded wave design, radiated electromagnetic energy is confined to the test volume and a small fringe around the test volume. The electromagnetic field is highly attenuated outside this volume. A report entitled *Environmental Assessment of the Resumption of Operation and Maintenance of the White Sands Electromagnetic Pulse Systems Test Array* in 1988 states that an E-field intensity below 50 volts meter was measured at 30.5 m (100 ft) from the facility.

4.14 HAZARDOUS MATERIALS/HAZARDOUS WASTE

This section describes potential impacts on the hazardous materials and hazardous waste use, transportation, storage, disposal, treatment, and management at WSMR due to the proposed action and the no action alternative. In this assessment, current and past WSMR activities and resulting environmental impacts were used to assess potential consequences of the proposed action and the no action alternative.

4.14.1 Proposed Action

This section describes the potential impacts of the proposed action.

4.14.1.1 Hazardous Materials Management. Consequences to hazardous materials management from the proposed action include those on the following list.

- Potential for the release of fuel products in storage and during transportation. Past releases related to the storage of fuels have occurred at HELSTF; the petroleum, oil, and lubricant storage area; SRC; LC-38; and the Main Post area.
- Increased inspection of hazardous material storage and use areas by the WSMR safety and fire departments. This also would include increased review of emergency contingency plans prepared by range users.
- Potential release of hazardous liquids from proposed impoundments into soil and ground water. Past releases have come from impoundments at HELSTF, NASA/WSTF, Temperature Test facility, and other minor facilities at WSMR.
- Increased asbestos abatement during building modifications, upgrades, and routine maintenance.
- Increased lead paint removal and abatement during building modifications, maintenance, and upgrades.

4.14.1.2 Hazardous Waste Management. Potential consequences to hazardous waste management from the proposed action include changes in storage, transportation, and disposal/treatment of hazardous wastes from some specific proposed programs; increases or decreases in shipment of hazardous wastes to off-range treatment, disposal, or recycling facilities due to these programs; potential releases of hazardous wastes from the programs; increased generation of hazardous wastes related to existing and proposed remedial investigation and feasibility study projects; and increased generation of asbestos and lead paint-related materials from building modifications, upgrades, and routine maintenance activities.

Treatment, Storage, and Disposal of Hazardous Wastes

With a few exceptions, increased activity at WSMR would not cause an adverse increase in the amount of hazardous waste generated. The wastes that are generated can be managed using the existing satellite accumulation sites, 90-day waste accumulation sites, and the hazardous waste storage facility. Small increases would occur related to all types of missile/aircraft testing and maintenance, laboratory research activities, and vehicle maintenance. However, adverse impacts could occur with existing and proposed range users that use large quantities of hazardous materials. These users typically generate large quantities of hazardous waste with potential impacts including releases to soil and ground water. The programs that have or may use large quantities of hazardous materials and generate large quantities of hazardous waste include high-energy laser programs (i.e., HELSTF), propulsion systems and materials testing (i.e., NASA/WSTF), and facility upgrades.

The wastes generated by these programs can be managed using the existing storage facilities. These programs have an increased potential in comparison to other proposed programs for hazardous waste releases at the program site; at storage facilities; during transportation; and at off-site disposal, treatment, or recycling facilities. Program sites that use impoundments to store hazardous materials/waste have the highest potential for releases into the environment. Decreases in program activities would result in corresponding decreases in use of hazardous materials, generation of hazardous wastes, and demands on associated support facilities.

RCRA Facility Investigation Activities

The investigation and remediation of sites contaminated by hazardous wastes would increase hazardous waste management activities. Any soil or water contaminated by hazardous waste that is removed from the ground during these activities must be managed as a hazardous waste. These wastes also may be placed in the hazardous waste storage facilities at WSMR and transported to off-site treatment, disposal, or recycling facilities.

4.14.2 No Action Alternative

This section describes the potential environmental impacts of the no action alternative.

4.14.2.1 Hazardous Materials Management. Consequences to hazardous materials management from the no action alternative would be the same as the proposed action with the following exceptions:

- continued asbestos and polychlorinated biphenyl (PCB) abatement at current levels rather than increased levels during building modifications, upgrades, and routine maintenance; and

- continued lead paint removal and abatement at current levels rather than increased levels during building modifications, maintenance, and upgrades. New lead abatement regulations are currently being promulgated by the EPA and will potentially include provisions for the testing, abatement, or removal of paint containing lead.

4.14.2.2 Hazardous Waste Management. Potential consequences to hazardous waste management from the no action alternative would be the same as the proposed action, with the exception of hazardous waste management programs. Under the no action alternative, hazardous waste management programs would have an increased potential for releases and thus would remain at current levels.

4.15 HEALTH AND SAFETY

The most visible concern regarding health and safety aspects of WSMR operations is missile testing, particularly the possibility of an errant missile landing in areas that jeopardize the public. A number of measures are in place on WSMR to minimize the possibility of a serious incident associated with a malfunctioning missile.

There are numerous WSMR site resources that serve to prevent and mitigate occupational and public health and safety problems from operations. Mutual participation by WSMR and local emergency management organizations (e.g., fire departments) in community health and safety emergency planning, and simulated disaster exercises lead to improved emergency response and health and safety services for the entire region.

4.15.1 Missile Testing

The Missile Flight Safety Office, which operates under the direct authority of the Commanding General, has authority to halt a missile test or to destroy a missile in flight. The top priorities of the Missile Flight Safety Office are to protect the general public and range personnel. The office uses range instrumentation including tracking radars, optical devices, and onboard flight termination systems. Before a missile is launched, the Missile Flight Safety Office reviews launch protocol, determines risk factors, and will halt flight tests unless an acceptable risk level is attained. Overall, the public has almost no probability (i.e., a 1 in 2 to 3 million risk factor) of being affected by a malfunctioning WSMR missile test (Sandia National Laboratories 1989).

4.15.2 Procedures and Resources

WSMR proponents who conduct tests have a vested interest in implementing procedures that prevent injury to personnel, damage to the environment, legal liability, equipment damage, and irretrievable loss of test data. Missile preparation activities are performed in isolated and secure parts of the range that are far removed from public areas. Various programs train employees in hazard communication and Material Safety Data Sheet usage, confined space entry, and hazardous material (HAZMAT) spill response procedures. Likewise, regulated hazardous materials used at WSMR are stored in areas that are far removed from the public. As identified in Section 3.15, WSMR facilities have existing or planned procedures addressing regulated chemicals that require proper handling, storage, and disposal. Section 3.14 describes the management and tracking of hazardous materials and the treatment and disposal of hazardous wastes. Potential risk to the public resulting from transportation of bulk chemical materials used at WSMR are mitigated by following the appropriate regulations regarding packaging, labeling, and transport of hazardous materials. There also are potential releases to the air from some WSMR activities; however, potential harm is considered not adverse or mitigable (see Section 4.3). Radiation concerns are discussed in Sections 3.13 and 4.13.

In addition to the Missile Flight Safety Office, WSMR has other resources with responsibility for health and safety at the base, including fire departments; a HAZMAT response team; a hospital; the emergency control center; and the Ground Safety Office, which conducts safety review, inspection, and oversight (see Section 3.15).

4.15.3 Emergency Management and Planning

As discussed in Section 3.15, there are numerous local, state, and federal public agencies whose primary function is protection of the public. Most obvious and visible are law enforcement and fire protection agencies. Other public agencies dealing with health and safety include those responsible for environment, emergency management, transportation, public health, and public service. Groups such as the Red Cross, Salvation Army, and Search & Rescue also serve to aid citizens needing assistance in critical situations. By law, emergency planning efforts for HAZMAT incidents must be coordinated by state and local officials through special planning groups, namely State Emergency Response Commissions and local emergency planning committees (LEPCs).

Prompt and efficient communications are critical during an emergency. The emergency operating centers set up through emergency management coordinators are a central point of coordination and communications during an incident. Similarly, WSMR has an emergency control center to coordinate responses to any incident at or adjacent to the range. Communications systems should include means for alerting the public as soon as word of the actual or anticipated disaster is received and for disseminating essential directions such as precautions to be taken by the public, evacuation routes, shelter locations, and sources of aid. Also, it is important in advance of disasters to help the public plan, understand, and prepare for them. Designation of a central contact or spokesperson is a necessary part of this preparation.

Emergency response personnel from all organizations communicate readily among themselves. WSMR mitigates the potential for emergencies by close coordination and mutual-support of federal facilities with LEPCs. Likewise there may be mutual benefits for coordinating other resources such as heavy equipment, helicopter support, ambulance support, specialized personal protective equipment, assessment and monitoring of spills, evacuation contingencies, HAZMAT response, and site cleanup.

4.16 CUMULATIVE IMPACTS

4.16.1 Background

For the purposes of this EIS, cumulative impacts were assessed utilizing analyses of both WSMR-specific as well as off-range operation and programmatic activities. The latter of these analyses focused on several contiguous land ownership, including White Sands National Monument, and on major operations such as those based at Ft. Bliss and Holloman Air Force Base. Off-range activities often overlap onto WSMR and a relationship between on- and off-range activities was examined.

Cumulative impacts on the environment result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or individual organization undertakes such other actions. Cumulative impacts can result from individually minor but collectively adverse actions taking place over a period of time. The sum of all changes — beneficial or detrimental — which will occur as the result of multiple activities and the reinforcing or dampening interaction between them is yet one other measure of cumulative effect. Table 4-24 lists and explains many principles of cumulative impact assessment. When numerous projects, apparently of relatively low individual environmental consequence, occur in the same area over a period of time, cumulative impacts often are undetectable at the level of NEPA documentation, such as an EA or Record of Environmental Consideration (REC), typically applicable to many of the individual WSMR projects reviewed for this EIS.

The proposed action and the no action alternative were reviewed against existing documentation on current and planned actions, together with documentation of existing conditions, to determine the potential for cumulative impacts. This information resulted in a low-level nominal cumulative impact analysis. Programs with similar activities occurring at the same locations are expected to have similar impacts. Many impact analyses presume that cumulative impact analyses need only compare programs with obviously similar activities. For example, surface-to-air missile programs that use the same launch sites will result in increased noise levels during launch events. However, distinctly different programs may have similar consequences with respect to many or just a few resource areas. Thus, the increase in consequences from noise-producing events resulting from two otherwise very different programs often will be higher than from the sum of these considered separately. The assessment of the significance of cumulative impacts requires complete information on the activities for all similar programs and for all programs having similar effects, even with respect to small apparent overlaps of activities or consequences.

Four areas of specific cumulative impacts concern have been identified by reviewers of the Draft EIS. These areas are land use, water resources, air quality, and hazardous waste. The focus of this analysis was on these resources, the relationship among one another and the relationship with other resources that did not receive the same level of scrutiny.

Potentially adverse cumulative impacts are anticipated in the areas of biological resources, and cultural resources. The cumulative impacts on biological and cultural resources are particularly but not exclusively associated with recovery operations. Mitigation measures deemed necessary as integral components of the proposed action are defined in Section 2.4 and detailed in Chapter 5. Several of the proposed mitigation measures address the need to avoid or otherwise mitigate the possibility of adverse cumulative impacts in several resource areas. In particular, mitigation measures for the cumulative impacts for biological and cultural resources and resulting from recovery actions are defined in Sections 2.4.4 and 2.4.6.

Table 4-24
Principles of cumulative impact assessment

1. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.	Seemingly insignificant actions can add up, or synergistically interact, to cause important negative influences on the environment.
2. Cumulative impacts are the total effect, including both direct and indirect impacts, on a given resource or ecosystem of all actions taken, no matter who (Federal, non-Federal, or person) has taken the actions.	Individual impacts may, over time or over a larger space, add up or interact to cause additional effects (cumulative impacts), not apparent when looking at the individual impacts one at a time. All influences on a given resource or ecosystem should be considered as a whole, not just those influences that occur on public lands or in a particular field of interest. Such impacts must also be added to past/present/future effects caused by actions taken by other entities insofar as they also cumulatively impact the same specific resource.
3. Cumulative impacts need to be analyzed in terms of the specific resources or ecosystem being impacted.	There needs to be an understanding of how components of a given ecosystem interrelate and where these systems are most susceptible to impacts. Potential actions can then be measured against these known vulnerable points. Impacts should be analyzed in terms of how the health, viability or sustainability of the impacted resource or ecosystem is affected, not in terms of what is needed for success of the proposed action.
4. Cumulative impacts may result from the buildup of repeated actions or from the synergistic interaction of multiple actions.	Actions taken may cause impacts to build up through simple addition (more and more of the same type of action), or impacts may occur as a result of the synergistic interaction of multiple actions (various actions add up to cause a new kind of impact.)
5. Each resource must be analyzed in terms of its own time and pace parameters, not in terms of the proposed action.	Each proposed action or alternative should be analyzed to see how it would impact the time and space needs of the ecosystem or resource in question. There is a tendency to think in terms of how to modify the ecosystem to permit the proposed action to take place, but this is "justification", not impact analysis.
6. Cumulative impacts are caused by the aggregate of past, present, and reasonable foreseeable future actions.	Impacts of a proposed action on a given resource must include what present and future impacts will occur when added to the impacts that have already taken place in the past.
7. It is not practical to analyze the cumulative impacts of an action on the universe. The list of environmental effects must be narrowed to those that are truly meaningful.	Environmental analysis must be limited to issues and impacts that are the most important to interested parties and the decisionmaker, since time and money is limited.
8. Cumulative impacts on a given resource or ecosystem are rarely aligned with political or administrative boundaries.	There is a tendency to put resources into neat little boxes with sides built of agency boundaries, county lines, grazing allotments, etc. Unfortunately, impacted resources are not so aligned, and each political entity ends up managing only a small piece of a resource but rarely the entire ecosystem.
9. Cumulative impacts cannot be analyzed unless the proposed action and alternatives are clearly stated and understood.	Impacts are assessed against the action(s) being proposed; it therefore follows that impacts may be overlooked or based on the wrong assumptions if the proposed action is not clearly stated. The proposed action must be described in terms of all its components over the entire project life. (table continues)

Table 4-24, Continued	
10. Reasonable foreseeable future actions scenarios are projections made only for the prediction of future impacts. They are not actual planning decisions or resource commitments.	These are projections of possible future actions that would be set in motion by implementing the proposed action. They are intended only for use in helping to predict future impacts, including cumulative impacts. They are not intend to be resource commitments and are not a part of the proposed action.
11. Cumulative impacts may last for many years beyond the life of the action that caused the impact.	Some actions caused damage lasting far longer than the life of the action itself (mine drainage, species extinction, radioactive waste, etc.) Science and sophisticated analytical processes must be brought into play to help us foresee and head off catastrophic consequences.

Source: Guidelines for Assessing and Documenting Cumulative Impacts, Bureau of Land Management, 1994

4.16.2 WSMR-Based Cumulative Impacts

Current and past programs, projects, and activities occurring at WSMR were analyzed to address the potential for cumulative effect. As previously described, the focus of these analyses was on land use, water resources, air quality, and hazardous waste. Due to the lack of comprehensive baseline information for these and other resources at WSMR, only estimates and qualitative analyses of the interactions were possible for this EIS. Follow-on Technical Support Documents (TSD) subsequent to the EIS will be instituted to both remedy the deficiencies in the baseline information and to continue to address the assessment of cumulative effects.

4.16.2.1 Land Use. Literally hundreds of activities occur at WSMR over a given period. Obviously, some land use areas such as the Main Post and southern range launch complexes receive more steady and quantitative use than do areas in the central and northern range areas. The focus for analyzing the accumulation of effect upon any of these areas must be derived from a comprehensive baseline composed of historic and current data. This baseline which compiles in one place all of the data does not presently exist in a final form which can be used in this EIS. The supplemental analyses proposed for the analysis cumulative effects will remedy this deficiency. A qualitative approach to assessing additive land use impacts is offered in this section.

For the ten major WSMR organizations reviewed for this cumulative impact summary, it was determined that most testing programs and other non-construction activities will take place at existing launch complexes, other existing operational sites, and over and in existing WITs. The cumulative effects of past and these proposed future testing activities upon land use can be best summarized as no unresolved or significant conflicts. This is due to the application of WSMR Universal Documentation System and the National Range Priority System which limit the potential for conflicting land uses and remedy conflicts that go beyond simple scheduling solutions.

Analyses are undertaken to ensure that a new program will "fit" into the WSMR mission and that an appropriate place is available. Theses analyses for land use include the standard tests for time-crowding and space-crowding. Although there is always competition for time and space at WSMR among competing land uses, no adverse cumulative impacts on WSMR resulting from WSMR weapons and other systems research, development, testing and evaluation have been determined as a result of this limited analysis.

Competition for non-military uses and conflicts among these uses would be significantly greater on WSMR if it were open to uses beyond those prescribed for its main mission as described for the proposed action in this EIS. Other uses such as hunting and sightseeing are accommodated only when they do not pose an endangerment to the recreationist or a security problem. Thus there are no land use conflicts resulting from recreational use which are not mitigated by WSMR Standard Operating Procedures.

Potential land use conflicts between WSMR's primary mission and other important purposes on the range such as protection of sensitive habitat for species of special concern and cultural resources are moderated by a number of mitigative actions. Programmatic level land use concerns such as those at issue among WSMR and co-use areas such as portions of White Sands National Monument and the San Andres National Wildlife Refuge are negotiated via memoranda of agreement. Specific resource management concerns which include potential land use conflicts (e.g., White Sands pupfish habitat) are addressed in planning documents such as cooperative agreements. On the individual project level, potential land use conflicts are analyzed in NEPA documents such as EISs and EAs.

In summary, cumulative impacts resulting in conflicts between land uses on WSMR has not been determined to be adverse. The cumulative impacts of these land uses on individual natural resources of the range (e.g., water resources and air quality) and attendant secondary effects such as those resulting from the production of hazardous wastes are summarized in the following sections.

4.16.2.2 Water Resources. To supplement the lack of a comprehensive baseline and to complete the cumulative impacts analysis, a follow-on analytical program is proposed. The Water Resources TSD would be initiated with the preparation of the Soledad Canyon wellfield management program currently proposed by WSMR. The significant components of the TSD would include:

- a compilation of all existing hydrological survey data into one report which would serve as the baseline for all WSMR water quantity and quality information;
- well and spring data for the range; and
- a comprehensive analysis of water quantity, supply, and quality, and the impact of all WSMR programs and projects on this resource.

4.16.2.3 Air Quality. Activities at WSMR generate constant, fluctuating, and intermittent air emissions that, collectively and when added to other past, present and reasonably foreseeable future action, might cause cumulative impacts to the public, to site personnel, and to the environment. WSMR will use the methodology outlined below to evaluate the nature and the extent of potential cumulative impacts from the proposed action and from the no action alternative.

- First, WSMR will collect air emissions data from all WSMR and WSMR-related activities. WSMR-related activities include the landing and take-off emissions from Holloman AFB aircraft that fly missions for WSMR as well as emissions from idling public vehicles at WSMR-activated roadblocks. These temporary roadblocks are set up by WSMR for public safety. Air emissions data will include estimated amounts of regulated air pollutants and hazardous air pollutants (HAPs) from stationary sources and mobile sources at WSMR, and baseline concentrations of PM_{10}, SO_2, and NO_2. Stationary and mobile sources at WSMR include laboratories, production facilities, aircraft, rockets, electrical generators, and ground vehicles. In addition to providing data for cumulative impacts analysis, air emissions data will be used for compliance with WSMR's 40 CFR Part 70 operating permit (Title V of the Clean Air Act) and for prevention of significant deterioration (PSD) evaluations (Title I of the Clean Air Act).

- Concurrent with air emissions data collection, WSMR will determine the types of cumulative impacts that are possible. Such impacts could include regional air quality degradation, the long-term health effects to site personnel and the general public from inhalation, dermal contact, and the ingestion of airborne species; and the long-term health effects to plants, wildlife, crops, and livestock from inhalation, dermal contact, and ingestion of airborne species.

- Once the type of cumulative impacts are defined, WSMR will determine the geographical and temporal limits for such impacts and will determine the fate and transport of the airborne species involved. WSMR will then analyze and document the extent of cumulative impacts to air quality using guidance from the EPA and other agencies, as appropriate. It is anticipated that the cumulative impacts analysis will include impacts to WSMR from air quality control region (AQCR) 153 near El Paso, Texas.

4.16.2.4 Hazardous Waste. To supplement the findings of cumulative effects related to hazardous materials and waste management, a follow-on analysis is proposed. The Hazardous/Waste Management TSD would nominally consist of the following:

- SWMU inventory information;
- RCRA permit information;
- pesticide and herbicide information; and
- interface with the Integrated Hazardous Materials Management Center.

4.16.2.5 Emissions Analysis Technical Support Document. To remedy the lack of a comprehensive baseline for noise, radiation, and other emissions cumulative impacts, supplemental documentation is proposed. The Emissions Analysis TSD would nominally consist of the following components:

- sonic boom analysis;
- monitoring noise with sound meters and data recorders at launch sites;
- ambient noise monitoring in the San Andres National Wildlife Refuge, White Sands National Monument co-use area, other "sensitive" areas, and in non-sensitive remote areas that are frequented by intermittent testing programs;
- data from the National Range Directorate (NR) and the Materiel Test Directorate (MTD) for missile test noise emissions;
- non-ionizing radiation (radio frequency radiation) study: inventory and document all sources for baseline; research other studies for impacts analysis;

- laser use inventory and impacts analysis;
- NRAO electromagnetic interference interface;
- Global Positioning System Interference Project input; and
- "light pollution" analysis and mitigation recommendations.

4.16.3 Off-Range Activities

The following sections describe the activities for each facility, installation, or mission that have the potential to adversely affect the WSMR environment. Because the level of available information relating to some of these activities varies, the level of description varies as well. This document does not attempt to cover all conceivable environmental interactions among WSMR and its neighboring missions; such an approach would undoubtedly fall short of success and is not the intent of the National Environmental Policy Act (NEPA). Rather, this analysis focuses on actions, impacts, and resolutions that fall within reason.

The activities analyzed within this section have been determined to be those associated with activities and missions of Fort Bliss, Texas; Holloman Air Force Base (AFB); the proposed Southwest Regional Spaceport; White Sands National Monument (WSNM); Roving Sands Joint Training Exercise (JTX); Theater Missile Defense (TMD) Extended Test Range testing; and the Bureau of Land Management (BLM).

Descriptions of facility, installation, or agency activities were derived from existing documents including mission statements, Descriptions of Proposed Actions and Alternatives (DOPAAs), scoping documents, and a variety of project-related technical reports. Where information was dated, incomplete, or absent, contacts with installation or mission personnel were initiated and data gaps filled.

No new resource special studies or surveys were conducted for this analysis. The types of existing environmental data reviewed include environmental assessments (EAs); environmental impact statements (EISs) and scoping documents; installation master plans; specific resource management plans (e.g., cultural or biological resource management plans); resource inventories and survey reports; resource models and monitoring reports; mitigation and monitoring plans; and maps and geographic information system (GIS) databases. Follow-on analyses and documentation will be undertaken to supplement the off-range cumulative effects baseline and impacts assessment (Appendix D, Commitment Management Summary).

4.16.3.1 Bureau of Land Management

The BLM's overall management philosophy is to manage under a multiple-use and sustained-yield concept. Special emphasis may be placed on specific requirements for Special Management Areas and Areas of Critical Environmental Concern. Land use and rangeland improvements are thoroughly analyzed to restrict new surface disturbance, reduce resource conflicts, and aid in the management of all resources. All proposals are subject to the NEPA process and especially to the mitigation of impacts.

Land managed by the BLM adjacent to WSMR is shown in Figure 4-2. Primary activities on BLM land adjacent to WSMR include grazing, off-road vehicle use, recreation use, and mining. Areas north and west of WSMR are designated call-up areas that are evacuated by agreement with the BLM and private land owners up to 20 times per year.

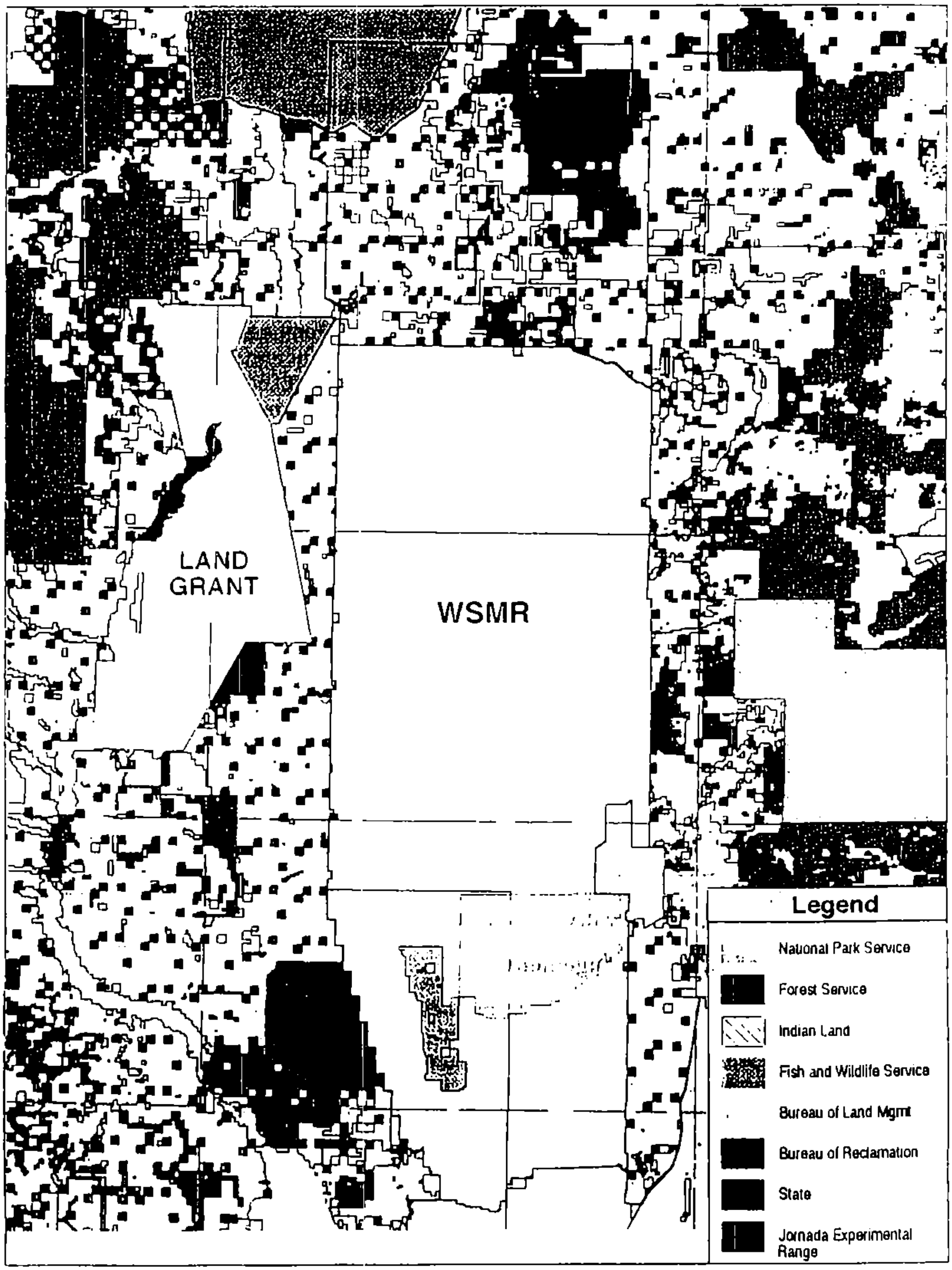

Figure 4-2. Contiguous land status, WSMR

4.16.3.2 Fort Bliss

Fort Bliss is located in El Paso County, Texas, and in Otero and Doña Ana Counties, New Mexico (Figure 4-3). It encompasses approximately 453,000 ha (1.12 million ac). About 90 percent of this acreage is located in New Mexico, most of which comprises the maneuver and training lands managed by Fort Bliss known as McGregor and Doña Ana/Orogrande Ranges. Otero Mesa, located in the northeastern region of McGregor Range, supports military training and weapons testing, as well as currently compatible livestock grazing (Figure 4-3). (U.S. Army Corps of Engineers, 1994)

Fort Bliss's current mission, established in 1957, is that of the U.S. Army Air Defense Artillery Center, where U.S. and Allied personnel are trained in the use of all types of air defense weapons, including missiles and other anti-aircraft weapons. (U.S. Army Corps of Engineers, 1994)

The ongoing mission of the United States Army Air Defense Artillery Center and Fort Bliss involves training activities employing troops, vehicles, and equipment in tactical situations; testing of military ordnance and weapons systems; missile and artillery firings; aerial gunnery training; air support operations; and other related activities. The current mission of Fort Bliss is to maintain assigned Strategic Forces units at a readiness condition equal to or higher than their assigned authorized levels of organization. Fort Bliss also coordinates and supports the execution of annual service practice for air defense units and surface-to-surface units in addition to commanding all activities and units assigned or attached. Fort Bliss operates the U.S. Army Defense Artillery School, provides units for continental U.S. and overseas deployment, maintains and supports air defense artillery automatic weapons, operates Biggs Army Air Field, and other missions assigned by U.S. Army Training and Doctrine Command and U.S. Forces Command (FORSCOM). There are about 15 flights per day over McGregor Range for ongoing training activities. (U.S. Army Corps of Engineers, 1994)

Wheeled and tracked vehicle maneuvering is associated with the ongoing training mission of the 3rd Armored Cavalry Regiment, 11th Air Defense Artillery Brigade, and Joint Training Exercises. Eight maneuver areas within McGregor Range and Doña Ana Range are used for ongoing training missions annually. Maneuver intensity on these areas is lower for wheeled vehicles (air defense training) than for tracked vehicles (cavalry training exercises). Maximum use of the maneuver areas (almost 134,000 ha [331,000 ac]) is estimated at 644,000 km (400,000 mi) per year for tracked vehicles. The average number of training exercises each year, which includes free maneuvering, missile firing, parachute drops, etc., for the 3-year period from 1991–1993 was 1,197 on McGregor Range and 1,207 on Doña Ana Range. No free maneuvers occur on Otero Mesa as part of the estimated range use. (U.S. Army Corps of Engineers, 1994).

4.16.3.3 Holloman AFB

Established during World War II as a training base, Holloman AFB is located in Otero County. New Mexico, 13 km (8 mi) west-southwest of Alamogordo and covers approximately 24,000 ha (59,000 ac) (Figure 4-4). Primary access is via U.S. Highway 70. White Sands Missile Range is located to the north, west. and partially to the south of the base, and White Sands National Monument is adjacent to the southwest portion of the base. Other nearby communities are the town of Tularosa located approximately 19 km (12 mi) north of Alamogordo and the village of La Luz, located approximately 5 km (3 mi) northeast of Alamogordo. The U.S. Air Force updated an Air Installation Compatible Use Zone (AICUZ) study in 1988 for Holloman AFB that provides guidelines for land use development around the base. Holloman AFB is located under the restricted airspace associated with WSMR. In

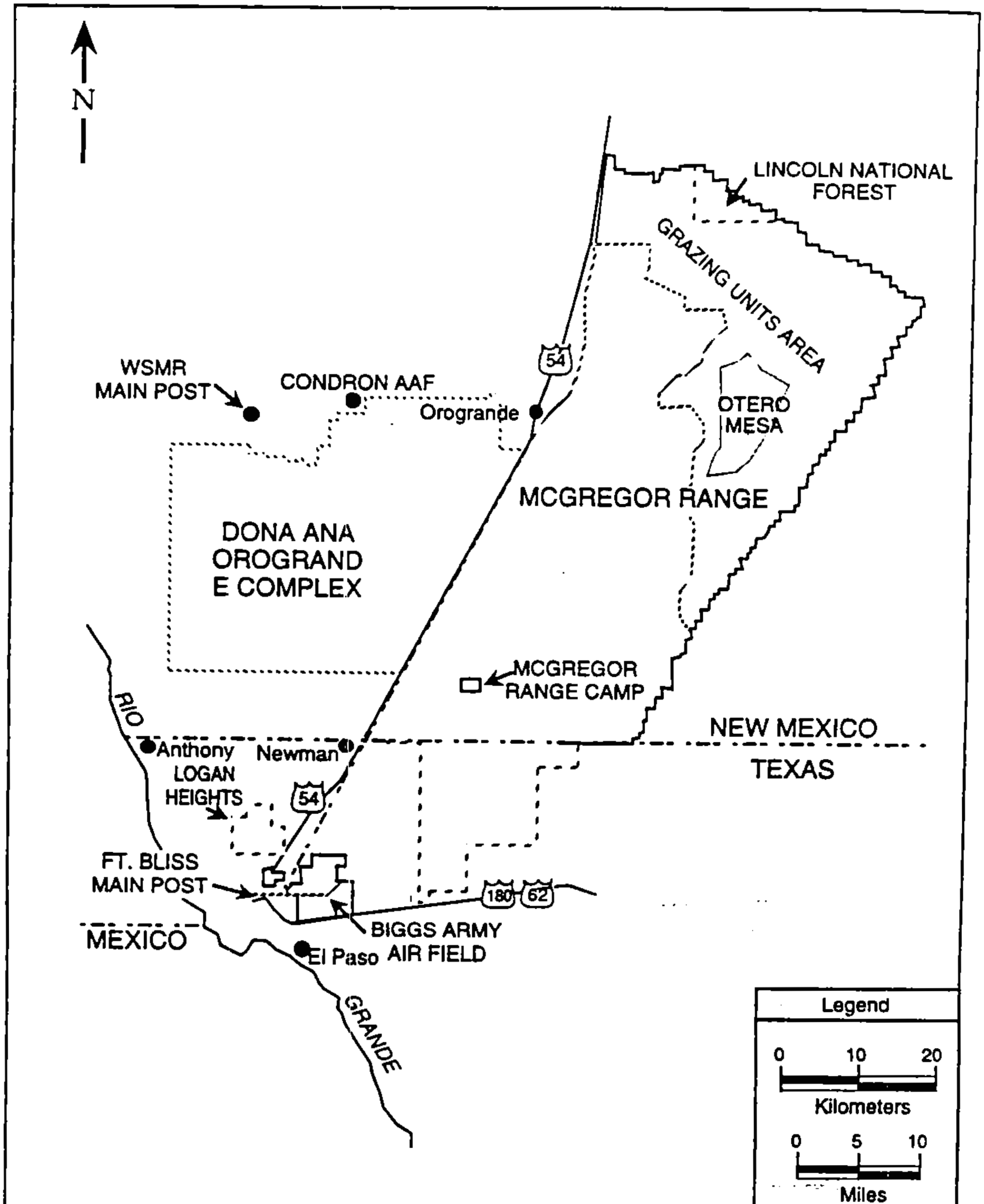

Figure 4-3.
Activity location map, Fort Bliss, Texas, White Sands Missile Range

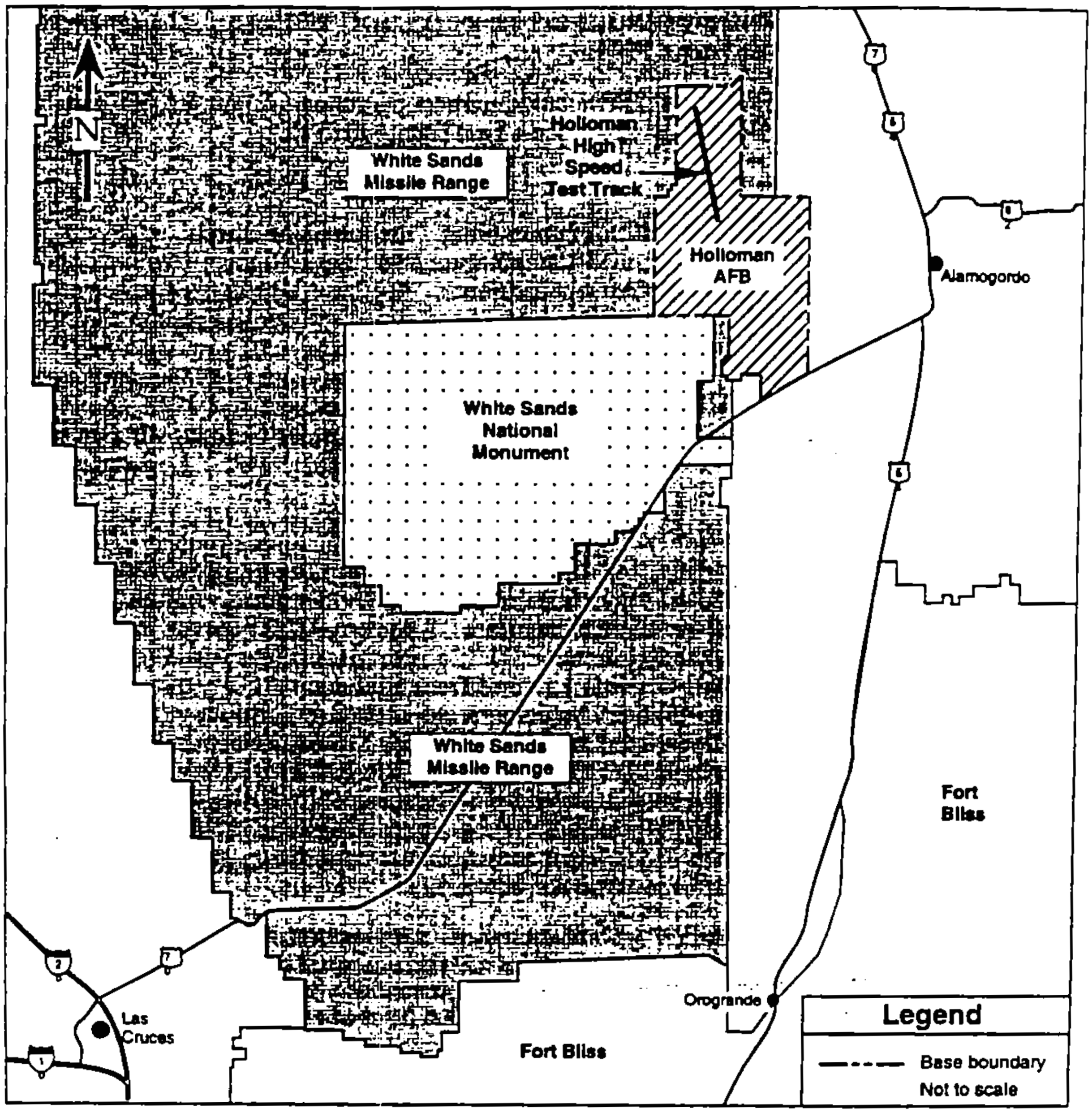

Figure 4-4.
Holloman Air Force Base vicinity location map, White Sands Missile Range, New Mexico

March 1994, the base consisted of 4,825 military personnel, 980 civilian-appropriated fund personnel, 315 civilian nonappropriated fund personnel, and 155 base exchange personnel (U.S. Department of the Air Force, 1995).

The primary activities at Holloman AFB include aircraft operations at the airfield and rocket sled test operations at the Holloman High Speed Test Track (HHSTT).

Aircraft Operations

Holloman AFB is the home of the 49th Fighter Wing. Predominant current air operations at the base consist of F-117 aircraft, AT-38 aircraft used for basic fighter training, and F-4 aircraft used in training pilots of the German Air Force. The base also houses lesser numbers of several other types of aircraft and is visited by various types of transient aircraft each year. Most of the sorties at Holloman AFB occur between the hours of 7:00 a.m. and 10:00 p.m. with the majority of these occurring during daylight hours. Only the F-117 aircraft regularly schedule operations during hours of darkness. Aircraft operations for 1992 show 7,344 sorties for F-117s, 11,856 sorties for AT-38s, and 3,720 sorties for German Air Force F-4s. Total operations data for transient aircraft are not currently available. (U.S. Department of the Air Force, 1993)

Holloman AFB has a field elevation of 1,248 m (4,093 ft) and has three runways from which to conduct its operations. Runway 16/34 serves as the primary departure runway for F-117 operations; most landings and closed patterns are conducted on this runway. Runway 04/22 is the primary runway for transient aircraft departures. Runway 07/25 serves as the primary runway for AT-38 and F-4 takeoff operations (U.S. Department of the Air Force 1993). In conjunction with aircraft training activities, aircraft from Holloman AFB regularly use special use airspace (SUA) including military operation areas (MOAs), military training routes (MTRs), bombing ranges, and restricted areas (Figure 4-5). MOAs used include the Beak and Talon MOAs. MTRs used include IR 113/133, IR 134, VR 100/113/125, VR 133, VR 176, and VR 1233. Bombing ranges used include the Oscura and Red Rio ranges (located on WSMR) and the McGregor Range (located to the south of and adjacent to WSMR). Restricted areas include various sections of R-5107 that are associated with the restricted airspace within the WSMR area. (U.S. Department of the Air Force, 1991)

The majority of F-117 operations are conducted on the Oscura, Red Rio, and McGregor bombing ranges and in the Beak and Talon MOAs. These aircraft do not normally require or regularly use MTRs. F-117s operate at altitudes in the medium-to-high range but would have occasional flight activities down as low as 610 m (2,000 ft) above ground level (AGL). Flight speeds are normally subsonic. (U.S. Department of the Air Force, 1991)

F-4 missions are conducted throughout the range of airspace parameters. Flight altitudes range from 30.5 m (100 ft) AGL and up. Most are conducted between 91 and 152 m (300 and 500 ft) AGL. Flight speeds are both subsonic and supersonic; however, supersonic speeds occur only in approved supersonic airspace. (U.S. Department of the Air Force, 1991)

AT-38 operations are also conducted throughout the range of airspace parameters with flight altitudes ranging from 30.5 m (100 ft) and up. Flight speeds are subsonic. (U.S. Department of the Air Force, 1991)

Holloman High Speed Test Track

The HHSTT (15,480 m [50,788 ft] long) is located on Holloman AFB, approximately 24 km (15 mi) west of Alamogordo (see Figure 4-4). The track is located in the northwest area of the base along the eastern edge of WSMR and is oriented in north-south direction. The HHSTT is

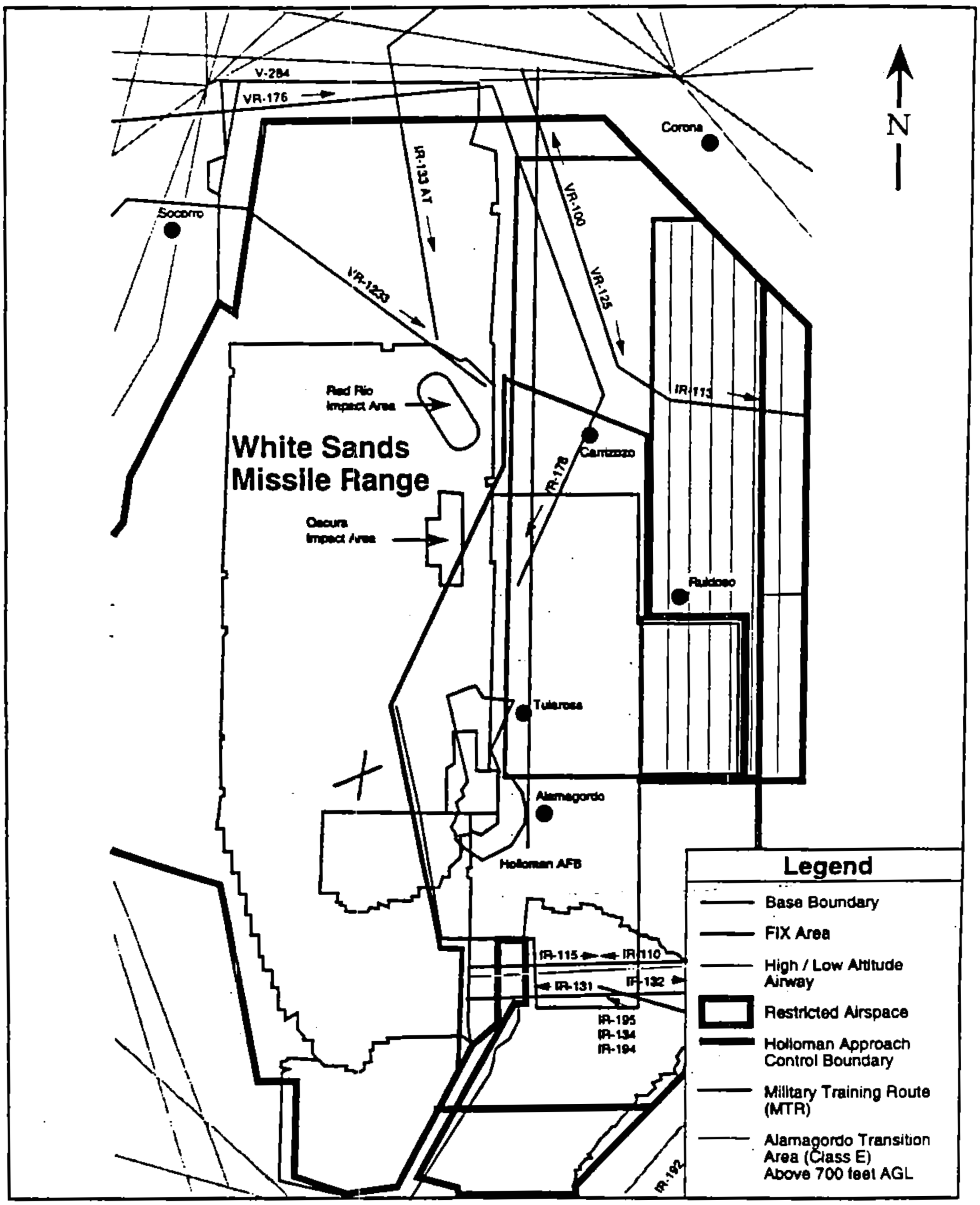

Figure 4-5.
WSMR area special use air space, WSMR and Ft. Bliss

currently the longest, most precisely aligned, and completely instrumented test track of its kind. All test activities at the track occur within the confines of Holloman AFB property.

The HHSTT is an aerospace ground test facility used to simulate selected portions of flight trajectories under programmed, controlled, and monitored conditions. The HHSTT provides unique test environments, such as extremely high accelerations and hypersonic velocities. Test items include theater missile defense interceptors, aircraft egress systems, and missile guidance systems. Approximately 100 to 190 tests are conducted annually on the HHSTT. (U.S. Department of the Air Force, 1995)

For test activities, payloads and instruments are moved in a straight line by means of rocket sleds operating on a set of continuously welded, heavy-duty crane rails mounted on reinforced concrete girders. Over its entire length, the track consists of two parallel concrete girders and rails with a concrete water trough between them. For the northern 4,633 m (15,200 ft) of the track, a third rail is located on the eastern side. One, two, or three rails may be used during any individual test. (U.S. Department of the Air Force 1995 [Holloman HHSTT Maglev Environmental Assessment])

Air emission permits are not required for mobile emission sources, which include sled test activities. Some high speed tests use water for braking. This water is obtained from the base water system, which has two sources: the Bonito Lake Reservoir (used in the winter), and well-water (used in the summer). The Holloman AFB area (including the HHSTT) is predominantly surrounded by vacant desert land. Noise from sled test activities can be heard in nearby towns although there are no noise monitoring stations in the vicinity of the HHSTT. (U.S. Army Space and Strategic Defense Command, 1993)

In general, surplus solid propellant rocket motors are used for propulsion on the sleds. Typical rocket motors used for testing include Improved Honest John, Nike, Roadrunner, Pupfish, Terrier Mark XII, Genie, or other equivalent type of solid propellant rocket motor. (U.S. Department of the Air Force, 1995)

A number of ancillary facilities are located adjacent to the track and include the Impact Test Area at the north end of the track that allows for impact of targets using both live and inert munitions. Four blockhouses along the track are used for firing sleds from fixed locations; however, sleds may be fired from any location on the track by using a mobile launch van that also supplies blockhouse capability. (U.S. Department of the Air Force, 1995)

4.16.3.4 Roving Sands Joint Training Exercise

The 11th Air Defense Artillery (ADA) Brigade on Fort Bliss, a contingency brigade, is required to be deployed during worldwide joint contingency missions. The purpose of such deployment is to deter or defeat threats to facilities and forces that are of strategic importance to the United States. To meet the training requirements for contingency brigade forces, the Chairman of the Joint Chiefs of Staff has coordinated with the U.S. Army Forces Command to establish the Roving Sands JTX. Roving Sands JTX includes elements from the active and reserve Army ADA and Marine Corps HAWK missile units, as well as command and control facilities. Also included are Navy combat, command and control aircraft, and Air Force combat and support aircraft and control facilities. These combined elements provide a simulated combat environment to allow training and evaluation of multiservice commanders, forces, and equipment.

Each annual exercise is conducted in four general phases as described in the following sections. Figure 4-6 shows the primary activity locations associated with the Roving Sands JTX program.

The deployment phase of the JTX typically begins during the third quarter of the Federal fiscal year (April-June) and continues for approximately 7 days. During this time participating forces move all personnel and equipment from their respective home bases and stations to the proposed exercise locations.

The majority of the equipment and personnel are brought into Fort Bliss by railroad and truck. Transport/cargo aircraft (for example, C-130) are also used. Other airplanes and helicopters are flown into the designated exercise locations such as Roswell Industrial Air Center (approximately 193 km [120 road mi] east-northeast of Alamogordo, New Mexico), Biggs Army Airfield (AAF), and Fort Bliss.

Approximately 10,000 personnel are expected to participate in each JTX. Approximately 6,000 personnel are deployed in field positions, including designated range camps (for example, Orogrande, Stallion, Doña Ana, and McGregor Range Camps). About 3,000 vehicles are used for each Roving Sands JTX, approximately 60 of which are tracked vehicles that are used only within the Tularosa Valley floor.

The transition phase ensures that all personnel and equipment are properly positioned in the maneuver areas and ready to begin the exercise. The 11th ADA Brigade conducts a series of communication tests from fixed positions to ensure all command and control systems are in place and operational before the start of the exercise. There is also orientation training during this phase to ensure that troops are aware of exercise environmental regulations governing off-limit areas, fire prevention and control measures, other exercise restrictions, and pertinent points of contact. The Maneuver Damage Prevention Team is in place before the exercise to ensure that Roving Sands participants occupy the proper training sites.

The Roving Sands exercise is conducted following the deployment and transition phases and continues for approximately 10 days. The exercise involves three major activities: 1) ground activities, 2) air activities, and 3) live fire exercises.

Ground Activities

Most of the ground training exercises, primarily static positioning of equipment, occur in the Fort Bliss training areas (the southern portion of the McGregor Range and Doña Ana/Orogrande maneuver areas). These areas are used to position several types of air defense gun and missile systems. Only about half of the estimated force strength is deployed into the field training areas on McGregor Range and WSMR.

Units are also deployed on and around Otero Mesa in the northern region of McGregor Range, at Orogrande Range Camp, at McGregor Range Camp, and at Roswell Industrial Air Center. Personnel are also in and around the Logan Heights Training Complex and Biggs AAF, located next to Fort Bliss. West of the Organ Mountains and south of U.S. Highway 70, foot-soldiers are stationed on BLM land adjoining the western boundary of Fort Bliss to simulate Stinger anti-aircraft missile operations.

Ground-to-air defense systems are established on WSMR. Approximately 80 sites near the Stallion AAF and Condron AAF in the northwestern and southern portion of WSMR, respectively, are used as ground-to-air defense sites.

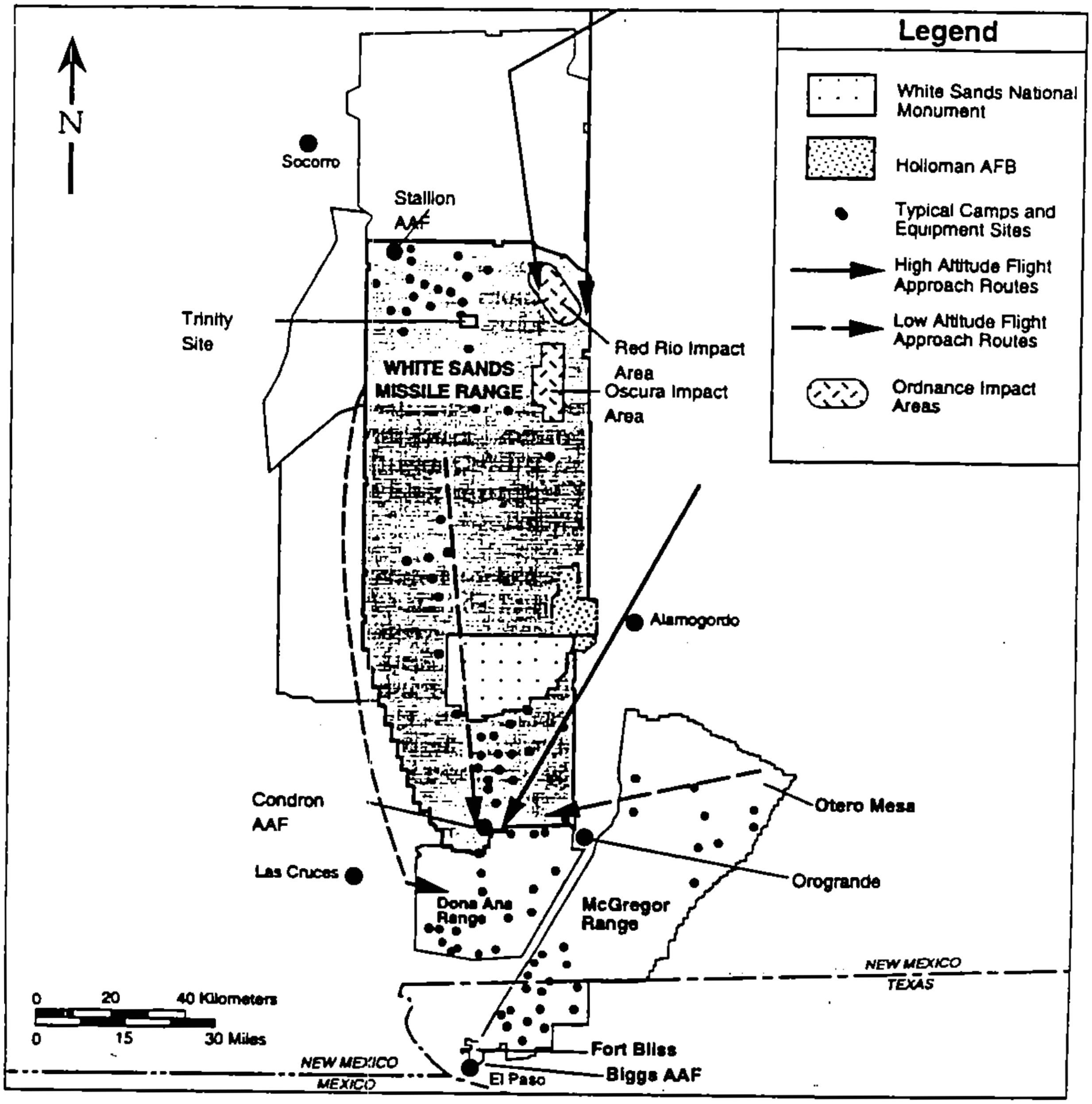

Figure 4-6.
Activity location map: Roving Sands Joint Training Exercise

Air Activities

Many types of air activities occur during the JTX, including air-to-ground and air-to-air attacks. Daytime and nighttime attack periods are conducted during weekdays over WSMR and Fort Bliss restricted airspace, with approximately 125 sorties per attack period. (A sortie is defined as an aircraft leaving the runway, performing its mission, and then returning.) Up to 50 night sorties (10 bomber, 30 fighter aircraft, and 10 transport airplanes/helicopters) could also occur. Approximately 300 sorties per 24-hour period are flown. Most of the sorties are less than 0.5 hour over WSMR. There is approximately a six-fold increase in air activity on Fort Bliss over the level required for ongoing mission activities. The remainder, or about a two-fold increase, in air activity on WSMR over the level required for ongoing mission activities would be expected. The exercise concludes with a 36-hour attack period during the weekend. These aircraft originate from the Roswell Industrial Air Center and Biggs AAF. They engage in the training exercise only in the designated airspace. Inert training ordnance is dropped on established target areas within the Red Rio and Oscura bombing ranges located in northern WSMR.

Aircraft begin the air-to-ground attacks from the north-central portions of WSMR, normally in groups of four, and proceed southeasterly toward Fort Bliss. Aircraft from Roswell use preapproved Federal Aviation Administration (FAA) routes. Generally, the aircraft return along the same routes after completing the attack. Low-level use of restricted airspace over the NASA Johnson Center and WSMR main post has been granted in the past to allow realistic tactical use of the airspace.

Air attacks over Fort Bliss maneuver area targets may involve flights down to 30.5 m (100 ft) AGL. However, flights over WSMR (not including designated noise-sensitive areas) are generally limited to a minimum altitude of 152 m (500 ft) AGL vertical and 152 m (500 ft) horizontal distance from structures.

Both B-52 and B-1B bombers participate in simulated bombing runs. The bombers drop inert ordnance on approved target areas in the Oscura Bombing Range and then continue south, leaving the area. All bombers fly at or above 152 m (500 ft) AGL over WSMR/Fort Bliss during the day and at or above 183 m (600 ft) AGL during night missions.

Bomber aircraft use FAA-approved IR-133 training route for access into WSMR restricted airspace.

Helicopter search and rescue training operations involving about three helicopters occur in the north-central area of WSMR during air activity windows. Helicopters fly under 152 m (500 ft) AGL and observe the same noise-sensitive areas as jet aircraft.

Electronic countermeasures operations include the use of chaff (fiberglass coated aluminum fibers) to disrupt specific radar frequency bands. Chaff fibers have a 1-mm (0.04-in) diameter and range from 0.97–5.1 cm (0.38–2.0 in) in total length. Each chaff charge weighs about 170 g (6 oz); an average load for an airplane is 20–30 charges. A maximum of approximately 6,800 kg (15,000 lb) of chaff may be dropped in restricted airspace over the northern portion of WSMR between 152 and 6,096 m (500 and 20,000 ft) AGL per exercise.

Live Fire Exercise

During the JTX, the 11th ADA Brigade fires several gun and missile systems using live ordnance. Air defense units fire approximately 25 HAWK missiles, 20 PATRIOT missiles, and 60 Stinger/Redeye/Chaparral missiles. All ordnance firing occurs on the established Fort

Bliss firing ranges, thereby eliminating the need for additional range preparation. Impacts associated with these types of activities have been addressed by the U.S. Army (U.S. Army Space and Strategic Defense Command, 1984). McGregor Range is intended to be the impact area.

Phase 4 lasts approximately 1 week and involves three major tasks. The first task, the field evaluation and critique of the JTX, begins immediately upon cessation of the actual exercise. Redeployment of troops and equipment comprises the second task. This task is accomplished in the reverse order in which these resources were deployed. The third task involves Maneuver Damage Prevention Team supplemented with necessary environmental and site/area expert personnel to ensure validity. The teams inspect the areas used to ensure that installation regulations and all appropriate Federal and state environmental regulations and guidelines have been satisfied.

Support activities include simulated equipment decontamination training throughout the Fort Bliss exercise area, the Stallion Range Camp, and the Trinity Site parking lot on WSMR. Equipment decontamination involves the use of high pressure hoses and fresh water to wash off simulated chemical contamination from equipment.

Fuel dispensing stations are located at battalion headquarters locations and at various Forward Arming and Refueling Points. A variety of oils and lubricants are also used, including engine oil, transmission fluids, hydraulic fluids, and lubricants of various types. Hot refueling of aircraft occurs on the aircraft ramp at Stallion AAF at WSMR. The aircrews conduct the refueling operations following applicable regulations for hot refueling. Units also have solvents, cleaning compounds, battery acid, and other petroleum products necessary for the operation of the defense and support equipment.

4.16.3.5 Southwest Regional Spaceport

The Southwest Regional Spaceport is a proposed commercial launch program currently planned to be located at a site within the WSMR western call-up area. The final location of the Spaceport would be dependent upon the findings in the Southwest Regional Spaceport EIS which is currently in preparation (New Mexico State University,1995). At present, the Southwest Regional Spaceport Task Force (and the EIS) are examining the technical feasibility and strategic business significance of establishing a spaceport in southeastern New Mexico (in proximity to the White Sands Missile Range), for the purposes of launching and recovering commercial and international reusable space capsules. As currently planned, the spaceport would include the following: the construction of final space vehicle assembly and maintenance facilities; testing and calibration laboratories; warehouses, payload buildup and testing facilities; flight operations control, radar sites, optics telemetry, crew support systems; and appropriate infrastructure for mission support. (White Sands Missile Range, 1992)

Proposed users of the spaceport would include the U.S. military, commercial organizations, and international businesses and governments. Planned missions include space vehicle launch and recovery, and orbital and suborbital operations.

4.16.3.6 TMD Extended Test Range Testing

WSMR has been selected as one test location to conduct TMD extended range testing. The WSMR test area activities include defensive missile launches from WSMR, New Mexico, and Fort Bliss, Texas, and off-range target missile launches from Fort Wingate Depot Activity (FWDA) located near Gallup, New Mexico, with intercepts over WSMR. Testing of TMD radars, positioned on WSMR, would occur during these flight tests. This testing also includes approximately six to eight launches per year of Army tactical missiles from FWDA with impacts on WSMR. Representative extended test range activity locations on WSMR are shown in Figure 4-7. The debris impact locations are to be determined (refer to the Theater Missile Defense Extended Test Range EIS, 1994).

4.16.3.7 White Sands National Monument

WSNM, established on January 18, 1933, and comprising nearly 596 km^2 (230 mi^2), is administered by the National Park Service, U.S. Department of the Interior. The park is about 24 km (15 mi) southwest of Alamogordo on U.S. Highway 70.

A portion of the eastern half of WSNM, adjacent to U.S. Highway 70, is open to visitors throughout the year. A 13-km (8-mi) scenic drive commences at park headquarters and winds into the heart of the dunes as shown in Figure 4-8. Activities at WSNM consist entirely of providing tours and information to visitors, and the care and maintenance of the park. During the 10-year period of 1985–1995 there were more than six million visitors to the WSNM. During this same 10-year period more than 95 million liters (25 million gallons) of water were used. Within the WSNM drinking water is only available at the visitor center, which is located at the entrance of the park on U.S. Highway 70.

From 1985–1995 the care and maintenance of the WSNM consumed 175,340 L (46,320 gal) of unleaded gasoline, 118,100 L (31,200 gal) of diesel fuel, 2080 L (550 gal) of motor oil, 159 kg (350 lb) of chassis grease, 190 L (50 gal) of antifreeze, and 30 L (8 gal) of pesticide/herbicide. All 30 L (8 gal) of pesticide/herbicide were used in 1995.

WSNM is a natural area. Removal or disturbance of archeological or natural objects, sand, selenite crystals, plants, or animals is prohibited.

The western half of the WSNM is under a co-use agreement with WSMR as a controlled impact area for missile material. Planned impacts within the co-use area of WSNM are only considered when the conditions of a test cannot be met otherwise.

Impact recovery ground operations sometimes involve heavy equipment that travels both on roads and cross-country and can disturb the flora. Consequently, ground vehicle recovery is used by WSMR only when helicopter recovery is not feasible.

This western section of the WSNM has limited public use; approximately 100 persons per year are permitted by NPS personnel for travel in this area.

4.16.4 Off-Range-Based Cumulative Impacts

This section describes baseline environmental conditions within the areas potentially affected by the total of all actions identified (i.e., where activities overlap) and analyzes the impact of all identified past, present, and reasonably foreseeable actions upon the WSMR environment based on the methods for cumulative impact analysis described in Section 4.16.1.

4.16.4.1 Regional Setting

To provide an overview of the past and present actions occurring at major facilities and installations in the region of WSMR, data concerning population and range utilization were collected for the last 7 years (1988 to 1994). The overall trend has been a decline in population and employment accompanied by an increase in range utilization from 1988 to 1994 (Table 4-25).

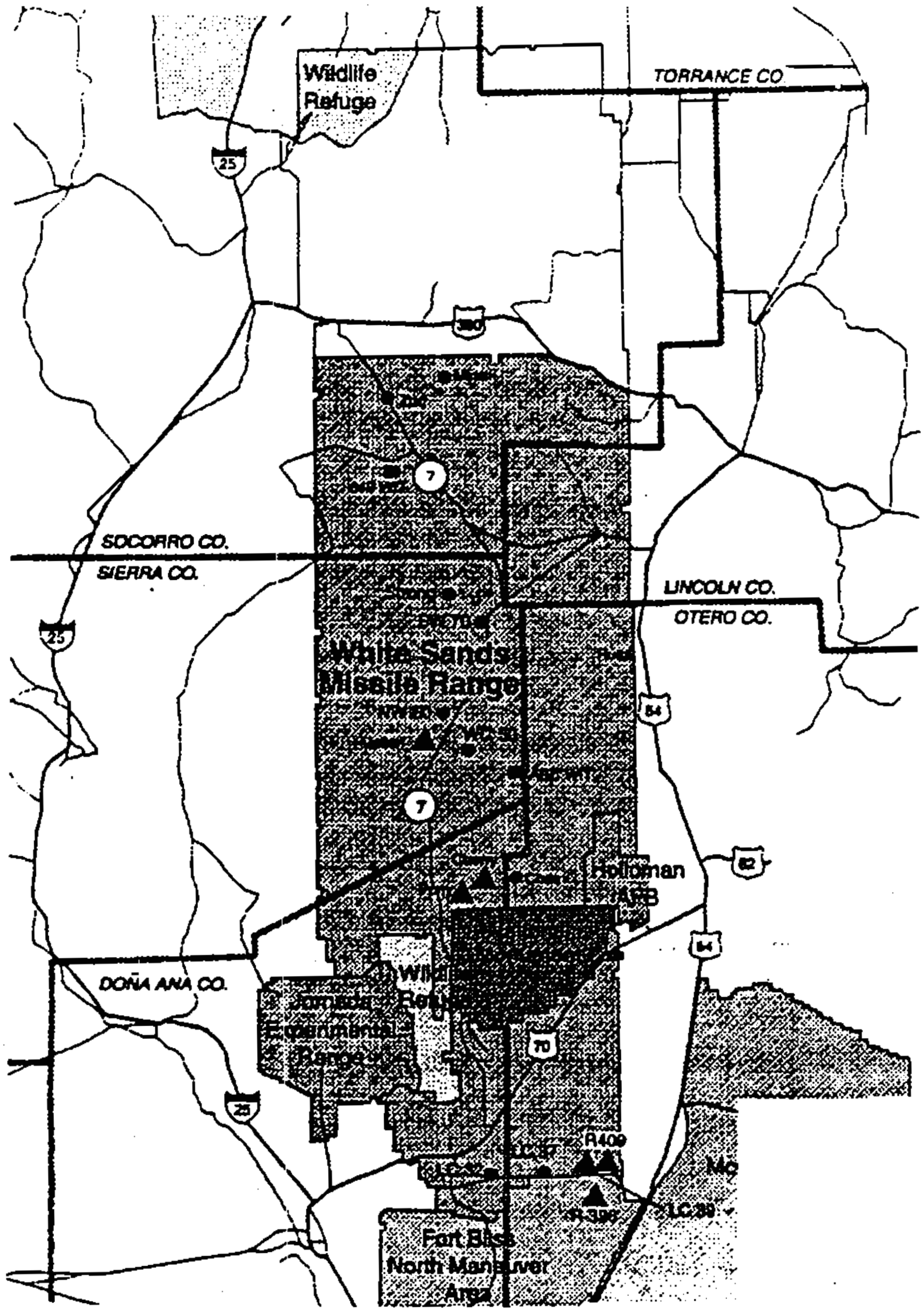

Figure 4-7.
Activity location map TMD Extended Test Range, White Sands Missile Range, New Mexico

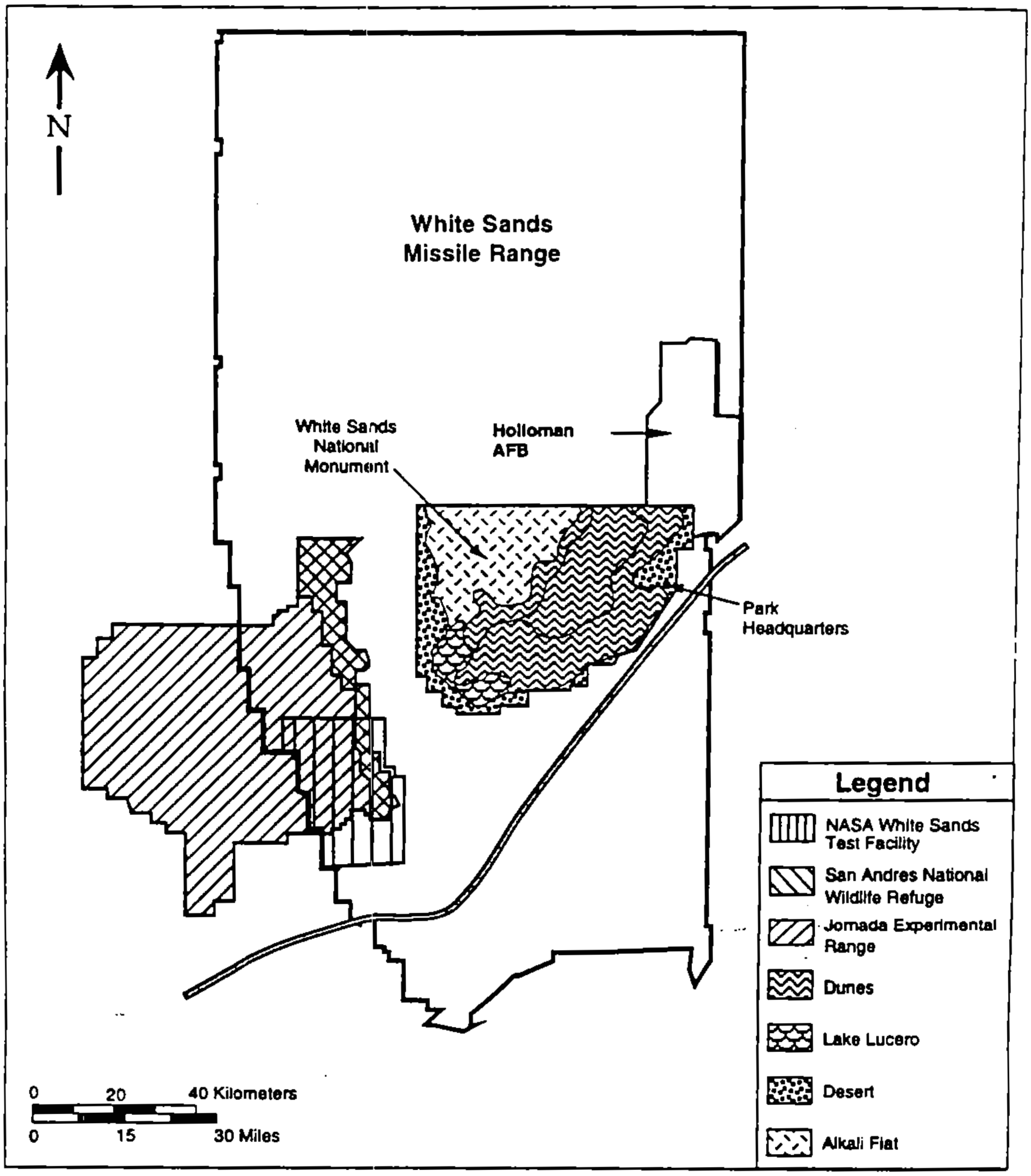

Figure 4-8.
White Sands National Monument general vicinity map
White Sands Missile Range, New Mexico

Table 4-25
Regional installation population and employment

	1987	1988	1989	1990	1991	1992	1993	1994
WSMR	8,829	9,560	9,527	9,780	9,033	8,801	8,386	7,913
Bliss	39,070	36,527	36,845	35,880	37,226	35,268	33,764	32,555
Holloman	9,478	8,666	8,379	8,088	7,404	7,102	–	–
WSTF	1,160	1,180	1,150	1,190	1,205	1,215	1,310	1,270
WSNM	–	–	16	16	17	18	19	19
Total	58,537	55,933	55,917	54,954	54,885	52,404	43,479	41,757

Future population and employment at WSMR, Holloman, WSTF, and WSNM are not expected to change significantly. As a result of the changes brought on by the Base Realignment and Closures (BRAC) act, military strength at Fort Bliss will be restructured. As presently planned, the restructuring will result in an initial loss of approximately 1,400 soldiers by 1996, with increases in 1997 and 1998 of approximately 1,400 soldiers, for a net change of 0.

Range utilization provides an indicator of the level of mission activities executed by tenant agencies at WSMR. As shown in Table 4-26, overall utilization has ranged from 23,825 hours to 32,377 hours.

4.16.4.2 Off-Range Analysis Approach

The amount of detail presented in this analysis is directly related to the current level of data available for the specific location, activity, or resource. Where data are available, the focus of this analysis is on actual proposed activities, rather than projected activities. Any projections that have been developed for analytical purposes are based on current conditions and trends and represent a best professional estimate of reasonably foreseeable future actions.

Individual resources were analyzed in terms of the resource's particular space and time parameters (i.e., geographical extent of the impact and the life span of the impact) which vary by resource. The time dimension covers impacts from any past actions, through any reasonably foreseeable impacts. The space dimension, which can be focused (localized at the project site) or expanded (a regional or global impact), depends on the nature of the action and the type of impact predicted. The concept of a "threshold" to determine the point at which

Table 4-26
Utilization of the WSMR Range (hours)

	1988	1989	1990	1991	1992	1993	1994
Army	10,099	15,917	8,891	7,969	8,611	10,010	10,324
Air Force	7,189	8,280	10,401	9,486	8,025	11,086	10,938
WSMR	5,190	6,311	6,595	8,408	7,046	8,768	8,115
Navy	549	447	668	556	559	799	443
NASA	611	843	657	652	759	615	456
Other	187	579	218	305	416	508	343
Total	23,825	32,377	27,430	27,376	25,416	31,786	30,619

significant impacts occur was considered during this analysis; however, guidance for this aspect of analysis is limited and is, necessarily, resource specific. As a result, this analysis primarily relied on established guidelines and legal mandates for individual resource programs to identify thresholds and the types of mitigation measures needed to avoid or minimize impacts to affected resources. Resource management actions and mitigations designed to recover resources to optimal conditions, while continuing to support agency missions, were also considered.

Based on the descriptions provided in Section 4.16.3, a list of current and planned activities in the region was compiled. This list was reviewed to determine the potential for an activity at a neighboring agency-controlled area to contribute to a cumulative impact on WSMR. This determination is primarily subjective. Table 4-27 identifies each agency and the activities that were identified. The potential for cumulative impacts at WSMR is indicated on the table as low, medium, or high. In cases where an activity is not carried out for a particular agency's area, the potential is identified as not applicable.

The activities described in Table 4-27 were then evaluated in terms of their potential to impact resources on WSMR. Table 4-28 identifies the activities and resources and indicates the potential for cumulative impact. Those resources with a potential for cumulative impacts are discussed further in the following sections.

4.16.4.3 Geology and Soils

Potential cumulative impacts to soils are related to direct impact of missiles, bombs, and other debris, and to off-road vehicle travel for recovery of debris. Surface to air and dispenser/bomb drop activities from Holloman AFB and JTX activities often utilize impact areas such as Red Rio and Oscura as well as other designated impact areas on WSMR. These activities generally produce debris that is not recovered. This debris consists of inert materials that do not affect the overall condition of the soil.

Surface to surface and target missiles are occasionally launched from Fort Bliss for impact on or intercept above WSMR. The debris from these launches is usually recovered as part of the test in order to verify missile performance. The area disturbed by direct impact of missiles or large pieces of debris is generally very small, requiring only minor raking of the area to mitigate the potential for increased erosion. Recovery of debris requiring travel off-road is likely to have the greatest effect on soils. Some soil types are more susceptible to compaction and erosion as well as loss of vegetation. A review of the soil type and the amount of road access within proposed impact areas could help to identify areas of potential impacts. Areas that have a limited road network have a higher potential for off-road travel. Some of the soils also have a higher potential to be impacted by off-road travel. By screening potential debris impact and recovery areas, those areas with the highest potential for impacts to soils can be identified and avoided. This would help to prevent impacts to soils and reduce the potential for cumulative impacts.

The off-range activities that could impact soils at WSMR represent a very small addition to on-base testing. The soils review described above and mitigation measures described in Section 2.4.2 should prevent any cumulative impacts to soils.

Table 4-27
Potential to contribute to cumulative impacts on WSMR

ACTIVITY	AGENCY/PROGRAM							
	Bliss	JTX	Holloman	NASA	BLM	Space-port	ETR	WSNM
Construction/Operations	◉	—	○	—	—	◉	—	○
Off-road Travel	○	◉	○	○	◉	○	◉	○
EOD	○	—	○	○	—	—	○	—
Air to Air (Airplanes)	—	○	○	—	—	—	—	—
Surface to Air (PATRIOT/HAWK)	○	◉	—	—	—	—	—	—
Surface to Surface (ATACMS)	○	—	—	—	—	—	◉	—
Dispenser/Bomb Drop	—	◉	◉	—	—	—	○	—
Target Systems	○	○	—	—	—	—	◉	—
Atmospheric Probe	—	○	○	○	—	○	○	—
NASA/Space Program	—	—	—	○	—	—	—	—
Equipment Testing	—	—	—	○	—	—	—	—
R&D	—	—	○	○	—	—	—	—
Grazing	○	—	—	○	◉	○	—	—
Recreation Use	○	—	○	○	◉	○	—	◉
Mining	—	—	—	—	○	○	—	—
Troop Movement	○	○	—	—	—	—	—	—
Artillery Firing	○	○	—	—	—	—	—	—
Aerial Gunnery	○	○	—	—	—	—	—	—
Air Support	○	○	○	—	—	—	—	—
Aircraft Overflight	○	◉	◉	—	—	—	—	—
High Speed Test Track	—	—	○	—	—	—	—	—
High Energy Laser	—	—	—	—	—	—	—	—
On-Road Travel	—	○	○	○	—	○	○	○

Legend: ○ = Low; ◉ = Medium; ● = High; — = Not Applicable or None

Table 4-28
Potential for cumulative impact to resources on WSMR

OFF-RANGE ACTIVITY	RESOURCE													
	Geology	Water	Air Quality	Biological	Cultural	Land Use	Utilities	Trans-port.	Recreation	Visual	Noise	Radiation	Haz	H&S
Construction/Operations	—	◉	○	○	○	○	—	○	—	—	—	—	—	—
Off-road Travel	◉	○	○	◉	◉	○	—	—	—	—	—	—	—	—
EOD	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Air to Air	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Surface to Air	○	○	○	○	○	—	—	○	—	—	○	—	—	—
Surface to Surface	○	○	○	○	○	—	—	○	—	—	○	—	○	—
Dispenser/Bomb Drop	○	○	○	○	○	—	—	○	—	—	○	—	○	—
Target Systems	○	○	◉	○	○	—	—	○	—	—	○	—	○	—
Atmospheric Probe	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NASA/Space Program	—	○	○	—	—	—	—	—	—	—	—	—	—	—
Equipment Testing	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R&D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Grazing	—	○	—	○	—	○	—	—	—	—	—	—	—	—
Recreation Use	—	—	—	○	—	○	—	—	—	—	—	—	—	—
Mining	—	—	—	—	—	○	—	—	—	—	—	—	—	—
Troop Movement	—	—	○	○	○	—	—	—	—	—	—	—	—	—
Artillery Firing	—	—	—	—	—	—	—	—	—	—	○	—	—	—
Aerial Gunnery	—	—	—	○	○	—	—	—	—	—	○	—	—	—
Aircraft Overflight	—	—	○	◉	○	○	—	—	—	—	◉	—	—	—
High Speed Test Track	—	—	○	—	—	—	—	—	—	—	—	—	—	—
High Energy Laser	—	—	—	—	—	—	—	—	—	—	—	—	—	—
On-Road Travel	—	—	◉	—	—	—	—	○	—	—	—	—	—	—

Legend: ○ = Low; ◉ = Medium; ● = High; — = Not Applicable or None

4.16.4.4 Water Resources

Surface Water

There is some potential for cumulative impacts to surface waters from missile exhaust products and flight-test debris. At launch sites, solid fuel rocket motor exhaust would typically disperse hydrogen chloride, carbon monoxide, and particulates which may affect nearby surface water. However, there is no significant surface water in the vicinity of the various launch sites on WSMR. It is also expected that the buffering capability of the soils will act to neutralize missile exhaust products to a level such that no cumulative impacts would occur in areas that pond during heavy rains.

Hazardous debris could land in small surface water areas that are a habitat or are used by wildlife as a water source. As programs become better defined, the potential amount of debris can be determined using predictive models. The results of the debris models for the WSMR proposed action, JTX intercepts, and extended test range intercepts can then be combined to determine the cumulative potential for debris landing in surface waters. A similar analytical approach for potential impacts on WSMR was used in the TMD Flight Test EA (U.S. Army Space and Strategic Defense Command, 1995). The results of that analysis indicated that the probability of a piece of hazardous debris impacting within pupfish streams and ponds on WSMR was approximately 1 in 450 tests.

Groundwater

Groundwater is the main source of water for the region. The geographic surface of primary interest consists of two closed basins, the Tularosa Basin and the Hueco Bolson. The Tularosa and Hueco groundwater aquifers are located below these basins. These aquifers are the primary source of water for WSMR, Fort Bliss, Holloman AFB, Alamogordo, and El Paso. Water for most NASA uses does not come from these aquifers but rather comes from a completely separate groundwater basin. Several studies have been conducted to analyze the water resources within these aquifers. Of particular interest to cumulative impacts is the Corps of Engineers Regional Water Requirements Study (U.S. Army Corps of Engineers, 1991) that provides information on the existing water resources and past use, future water requirements, and an evaluation of the capability to meet the future needs. Table 4-29 summarizes much of the information from the Corps of Engineers report regarding existing use and future needs. As can be seen in the table, the withdrawal rate for each installation exceeds the recharge rate. This is known as mining of the water supply, and has resulted in a cumulative drawdown, or lowering of the water table in the vicinity of the water supply wells of between 1.5 and 44 m (5 and 145 ft) over the past 50 to 90 years. The combined water requirements of all three installations were determined to be 14,662 ac-ft per year by the year 2030. Although this number is very small when compared to estimates of 15 million ac-ft of available water within the Tularosa Basin and Hueco Bolson aquifers, the quantity of water must be considered together with the quality of the water. The result of lowering the water table has been a decrease in the water quality as indicated by an increase in the total dissolved solids. Modeling of continued groundwater withdrawal shows continued lowering of the water table and further degradation of the quality of water.

As shown in Table 4-29, Fort Bliss represents a small percentage (5 percent) of the current usage in the El Paso area. The city of El Paso has the greatest potential to impact groundwater within the Hueco Bolson and must be considered in any future analysis of water resources. The city of Alamogordo receives its water from several sources including springs in the mountains northeast of Alamogordo, Bonito Lake, and six wells in a city well field located north of Alamogordo (U.S. Department of the Air Force, 1991). Holloman AFB and the city

Table 4-29
Regional water requirements study — projections and parameters

1989 and Projected Use

Installation	1989	2000	2010	2020	2030
WSMR	2,288	2,248	4,027	5,097	5,110
Fort Bliss	6,866	6,783	6,763	6,760	6,757
Holloman AFB	2,679	2,793	2,790	2,792	2,795

Water Use and Water Quality Parameters

Installation	Current Use	Local Recharge (acre-feet/year)	Historic Cumulative Drawdown (feet)	Projected Cumulative Drawdown (feet)	Historic TDS Increase (milligrams/liter)	Projected TDS Increase (milligrams/liter)	Available Potable Water (acre-feet)
WSMR							
Main Post Field	1,420	1,150	—100	—83	200	500	1 million
Soledad Canyon	750	750	-	—50	-	200	2.3 million
Fort Bliss							
Fort Bliss Field	7,059	***	—5 to —145	—475	500	500	
El Paso Area	131,000	6,000	—5 to —145	—475			9.5 million
Holloman AFB							
Boles Field	261		—35	—39	250	300	
San Andr/	782		—48	—56			
Dog Canyon	797	3,200	-	—33			
Escondido Field	782		-	—44			
Bonito Lake	1,100						
City of	5,692		-	-	-	-	-

Sources: U.S. Army Corps of Engineers, 1991; [1]U.S. Department of the Air Force, 1991

Notes:
- * Projected drawdown through 2017 for WSMR, through 2030 for Fort Bliss, and through 2001 for Holloman AFB
- ** Projected through 2030
- *** Fort Bliss field is within the El Paso area

of Alamogordo have an equal share of the water from Bonito Lake. At the present time, the Holloman AFB wells, located south of Alamogordo, do not interact with the city wells.

The Corps of Engineers report concluded that the Department of Defense water requirements for the 40-year planning period could be met by utilizing existing and undeveloped water resources. However, this would be accomplished through the continued mining of groundwater aquifers. The report also concluded that additional studies need to be carried out to better understand the dynamics of water quality changes and how to minimize degradation of the water supply. As shown in Table 4-30, a number of recommendations made in the report are currently being addressed.

4.16.4.5 Air Quality

There is the potential for impact to air quality from the cumulative effects of WSMR activities and off-range operations and programmatic activities. As discussed earlier, the air quality of a region is determined by the characteristics of the air pollution sources within and the defining meteorology of the regional airshed.

The regional airshed for WSMR is the Tularosa Basin, which is a closed intermountain area. As detailed earlier, air quality within the Tularosa Basin is good. This is due to the fact that there are relatively few sources of air pollution within the basin, and they emit relatively minor amounts of air pollutants. The only pollutant of any concern within the basin is PM_{10}, and this is due to the relatively large amounts of dust that occur naturally.

Table 4-30
Regional water requirements – recommendations and status

Recommendation	Current Status
A groundwater management strategy for all three installations should be developed.	Strategy is in planning stage.
WSMR should meet its additional water requirements from sources other than the Post Area well field.	WSMR is utilizing the Soledad Canyon well field.
Fort Bliss should pursue water development from the Hueco Underground Water Basin in New Mexico.	Fort Bliss is planning wells in Soledad Canyon and Fillmore Pass.
Holloman AFB should continue to utilize Bonito surface water to the maximum extent possible.	Holloman AFB is considering additional well field locations.
Desalinization of millions of acre-feet of slightly to moderately saline water in the Tularosa Basin could provide a potable water supply if desalinization processes become more economical.	WSMR is currently utilizing desalination at the Stallion area for brackish water. An additional desalination plant has been installed at the Oscura Range Center.
Additional analysis of the water sources should be conducted with emphasis on water quality and optimization of operation of existing (and future) well fields and distribution systems.	Additional analysis will be carried out by WSMR in a Water Resources Technical Support Supplement to the EIS.

Air pollutants emitted outside of the Tularosa Basin, unless emitted in quantities exceeding thousands of tons per year, will have no measurable effect, cumulative or otherwise, with air pollutants emitted within the Basin. Therefore, air pollutants emitted by activities at NASA's WSTF and GSFC WSC will have no measurable cumulative effects because these facilities are located outside the Tularosa Basin. They are separated from it by the San Andres Mountains.

As described for WSMR activities, some off-range operations and programmatic activities would possibly elevate airborne concentrations of criteria pollutants and hazardous air pollutants above ambient air quality standards and applicable health guidelines in the local vicinity of the activity (e.g., missile launches and off-road travel). However, the public is excluded from the ground area near these activities during critical times. Furthermore, the long-range, both spatially and temporally, effects of these emissions are minimal.

As mentioned earlier, the meteorological conditions of the Tularosa Basin generally promote excellent air quality. Air pollutants are quickly dispersed into the large volume of low pollutant concentration air of the Tularosa Basin. Therefore, for all inert pollutants (i.e., all except volatile organic compounds [VOCs] and nitrogen oxides [NO_X]), no effect of these emissions is detectable for more than a few miles from the emission point. Additionally, if the emissions are discrete, such as a missile launch, rather than continuous, such as for a boiler, the emissions will generally be undetectable after a few hours.

The air pollutants VOCs and NO_X can accumulate on a regional scale and combine hours or even days later at locations tens of miles from their sources to form tropospheric ozone. However, as mentioned earlier, occurrence of ozone is not a problem within the Tularosa Basin. Ozone pollution problems are typically found in urban areas. Emissions of the air pollutants VOCs and NO_X are relatively minor for WSMR and off-range activities, and for all sources within the Tularosa Basin.

In summary, no cumulative impacts to the air quality are expected to occur for WSMR and off-range activities. This is primarily due to four factors. First, the air quality in the Tularosa Basin is good; that is, the air contains very low concentrations of pollutants. Second, the meteorology of the Tularosa Basin generally quickly disperses any air pollutants that are emitted. Third, the sources of air pollution considered are generally separated by tens if not hundreds of miles, or, for discrete sources such as missile launches or training exercises, they are separated in time by days or months, or both. Finally, all but a few of the sources considered produce relatively minor amounts of air pollutants, that is, less than one ton of pollutant per year.

4.16.4.6 Biological Resources

Cumulative impacts to biological resources could potentially result from direct impact of missiles, bombs, and other debris; noise from aircraft overflights; and debris recovery activities during current and future off-range programs. Debris from surface-to-surface and target missiles launched from Fort Bliss and target missiles launched from Fort Wingate Depot Activity toward WSMR has the potential to impact both vegetation and wildlife on WSMR. Debris could result in the loss of some vegetation including areas with suitable habitat for grama grass cactus. Information on distribution of this species is limited, but the plants tend to be widely scattered and occupy small surface areas. Use of the WSMR GIS database would assist in selecting preferred debris impact areas to minimize the potential for impacting this and other sensitive species, and thus minimize cumulative impacts to these species.

A risk analysis was performed as part of the TMD Flight Test program (1995) to determine the probability of hazardous debris impacting White Sands pupfish habitat. The results of the analysis for that particular program indicated that the probability of a piece of debris impacting within pupfish streams and ponds was approximately 1 in 450 tests. Similar analysis for other missile testing will help to identify potential impacts. In addition, a comprehensive surface water monitoring program for Salt Creek is being instituted in order to establish a baseline for the pupfish. Data collection will include characterization of present water quality and stream flow, monitoring, and assessment of run-off potential. The results will also be used to determine individual and cumulative effects of WSMR activities on the pupfish and their habitat. (U.S. Army Space and Strategic Defense Command, 1995)

The consequences of disturbance to wildlife caused by noise from aircraft overflights, while cumulative, are not additive. Physiological and behavioral responses of wildlife to the noise of aircraft overflights range from no reaction to stress, elevated heart rate, and the animal leaving the area. Lower altitude flights generally cause more of a response; however, no particular altitude has been identified as causing a sudden increase in response. Some individuals react the same no matter what the overflight altitude is. The effects may be synergistic when combined with natural events such as harsh winters or periods of water shortage. Helicopter noise disturbs some animals more than other types of aircraft, which may be a result of flight patterns in addition to the noise of the helicopter itself. Sudden aircraft approaches also influence wildlife responses such as a helicopter appearing from over cliff tops. Species such as bighorn sheep appear more at ease in response to helicopters when in open terrain where escape is more easily managed. (National Park Service, 1994)

Some studies indicate that some animals may develop increased tolerance to frequent or regular overflights. Long-term impacts of overflight noise to wildlife are hard to verify due to limitations of research and the nature of long-term responses. Variables such as predation, weather, and food availability also contribute impacts to survival. WSMR will restrict overflights to 610 meters (2,000 ft) above ground level over refuges and areas where sensitive wildlife occurs, and will, wherever possible, avoid direct or indirect impacts to these sensitive areas. If impacts cannot be avoided, WSMR will contact the appropriate management agencies and develop coordinated mitigative measures to avoid irreparable harm to the resource. Monitoring low-level overflights and maintaining statistics could help quantify the frequency of impacts. (National Park Service, 1994)

Debris recovery activities also contribute to the potential for cumulative impacts to biological resources. Debris-recovery helicopter flights would involve gradual descents to pick up debris, followed by a flight of the recovery vehicle at an altitude that would avoid startling raptors and cause minimal disturbance to big game species. Potential cumulative impacts are related to off-road vehicle travel for recovery of testing debris in a similar manner as discussed for soils in Section 4.16.4.3. This is related to a limited number of missile launches from Fort Bliss and Fort Wingate Depot Activity and bomb drops from Holloman AFB.

Previous studies indicate that certain soil types on WSMR are more likely to support threatened and endangered plant species. A review of the soil type and amount of road access within proposed impact areas could help to identify areas of potential impacts to these threatened and endangered species. By screening potential debris impact and recovery areas, those areas with the highest potential for impacts to biological resources can be avoided.

The off-range activities that could impact biological resources at WSMR represent a very small addition to on-base testing. The review of potential recovery sites described above, mitigation measures described above and in Chapter 5, and continued agency coordination should reduce the potential for cumulative impacts to biological resources resulting from off-range activities.

4.16.4.7 Cultural Resources

Cultural resources sites are spatially discreet, fragile, non-renewable resources that are sensitive to a variety of operational and test activities. As a result, the analysis of cumulative impacts on this resource (in particular, National Register-eligible or -listed cultural resources [i.e., historic properties]) within the boundary of WSMR from off-range activities considered all of the following types of activities as having the potential to cumulatively affect cultural resources sites as a result of spatially overlapping or repetitive actions:

- Disturbance of prehistoric, historic, or traditional resources sites from construction; off road travel; troop movements; aerial gunnery activities; EOD operations; high explosive missile impacts; drone and tow target impacts; missile debris recovery operations; and fire, fire fighting, and fire break construction
- Chemical contamination (which could alter the ability to accurately date artifacts or sites) from pesticide, herbicide, and fire fighting activities
- Soil compaction from intensive surface usage (e.g., repetitive movement of vehicles or heavy equipment) that could alter or damage subsurface artifacts
- Landscape alterations (e.g., grading, installation of new utility lines) that could increase erosion and damage sites or affect the visual quality of historic landscapes
- Renovation, restoration, demolition, or other modification of historic buildings or structures
- Noise induced effects on fragile historic buildings or structures, including those from sonic booms, and low frequency vibrations from fixed wing aircraft, helicopters, and heavy artillery
- Unauthorized artifact collection or site disturbance from increased numbers of personnel in archaeologically sensitive areas

As described in Section 3.6.1.4, there are 5,976 identified prehistoric, historic, and traditional resources sites within the boundary of WSMR (including the WSMR Call-Up areas); two of these sites are National Register-listed, and three are New Mexico State-listed. The remaining identified sites have not, as yet, been evaluated for National Register eligibility. Identification of this large number of sites is the result of cultural resources surveys that have encompassed only 6.72 percent of the entire installation, indicating the potential for numerous sites to occur in the unsurveyed areas. Because such a small portion of the installation has been surveyed; because the cultural resources, and therefore the historic property, complexion of such a large portion of the installation (93.29 percent) remains undefined; and because the specifics of the identified off-range programs have not been finalized, it is not currently possible to analyze cumulative impacts by quantitative methods. It is, however, possible to assess qualitatively the kinds of adverse effects on historic properties that could be expected from the types of proposed activities identified. A similar analytical approach for potential impacts at WSMR was used in the TMD Flight Test Environmental Assessment (U.S. Army Space and Strategic Defense Command, 1995).

Ground Disturbing Activities

Specific areas for potential ground disturbing activities with programs at Fort Bliss, Holloman, and the construction of the Southwest Regional Spaceport have not been finalized. As program requirements are better defined, ground disturbance footprints will be identified and additional site-specific cultural resources studies undertaken. In general, ground disturbing activities have the potential to disturb historic properties. Avoidance of sites is the preferred mitigation; however, because of a variety of program-specific requirements, avoidance cannot always be ensured. When avoidance is not feasible, intensive survey, recordation, and data recovery prior to program activities are the accepted mitigation. Data recovery would be conducted in coordination with WSMR cultural resources specialists and in consultation with the New Mexico State Historic Preservation Officer (SHPO). During emergency procedures (e.g., construction of firebreaks), the WSMR Environmental Services Division would monitor firebreak construction to the extent possible.

Chemical Contamination

The application of herbicides, pesticides, and fire retardants required by a variety of programs (e.g., debris recovery activities associated with NASA and TMD Extended Test Range launch programs) has the potential to alter scientific data important to the analysis and evaluation of archaeological sites. Application of these types of chemicals would be prohibited, or minimized, in archaeologically sensitive areas.

Soil Compaction

Subsurface site and individual artifact integrity could be affected by repetitive surface pressure from activities such as the off-road travel, troop movements, and heavy equipment activities required by missile test debris recovery and JTX programs. Mitigation measures would include prohibition, or minimizing off-road activities in archaeologically sensitive areas and regular assessment of frequently used troop and heavy equipment areas.

Landscape Alterations

Grading and trenching activities (e.g., installation of new utility lines) associated with any of the identified off-range programs could have the potential to adversely affect historic properties (particularly previously unidentified, subsurface sites). These types of activities can also precipitate erosional disturbance which can damage surface features. As feasible, utility corridors would be routed to avoid known sites and would be sited along, or within, existing, disturbed corridors and rights-of-way; erosion control procedures may also be required.

In addition, landscape alterations (e.g., grading, contouring, construction of new facilities) have the potential to affect the visual characteristics of certain types of historic features by introducing or modifying the physical setting or environment. In visually sensitive historic areas, such activities would be conducted in consultation with the SHPO and the Advisory Council to ensure that significant impacts do not occur.

Renovation, Restoration, or Demolition of Historic Buildings or Structures

Historic buildings and structures are particularly sensitive to physical change. Any historic properties identified for renovation, restoration, or demolition, to accommodate off-range program requirements would necessitate consultation with the SHPO and the Advisory Council. Adherence to guidance outlined in any existing agreement documents (e.g., Memorandums of Agreement, Memorandums of Understanding), or the WSMR Historic Preservation Plan would also be required.

Noise Effects

Fragile historic structures and certain types of archaeological sites (rock art panels, rock alignments, earthen features) are sensitive to shocks from sonic booms associated with missile launch programs and repetitive low frequency sounds generated by helicopter overflight and heavy artillery. As a result, proposed programs identified for Fort Bliss, JTX, NASA, and the Southwest Regional Spaceport have the potential to adversely effect these types of resources. Avoidance of overflight of these types of resources by low flying fixed wing aircraft and helicopters is the preferable mitigation; however, because of training and mission requirements, avoidance cannot always be ensured. Regular inspection of fragile features and sites should be conducted in order to monitor integrity degradation; depending on the type of feature, some type of physical stabilization may also be required.

Unauthorized Artifact Collection or Site Disturbance

Increased numbers of personnel in archaeologically sensitive areas increase the possibility of artifact collection and archaeological site disturbance. Troop movements associated with Fort Bliss and JTX and recreational uses and off-road travel by several of the off-range programs have the potential to increase the numbers of personnel in archaeologically sensitive areas. To discourage artifact and site disturbance, personnel would receive instructions regarding the penalties for unauthorized artifact collection and disciplinary measures will be imposed on violators. To the extent possible, sites and structures will be posted.

As described in Section 4.16.1, a potential for cultural resources cumulative impacts to occur from proposed on-range activities has been identified and mitigation measures have been proposed. When reviewed against the past, present, and reasonably foreseeable activities identified for the off-range locations, cumulative impacts could also occur; however, because the specific locations for these programs has not, as yet, been finalized additional analysis may be required as program requirements are more clearly defined. Based on existing levels of information, it is expected that the majority of locations for the off-range programs will not overlap geographically with on-range programs. The proposed mitigation measures described above and in Sections 2.4.6 and 4.6 have been designed to reduce the potential for any cumulative impacts. In addition, there is an extensive body of formal guidance designed to protect and preserve cultural resources on WSMR; off-range programs would adhere to that guidance. Legally mandated consultation with the New Mexico SHPO, the Advisory Council (as required), and any affected American Indian group would further contribute to the reduction of any expected adverse effects.

4.16.4.8 Land Use

Potential cumulative land use impacts are related to activities within off-range Call-Up areas and the White Sands National Monument (WSNM).

The Call-Up areas west and north of WSMR provide for additional security, public safety, and in some cases missile impact areas. These Call-Up areas were established in 1960, through agreements with private landowners and a Memorandum of Agreement (MOU) with the Department of the Interior, as call-up areas in connection with the Nike-Zeus and similar types of critical military testing. The agreements granted the Government "the right to fire projectiles over the general area (with the possibility that projectiles, fragments thereof, or debris therefrom may fall on said premises) . . . ." The agreements and the MOU also grant the Government "the right to enter upon or pass through said premises after firings to investigate claims for damage, resulting from firings, and to search for, guard, and recover projectiles, fragments thereof, or other debris which may have fallen on said premises . . . ."

In 1963, a supplemental agreement with the private landowners was established to provide for additional uses such as impact areas for boosters and for missile launches from within or over the call-up areas. The call-up areas are temporarily evacuated for testing that cannot be accommodated completely within the WSMR boundaries. By agreement with the landowners, missile testing is limited to 20 evacuations per year.

Land use within these Call-Up areas consists of cattle grazing, recreation (including off-road vehicles, trails, and hunting), wildlife refuge areas, and some mineral prospecting. A significant increase in the current uses of the Call-Up areas could limit their availability to WSMR and result in a reduction in the capability of WSMR to support missile testing. However, for the reasonably foreseeable future, activities within the Call-Up areas are likely to increase at a slow rate. The nature and extent of the current use of the area, together with the short term, limited use of the area by WSMR, results in successful co-use with few impacts. A new land use in the area could occur if the candidate Spaceport site is developed. The proposed site occupies the southern quarter of the Western Call-Up area. Use of this site as a spaceport would result in land use conflicts with WSMR, however, the southern portion of the western Call-Up area is the least used. Very limited use and evacuation of this portion of the Call-Up area would allow WSMR activities to continue while causing minimal impacts to a spaceport.

WSNM is surrounded by WSMR. Use of the western half of WSNM, excluding the Lake Lucero area, is governed by a Special Use Agreement and a MOU between WSMR and WSNM which allow technical tests over the land area of WSNM and on a portion of the land area itself. This allows WSMR sufficient flexibility to carry out its mission while providing adequate protection to the WSNM land use. While there may be localized impacts to WSNM from debris occasionally impacting within WSNM, the overall impact of WSMR is beneficial. WSMR creates a natural habitat buffer zone around the WSNM that provides additional habitat for flora and fauna. Continued co-use of the land should result in no cumulative impacts to land use.

4.16.4.9 Traffic and Transportation

Potential cumulative impacts are related primarily to roadblocks on Highway 70, traffic flow on Highway 70, and the road network on WSMR. Missile testing activities have the potential to require roadblocks on Highway 70. Off-base missile testing could result in a small increase in the number of roadblocks on Highway 70.

Traffic flow along Highway 70, especially during commuting hours, could be affected if there were increases in either the number of commuters for NASA or the number of visitors to WSNM. However, increases to a level that would significantly affect traffic flow are not expected. Construction of the Spaceport could also result in an increase in traffic on Highway 70. As the Spaceport project becomes better defined, an analysis of the proposed traffic flow will be evaluated for potential to impact WSMR.

JTX activities directly affect the road network on WSMR; however, the short duration of the activity results in a minor contribution to the additive impact to on-base roads.

None of these activities, as currently defined, would cause adverse effects on traffic or the transportation network.

4.16.4.10 Noise

There is the potential for noise impact from the cumulative effects of WSMR activities and off-range operations and programmatic activities. As shown in Table 4.16-4, the activities of concern are missile and rocket launches and flights, bomb drops, and aircraft overflight.

Noise impacts from several Holloman AFB, JTX, and NASA activities are addressed earlier in the EIS, and thus will not be repeated here. Generally speaking, the impacts from the noise of missile and rocket launches are located in the immediate vicinity of the launch site. This leads to a very low potential for cumulative impacts from effects of WSMR activities and those of off-range operations and programmatic activities. Noise impacts from bomb drops are similarly localized.

In contrast, impacts from sonic booms, whether from supersonic flight of missiles or aircraft, typically occur over large geographic areas. Therefore, the potential for cumulative effects are great. WSMR and off-range activities that produce sonic booms are almost always designed to keep most of the area exposed to the sonic boom contained within WSMR. Consequently, there is little cumulative impact with respect to land use compatibility and to the public.

Another area for cumulative noise effects is annoyance to the public from aircraft overflights. It is known that as the number of noise occurrences increases, the percentage of the public that is annoyed increases. Therefore, for those areas where there is an overlap of WSMR and off-range aircraft overflights, the potential for annoyance to the public increases.

Anecdotal evidence that supports this claim comes from Holloman AFB and Fort Bliss. Both Holloman AFB and Fort Bliss report that most of the noise complaints they receive are for helicopter overflights. Furthermore, they both report that upon investigation, most of the complaints they receive are for aircraft that are not under their jurisdiction. Because WSMR and a number of off-range activities have associated aircraft overflights all in the same geographic region, the potential for public annoyance will increase. Quantifying this potential would require detailed and coordinated information about the overflights and the complaints filed.

4.16.4.11 Hazardous Materials and Hazardous Waste

Potential cumulative impacts from off-range activities are limited to hazardous materials in the form of unspent fuel in missile tests from Fort Bliss and petroleum products from vehicle refueling in support of JTX activities. The potential for the generation of these hazardous materials is remote. In addition, the containment and disposal of such materials are covered by WSMR standard operating procedures. Therefore, cumulative impacts are not expected.

4.16.4.12 Supplemental Analysis

Follow-on cumulative impacts analyses are proposed to supplement the findings for off-range activities. These analyses will remedy deficiencies in the baseline information and will continue to address the assessment of the relationship between WSMR-based and off-range activities.

4.17 RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENTAL RESOURCES AND LONG-TERM PRODUCTIVITY

Future impacts resulting in the short-term use of the WSMR environment under the proposed action depend on whether activity increases, decreases, or remains at current levels. Existing uses under the proposed action may result in incremental losses in long-term productivity of the WSMR environment to the degree that testing activities and facilities construction alter or eliminate habitat. These losses would continue to a lesser extent under the no action alternative as well. However, these losses are expected to be small and are likely to be balanced by the limitation of public access to the site, which prevents potential productivity losses associated with alternate uses, such as grazing, and with the possible destruction of cultural resources and sensitive species by public collectors and vandals. Further, full implementation of the mitigation measures outlined in Chaper 5 would reduce the extent of losses of biological and cultural resources. Uses of the site under the proposed or no action alternatives do not significantly limit the range of likely future uses.

WSMR activities at all locations would take advantage of existing facilities and infrastructure with minor construction required in some locations. Therefore, the proposed action does not eliminate any options for future use of the environment for any of the locations under consideration.

As new projects are proposed, the relationship between short-term use of WSMR environmental resources and long-term productivity of the site will need to be assessed on a continuing basis in project-specific NEPA documents tiered to this EIS.

4.18 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed action would result in minor loss of habitat for plants or animals, insignificant loss or impact on threatened or endangered species, and insignificant loss of cultural resources such as archaeological or historic sites. Moreover, there would be no changes in land use or preclusion of development of underground mineral resources that were not already precluded.

The amount of materials required for any program-related activities and energy used during the project would be small. Although the proposed project and program activities would result in some irreversible and irretrievable commitment of resources such as various metallic materials, minerals, and labor, this commitment of resources is not significantly different from that necessary for many other defense research and development programs. It is similar to the activities that have been carried out in previous defense programs over the past several years. The ongoing and projected WSMR activities would not commit natural resources in unacceptable quantities.

4.19 ADVERSE ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED

If the mitigation measures incorporated into the proposed action and as specified in Chapter 5 are fully implemented, adverse environmental effects will be avoided.

4.20 CONFLICTS WITH FEDERAL, REGIONAL, STATE, LOCAL, OR INDIAN TRIBAL LAND USE PLANS, POLICIES, AND CONTROLS

Land use planning will follow the Installation Master Plan and the requirements of paragraphs 2-8 and 2-9, Section 111 (Chapter 2) of AR 200-1. In addition, use of the Geographic Information System/Decision Analysis System as envisioned in both the proposed action and the no action alternative will enhance land use planning by providing a ready means of identifying optimal locations for projects of various types. Any potential land use impacts identified using the Geographic Information System/Decision Analysis System will be documented in project-specific NEPA documentation tiered to this EIS. Neither the proposed action nor the no action alternative activities are known to be in conflict with any existing land use plans, policies, or controls.

4.21 FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS

All WSMR test programs and other operations will be conducted in a manner that will not substantially affect human health or the environment. The activities will also be conducted in a manner that will not exclude persons from participation in, deny persons the benefit of, or subject persons to discrimination under the WSMR programs and operations because of their race, color, or national origin.

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CHAPTER FIVE
MITIGATION MEASURES

CHAPTER 5
MITIGATION MEASURES

5.1 INTRODUCTION

This section provides specific mitigation measures designed to reduce or eliminate the environmental consequences of the proposed action.

Future WSMR operations could involve missiles, different construction techniques, or other material different from those items specified in this EIS. Tests of such material would use the facilities and instrumentation defined in this EIS. In addition, to the extent practical, such tests would be constrained by the environmental factors developed in this EIS. If such future tests represent a significant change to the environmental baseline defined herein, as necessary and appropriate, tiered environmental analyses will be completed.

5.2 GEOLOGY AND SOILS

Upon the establishment of an initial route into a recovery area, this route will be used for subsequent entries where practicable to minimize the damage throughout the area and to minimize the need for repeated environmental surveys for entry routes into the same locale. Appropriate landscaping and building design techniques will be employed to prevent water and wind erosion caused or increased by permanent structures.

Under WSMR direction, surface disturbing projects will revegetate disturbed areas no longer required for operations. Recontouring and revegetation of sites will be evaluated by the WSMR Environmental Office when site abandonment is proposed. Such revegetative measures will be coordinated with the WSMR Environmental Services Division.

An annual inspection will be held by WSMR representatives to evaluate the effectiveness of erosion control and soil stabilization measures in disturbed areas. Corrective action will be implemented where necessary.

Impacts from hydrocompaction and surface settlement will be avoided by proper engineering of foundations and by directing drainage away from the pyroclastic and alluvial materials around structural supports. As necessary, a compacted fill mat and subsurface drainage system also will be used to direct water away from soils supporting footing and structural fill used in new construction.

Water erosion in disturbed areas will be controlled by constructing cut-and-fill slopes to reduce runoff velocity; by installing energy dissipaters, berms, and lined drainage ditches when slopes are steeper than 20 percent; and by using water bars on access roads where slopes exceed five percent. Wind erosion will be controlled by watering or using tackifiers on the disturbed areas and applying dust suppressants to access roads during construction.

5.3 HYDROLOGY/WATER RESOURCES

Potentially hazardous and toxic substances generated during WSMR operations will be segregated and stored in approved containers for disposal in a designated and approved area in compliance with applicable DoD, DA, WSMR, and RCRA regulations. Any inadvertent spillage of potentially hazardous and toxic wastes will be mediated by recovering all the spilled material and sufficient contaminated soil to assure that no significant residue would be left which might serve as a future ground water contaminant.

Specific monitoring and other mitigation requirements will be implemented for the Main Post and selected outlying impacted areas based on the water resources management study to be completed as a supplement to this EIS.

All necessary equipment, personnel, and training will be maintained as necessary to ensure compliance with the Spill Contingency Plan (U.S. Army 1993b). The Installation Spill Control Plan will be activated in the event of any spills of hazardous substances, and to minimize impacts on surface and groundwater.

Engineering and planning programs will continue to anticipate future water and wastewater system improvements, utility upgrades, and expansion of waste management capacities.

All requirements for permitting of wastewater treatment and discharge facilities will be met and maintained in accordance with EPA and New Mexico State requirements under Sections 401 and 402 of the Clean Water Act.

All requirements will be met for timely compliance with U.S. Army Corps of Engineers (COE) permits associated with the disturbance of jurisdictional wetlands under Section 404 of the Clean Water Act, and for State of New Mexico Environment Department (NMED) permit review and certification review of such permits.

5.4 AIR QUALITY

Notice of Intent (NOI) forms and permit applications will be filed with the New Mexico Air Quality Bureau for any emissions source requiring New Mexico Air Quality Bureau notification or permitting.

Dust suppressants will be used to suppress fugitive dust generation during maintenance of extensive exposed surfaces of soils known to generate nonpoint fugitive dust emissions. Additional mitigation measures to reduce the adverse air quality impacts of fugitive dust sources will include minimization of new roads and the reclamation, including revegetation, of old roads and cleared areas.

Ambient air monitoring will be maintained during and after laser testing at the High Energy Laser System Test facility.

As a part of documentation planned to supplement this EIS, WSMR will collect air quality data to assess the cumulative impact of the no action alternative and to analyze the cumulative impacts of the proposed action.

5.5 BIOLOGICAL RESOURCES

Previous surveys for threatened and endangered, and rare species have contributed significant information on the occurrence, range, and distribution of these species on WSMR. These data have been incorporated into the WSMR GIS database and will serve as an initial review source when activities are proposed on WSMR. The information from this database will facilitate on-the-ground surveys which will be undertaken at all activity sites for threatened and endangered species. Surveys or other investigations will be implemented at the earliest possible planning stage for all proposed ground disturbing projects, including but not limited to infrastructure improvements.

Beginning with but not limited to a DAS/GIS data base review, surveys for threatened and endangered species will be undertaken in undocumented or inadequately surveyed areas where ground disturbing activities will occur and where suitable habitat exists. A qualified biologist will monitor all construction operations involving critical habitat disturbance. Examples of such activity include, but are not necessarily limited to, soil test borings, road construction, excavation of building foundations, support structure installation, and related construction activities. All facilities will be sited to avoid or minimize potential harm to protected, threatened, and endangered plant and animal species. Siting of new access roads and subsequent road construction will consider potential habitat disturbance or destruction which could result from diversion of water run-off from existing drainage patterns. Potential impacts on sensitive species identified during project-specific surveys will be evaluated in NEPA documents tiered to this EIS. Mitigation or avoidance measures to minimize any potentially significant impacts will be identified in this NEPA document. The USFWS and the NMDGF will be contacted if any proposed action is anticipated to impact listed species, species proposed for listing, or under review for listing as endangered or threatened under the Endangered Species Act. All data gathered on threatened, endangered, and candidate species will be reported to the USFWS and the NMDGF to assist in sustaining status records. Proactive management efforts for the protection and enhancement of federally listed species will be developed in coordination with the USFWS and the NMDGF.

The greatest likelihood of significant adverse consequences to biological resources to arise during recovery actions requiring entry to previously unsurveyed areas. Recovery procedures are generally foreseeable and rarely constitute emergencies for the purposes of exceptions under environmental regulation. In order to meet minimum environmental protection requirements under NEPA and the Endangered Species Act during any recovery action outside of the approved and surveyed area, proposed entry routes and project-related disturbance areas will be reviewed through the DAS/GIS data base. In the event that overriding project or other environmental requirements prohibit an adequate survey, a biologist or other qualified representative from the WSMR Environmental Services Division will accompany the recovery team, if required. This individual will assist in the selection of an entry path that will minimize the potential for adverse impacts. In addition, this individual will identify any activity with potential impacts on sensitive resources and assist in avoiding those impacts. Off-road travel required for other activities will be minimized and coordinated with the WSMR Environmental Services Division. The WSMR Environmental Services Division may prohibit off-road travel in sensitive areas.

In any instance where there is a question of possible impacts to wetlands, WSMR will request review by COE and EPA for Section 404 permit applicability, and permit review and certification by NMED under Section 401 of the Clean Water Act. The location and type of any wetlands within proposed project areas will be determined. Potential impacts will be analyzed and verified with field investigations. Any activities potentially affecting jurisdictional wetlands will be reviewed for permit applicability by COE and EPA under Section 404 of the Clean Water Act, and by the NMED for state review and certification under Section 401 of the Clean Water Act. If avoidance of wetlands is not practicable, WSMR will implement measures to mitigate impacts to wetland sites. Mitigative measures will be site specific and developed on a case-by-case basis in coordination with the COE, USFWS, and EPA. The measures may include enhancement or enlargement of existing wetlands or potentially the creation of new wetlands.

All above-ground power lines modified or constructed on WSMR will be constructed in accordance with *Suggested Practices for Raptor Protection on Power Lines, the State of the Art in 1981* (Olendorff et al. 1981) or most current standards, in accordance with direction from the WSMR Environmental Services Division. These guidelines describe the proper spacing of phase conductor lines and ground lines on poles, as well as positioning of poles. Obsolete aboveground power and communication lines have been removed from WSMR (Morrow, pers. com. 1993a). In future removals poles containing raptor nests and every 20th pole in obvious perch locations will be retained to provide proper perches and nesting sites (U.S. Army n.d.b).

WSMR will implement procedures recommended in Raptor Research Report No. 4 (Olendorff, et al 1981) or other more restrictive procedures developed by the U.S. Army Corps of Engineers. Specific procedures will include the following

- Electrical conductors will be spaced a minimum of 60 inches apart.
- Vertical separation of a minimum of 60 inches will be maintained between the phase conductor and the neutral conductors by using a pole-top extension to raise the center conductor.
- The upper end of the pole grounding wire (usually a lightning arrester) will terminate at least 12 inches below the top of the pole.
- Crossarms will be wooden where appropriate.
- For pole-mounted transformers, all equipment and protective devices (lightning arresters and fused cutouts) will be installed on a second, lower crossarm, leaving the top crossarm for perching. In addition, transformer risers and jumpers will be insulated.
- Where primary deadends occur, such as corner poles, non-conductor extension links will be installed to keep the phase wires farther away from the poles and crossarms. Installation of jumpers underneath the crossarms will be completed to minimize phase-to-phase contacts.
- Use of elevated perch construction will be considered. The perches can be constructed of 2-in by 4-in wooden material. Such perches must provide a minimum of 16 inches of vertical clearance above the top conductor wire. These perches would be installed only on those poles which show high usage as raptor perches.

WSMR has entered into a cooperative agreement for the protection of the White Sands pupfish. This agreement (among the U.S. Army, U.S. Air Force, WSNM, USFWS, and NMDGF) commits to the creation of limited-use areas around the White Sands pupfish habitat as well as a variety of other measures to avoid harm to this species. In addition to the cooperative agreement, a White Sands pupfish management and recovery plan is being developed by WSMR. This plan will further define specific management and mitigation prescriptions for the protection and enhancement of this species.

Routes for all ground-disturbing activities will be mapped and provided to WSMR Environmental Services Division prior to disturbance to ensure compliance with mitigation requirements, including those of the Endangered Species Act. Trenches will not be left open overnight unless escape ramps are installed every 274 m (300 yards). Escape ramps include short lateral trenches sloping to the surface or wooden planks extending to the surface. Ramp slopes will be less than 45 degrees (100 percent). Trenches left open overnight will be inspected and any animals found will be reported to WSMR Environmental Services Division. Live animals will be removed before filling the trench.

Native grasses, forbs, and shrubs indigenous to WSMR and suitable to replace extant vegetation within the habitat will be used during revegetation of disturbed areas unless otherwise directed by the WSMR Environmental Services Division. Wherever possible, species beneficial to wildlife will be used. Seeding and transplanting plans will be prepared by the proponent and submitted to WSMR Environmental Services Division for approval prior to ground disturbance. Revegetated areas that have not become established by the end of the growing season will be treated to prevent erosion and site degradation (e.g., mulched, contoured). Vegetation will not be cleared within 0.5 km (0.3 mi) of sensitive habitat features unless prior approval is given by the WSMR Environmental Services Division.

A screen of undisturbed, natural vegetation will be left between sensitive habitat features and any new, permanent roads or facilities where possible. Where natural vegetation must be destroyed or does not provide a screen, seeding, reseeding, or transplanting of vegetation will be conducted to establish or enhance the screen.

Any animal carcasses discovered during routine maintenance and repair of existing electrical transmission and distribution lines will be reported to the WSMR Environmental Services Division within 24 hours of observation regardless of age or degree of decomposition. Records of carcass locations will be maintained in order to facilitate the identification of specific problem areas and to prioritize methods to prevent electrocution. Reports will include the pole number and location (e.g., coordinates, and Universal Transverse Mercator).

5.6 SOCIOECONOMICS

Any proposals for major changes in WSMR programs that could affect regional community planning will be analyzed in the appropriate level of NEPA documentation, and tiered to this EIS. These impacts will be assessed and reviewed with appropriate municipal and state officials to assist then in responding to any need for increases or decreases in community services or employment.

5.7 CULTURAL RESOURCES

Project proponents will incorporate cultural resources, DAS/GIS data base reviews, surveys in undocumented areas, and monitoring programs into proposed projects at the earliest possible planning stage. This includes cultural resource surveys of areas where no data exist and that exhibit a valid potential for cultural resources. Cultural resources will be avoided if practicable; if not, data recovery will be conducted as directed by the WSMR Archaeologist in consultation with the State Historic Preservation Officer (SHPO) under the existing Programmatic Memorandum of Agreement (PMOA). Potential impacts on cultural resources identified during project-specific surveys will be evaluated in NEPA documents tiered to this EIS. Mitigation or avoidance measures to minimize any potentially significant impacts will be identified in the appropriate NEPA document.

During any recovery action in an unsurveyed area, proposed entry routes and project-related disturbance areas will be reviewed through the DAS/GIS data base and surveyed in advance, when practicable. In the event that overriding project or other environmental requirements preclude an adequate survey, an archaeologist or other qualified representative of the WSMR Environmental Services Division will accompany the recovery team, if possible. This individual will assist in the selection of the entry path that will minimize the potential for adverse impacts and will identify and assist in avoiding or otherwise record any activity with potential impacts on cultural resources. The WSMR Environmental Services Division will require project proponents to implement additional mitigation measures beyond those stated in the project NEPA document if an adverse effect is identified.

Off-road travel required for recovery actions and other activities will be minimized and coordinated with the WSMR Environmental Services Division. The WSMR Environmental Services Division may prohibit off-road travel in areas of sensitive cultural resources.

Before construction firebreaks will be surveyed for sensitive resources and rerouted to avoid any resources discovered. Projects that could produce fires will be reviewed in advance to protect identified cultural resources eligible for inclusion on the National Register of Historic Places. The WSMR Environmental Services Division will inform fire control personnel of site marking techniques.

Mitigation of any potential impacts of construction on cultural resources will be accomplished through relocation of the project to avoid the resource site; fencing of the site to exclude vehicles and trespassers; or, if no alternative is available, by data recovery or other approved treatment designed to protect values for which the site is considered significant. To the extent possible, signs will be posted around historic structures and, in rare instances, at prehistoric sites. Signs will be posted at WSMR entrances warning of penalties for unauthorized removal of cultural resources.

As described in Section 4.6.3, the WSMR Environmental Services Division will be notified immediately if any historic or archaeological resources are discovered during construction or other ground disturbing activities. Construction must halt in the vicinity of cultural resources per Section 9.C PMOA with the State Historic Preservation Office. The WSMR Archaeologist will assess any potential adverse effects and consult with the SHPO to determine an appropriate course of action. The final determination as to the adequacy of proposed mitigation measures would be made through consultation between WSMR and the SHPOs office.

All potential visual impacts to culturally sensitive areas related to proposed new facilities will be assessed by the WSMR Archaeologist in consultation with the NMSHPO.

The following measures will be taken to minimize impacts to visual resources:

- Final siting decisions for roads and structures will consider an evaluation of the placement of these facilities to preclude significant visual impact on Trinity Site National Historic Landmark and other sensitive areas.
- Final construction design and facility siting recommendations will be coordinated with the WSMR staff Archaeologist for follow-on consultation with the NMSHPO.
- To minimize visual impact, building and road sizes will be restricted to the smallest size consistent with sound engineering practices.

5.8 LAND USE

No potentially significant adverse effects of the proposed action or the no action alternative on land use have been identified to date. As the DAS/GIS systems are applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized. Mitigation measures will be required if such impacts are identified. Established procedures under the Universal Documentation System (UDS) land use and WSMR Standard Operating Procedures will adequately resolve any potential land use conflicts. Aircraft tactical training in WSMR airspace undergoes the normal scheduling process. Generally, training receives a lower scheduling priority than does research and development testing when conflicts occur. Scheduling conflicts will be resolved by coordination with the WSMR National range Directorate.

5.9 UTILITIES AND INFRASTRUCTURE

No potentially significant adverse effects of the proposed action or the no action alternative on utilities and infrastructure have been identified to date.

WSMR will establish design parameters and equipment operating procedures to assure that peak electric loading is minimized, and that electric machines and other apparatus are efficient in design and maintained for efficient operation. Electricity studies will consider load sharing, off-peak operations, and scheduling constraints to assure that Range users would have required levels of electricity to meet time-sensitive missions.

5.10 TRAFFIC AND TRANSPORTATION

No potentially significant adverse effects of the proposed action or the no action alternative on traffic and transportation networks have been identified to date. Cumulative and indirect impacts will be comprehensively analyzed in documentation proposed to supplement this EIS. Mitigation measures will be required if such impacts are identified.

5.11 AESTHETICS AND VISUAL RESOURCES

No potentially significant adverse effects of the proposed action or the no action alternative on aesthetic and visual resources have been identified to date, although the potential is deemed likely in the long term.

Potential light pollution effects is mitigated by the following actions.

- Lighting will be the absolute minimum required for operations. Lighting will be turned off when it is not required for site activities, security, and aircraft warning.
- Low pressure sodium luminaries or similarly acceptable lighting will be used for area lighting. These emit virtually all their light in a narrow frequency range which coincides with the peak sensitivity of the human eye. This makes such luminaries extremely efficient lighting devices. High pressure sodium, mercury, metal halide, or incandescent luminaries will be avoided unless required for aircraft hazard warning or other requisite uses.
- Lighting fixtures will illuminate only the areas which need to be illuminated; shielding will prevent upward directed light. Illumination of highly reflective surfaces will be avoided.
- Reasonable attempts will be made to minimize leakage of interior illumination through windows, glass doors, and other transparent surfaces.

5.12 RECREATION

No potentially adverse effects of the proposed action or the no action alternative on recreation have been identified to date. As the DAS / GIS system is applied to future projects in the development of NEPA documentation tiered to this EIS, cumulative and indirect impacts will be scrutinized carefully. Mitigation measures will be required if such impacts are identified.

5.13 NOISE

The public will continue to be excluded from areas where they could be exposed to potentially harmful noise levels. WSMR personnel are required to use hearing protection devices in any environment where they may be exposed to harmful noise levels. Warning signs are posted in areas where high noise levels may occur. Test personnel are administered periodic hearing tests in compliance with U.S. Army hearing conservation programs.

On-range operations are conducted in remote areas to the extent possible. Any potential impacts of project-specific noise on wildlife will be addressed in project-specific NEPA documentation. Potentially significant impacts will be avoided. Restricted areas (such as the San Andres National Wildlife Refuge) where sensitive wildlife exists will be avoided by maintaining aircraft at 610 m (2,000 ft) above ground level (AGL).

5.14 RADIATION SOURCES

Instrumentation presently in service on WSMR meets applicable standards for non-ionizing radiation hazards and EMI. Before operation of a possible new EMI source, tracking, or countermeasure device, an analysis will be conducted to assure that the device will cause no degradation of the electromagnetic environment.

During construction, the following mitigation measures will be taken by the project to avoid potential EMI:

- To ensure that construction radio communication will not interfere with WSMR activities, the project will coordinate with the DoD Area Frequency Coordinator to provide a separate radio channel if available for use during construction activities.
- The use of any transmitting or receiving equipment within the WSMR boundary will require prior approval from the DoD Area Frequency Coordinator and the WSMR Frequency Management Office.

During operations, the following mitigation measures will be taken by the project to avoid potential EMI:

- A spectrum usage agreement will be developed in coordination with the DoD Area Frequency Coordinator.
- The project will schedule operations in advance using the Universal Documentation System to document test parameters.
- The project will conduct tests using adequate test and measuring equipment to assure that public safety radio users are not threatened by potentially harmful EMI.
- All test will comply with all applicable provisions of Army Regulations 105-24 and DoD Directive 4650-1, Management and Use of the Radio Frequency Spectrum.

The impact of WSMR electromagnetic radiation on the Very Large Array (VLA) and Very Long Baseline Antenna (VLBA) radio telescopes can be mitigated by avoiding emissions above the Harmful Effective Isotropic Radiated Power (HEIRP) as discussed in Section 4.13.2.3. Coordination between the National Radio Astronomy Observatory (NRAO) and WSMR's Frequency Coordinator Office will continue to assist with mitigation of radio frequency interference. The WSMR Frequency Coordinator will forward schedules of potentially impactive emissions to NRAO for use in avoiding interference with the radio telescope's observing schedules.

5.15 HAZARDOUS MATERIALS/HAZARDOUS WASTE

Where necessary to meet regulatory requirements or other concerns, the mitigation measures below would be implemented to reduce potential impacts associated with hazardous materials and waste management.

- Inspections by the WSMR Environmental Services Division.
- Upgrading above-ground storage tanks (UST) and associated piping to reduce the potential for release of stored fuels.
- Installing leak detection systems in USTs.

- Increasing safety and fire department inspections of hazardous materials and waste storage and use areas, plus review of emergency contingency plans.
- Upgrading existing impoundments and inspection of impoundments to determine if hazardous materials are being or have been released into soil and groundwater.
- Continuing surveys for, and remediation of, asbestos-containing materials (ACM).
- Test uncertified electrical transformers and capacitors for oils containing polychlorinated biphenyls (PCB) adjacent to buildings used in remote areas of WSMR. Currently, only the transformers at the Main Post, range centers, and NASA/WSTF have been tested.
- Implementing, where possible, hazardous material reuse rather than hazardous waste generation, treatment, storage, and disposal where replacement with hazard-free substitutes is demonstrably impossible.
- Performing in-situ remediation of contaminated sites wherever practicable, environmentally protective, and cost efficient.

New projects will prepare and issue a Hazardous Waste Management Plan (HWMP) to be this HWMP will include as a minimum the following elements approved prior to Initial Operational Capability for the project.

- A description of the Hazardous Waste Minimization (HAZMIN) program to assure that generation of potentially hazardous and toxic wastes is controlled to the irreducible minimum level during WSMR operations.
- A definition of all potentially hazardous and toxic wastes expected to be generated by the project. Substances to be reviewed for inclusion in the HWMP will include all substances defined by the U.S. EPA as possessing characteristics of ignitability, corrosively, reactivity, or toxicity; and all substances listed in 40 CFR, Part 261, as amended.
- Potential hazardous and toxic wastes will be accounted for, controlled, stored, transported, reported, and disposed of in accordance with the provisions of AR 200-1 and applicable WSMR requirements.

5.16 HEALTH AND SAFETY

Health and safety planning and implementation are by nature mitigation measures. WSMR operations all require thorough health and safety planning at the earliest stages of facility planning and operational design. These health and safety requirements are implemented during all phases of operation, from initial construction, through the life of the facility, to final disposition. Project specific health and safety plans are required and will be implemented to mitigate potential human health effects U.S. Center for Health Promotion and Preventative Medicine (USACHPPM).

If a hazardous area is identified during USACHPPM or equivalent evaluations of equipment potentially producing radio-frequency radiation WSMR will take the following measures:

- The affected area will be posted with RFR Hazard Warning Signs in accordance with Technical Guide No. 153 (U.S. Army, 1987b), and all personnel will be briefed on required protective measures to be taken.
- Personnel will be adequately protected from electrical shock, and will be given RFR hazard training, either during basic technical training or before assignment to work areas involving RFR exposure. Personnel will take annual refresher training to reemphasize raining objectives. All training will be documented.
- In areas where access to RFR levels greater than 10 times the Permissible Exposure Limit might exist, warning devices such as flashing lights, audible signals, fences, and mechanical and electronic interlocks will be required, depending on the potential risk of exposure.

Many projects use ground-based laser rangefinders and laser guidance system. The possibility exists that the nominal ocular hazard distance (NOHD) would extend beyond the immediate test area. A potential hazard would exist for aircraft at some distance, as well as a potential hazard to raptors and other bird species. To mitigate potential health effects the following measures will be implemented:

- Projects shall designate a Local Radiation Protection Officer (LRPO).

- In coordination with the WSMR Safety Office and Flight Safety Office Branch of the National Range Directorate, the LRPO shall develop Standing Operating Procedures for each hazardous operation to ensure that all safety concerns are met.

- For each laser device, a NOHD will be determined as a function of operators, casual observers, and aircraft that might be in the sphere of influence.

- Procedures will be developed to minimize the chances of accidental human exposure.

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CHAPTER SIX
AGENCIES CONTACTED

CHAPTER 6
AGENCIES CONTACTED

U.S. ARMY

Commander, U.S. Army
STEWS-MTD-MA
White Sands Missile Range, New Mexico 88002

U.S. Army, Test and Evaluation Command
Atmospheric Sciences Division
AMSTE-TC-AM(WS)
White Sands Missile Range, New Mexico 88002

U.S. Army, Research Laboratory
Battlefield Environment Directorate
AMSRL-BE
White Sands Missile Range, New Mexico 88002

U.S. Army, Directorate of Public Works
STEWS-DPW-PD
White Sands Missile Range, New Mexico 88002

U.S. Army
White Sands Missile Range Public Affairs Office
Building 122
White Sands Missile Range, New Mexico 88002

U.S. Army, Radiation Protection Division
White Sands Missile Range, New Mexico 88002

U.S. Army Nudear Effects Directorate
White Sands Missile Range, New Mexico 88002

U.S. Army
Directorate of Environment
Building 5158
Fort Bliss, Texas 79916-0058

U.S. Army Environmental Hygiene Agency (HSHB/MD/B)
Aberdeen Proving Grounds, Maryland 21010-5422

U.S. AIR FORCE

Deputy for Air Force
Air Force Scheduling Branch
White Sands Missile Range, New Mexico 88002

Base Commander
Holloman Air Force Base, New Mexico

Headquarters, Air Combat Command (HQ ACC)
Environmental Engineering Division (CEV)
129 Andrews Street, Suite 102
Langley Air Force Base, Virginia 23665-2769

STATE AGENCIES

Historic Preservation Division
Office of Cultural Affairs
Villa Rivera Building
228 E. Palace Avenue
Santa Fe, New Mexico 87503

New Mexico Department of Game and Fish
Villagra Building
Santa Fe, New Mexico 87503

New Mexico Forestry & Resources Conservation Division
Minerals and Natural Resources Department
Villagra Building
408 Galisteo
P.O. Box 1498
Santa Fe, New Mexico 87504

New Mexico Natural Heritage Program
University of New Mexico
2500 Yale Blvd. S.E., Suite 100
Albuquerque, New Mexico 87131-1091

New Mexico State Highway and Transportation Department
P.O. Box 1149
Santa Fe, New Mexico 87504

Physical Science Laboratory
New Mexico State University
P.O. Box 30002
Las Cruces, New Mexico 88003

State of New Mexico
Environment Department
Air Quality Bureau
1190 St. Francis Drive
P.O. Box 26110
Harold Runnels Building, Room S2100
Santa Fe, New Mexico 87502

State of New Mexico
Parks and Recreation Division
408 Galisto
P.O. Box 1147
Santa Fe, New Mexico 87504

The University of New Mexico
Department of Biology
Albuquerque, New Mexico 87131

FEDERAL AGENCIES

Bureau of Land Management
Las Cruces District Office
1800 Marquess
Las Cruces, New Mexico 88005

Federal Aviation Administration
National Headquarters
Office of Environment and Energy Research & Engineering Branch (AEE-110)
800 independence Ave., S.W.
Washington, D.C. 20591

Federal Emergency Management Administration, Region Six
800 North Loop 288
Denton, TX 76201

NASA-WSTF
NASA-Johnson Space Center
White Sands Test Facility
Las Cruces, New Mexico

U.S. Fish and Wildlife Service
P.O. Box 1246
Socorro, New Mexico 87801

U.S. Fish and Wildlife Service
San Andres National Wildlife Refuge
P.O. Box 756
Las Cruces, New Mexico 88004

U.S. Fish and Wildlife Service
Ecological Services Branch
3530 Pan American Highway
Suite D
Albuquerque, New Mexico 87107

U.S. Forest Service
517 Gold Avenue, SW
Albuquerque, New Mexico 87102

White Sands National Monument
National Park Service
P.O. Box 1086
Holloman Air Force Base, New Mexico 88330-1086

LOCAL AGENCIES

City of Las Cruces
P.O. Drawer CLC
Las Cruces, NM 88001

City of Las Cruces
Parks and Recreation Department
P.O. Drawer CLC
Las Cruces, New Mexico 88004

Doña Ana County
1131 Med Park Drive
Las Cruces, NM 88005

City of Alamogordo
1376 E. Ninth Street
Alamagordo, NM 88310

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CHAPTER TEN
ABBREVIATIONS, ACRONYMS, AND GLOSSARY

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Abbreviations and Acronyms

AAF	Army Air Field
ACM	Asbestos-Containing Material
ADA	Air Defense Artillery
AFB	Air Force Base
AFSWC	Air Force Special Weapons Complex
AGL	above ground level
AICUZ	Air Installation Compatible Use Zone
ALPHA	laser program
ANFO	Ammonium Nitrate Fuel Oil (an explosive mixture)
AMRAAM	Advanced Medium Range Air-to-Air Missile
AQCR	Air Quality Control Region
AR	Army Regulation
ARMS	Archaeological Records Management Section
ATACMS	Army Tactical Missile System
BAT	Brilliant Anti-Armor Submunition
BLM	Bureau of Land Management
BRAC	Base Realignment and Closures
CFR	Code of Federal Regulations
CHRIS	Chemical Hazardous Response Information System
COE	[U.S. Army] Corps of Engineers
DA	Department of the Army
DIF	Data Interface Facility
DAS	Decision Analysis System
DoD	Department of Defense
DOPAA	Description of Proposed Action and Alternatives
DOT	[U.S.] Department of Transportation
DPW	Directorate of Public Works
DTA	Detonation Test Area
EA	Environmental Assessment
EAS	Environmental Analysis System
EIS	Environmental Impact Statement
EMP	electromagnetic pulse
EMRE	Electro-Magnetic Radiation Effects
EOD	Explosive Ordnance Disposal
EOP	Emergency Operations Plan
EOS	Earth Observation Satellite

EPA	[U.S.] Environmental Protection Agency
ERINT	Extended Range Intercept Technology
FAA	Federal Aviation Administration
FAADS	Forward Area Air Defense System
FBR	Fast Burst Reactor
FEMA	Federal Emergency Management Agency
FWDA	Fort Wingate Depot Activity
GAM83	weapons impact target area
GBFEL-TIE	Ground Based Free Electron Laser-Technology Integration Experiment
GBR	Ground Based Radar
GEODESS	Ground Electro-optical Deep Space Surveillance
GIS	Geographic Information System
GSFC	Goddard Space Flight Center
HAP	Hazardous Air Pollutant
HAWK	Homing All the Way to Kill
HEIRP	Harmful Effective Isotropic Radiated Power
HAZCOM	Hazard Communication
HAZMAT	hazardous material
HAZMIN	Hazardous Waste Minimization
HEIRP	Harmful Effective Isotropic Radiated Power
HELSTF	High Energy Laser System Test Facility
HHST	Holloman High Speed Test Track
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HPD	Harmful Power Densities
HPPD	Harmful Peak Power Densities
HSWA	Hazardous and Solid Waste Amendments
HTA	Hazardous Test Area
HWMP	Hazardous Waste Management Plan
INRMP	Integrated Natural Resources Management Plan
IR	infrared
IRM	interim remediation measures
JER	Jornada Experimental Range
JSC	[Lyndon B.] Johnson Space Center
JSE	Joint Services Exercise
JTX	Joint Training Exercise
KEM	Kinetic Energy Missile
LAW	Light Anti-Armor Weapon
LBTS	Large Blast/Thermal Simulator
LC	Launch Complex
LCTA	land condition trend analysis
LINAC	Linear Electron Accelerator
LORAINS	Low On-Range Active Inertial Navigation System
LOS-F-H	Line of Sight Forward-Heavy
LOSAT	Line of Sight Anti-Tank
LEPC	local emergency planning committee
LPSA	liquid propellant storage area
LPPO	Local Radiation Protection Office
MAR	Multi-Function Array Radar
MIL-STD	Military Standard
MLRS	Multiple Launch Rocket System
MOU	Memorandum of Understanding
MPD	Master Planning Division

MTR	Military Training Route
MSL	mean sea level
MTD	Materials Test Directorate
NAAQS	national ambient air quality standard(s)
NAGPRA	Native American Graves Protection and Repatriation Act
NASA	National Aeronautics and Space Administration
NAWCWPNS WS	Naval Air Weapons Center – Weapons – White Sands
NATO	North Atlantic Treaty Organization
NCTR	Non-Cooperative Target Recognition
NECI	Northeast Center Impact (Area)
NED	Nuclear Effects Directorate
NEPA	National Environmental Policy Act
NGT	NASA Ground Terminal
NHPA	National Historic Preservation Act
NLOS	Non Line of Sight
NMDGF	New Mexico Department of Game and Fish
NMED	[State of] New Mexico Environment Department
NMNHP	New Mexico Natural Heritage Program
NOHD	nominal ocular hazard distance
NOI	Notice of Intent
NOP	North Oscura Peak
NORC	North Oscura Range Center
NPS	National Park Service
NR	National Range (Directorate)
NRAO	National Radio Astronomy Observatory
NRAP	Noise/Radiation Analysis Report
NRHP	National Register of Historic Places
ORC	Oscura Range Center
OSHA	Occupational Safety and Health Administration
PATRIOT	Phased-array Tracking to Intercept of Target
PCB	polychlorinated biphenyl
PHETS	Permanent High Explosive Test Site
PM_{10}	particulate matter less than 10 microns in diameter
PMOA	Programmatic Memorandum of Agreement
RA	Radio Astronomy
RAM	Rolling Airframe Missile
RATSCAT	Radar Advanced Technology Backscatter
RCRA	Resource Conservation and Recovery Act
RCRC	Rhodes Canyon Range Center
REBA	Relativistic Electron Beam Accelerator
REC	Record of Environmental Consideration
RFA	radio frequency authorization
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RLV	re-usable launch vehicle
ROI	region of influence
ROWL	location named after a WSMR worker
RPPB	Real Property Planning Board
RRTC	Richardson Ranch Training Complex
SALT	location named after the saline soils
SAMS	Surface Atmospheric Measuring System
SANWR	San Andres National Wildlife Refuge

SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SEC	Socorro Electric Cooperative
SEL	Sound Exposure Level
SERC	State Emergency Response Commission
SHPO	State Historic Preservation Office
SOP	Standard Operating Procedure
SRC	Stallion Range Center
SSRT	Single Stage Rocket Technology
STA	Shuttle Training Aircraft
STEWS	[U.S. Army] Strategic Test and Evaluation Command, White Sands Missile Range
STGT	Second TDRSS Ground Terminal
STORM	target missile and associated program
STP	sewage treatment plant
SUA	Special Use Airspace
SWMU	solid waste management unit
TAL	Transatlantic Abort Landings
TDRSS	Tracking and Data Relay Satellite System
TECOM	[U.S. Army] Test and Evaluation Command
THAAD	Theater High Altitude Area Defense
TLV-TWA	threshold limit value-time weighted average
TMD	Theater Missile Defense
TREE	Transient Radiation Effects on Electronics
TSD	Technical Support Document
TSP	total suspended particulate matter
USA	U.S. Army Center for Health Promotion and Preventative Medicine
UDS	Universal Documentation System
USASDC	U.S. Army Strategic Defense Command
USASSDC	U.S. Army Space and Strategic Defense Command
USC	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UST	underground storage tank
UV	ultraviolet
VLA	Very Large Array
VLBA	Very Long Baseline Array
WC	West Center (Target Area)
WIT	Warhead Impact Target
WSC	White Sands Complex
WSGT	White Sands Ground Terminal
WSMR	White Sands Missile Range
WSNM	White Sands National Monument
WSPG	White Sands Proving Ground
WSSF	White Sands Solar Facility
WSSH	White Sands Space Harbor
WSTF	White Sands Test Facility

Units of Measure

°C	degree Centigrade
°F	degree Fahrenheit
µg	microgram
µg/L	microgram per liter
µg/m³	microgram per cubic meter
µm	micrometer
ac-ft	acre-feet
Btu	British thermal units
cm	centimeter
dB	decibel
dBA	"A" weighted decibel level
dBC	"C" weighted decibel level
ft	foot
ft^2	square foot
ft^2/d	square foot per day
ft^3/d	cubic foot per day
g	gram
gal	gallon
GHz	gigahertz
g/m^3	gram per cubic meter
GPD	gallon per day
gpm	gallon per minute
gpm/ft	gallon per minute per foot
Hz	hertz
kg	kilogram
kJ	kilojoule
km	kilometer
km^2	square kilometer
kph	kilometers per hour
kV	kilovolt
kVA	kilovoltampere
kW	kilowatt
kWh	kilowatthour
L	liter
lb	pound
L_{dn}	day-night average sound level
L_{dnmr}	A-weighted, day-night, onset rate adjusted
L_{max}	maximum noise levels
m	meter
m/s	meters per second
m^2	square meter
m^2/d	square meter per day
m^3	cubic meter
m^3/s	cubic meter per second
mg	milligram
MGD	million gallons per day
mg/L	milligram per liter

mg/m^3	milligram per cubic meter
MHz	megahertz
mi	mile
mi^2	square mile
mm	millimeter
MPa	megaPascal (one million Pascal)
mph	mile per hour
mrem	milliroentgen equivalent man
m/s	meter per second
m^3/s	cubic meter per second
MW	megawatt
MWh	megawatt hour
nm	nanometer
oz	ounce(s)
Pa	pascal
ppm	part per million
psf	pound per square foot
psi	pound per square inch
rem	roentgen equivalent man
Vac	volt alternating current

Glossary

Acre-foot (ac-ft) – The volume of water that covers 1 acre to a depth of 1 foot; approximately 326,000 gallons.

Advisory Council on Historic Preservation – A 19-member body appointed to advise the President and Congress in the coordination of actions by federal agencies on matters relating to historic preservation and to perform other duties as required by law (Public Law 89-655; 16 USC 470).

Aerosols – Tiny particles, either solid or liquid, dispersed in the air.

Air Quality Control Region – An area, which is based on jurisdictional boundaries, urban-industrial aggregations, and other factors including atmospheric areas, that is necessary to provide adequate implementation of air quality management plans for the attainment and maintenance of ambient air quality standards.

Alkali sink – An internally drained depression where soil salts accumulate.

Alluvial – Pertaining to or composed of material deposited by a stream or running water.

Alluvial deposition – An unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay deposited by water.

Alluvial fans – The alluvial deposit of a stream where it issues from a gorge upon a plain or of a tributary stream and its junction with the main stream.

Alluvium – General term applied to sediments deposited by a stream or running water.

Alpha radiation – Radiation emitted from the nucleus of an unstable atom in the form of a helium nucleus.

Ambient air – That portion of the atmosphere, external to buildings, to which the general public has access.

Ambient air quality standards – Standards established by federal or state environmental protection agencies or departments that define levels of air quality that are necessary, with an adequate margin of safety, to protect public health (primary standards) and to protect public welfare, including animals and vegetation, buildings and other materials, visibility, and the general quality of life, from any known or anticipated adverse effects of a pollutant (secondary standards).

Anticline – A fold, generally convex upward, whose core contains older rocks than the outer layers of the fold.

Aquifer – The water-bearing portion of subsurface earth material that yields or is capable of yielding useful quantities of water to wells.

Areas of Aesthetic Concern – Highest of three viewing categories. This category is one in which the most potential impact would have the greatest effect on the viewing public.

Arroyo – A small, relatively deep, flat-floored channel or gully of an ephemeral or intermittent stream. It is usually dry and has steep banks of unconsolidated material.

Asbestos – Any of several minerals (e.g., chrysotile) that readily separates into long flexible fibers suitable for use as a noncombustible, nonconducting, or chemically-resistant material. Asbestos has been used in the construction of floor tile, wall panels, brake pads in vehicles, ceiling tile, pipe material, and as insulating material around pipes and buildings. Inhalation of asbestos fibers can cause lung cancer. *See* Toxic Substances Control Act.

Aspect – The relative direction or compass orientation of a land slope.

Attainment – A designation by the EPA for an air quality control region, in whole or in part, that the area meets the national primary or secondary ambient air quality standard for an air pollutant.

Barchan dune – Sand dunes shaped like a crescent with the points of the crescent facing downwind.

Basalt – A fine-grained dark mafic igneous rock composed largely of plagioclase feldspar and pyroxene.

Basalt lava flow – A fine-grained dark mafic igneous rock composed largely of plagioclase feldspar and pyroxene, which is extruded on the surface and flows.

Basin – A drainage or catchment area of a stream or lake.

Berino-Doña Ana – A soil unit located on WSMR.

Beta radiation – Radiation emitted from the nucleus of an unstable atom with a mass of one electron and a charge of plus or minus one electron.

Biodiversity – Different life forms or species within a defined area.

Biogeographic history – Changes in biological communities across the landscape in geologic time frames.

Biogeography – Study of present and past distributions of organisms and their causes.

Biomass – Total living mass present in an ecosystem at any given time.

Biome – All the plants, animals, and other organisms that make up a distinct natural community in any climatic region.

Bolson – An extensive, flat-floored depression with no external drainage, into which drainage from surrounding mountains flows to a central dry or ephemeral lake or lakes.

Bremsstrahlung – German term for Breaking Radiation, that is, radiation emitted as electrons decelerate in the Coulomb fields of target nuclei.

Canopy – The uppermost layer in a woody vegetation community, consisting of the crowns of trees or shrubs.

Cantonment – Housing quarters for personnel.

Chlorinated solvents – Class of hazardous, toxic, nonflammable volatile solvents containing chloride. These solvents typically are used in cleaning activities. Most chlorinated solvents persist in the environment, do not readily degrade, and some deplete the ozone.

Climate – A description of aggregate weather conditions; the sum of all statistical weather information that help describe a place or region.

Climax – The final stage of the process of ecological succession.

Codominant – One of the most common or important species in a vegetation community.

Community type – A vegetation association resulting from disturbance and which is assumed to represent a subclimax stage of a successional continuum.

Coniferous – Evergreen trees or shrubs that bear cones and are members of the order Coniferales.

Coppice dunes – Coppice dunes are sand dunes characterized by a thicket of woody vegetation.

Criteria pollutants – A widely used term of six air pollutants for which the EPA has published ambient air quality standards. The six criteria pollutants are carbon monoxide, nitrogen dioxide, ozone, sulfur oxides (measured as sulfur dioxide), particulate matter (measured as PM_{10}), and lead.

Cultural – The system of behavior, beliefs, institutions, and objects human beings use to relate to each other and to the environment.

Deama-Rock – A soil unit located on WSMR.

Decibel (dB) – A unit of level which denotes the ratio between two quantities that are proportional to power; the number of decibels is 10 times the logarithm (to the base 10) of this ratio. In many sound fields, the sound pressure ratios are not proportional to the corresponding power ratios, but it is common practice to extend the use of the unit to such cases. One decibel is one-tenth of a bel.

Deflation – The removal of clay and dust from dry soil by strong winds.

Diversity – A measure of the richness of species in a community relative to the number of individuals of each species.

Dominant species – Those species that are most extensive in and characteristic of a plant community.

Drawdown – The distance between the static water level and the temporarily depressed water level caused by well pumpage.

Ecotone – An ecotone is a transition between two or more diverse communities or habitats.

Ectotherm – Cold-blooded animal that is dependent on external sources for control of body temperatures.

Effluent – Wastewater discharge from a wastewater treatment facility.

Electromagnetic radiation – Radiation given off as an electron drops from a higher energy level to a lower atomic energy level.

Emergency – A situation created by an accidental release or spill of hazardous chemicals, which poses a threat to the safety of workers, residents, the environment, or property.

Emergency Broadcast System – Media broadcasting system used to inform the public about the nature of a hazardous materials incident and what safety steps should be taken.

Emergency Operations Plan (EOP) – A multihazard, functional plan addressing aspects of procedures to be followed in the event of disasters, typically coordinated through public agencies.

Emergency response – The efforts to minimize the risks created in an emergency by protecting the people, the environment, and property, and the efforts to return the scene to normal pre-emergency conditions.

Emergent wetland vegetation – Vegetation rooted in submerged or saturated soils, with stems, leaves, or flowers that extend above the surface of the water.

Endemic – Native, restricted, or peculiar to a locality or region.

Eolian – Pertaining to or deposited by wind.

Ephemeral – Transitory or of short duration.

Erosion – The set of all processes by which soil and rock are loosened and moved downhill or downwind.

Escarpment – A long, usually continuous cliff or steep slope facing in one general direction, separating two level or gently sloping surfaces, and produced by erosion or faulting.

Esprit de corps – The common spirit existing among the members of the group.

Ethnography – A written account of human groups and behavior based on direct observation of actual events, objects, and places, or on statements by living persons.

Evaporites – Sediments precipitated from an aqueous solution as a result of extensive or total evaporation.

Evapotranspiration – The loss of water to the atmosphere through evaporation from the soil and by the transpiration of plants growing on land.

Fan – A gently sloping mass of sediments (alluvium) deposited in an area where a stream issues from a canyon onto a plain or valley floor.

Fault block – A mountain or range formed as a horst when it was elevated (or as the surrounding region sank) between two normal faults.

Fault-block mountain – A mountain or range formed as a horst when it was elevated (or as the surrounding region sank) between two normal faults.

Feasibility study – Under RCRA, feasibility studies are conducted at treatment, storage, and disposal facilities to assess the feasibility of remediation technologies for contaminated soil and/or groundwater.

Feral – Domesticated animals that have been allowed to exist in an essentially wild or undomesticated state.

Fill – A sediment deposited so as to fill or partly fill a valley or other low place.

Fine respirable particulate matter (PM_{10}) – Finely divided solids or liquids less than 10 microns in diameter which, when inhaled, remain lodged in the lungs and contribute to adverse health effects.

Floodplain – The relatively flat land lying adjacent to a river channel that is covered by water when the river overflows.

Fluvial – Pertaining to or produced by the actions of a river or stream.

Fluvial-eolian – Sediment deposited by water and wind, respectively.

Forb – Flowering plant, other than grass and grass-like species, whose aboveground stems do not become woody.

Formation – A general level in a hierarchial classification of vegetation. Characterized by life-forms such as trees, grasses, or shrubs rather than species. A formation results from the interaction of vegetation with broad environmental factors including soil, climate, and fire adaptation. Examples of formations include temperate grasslands, temperate woodlands, temperate scrub, and tropical rain forests.

Gamma radiation – High-energy (10 kiloelectronvolt and beyond) photons emitted from the nucleus of an atom.

Genus – A group of related organisms ranking above a species and below a family.

Geothermal gradient – The change in temperature for a given distance.

Gilland-Rock – A soil unit located on WSMR.

Graben – A downthrown block between two normal faults of parallel strike but converging dips; hence, a tension feature.

Gypsum dune – Dune composed of gypsum.

Habitat fragmentation – The carving up of a former large expanse of habitat into smaller fragments separated from each other by alien habitats.

Habitat type – A land area capable of supporting a given plant association at climax. It represents a mature vegetation association and is usually characterized by two indicator species.

Hazardous and Solid Waste Amendments (HSWA) – HSWA significantly expanded the scope of RCRA to include land disposal restrictions; waste minimization; and other treatment, storage, and disposal requirements.

Hazardous material (HAZMAT) – Any substance or material in a quantity or form that may be harmful to humans, animals, crops, water systems, or other elements of the environment if accidentally released. Hazardous materials include explosives, gases (compressed, liquefied, or dissolved), flammable and combustible liquids, flammable solids or substances, oxidizing substances, poisonous and infectious substances, radioactive materials, and corrosives.

Hazardous waste – Any waste material that presents a health or physical hazard. Hazardous wastes are regulated under RCRA (40 CFR 240 – 271).

Hazardous Waste Minimization Program – Designed to reduce the quantity and toxicity of hazardous wastes generated. Waste minimization is mandated by the 1984 Hazardous and Solid Wastes Amendments to RCRA.

Hazardous Waste Operating Permit – A RCRA permit issued by the EPA for the design, construction, and operation of hazardous waste treatment, storage, and disposal facilities.

Hazardous Waste Tracking System – A system designed by the U.S. Army to track hazardous wastes from the generator through disposal or treatment. The system tracks wastes using a computer data base.

Herb – Flowering plant whose stems are soft and not woody.

Herbaceous – A term used to describe plants that are soft and not woody in texture.

Herbicide – A chemical used to kill or inhibit the growth of plants.

Holocene – A geologic epoch dating back to the end of the Pleistocene to the present.

Horst – An elongated, elevated block of crust forming a ridge or plateau, typically bounded by parallel, outward-dipping normal faults.

Hydrologic – Issues of, or having to do with, the science of water and its properties, laws, and geographical distribution.

Hydrology – The science dealing with the properties, distribution, and circulation of water on the surface of the land and in the soil and underlying rocks.

Hydrophytic – Pertaining to any plant that can grow only in water or very wet soil.

Hypergolic fuels – Rocket engine propellants that are liquid and burn spontaneously and rapidly when they are mixed together; they are extremely toxic.

Igneous intrusion – When igneous rock is emplaced into a host rock while still liquid.

Impact area – Location where test material (e.g., missile, bomb, munitions) will land or be detonated.

Incident Command – The combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure with responsibility for management of assigned resources to effectively accomplish stated objectives at the scene of a hazardous materials accident.

Incident Commander – The individual in charge at a HAZMAT spill scene who assesses the need and extent of a response, and monitors the site. Objectives typically include monitoring and directing response activity to neutralize and contain the spill; and to protect life, environment, and property. Eventual cleanup of a spill is typically accomplished and directed by a remediation team and not an Incident Commander.

Instrumentation sites – Sites where mechanical support activities for tests are located, may include measuring devices, cameras, optics, telemetry, and radio relay.

Intermittent stream – A stream that does not flow continuously during all periods of the year.

Inundate – Inundate means to cover with water.

Invertebrate fauna – All the species of animal organisms without backbones that occur in a particular place or time.

Ionizing radiation – Any radiation capable of forming ionization of atoms.

Lacustrine – Lakes and things that originate in lakes.

Loam – A rich, permeable soil composed of a mixture of clay, silt, sand, and organic matter.

Local Emergency Planning Committee (LEPC) – A committee appointed by SERC, as required by Title III of the Superfund Amendments and Reauthorization Act, to formulate a comprehensive emergency plan for its district.

Lozier-Rock – A soil unit located on WSMR.

Malpais – A vernacular term for lava flows.

Management agronomist – An agriculturalist that manages field-crop production; manages soils; and controls weeds, insects, and rodents.

Manifest – A document required under RCRA that describes a hazardous waste. It is prepared and signed by the generator of the hazardous waste. The manifest must accompany a hazardous waste during transportation and disposal or treatment of the waste.

Material Safety Data Sheet – A compilation of information required under the OSHA Hazard Communication Standard on the identity of hazardous chemicals, health and physical hazards, exposure limits, and precautions. Written forms are prepared by manufacturers and importers of hazardous wastes. The document identifies the hazardous material, describes the physical and chemical characteristics of the material, states the physical and health hazards, includes precautionary and control measures, describes suitable emergency and first aid procedures, and identifies the manufacturer or importer.

Mercalli Intensity Scale – A numerical index describing the effects of an earthquake on man, on structures built by him, and on the earth's surface. The number is rated on the basis of an earthquake intensity scale. The scale in common use in the United States today is the modified Mercalli Intensity Scale of 1931, with grades indicated by Roman numerals from I to XII.

Mesic – A relative term pertaining to moist conditions.
Mesoscale – A meteorological scale of motion characterized by phenomena occurring on scales of hundreds of kilometers (miles), such as land-sea breezes, mountain-valley winds, and migratory high- and low-pressure fronts.

Mesozoic – A geologic era extending from 225 million years ago to 65 million years ago.

Metamorphism – The changes of mineralogy and texture imposed on a rock by pressure and temperature in the earth's interior.

Microhabitat – A habitat, usually within a small area, containing a small number and variety of organisms.

Micron (μ) – One millionth (10^{-6}) of a meter; also called a micrometer.

Microwave radiation – Lower energy (10^{-6} to 10^{-3} electrovolts) electromagnetic radiation.

Midden – From the Danish word "modden" meaning "muck-heap," refers to a pile of refuse and discarded materials from human activity.

Mitigation – A method or action to reduce or eliminate program impacts.

Montane scrub – A type of vegetation dominated by low-growing, primarily woody species and occurring in mountainous areas.

Morphology – The science of surface landforms and their interpretation on the basis of geology and climate.

Native American – A generalized term referring collectively to individuals, tribes, bands, or organizations that trace their ancestry to indigenous populations of North America.

Netropical – Belonging to the region that includes most of the Caribbean, tropical North America, and all of South America.

Neotropical migrants – Birds that breed in the temperate zone and then migrate in winter to tropical zones.

Nickel-Tencee – A soil unit located on WSMR.

Noise – (1) Any disagreeable or undesired sound or other disturbance; unwanted sound. By extension, any unwanted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device. (2) Sound of a general random nature, the spectrum of which does not exhibit clearly defined frequency components.

Nominal dollars – Dollar values unadjusted for inflation.

Nonattainment – A designation by the EPA for an air quality control region, in whole or in part, that does not meet, or that contributes ambient air quality in a nearby area that does not meet, the national primary or secondary ambient air quality standard for an air pollutant.

Nonionizing radiation – Radiation incapable of causing ionization.

Obligate – To be able to exist under or to be restricted to only one set of environmental conditions.

Obscurant - A substance used to simulate extreme weather conditions or battlefield settings such as explosives - generated smoke and dust.

Ordnance – Miliary supplies including weapons, ammunition, combat vehicles, and maintenance equipment.

Overstory – The portion of a layered vegetation community that extends above the main canopy.

Paleo- – Prefix meaning old or ancient.

Paleoenvironment – The ancient environment, including flora, fauna, and climatology.

Paleozoic – A geologic era extending from 570 million years ago to 225 million years ago.

Palustrine – To things of, or having to do with, marshes.

Passerine – A suborder of birds comprising the true song birds with a specialized vocal apparatus or syrinx.

Per capita personal income – A measure of income derived by dividing total personal income in a defined geographic region (e.g., state, county, city) by the total population.

Pesticide - Chemical used to kill or inhibit growth of undesirable species.

Pesticide management plan – A plan, mandated by Army Regulation AR 200-1, that describes how pesticides, herbicides, and rodenticides will be applied, stored, and managed at a particular U.S. Army facility.

Petroleum, oil, and lubricant (POL) – Petroleum hydrocarbon products used as fuels, lubricants, and cleaners for automobiles, trucks, combat vehicles, other vehicles, and aircraft.

Pitfall trap – Trap consisting of drift fences and plastic buckets buried with the top flush to the ground and a square plywood lid set approximately 5 cm (2 inches) above the ground using rocks underneath to protect captured animals from sun and rain.

Pithouse – A form of human dwelling that is partially subterranean in construction.

Playa – The floor of an internally drained desert basin that contains water at irregular intervals.

Pluton – A large, solidified intrusion of molten rock.

Polychlorinated biphenyl (PCB) – A class of toxic, nonflammable, nonvolatile chlorinated oils used in transformers, capacitors, and fluorescent ballasts. PCBs are potential carcinogens and are regulated under the Toxic Substances Control Act.

Precambrian-age – A geologic era extending from 4700 million years ago to 570 million years ago.

Protohistoric – Period that is temporally the earliest in the historic era.

Public roads and highways – Lowest ranking of the three viewing categories. This category has the least impact on the public of the three viewing categories.

Quaternary – A geologic period extending from 2 million years ago to the present.

Region of influence (ROI) – Areas located on or off WSMR from which areas may be viewed by the general public.

Remedial investigations – Under RCRA, remedial investigations are conducted to assess the extent of soil and groundwater contamination at a site and to assess potential exposure pathways to the general public. The results of a remedial investigation are used to assess remedial alternatives in a following feasibility study.

Resource Conservation and Recovery Act (RCRA) – Law that regulates the generation, storage, transportation, and management of hazardous wastes; the design, construction, operation, and management of hazardous waste treatment, storage, and disposal facilities; and the installation, operation, and monitoring of USTs.

Rift valley – A fault trough formed in a divergence zone or other area of tension.

Riparian – Relating to the banks and plains associated with a natural watercourse, lake, or tidewater.

Risk – A measure of the probability that damage to life, property, or the environment will occur if a hazard manifests itself. This measure includes the severity of anticipated consequences to people.

Rodenticide – Chemicals used to control, kill, or inhibit the population growth of rodents.

Runoff – The noninfiltrating water entering a stream or other conveyance channel shortly after a rainfall event.

Rut – Breeding season, behaviorally marked by elevated levels of male-male aggression.

Satellite waste accumulation points – A permitted hazardous waste storage area that is not subject to the 90-day hazardous waste accumulation rule of RCRA. A hazardous waste may be allowed to accumulate and to be stored in these areas if the quantity is below regulatory limits.

Savanna – A grassland habitat characterized by the presence of scattered trees or large shrubs.

Sclerophyllous – Having hard, leathery leaves that resist the loss of moisture, as a result of a well developed sclerenchyma.

Scree – *See* Talus.

Seismicity – The worldwide or local distribution of earthquakes in space and time; a general term for the number of earthquakes in a unit time.

Series – A level in a hierarchial vegetation classification characterized by a single, dominant species (e.g., Pinyon Pine Series). It is intermediate between a formation and a habitat type.

Solid waste management units – Areas of a permitted treatment, storage, and disposal facility, identified by the EPA in a hazardous waste operating permit, in which hazardous wastes are being, have been, or will be treated, stored, or disposed.

Sonic boom – An impulse noise, defined as a discrete noise of short duration (fractions of a second) in which the sound pressure level rises very rapidly to a peak level. The most important parameter for characterizing impulsive noise are the peak sound pressure level, the effective duration, the rise time, and the number of repeated impulses.

Sound – (1) A physical disturbance in a medium (e.g., air) that is capable of being detected by the human ear. (2) The hearing sensation excited by a physical disturbance in a medium.

Spanish entrada – The advent of the Spanish/Europeans in the New World.

Special Management Area – Second highest of the three viewing categories. This category has an impact on the viewing public but is not as significant as the Areas of Aesthetic Concern.

Species richness – Number of species in a given area.

Spill – The unexpected occurrence, failure, or loss, either at a facility or along a transportation route, resulting in a release of hazardous materials.

State Emergency Response Commission (SERC) – The commission appointed by each state governor according to the requirements of Title III of the Superfund Amendments and Reauthorization Act. Duties of the commission include designating emergency planning districts, appointing local emergency planning committees, supervising and coordinating the activities of planning committees, reviewing emergency plans, receiving chemical release notifications, and establishing procedures for receiving and processing requests from the public for information.

Strata – Layers of sedimentary rock; each layer with a distinct set of physical or compositional characteristics such that it can be distinguished readily from the beds above and below.

Substrate – The medium on which a plant is rooted or to which an organism is attached.

Succession – The process of gradual replacement of one community or ecosystem by another, involving a series of changes in the plant and animal life.

Superfund Amendments and Reauthorization Act, Title III – Known as the Emergency Planning and Community Right-to-Know Act of 1986. Specifies the requirements for the planning process at state and local levels for specific extremely hazardous substances, contents of the emergency response plan, requirements for fixed facility owners and operators to inform officials about extremely hazardous substances present at the facilities, and mechanisms for making information about extremely hazardous substances available to citizens.

Surface Atmospheric Measuring System (SAMS) – A network of remote surface weather data collection stations around the WSMR facility that is operated by the U.S. Army Atmospheric Sciences Division.

Survey Cultural Resources – The archaeological exploration of an area to obtain samples from each culture phase contained, conducted under various field techniques.

Syncline – A fold, generally concave upward, whose core contains younger rocks than the outer layers of the fold.

Talus – A steep mass of loose, rocky fragments lying at the base of a cliff or on the side of a mountain.

Tertiary – A geologic time period extending from 65 million years ago to 2 million years ago.

Thermoregulation – Regulation of body temperature.

Threshold limit value-time-weighted average (TLV-TWA) – A guideline for occupational exposure to airborne substances. Published by the American Conference of Governmental Industrial Hygienists. The TLV-TWA is the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Time-area count – Thirty-minute survey in 30-m (98-ft) radius of study sites during which the observers recorded all evidence of animal presence as well as live animals seen.

Total dissolved solids – The concentration of solid materials that are dissolved in a sample of water; determined as the weight of the residue of a water sample upon filtration and evaporation divided by the volume of the sample.

Total suspended particulate matter (TSP) – Finely divided solids or liquids up to 50 microns in diameter, which comprise the bulk of particulate matter in the atmosphere.

Total water use – The amount of water withdrawn from the natural resource base for a beneficial purpose, excluding water used for hydroelectric power generation and certain noncomsumptive uses such as once-through cooling water for thermoelectric power generation, wildlife habitat, and fish farming.

Toxic chemicals – Chemicals that can cause illness, impairment, or significant irritation; or affect the well-being of the public, responders, and workers; or cause significant harm to the environment. Acutely toxic chemicals can cause severe short- and long-term health effects after a single, brief exposure.

Toxic Substances Control Act -- Under 40 CFR 700 to 799, this law requires that new chemicals be screened for health and physical hazards, certain chemicals be tested for risk, chemical data be complied for the EPA, and chemicals that pose a risk be controlled. the Toxic Substances Control Act also regulates the production, use, and disposal of PCBs, chlorofluorocarbons, asbestos, furans, and dioxins.

Trace metals – Metals with high specific gravities such as cadmium, lead, mercury, and nickel. Many such metals will, if ingested, accumulate in human tissue and bones and pose potential health risks to humans.

Traditional Cultural Properties – A legal term; refers to properties, regions, or locales used by peoples of Native American heritage in religious, sacred, or ceremonial activities.

Transect – A conceptual line or belt imposed upon the landscape by scientists in order to localize and systematize field observations and data collection.

Transverse dune – Sand dunes that form long, nearly parallel lines perpendicular to the direction of the prevailing wind.

Tree story – The portion of a layered vegetation community made up of trees.

Triassic – A geologic time period extending from 225 million years ago to 190 million years ago.

Unclassifiable – EPA designation for an air quality control region, in whole or in part, that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for an air pollutant.

Underground storage tank (UST) -- Typically used to contain gasoline or other petroleum fuels; buried beneath the ground surface.

Understory – A relative term for a lower vegetative strata in a layered community.

Upper Cretaceous – A geologic time period extending from 100 million years ago to 65 million years ago.

Vadose – The area between the surface of the ground and the water table.

Water table – The sustainable volume of water discharged from a well per units of time, often expressed in gallons per minute.

Watershed – *See* Basin.

Weather – The state of the atmosphere at any given time.

Well yield – The sustainable volume of water discharged from a well per unit of time, often expressed in gallons per minute.

Wetland – Defined by COE (1987) as: Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Woodland – Plant community characterized by a generally open growth of small trees.

X-ray – High-energy (100 electronvolt to 1 megaelectronvolts) radiation emitted as electrons fall from high energy states to lower energy states.

Xeric – Pertaining to dry conditions.

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CHAPTER 11
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Appendix A
Bibliography

APPENDIX A
BIBLIOGRAPHY

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APPENDIX B
WILDLIFE SPECIES LIST

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WILDLIFE SPECIES LIST

Scientific Name	Common Name	WSMR Occurrence*
Mammals		
Sorex merriami	Merriam's shrew	E
Sorex nanus	dwarf shrew	E
Notiosorex crawfordi	desert shrew	E
Myotis auriculus	Southwestern myotis (bat)	K
Myotis californicus	California myotis (bat)	K
Myotis ciliolabrum	Western small-footed myotis (bat)	K
Myotic evotis	Long-eared myotis (bat)	K
Myotis leibii	eastern small-footed myotis (bat)	K
Myotis lucifugus	little brown myotis (bat)	E
Myotis thysanodes	fringed myotis (bat)	K
Myotis velifer	cave myotis (bat)	K
Myotis volans	long-legged myotis (bat)	K
Myotis yumanensis	Yuma myotis (bat)	E
Lasiurus borealis	eastern red bat	E
Lasiurus cinereus	hoary bat	K
Lasionycteris noctivagans	silver-haired bat	E
Pipistrellus hesperus	western pipistrelle	K
Eptesicus fuscus	big brown bat	K
Euderma maculatum	spotted bat	E
Plecotus townsendii	Townsend's big-eared bat	K
Idionycteris phyllotis	Allen's big-eared bat	E
Antrozous pallidus	pallid bat	K
Tadarida brasiliensis	Brazilian free-tailed bat	K
Nyctinomops macrotis	big free-tailed bat	E
Sylvilagus audubonii	desert cottontail	K
Sylvilagus floridanus	eastern cottontail	K
Lepus californicus	black-tailed jackrabbit	K
Tamias cinereicollis	gray-collared chipmunk	K
Tamias minimus	least chipmunk	K
Tamias quadrivittatus	Colorado chipmunk	K
Ammospermophilus interpres	Texas antelope ground squirrel	K
Ammospermophilus leucurus	white-tailed antelope squirrel	K
Spermophilus spilosoma	spotted ground squirrel	K
Spermophilus tridecemlineatus	thirteen-lined ground squirrel	E

Scientific Name	Common Name	WSMR Occurrence*
Spermophilus variegatus	rock squirrel	K
Cynomys ludovicianus	black-tailed prairie dog	K
Thomomys bottae	Botta's pocket gopher	K
Geomys arenarius	desert pocket gopher	K
Cratogeomys castanops	yellow-faced pocket gopher	K
Perognathus flavescens	plains pocket mouse	K
Perognathus flavus	silky pocket mouse	K
Chaetodipus hispidus	Hispid pocket mouse	E
Chaetodipus intermedius	rock pocket mouse	K
Chaetodipus penicillatus	desert pocket mouse	K
Dipodomys merriami	Merriam's kangaroo rat	K
Dipodomys ordii	Ord's kangaroo rat	K
Dipodomys spectabilis	banner-tailed kangaroo rat	K
Reithrodontomys megalotis	western harvest mouse	K
Peromyscus boylii	brush mouse	K
Peromyscus eremicus	cactus mouse	K
Peromyscus leucopus	white-footed mouse	K
Peromyscus maniculatus	deer mouse	K
Peromyscus nasutus	northern rock mouse	K
Peromyscus truei	pinon mouse	K
Onychomys arenicola	Mearns' grasshopper mouse	E
Onychomys leucogaster	northern grasshopper mouse	K
Sigmodon fulviventer	tawny-bellied cotton rat	K
Sigmodon hispidus	hispid cotton rat	K
Neotoma albigula	white-throated woodrat	K
Neotoma mexicana	Mexican woodrat	K
Neotoma micropus	southern plains woodrat	K
Rattus norvegicus	Norway rat	K
Rattus rattus	black rat	K
Mus musculus	house mouse	K
Ondatra zibethicus	common muskrat	E
Zapus hudsonius	meadow jumping mouse	E
Zapus princeps	western jumping mouse	K
Erethizon dorsatum	common porcupine	K
Canis latrans	coyote	K
Vulpes velox	kit or swift fox	K
Vulpes vulpes	red fox	K
Urocyon cinereoargenteus	common gray fox	K
Ursus americanus	black bear	K
Bassariscus astutus	ringtail	K
Procyon lotor	common raccoon	K
Mustela frenata	long-tailed weasel	K
Taxidea taxus	American badger	K
Spilogale gracilis	western spotted skunk	K
Mephitis mephitis	striped skunk	K
Conepatus mesoleucus	common hog-nosed skunk	K
Felis concolor	mountain lion	K
Lynx rufus	bobcat	K
Equus caballus	feral horse	K

Scientific Name	Common Name	WSMR Occurrence*
Tayassu tajacu	collared peccary	K
Cervus elaphus	wapiti or elk	K
Odocoileus hemionus	mule deer	K
Antilocapra americana	pronghorn	K
Oryx gazella	gemsbok or oryx	K
Ovis canadensis mexicana	desert bighorn sheep	K
Ammotragus lervia	barbary sheep	K
Birds		
Aechmophorus occidentalis	western grebe	K
Aechmophorus clarkii	Clark's grebe	E
Podiceps auritus	horned grebe	K
Podiceps nigricollis	eared grebe	K
Podilymbus podiceps	pied-billed grebe	K
Gavia immer	common loon	K
Larus argentatus	herring gull	E
Larus delawarensis	ring-billed gull	K
Larus pipixcan	Franklin's gull	K
Larus philadelphia	Bonaparte's gull	K
Xema sabini	Sabine's gull	K
Sterna forsteri	Forster's tern	K
Sterna hirundo	common tern	K
Sterna antillarum	least tern	K
Chlidonias niger	black tern	K
Anous stolidus	brown noddy	K
Phalacrocorax auritus	double-crested cormorant	E
Phalacrocorax brasilianus	neotropic cormorant	K
Pelecanus erythrorhynchos	American white pelican	K
Mergus merganser	common merganser	K
Mergus serrator	red-breasted merganser	K
Lophodytes cucullatus	hooded merganser	E
Anas platyrhynchus	mallard	K
Anas strepera	gadwall	K
Anas americana	American wigeon	K
Anas crecca	green-winged teal	K
Anas discors	blue-winged teal	K
Anas cyanoptera	cinnamon teal	K
Anas clypeata	northern shoveler	K
Anas acuta	northern pintail	K
Aix sponsa	wood duck	K
Aythya americana	redhead	K
Aythya valisineria	canvasback	K
Aythya marila	greater scaup	K
Aythya affinis	lesser scaup	K
Aythya collaris	ring-necked duck	K
Bucephala clangula	common goldeneye	K
Bucephala albeola	bufflehead	K
Clangula hyemalis	oldsquaw	K
Oxyura jamaicensis	ruddy duck	K

Scientific Name	Common Name	WSMR Occurrence*
Chen caerulescens	snow goose	K
Chen rossii	Ross' goose	E
Anser albifrons	greater white-fronted goose	E
Branta canadensis	Canada goose	K
Dendrocygna bicolor	fulvous whistling duck	K
Cygnus columbianus	tundra swan	E
Plegadis chihi	white-faced ibis	K
Botaurus lentiginosus	American bittern	E
Ixobrychus exilis	least bittern	E
Ardea herodias	great blue heron	K
Casmerodius albus	great egret	E
Egretta thula	snowy egret	K
Bubulcus ibis	cattle egret	K
Butorides virescens	green heron	K
Nycticorax nycticorax	black-crowned night heron	K
Grus canadensis	sandhill crane	K
Rallus limicola	Virginia rail	K
Porzana carolina	sora	K
Gallinula chloropus	common moorhen	K
Fulica americana	American coot	K
Phalaropus fulicaria	red phalarope	K
Phalaropus lobatus	red-necked phalarope	K
Phalaropus tricolor	Wilson's phalarope	K
Recurvirostra americana	American avocet	K
Himantopus mexicanus	black-necked stilt	K
Gallinago gallinago	common snipe	K
Limnodromus scolopaceus	long-billed dowitcher	K
Calidris himantopus	stilt sandpiper	K
Calidris canutus	red knot	K
Calidris melanotos	pectoral sandpiper	K
Calidris bairdii	Baird's sandpiper	K
Calidris minutilla	least sandpiper	K
Calidris alpina	dunlin	K
Calidris pusilla	semipalmated sandpiper	K
Calidris mauri	western sandpiper	E
Calidris alba	sanderling	K
Limosa fedoa	marbled godwit	K
Tringa melanoleuca	greater yellowlegs	K
Tringa flavipes	lesser yellowlegs	K
Tringa solitaria	solitary sandpiper	K
Catoptrophorus semipalmatus	willet	K
Bartramia longicauda	upland sandpiper	K
Actitis macularia	spotted sandpiper	K
Numenius americanus	long-billed curlew	K
Numenius phaeopus	whimbrel	K
Pluvialis squatarola	black-bellied plover	K
Pluvialis dominica	American golden plover	K
Charadrius vociferus	killdeer	K
Charadrius semipalmatus	semipalmated plover	K

Scientific Name	Common Name	WSMR Occurrence*
Charadrius alexandrinus	snowy plover	K
Charadrius montanus	mountain plover	K
Arenaria interpres	ruddy turnstone	K
Arenaria melanocephala	black turnstone	K
Alectoris chukar	chukar	K
Callipepla squamata	scaled quail	K
Callipepla gambelii	Gambel's quail	K
Cyrtonyx montexumae	Montezuma quail	K
Meleagris gallopavo	wild turkey	K
Columba livia	rock dove	K
Zenaida macroura	mourning dove	K
Zenaida asiatica	white-winged dove	K
Columbina passerina	common ground-dove	K
Columbina inca	Inca dove	E
Cathartes aura	turkey vulture	K
Elanus leucurus	white-tailed kite	K
Ictinia mississippiensis	Mississippi kite	E
Circus cyaneus	northern harrier	K
Accipiter striatus	sharp-shinned hawk	K
Accipiter cooperii	Cooper's hawk	K
Parabuteo unicinctus	Harris' hawk	K
Buteo jamaicensis	red-tailed hawk	K
Buteo albonotatus	zone-tailed hawk	K
Buteo swainsoni	Swainson's hawk	K
Buteogallus anthracinus	common black-hawk	K
Buteo lagopus	rough-legged hawk	K
Buteo regalis	ferruginous hawk	K
Aquila chrysaetos	golden eagle	K
Haliaeetus leucocephalus	bald eagle	K
Falco mexicanus	prairie falcon	K
Falco peregrinus	peregrine falcon	K
Falco columbarius	merlin	K
Falco femoralis	Aplomado falcon	K
Falco sparverius	American kestrel	K
Pandion haliaetus	osprey	K
Tyto alba	barn owl	K
Asio otus	long-eared owl	K
Asio flammeus	short-eared owl	K
Strix occidentalis	spotted owl	K
Aegolius acadicus	northern saw-whet owl	E
Otus kennicottii	western screech-owl	K
Otus flammeolus	flammulated owl	E
Bubo virginianus	great-horned owl	K
Speotyto cunicularia	burrowing owl	K
Glaucidium gnoma	northern pygmy-owl	E
Geococcyx californianus	greater roadrunner	K
Coccyzus americanus	yellow-billed cuckoo	E
Ceryle alcyon	belted kingfisher	K
Picoides villosus	hairy woodpecker	E

Scientific Name	Common Name	WSMR Occurrence*
Picoides pubescens	downy woodpecker	E
Picoides scalaris	ladder-backed woodpecker	K
Picoides tridactylus	three-toed woodpecker	E
Sphyrapicus nuchalis	red-naped sapsucker	K
Sphyrapicus thyroideus	Williamson's sapsucker	E
Melanerpes erythrocephalus	red-headed woodpecker	E
Melanerpes formicivorus	acorn woodpecker	K
Melanerpes lewis	Lewis' woodpecker	E
Colaptes aurates	northern flicker	K
Caprimulgus vociferus	whip-poor-will	E
Phalaenoptilus nutallii	common poorwill	K
Chordeiles minor	common nighthawk	K
Chordeiles acutipennis	lesser nighthawk	K
Aeronautes saxatalis	white-throated swift	K
Archilochus alexandri	black-chinned hummingbird	K
Calypte costae	Costa's hummingbird	E
Selaphorus platycercus	broad-tailed hummingbird	K
Selasphorus rufus	Rufous hummingbird	K
Tyrannus verticalis	western kingbird	K
Tyrannus vociferans	Cassin's kingbird	K
Myiarchus cinerascens	ash-throated flycatcher	K
Myiarchus tuberculifer	dusky-capped flycatcher	K
Sayornis saya	Say's phoebe	K
Sayornis nigricans	black phoebe	K
Contopus borealis	olive-sided flycatcher	K
Contopus sordidulus	western wood pewee	K
Empidonax occidentalis	Cordilleran flycatcher	K
Empidonax traillii	willow flycatcher	E
Empidonax hammondii	Hammond's flycatcher	E
Empidonax oberholseri	dusky flycatcher	E
Empidonax wrightii	gray flycatcher	E
Pyrocephalus rubinus	vermilion flycatcher	K
Eremophila alpestris	horned lark	K
Cyanocitta stelleri	Steller's jay	K
Aphelocoma coerulescens	scrub jay	K
Aphelocoma ultramarina	gray-breasted jay	K
Corvus corax	common raven	E
Corvus cryptoleucus	Chihuahuan raven	K
Corvus brachyrhynchos	American crow	K
Nucifraga columbiana	Clark's nutcracker	K
Gymnorhinus cyanocephalus	pinyon jay	K
Sturnus vulgaris	European starling	K
Molothrus ater	brown-headed cowbird	K
Xanthocephalus xanthocephalus	yellow-headed blackbird	K
Agelaius phoeniceus	red-winged blackbird	K
Sturnella magna	eastern meadowlark	K
Sturnella neglecta	western meadowlark	K
Icterus parisorum	Scott's oriole	K
Icterus cucullatus	hooded oriole	K

Scientific Name	Common Name	WSMR Occurrence*
Icterus galbula	northern oriole	K
Euphagus cyanocephalus	Brewer's blackbird	K
Quiscalus quiscula	common grackle	K
Quiscalus mexicanus	great-tailed grackle	K
Coccothraustes vespertinus	evening grosbeak	K
Pinicola enucleator	pine grosbeak	K
Carpodacus cassinii	Cassin's finch	K
Carpodacus mexicanus	house finch	K
Loxia curvirostra	red crossbill	E
Carduelis tristis	American goldfinch	K
Carduelis psaltria	lesser goldfinch	K
Carduelis lawrencei	Lawrence's goldfinch	K
Carduelis pinus	pine siskin	K
Calcarius ornatus	chestnut-collared longspur	K
Calcarius mccownii	McCown's longspur	E
Pooecetes gramineus	vesper sparrow	K
Passerculus sandwichensis	Savannah sparrow	K
Ammodramus bairdii	Baird's sparrow	K
Ammodramus savannarum	grasshopper sparrow	E
Chondestes grammacus	lark sparrow	K
Zonotrichia querula	Harris' sparrow	E
Zonotrichia leucophrys	white-crowned sparrow	K
Zonotrichia albicollis	white-throated sparrow	K
Spizella arborea	American tree sparrow	K
Spizella passerina	chipping sparrow	K
Spizella pallida	clay-colored sparrow	K
Spizella breweri	Brewer's sparrow	K
Spizella atrogularis	black-chinned sparrow	K
Junco hyemalis	dark-eyed junco	K
Amphispiza bilineata	black-throated sparrow	K
Amphispiza belli	sage sparrow	K
Aimophila cassinii	Cassin's sparrow	K
Aimophila ruficeps	rufous-crowned sparrow	K
Melospiza melodia	song sparrow	K
Melospiza licolnii	Lincoln's sparrow	K
Passerella iliaca	fox sparrow	E
Pipilo erythrophthalmus	rufous-sided towhee	K
Pipilo chlorurus	green-tailed towhee	K
Pipilo fuscus	canyon towhee	K
Cardinalis sinuatus	pyrrhuloxia	K
Pheucticus ludovicianus	rose-breasted grosbeak	K
Pheucticus melanocephalus	black-headed grosbeak	K
Guiraca caerulea	blue grosbeak	K
Passerina cyanea	indigo bunting	K
Passerina amoena	lazuli bunting	K
Passerina versicolor	varied bunting	K
Passerina ciris	painted bunting	E
Spiza americana	dickcissel	K
Calamospiza melanocorys	lark bunting	K

Scientific Name	Common Name	WSMR Occurrence*
Piranga ludoviciana	western tanager	K
Piranga flava	hepatic tanager	K
Piranga rubra	summer tanager	K
Progne subis	purple martin	K
Hirundo pyrrhonota	cliff swallow	K
Hirundo rustica	barn swallow	K
Tachycineta bicolor	tree swallow	K
Tachycineta thalassina	violet-green swallow	K
Riparia riparia	bank swallow	K
Stelgidopteryx serripennis	northern rough-winged swallow	K
Bombycilla cedrorum	cedar waxwing	K
Phainopepla nitens	phainopepla	K
Lanis excubitor	northern shrike	K
Lanius ludovicianus	loggerhead shrike	K
Vireo gilvus	warbling vireo	K
Vireo solitarius	solitary vireo	K
Vireo bellii	Bell's vireo	K
Vireo vicinior	gray vireo	K
Mniotilta varia	black-and-white warbler	E
Vermivora luciae	Lucy's warbler	K
Vermivora virginiae	Virginia's warbler	K
Vermivora ruficapilla	Nashville warbler	E
Vermivora celata	orange-crowned warbler	K
Parula americana	northern parula	K
Dendroica petechia	yellow warbler	K
Dendroica coronata	yellow-rumped warbler	K
Dendroica graciae	Grace's warbler	E
Dendroica nigrescens	black-throated gray warbler	K
Dendroica virens	black-throated green warbler	K
Dendroica townsendi	Townsend's warbler	K
Dendroica palmarum	palm warbler	K
Seiurus aurocapillus	ovenbird	E
Seiurus noveboracensis	northern waterthrush	K
Oporornis tolmiei	Macgillivray's warbler	K
Geothlypis trichas	common yellowthroat	K
Icteria virens	yellow-breasted chat	E
Wilsonia pusilla	Wilson's warbler	K
Setophaga ruticilla	American redstart	K
Myioborus picta	painted redstart	K
Passer domesticus	house sparrow	K
Anthus rubescens	American pipit	K
Oreoscoptes montanus	sage thrasher	K
Mimus polyglottos	northern mockingbird	K
Toxostoma rufum	brown thrasher	K
Toxostoma curvirostre	curve-billed thrasher	K
Toxostoma crissale	crissal thrasher	K
Campylorhynchus brunneicapillus	cactus wren	K
Salpinctes obsoletus	rock wren	K
Catherpes mexicanus	canyon wren	K

Scientific Name	Common Name	WSMR Occurrence*
Thryomanes bewickii	Bewick's wren	K
Troglodytes aedon	house wren	K
Cistothorus palustris	marsh wren	K
Certhia americana	brown creeper	K
Sitta carolinensis	white-breasted nuthatch	E
Sitta canadensis	red-breasted nuthatch	K
Sitta pygmaea	pygmy nuthatch	E
Parus inornatus	plain titmouse	K
Parus wollweberi	bridled titmouse	E
Parus gambeli	mountain chickadee	K
Psaltriparus minimus	bushtit	K
Auriparus flaviceps	verdin	K
Regulus satrapa	golden-crowned kinglet	K
Regulus calendula	ruby-crowned kinglet	K
Polioptila caerulea	blue-gray gnatcatcher	K
Polioptila melanura	black-tailed gnatcatcher	K
Myadestes townsendi	Townsend's solitaire	K
Catharus ustulatus	Swainson's thrush	K
Catharus guttatus	hermit thrush	K
Turdus migratorius	American robin	K
Siala sialis	eastern bluebird	K
Sialia mexicana	western bluebird	K
Sialia currucoides	mountain bluebird	K
Reptiles		
Terrapene ornata	ornate box turtle	K
Kinosternon flavescens	yellow mud turtle	E
Crotaphytus collaris	collared lizard	K
Gambelia wislizenii	longnose leopard lizard	K
Coleonyx brevis	Texas banded gecko	E
Hemidactylus turcicus	Mediterranean gecko	E
Cnemidophorus exsanguis	Chihuahuan spotted whiptail	K
Cnemidophorus grahamii	checkered whiptail	K
Cnemidophorus inornatus	little striped whiptail	K
Cnemidophorus neomexicanus	New Mexican whiptail	K
Cnemidophorus tigris	western whiptail	K
Cnemidophorus uniparens	desert grassland whiptail	K
Cophosaurus texanus	greater earless lizard	K
Holbrookia maculata	lesser earless lizard	K
Phrynosoma cornutum	Texas horned lizard	K
Phrynosoma douglassi	short-horned lizard	K
Phrynosoma modestum	roundtail horned lizard	K
Sceloporus magister	desert spiny lizard	K
Sceloporus poinsetti	crevice spiny lizard	K
Sceloporus undulatus	prairie lizard	K
Urosaurus ornatus	tree lizard	K
Uta stansburiana	side-blotched lizard	K
Eumeces multivirgatus	many-lined skink	E
Eumeces obsoletus	Great Plains skink	K

Scientific Name	Common Name	WSMR Occurrence*
Leptotyphlops dulcis	Texas blind snake	E
Leptotyphlops humilis	western blind snake	K
Arizona elegans	glossy snake	K
Bogertophis subocularis	Trans-Pecos rat snake	K
Coluber constrictor	racer	E
Diadophus punctatus	ringneck snake	K
Elaphe guttata	Great Plains rat snake	E
Gyalopion canum	western hooknose snake	K
Heterodon nasicus	western hognose snake	K
Hypsiglena torquata	night snake	K
Lampropeltis getula	common kingsnake	K
Lampropeltis triangulum	milk snake	E
Masticophis flagellum	coachwhip	K
Masticophis taeniatus	striped whipsnake	K
Pituophis melanoleucus	bullsnake	K
Rhinocheilus lecontei	longnose snake	K
Salvadora deserticola	Big Bend patchnose snake	K
Salvadora grahamiae	mountain patchnose snake	K
Sonora semiannulata	ground snake	K
Tantilla hobartsmithi	southwestern blackhead snake	E
Tantilla nigriceps	plains blackhead snake	K
Thamnophis cyrtopsis	blackneck garter snake	K
Thamnophis elegans	western terrestrial tarter snake	E
Thamnophis marcianus	checkered garter snake	E
Thamnophis sirtalis	common garter snake	E
Trimorphodon biscutatus	lyre snake	E
Tropidoclonion lineatum	lined snake	E
Crotalus atrox	western diamondback rattlesnake	K
Crotalus lepidus	rock rattlesnake	K
Crotalus molossus	blacktail rattlesnake	K
Crotalus viridis	western rattlesnake	K
Sistrurus catenatus	massasauga	K
Amphibians		
Ambystoma tigrinum	tiger salamander	K
Scaphiopus couchii	Couch's spadefoot toad	K
Spea bombifrons	plains spadefoot toad	K
Spea multiplicata	New Mexico spadefoot toad	K
Bufo cognatus	Great Plains toad	K
Bufo debilis	green toad	K
Bufo punctatus	red-spotted toad	K
Bufo woodhouseii	Woodhouse's toad	E
Rana catesbeiana	bullfrog	E
Hyla arenicolor	canyon treefrog	E
Fish		
Cyprinidon tularosa	White Sands pupfish	K
Cyprinus carpio	carp	K
Lepomis macrochirus	bluegill	K

Scientific Name	Common Name	WSMR Occurrence*
Micropterus salmonoides	largemouth bass	K
Gambusia affinis	mosquitofish	K
Carissus auratus	goldfish	K
Flatworms		
F. Planariidae	flatworms	K
Snails		
Bulimulus dealbatus sspp.		K
Euconulus fulvus		K
Hawaiia minuscula		K
Holospira roemeri		K
Retinella indentata		K
Striatura meridionalis		K
Thysanophora hornii		K
Vallonia perspectiva		K
F. Helminthoglyptida		K
Sonorella orientis		K
F. Hydrobildae		K
Cochlicopa lubrica		K
F. Oreohelicidae		K
Oreohelix socorroensis	Oscura Mountain land snail	K
F. Physidae		K
Physa virgata		K
F. Polygyridae		K
Ashmunella harrisi	land snail	K
Ashmunella kochi coballoensis	land snail	K
Ashmunella kochi kochi	land snail	K
Ashmunella kochi sanandresensis	land snail	K
Ashmunella pasonis pasonis	land snail	K
Ashmunella salinasensis	land snail	K
F. Pupillidae		K
Gastrocopta ashmuni		K
Gastrocopta pellucida		K
Gastrocopta pilsbryana		K
Pupilla sonorana		K
F. Succineidae		K
F. Vertiginidae		K
Vertigo gouldii		K

Scientific Name	Common Name	WSMR Occurrence*
Earthworms		
F. Lumbricidae	earthworm	K
F. Tubificidae	aquatic annelid	K
Arachnids		
F. Bothidae	scorpion	K
F. Eremobatidae	solpugids	K
F. Thelyphonidae	whip scorpion	K
F. Araneidae	orb weaver	K
F. Lycosidae	wolf spider	K
F. Salcticidae	jumping spiders	K
F. Theraphosidae	tarantula	K
F. Theridiidae	black widow	K
F. Thomisidae	crab spider	K
F. Trombidiidae	velvet mites	K
Crustaceans		
F. Gammaridae	gammarid amphipod	K
Gammarus lacrustis		K
Insects		
F. Machilidae	jumping bristletail	K
F. Lepismatidae	silverfish	K
F. Entomobryidae	common springtail	K
F. Baetidae	Baetid mayflies	K
Callibaetis sp.		K
F. Siphlonuridae	Siphlonurid mayflies	K
F. Aeshnidae	darner	K
Anax sp.		K
F. Coenagrionidae	damselfly, narrow-winged	K
Enallagma sp.		K
F. Libellulidae	dragonfly-common skimmer	K
Pseudoloen superbus		K
F. Acrididae	grasshopper	K
F. Blattellidae	German cockroach	K
F. Grillacrididae	Jerusalem and cave crickets	K
F. Grillidae	black cricket	K
F. Mantidae	praying mantis	K
F. Phasmatidae	walking stick	K
F. Tettigoniidae	long-horned grasshopper	K
F. Termitidae	termite	K
F. Labiidae	little earwig	K
F. Aphididae	aphid	K

Scientific Name	Common Name	WSMR Occurrence*
F. Belostomatidae	giant water bug	K
Abedus sp.		K
F. Cercopidae	spittlebug or froghopper	K
F. Cicadellidae	leafhopper	K
F. Cicadidae	cicada	K
F. Coreidae	leaf-footed bug	K
F. Corixidae	water boatmen	K
Trichocorixa sp.		K
F. Corizidae	scentless plant bug	K
F. Dictyopharidae	planthopper	K
F. Flatidae	planthopper	K
F. Gerridae	water strider	K
Gerris sp.		K
F. Lygaeidae	seed bug	K
F. Miridae	plant bug	K
F. Nabidae	damsel bug	K
F. Notonectidae	backswimmer	K
Notonecta sp.		K
F. Pentatomidae	stink bug	K
F. Pyrrhocoridae	red bug	K
F. Scutelleridae	shield-backed bug	K
F. Veliidae	water skimmer	K
Microvelia sp.		K
F. Chrysopidae	green lacewing	K
F. Myrmeleontidae	ant lion	K
F. Anthicidae	antlike flower beetle	K
F. Bostrichidae	branch and twig borer	K
F. Bupresitidae	metallic wood-boring beetle	K
F. Carabidae	ground beetle	K
F. Cerambycidae	longhorn beetle	K
F. Chrysomelidae	leaf beetle (cucumber)	K
F. Cicindelidae	tiger beetle	K
Cicindela nevadica olmosa	Los Olmos tiger beetle	E
F. Cleridae	checkered beetle	K
F. Coccinelidae	lady beetle	K
F. Curuculionidae	snout beetles	K
F. Dermestidae	dermestid beetle	K
F. Dysticidae	predacious diving beetles	K

Scientific Name	Common Name	WSMR Occurrence*
F. Hydrophilidae	water scavenger beetle	K
Berosus sp.		K
F. Elateridae	click beetle	K
F. Elmidae	rifle beetle	K
Microcylloepus sp.		K
F. Haliplidae	crawling water beetle	K
Haliplus sp.		K
F. Histeridae	hister beetle	K
F. Lucanidae	stag beetle	K
F. Malachiidae	soft-winged flower beetle	K
F. Meloidae	blister beetle	K
F. Melolonthinae	junebeetle	K
F. Oedemeridae	false blister beetle (oedemerid)	K
F. Scarabaeidae	dung beetle	K
F. Silphidae	carrion beetle	K
F. Tenebrionidae	darkling beetle	K
F. Limnephilidae	northern caddisflies	K
Hesperophylax sp.		K
F. Danaidae	milkweed butterfly	K
F. Gelechiidae	gelechid moth	K
F. Hesperiidae	skipper	K
F. Incurvaridae	yucca moth	K
F. Lycaenidae	gossamer-winged butterfly	K
F. Noctuidae	noctuid moth	K
F. Nymphalidae	brush-footed butterfly	K
F. Papilionidae	butterfly (swallowtail)	K
F. Pieridae	moth (whites, sulphurs)	K
F. Sphingidae	sphinx or hawk moth	K
F. Asilidae	robber fly	K
F. Bombyliidae	bee fly	K
F. Calliphoridae	blow fly	K
F. Chironomidae	midge	K
F. Culicidae	mosquito	K
F. Dolichopodidae	long-legged fly	K
F. Ephydridae	shore fly	K
F. Muscidae	house fly	K
F. Otitidae	picture-winged fly (otitid)	K
F. Sacrophagidae	flesh fly	K
F. Simuliidae	gnat	K
F. Syrphidae	flower fly	K
F. Tabanidae	deer and horse flies	K
F. Tachinidae	Tachinid fly	K
F. Tipulidae	crane fly	K
F. Anthophoridae	carpenter bee	K

Scientific Name	Common Name	WSMR Occurrence*
F. Apidae	honey bee and bumble bee	K
F. Colletidae	colletid bee	K
F. Cynipidae	gall wasp or cynipid	K
F. Formicidae	ant	K
F. Halictidae	sweat bee	K
F. Halictidae	augochlora green metallic	K
F. Ichneumonidae	Ichneumon wasp	K
F. Megachilidae	leafcutting bee	K
F. Mutillidae	velvet ant	K
F. Pompilidae	tarantula hawk (spider wasp)	K
F. Scoliidae	Scollid wasp	K
F. Sphecidae	mud dobber	K
F. Sphecidae	digger wasp	K
F. Tiphiidae	Tiphiid wasp and others	K
F. Vespidae	paper wasp (yellow jacket)	K
Centipedes		
F. Scolopendridae	giant desert centipede	K

* K – Wildlife known to occur or that has occurred on WSMR.
E – Wildlife expected to occur on WSMR.

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APPENDIX C
WSMR REAL PROPERTY INVENTORY

APPENDIX C
WSMR REAL PROPERTY INVENTORY

The following is an inventory of WSMR real property that is slated for historic significance between 1994 and 2004.

Construction Date	Building Number	Description
1943	29348	FW runway
1945	01538	lab, general purpose
	20811	GM facility
	20815	GM facility
1946	01795	WVEH WASH UNC
	01525	ORD facility
	20819	GM facility
	20820	GM facility
	19243	PROP SYS facility
	01592	general storehouse
	19300	general storehouse
	23101	general purpose warehouse
	01558	administration, general purpose
	00108	administration, general purpose
	00109	administration, general purpose
	00117	administration, general purpose
	00118	administration, general purpose
	00119	administration, general purpose
	00357	administration, general purpose
	22850	ELEV WA STOR TK
	19244	ELEV WA STOR TK
	19320	ELEV WA STOR TK
	21763	ELEV WA STOR TK
1947	00418	general storehouse
	00420	general storehouse
	00442	general storehouse
	01419	general storehouse

Construction Date	Building Number	Description
1947, continued	01420	general storehouse
	01421	general storehouse
	01422	general storehouse
	01423	general storehouse
	01424	general storehouse
	01425	general storehouse
	00148	administration, general purpose
	21610	administration, general purpose
	00149	administration, general purpose
	00150	administration, general purpose
	00890	exchange warehouse
	00419	recreation building
	00421	skating rink
	00472	thrift shop
	00422	arms building
1948	29266	diesel oil Str
	21313	LT WIND DIR IND
	01790	VEH MNT SH DS
	01418	general storehouse
	00122	administration, general purpose
	00908	FH COL
	00910	FH COL
	00928	FH LC & MJ
	00930	FH LC & MJ
	00932	FH LC & MJ
	00934	community center
	00936	community center
	00230	bath house
	00231	outdoor swimming pool
	29267	gas store tanks
	00912	SEN ENL QTRS
	00914	SEN ENL QTRS
	00916	SEN ENL QTRS
	00938	SEN ENL QTRS
	00940	SEN ENL QTRS
	00918	Off Qtrs Mil
	00920	Off Qtrs Mil
	00922	Off Qtrs Mil
	00924	Off Qtrs Mil
	00942	Off Qtrs Mil
	00944	Off Qtrs Mil
	00946	Off Qtrs Mil
	00948	Off Qtrs Mil
	00950	Off Qtrs Tran
	00960	Off Qtrs Tran
	00964	Off Qtrs Tran
	00966	Off Qtrs Tran
	00904	FH NCO & ENL

Construction Date	Building Number	Description
1948, continued	00906	FH NCO & ENL
	00968	Off Qtrs Tran
	00970	Off Qtrs Tran
	00972	Off Qtrs Tran
	00974	Off Qtrs Tran
	00976	Off Qtrs Tran
	00978	Off Qtrs Tran
	00980	Off Qtrs Tran
1949	01797	diesel Sta building
	01764	FE maintenance shop
	01554	GM facility
	01765	general storehouse
	22253	general storehouse
	01768	engineer administration building
	11182	general purpose playground
	22255	Sep Tk Drn Fld
	19241	fallout shelters
	01756	public toilet
1950	19242	FE maintenance shop
	20451	electron Eqp Facb
	20454	electron Eqp Facb
	21870	electron Eqp Facb
	21880	electron Eqp Facb
	21910	electron Eqp Facb
	21911	electron Eqp Facb
	21912	electron Eqp Facb
	21925	electron Eqp Facb
	22110	electron Eqp Facb
	22640	electron Eqp Facb
	22821	electron Eqp Facb
	23015	electron Eqp Facb
	23310	electron Eqp Facb
	23510	electron Eqp Facb
	23512	electron Eqp Facb
	24802	electron Eqp Facb
	25061	electron Eqp Facb
	25481	electron Eqp Facb
	25482	electron Eqp Facb
	27650	electron Eqp Facb
	28170	electron Eqp Facb
	28881	electron Eqp Facb
	29320	electron Eqp Facb
	29322	electron Eqp Facb
	29760	electron Eqp Facb
	29902	electron Eqp Facb
	30430	electron Eqp Facb
	29760	electron Eqp Facb

Construction Date	Building Number	Description
1950, continued	29902	electron Eqp Facb
	30430	electron Eqp Facb
	31350	electron Eqp Facb
	32970	electron Eqp Facb
	28010	electron Eqp Facb
	21560	ORD facility
	20500	electron Eqp Fac
	25062	electron Eqp Fac
	21690	high explosive magazine
	19240	general purpose magazine
	01778	SUP maintenance warehouse
	00315	general storehouse
	01851	general storehouse
	20102	general storehouse
	20104	general storehouse
	20712	general storehouse
	21000	general storehouse
	21001	general storehouse
	21574	general storehouse
	28012	general storehouse
	01870	administration, general purpose
	11102	FH CG & WO
	11104	FH CG & WO
	11106	FH CG & WO
	11108	FH CG & WO
	11114	FH CG & WO
	11116	FH CG & WO
	11118	FH CG & WO
	11120	FH CG & WO
	11122	FH CG & WO
	11124	FH CG & WO
	11126	FH CG & WO
	11128	FH CG & WO
	11130	FH CG & WO
	11132	FH CG & WO
	11134	FH CG & WO
	11136	FH CG & WO
	11138	FH CG & WO
	11140	FH CG & WO
	11142	FH CG & WO
	11144	FH CG & WO
	11146	FH CG & WO
	11148	FH CG & WO
	11151	FH CG & WO
	11153	FH CG & WO
	11155	FH CG & WO
	11157	FH CG & WO
	11159	FH CG & WO
	11161	FH CG & WO

Construction Date	Building Number	Description
1950, continued	11163	FH CG & WO
	11164	FH CG & WO
	11166	FH CG & WO
	11168	FH CG & WO
	11170	FH CG & WO
	00250	recreation center
	30883	gas storage tanks
	31352	gas storage tanks
	33483	gas storage tanks
	88010	fire alarm system
	01794	UCH MNT SH DS
	27651	electron Eqp Facb
	27900	electron Eqp Facb
	31572	electron Eqp Facb
	00622	FH NCO & ENL
	00623	FH NCO & ENL
	00625	FH NCO & ENL
	00627	FH NCO & ENL
	00631	FH NCO & ENL
	00632	FH NCO & ENL
	00635	FH NCO & ENL
	00637	FH NCO & ENL
	00641	FH NCO & ENL
	00643	FH NCO & ENL
	00645	FH NCO & ENL
	00647	FH NCO & ENL
	00649	FH NCO & ENL
	00651	FH NCO & ENL
	00652	FH NCO & ENL
	00654	FH NCO & ENL
	00656	FH NCO & ENL
	00657	FH NCO & ENL
	00659	FH NCO & ENL
	00661	FH NCO & ENL
	00716	FH NCO & ENL
	00718	FH NCO & ENL
	00719	FH NCO & ENL
	00721	FH NCO & ENL
	00723	FH NCO & ENL
	00724	FH NCO & ENL
	00726	FH NCO & ENL
	00728	FH NCO & ENL
	00730	FH NCO & ENL
	00732	FH NCO & ENL
	00733	FH NCO & ENL
	00735	FH NCO & ENL
	00737	FH NCO & ENL
	00739	FH NCO & ENL
	00742	FH NCO & ENL

Construction Date	Building Number	Description
1950, continued	00743	FH NCO & ENL
	00745	FH NCO & ENL
	11173	FH CG & WO
	11174	FH CG & WO
	11176	FH CG & WO
	11177	FH CG & WO
	11179	FH CG & WO
	11180	FH CG & WO
	12202	FH CG & WO
	12204	FH CG & WO
	12206	FH CG & WO
	12208	FH CG & WO
	12210	FH CG & WO
	12212	FH CG & WO
	12214	FH CG & WO
	12216	FH CG & WO
	12218	FH CG & WO
	00610	FH NCO & ENL
	00611	FH NCO & ENL
	00613	FH NCO & ENL
	00615	FH NCO & ENL
	00617	FH NCO & ENL
	00619	FH NCO & ENL
	00620	FH NCO & ENL
	00801	FH NCO & ENL
	00803	FH NCO & ENL
	00805	FH NCO & ENL
	00806	FH NCO & ENL
	00808	FH NCO & ENL
	00809	FH NCO & ENL
	00811	FH NCO & ENL
	00812	FH NCO & ENL
	00814	FH NCO & ENL
	00815	FH NCO & ENL
	00501	Off Qtrs Tran
	00952	Off Qtrs Tran
	00954	Off Qtrs Tran
	00956	Off Qtrs Tran
	00958	Off Qtrs Tran
	00962	Off Qtrs Tran
	11110	Off Qtrs Tran
	11112	Off Qtrs Tran
	00155	fire station
1951	00655	detached garages
	00658	detached garages
	00660	detached garages
	00662	detached garages
	00715	detached garages

Construction Date	Building Number	Description
1951, continued	00717	detached garages
	00720	detached garages
	00722	detached garages
	00725	detached garages
	00727	detached garages
	00729	detached garages
	00731	detached garages
	00734	detached garages
	00736	detached garages
	00738	detached garages
	00740	detached garages
	00741	detached garages
	00744	detached garages
	00746	detached garages
	00807	detached garages
	00810	detached garages
	00813	detached garages
	00816	detached garages
	00907	detached garages
	00911	detached garages
	00609	detached garages
	00612	detached garages
	00614	detached garages
	00616	detached garages
	00618	detached garages
	00621	detached garages
	00624	detached garages
	00626	detached garages
	00628	detached garages
	00630	detached garages
	00633	detached garages
	00634	detached garages
	00636	detached garages
	00640	detached garages
	00642	detached garages
	00644	detached garages
	00646	detached garages
	00648	detached garages
	00650	detached garages
	00653	detached garages
	01867	public toilet
	21326	FW runway
	21318	FW AC PK apron
	21314	ROT LT beacon
	21311	AF OPS building
	00316	gas chamber
	01303	auto rifle range
	01776	battery shop
	20455	electron Eqp Facb

Construction Date	Building Number	Description
1951, continued	22112	electron Eqp Fac
	29059	electron Eqp Fac
	29370	electron Eqp Fac
	29375	electron Eqp Fac
	29380	electron Eqp Fac
	34710	electron Eqp Fac
	29290	electron Eqp Fac
	21538	general purpose magazine
	21528	Liq Propl Str
	21532	Liq Propl Str
	21536	Liq Propl Str
	21546	Liq Propl Str
	00368	general storehouse
	00371	general storehouse
	01738	general storehouse
	21542	general storehouse
	21105	vet facility
	00100	post HQ building
	01530	administration, general purpose
	00360	administration, general purpose
	00362	administration, general purpose
	00364	administration, general purpose
	00365	administration, general purpose
	00370	administration, building R&D
	01758	administration, general purpose
	00145	unit chapel
	00270	EXCH SVC STA
	00254	THTR W/DRESS RM
	00434	EXCH SVC outlet
	00436	EXCH SVC outlet
	00227	tennis courts
	00322	switch sta
	10292	GND STOR TK
	10350	water well W/PS
1952	00502	Off Qtrs Mil
	33207	diesel oil Str
	30724	XMTR building radio
	01510	weather station
	24804	OPS general purpose
	23396	Barr Explo
	01784	VEH MNT SH DS
	01742	FE facility
	01552	metallurgy lab
	23452	GM facility
	00304	COMP EQP facility
	20457	COMP EQP facility
	20452	electron Eqp Facb
	20710	electron Eqp Facb

Construction Date	Building Number	Description
1952, continued	21860	electron Eqp Facb
	21901	electron Eqp Facb
	21913	electron Eqp Facb
	23312	electron Eqp Facb
	27110	electron Eqp Facb
	27111	electron Eqp Facb
	27112	electron Eqp Facb
	27113	electron Eqp Facb
	27114	electron Eqp Facb
	27115	electron Eqp Facb
	27116	electron Eqp Facb
	27117	electron Eqp Facb
	27118	electron Eqp Facb
	27120	electron Eqp Facb
	27121	electron Eqp Facb
	27122	electron Eqp Facb
	27123	electron Eqp Facb
	27124	electron Eqp Facb
	27125	electron Eqp Facb
	27126	electron Eqp Facb
	27127	electron Eqp Facb
	27128	electron Eqp Facb
	27129	electron Eqp Facb
	27130	electron Eqp Facb
	27131	electron Eqp Facb
	27132	electron Eqp Facb
	27133	electron Eqp Facb
	27134	electron Eqp Facb
	27135	electron Eqp Facb
	27136	electron Eqp Facb
	27137	electron Eqp Facb
	27138	electron Eqp Facb
	27139	electron Eqp Facb
	27140	electron Eqp Facb
	27141	electron Eqp Facb
	27142	electron Eqp Facb
	27143	electron Eqp Facb
	27144	electron Eqp Facb
	27145	electron Eqp Facb
	27146	electron Eqp Facb
	27147	electron Eqp Facb
	27148	electron Eqp Facb
	27149	electron Eqp Facb
	27150	electron Eqp Facb
	27151	electron Eqp Facb
	27152	electron Eqp Facb
	27154	electron Eqp Facb
	27155	electron Eqp Facb
	27157	electron Eqp Facb

Construction Date	Building Number	Description
1952, continued	27158	electron Eqp Facb
	27950	electron Eqp Facb
	28013	electron Eqp Facb
	29901	electron Eqp Facb
	33200	electron Eqp Facb
	33470	electron Eqp Facb
	22250	electron Eqp Facb
	22251	electron Eqp Facb
	31800	electron Eqp Facb
	34187	electron Eqp Facb
	29904	lab general purpose
	21560	ORD facility
	20453	electron Eqp Fac
	20711	electron Eqp Fac
	23397	electron Eqp Fac
	31120	electron Eqp Fac
	33205	electron Eqp Fac
	23585	GM facility
	23586	GM facility
	23587	GM facility
	23589	GM facility
	23590	GM facility
	23594	GM facility
	23595	GM facility
	23596	GM facility
	23597	GM facility
	31121	gas storage tanks
	23454	Comp Air PL building
	21374	fuse Det magazine
	21376	fuse Det magazine
	21378	fuse Det magazine
	21380	fuse Det magazine
	21354	GM magazine
	21356	GM magazine
	21358	GM magazine
	21360	GM magazine
	21500	Liq Propl Str
	21510	Liq Propl Str
	01852	general purpose warehouse
	01854	general purpose warehouse
	01858	general purpose warehouse
	01860	general purpose warehouse
	01862	general purpose warehouse
	21502	storage shed general purpose
	21512	storage shed general purpose
	01720	Flam Mat Sths
	01721	Flam Mat Sths
	28011	general storehouse
	32984	general storehouse

Construction Date	Building Number	Description
1952, continued	01796	Ord administration building
	01740	administration, general purpose
	29903	PWR PL building OTH
	31802	PWR PL building OTH
	23450	heat plant gas
	23103	gas storage tanks
	33862	gas storage tanks
	33861	gas storage tanks
	10002	FH NCO & ENL
	10003	FH NCO & ENL
	10004	FH NCO & ENL
	10005	FH NCO & ENL
	10006	FH NCO & ENL
	10007	FH NCO & ENL
	10008	FH NCO & ENL
	10009	FH NCO & ENL
	10010	FH NCO & ENL
	10011	FH NCO & ENL
	10012	FH NCO & ENL
	10016	FH NCO & ENL
	10017	FH NCO & ENL
	10018	FH NCO & ENL
	10020	FH NCO & ENL
	10021	FH NCO & ENL
	10022	FH NCO & ENL
	10023	FH NCO & ENL
	10024	FH NCO & ENL
	10025	FH NCO & ENL
	10026	FH NCO & ENL
	10027	FH NCO & ENL
	10028	FH NCO & ENL
	10029	FH NCO & ENL
	10030	FH NCO & ENL
	10031	FH NCO & ENL
	10032	FH NCO & ENL
	10033	FH NCO & ENL
	10034	FH NCO & ENL
	10035	FH NCO & ENL
	10036	FH NCO & ENL
	10037	FH NCO & ENL
	10038	FH NCO & ENL
	10039	FH NCO & ENL
	10040	FH NCO & ENL
	10041	FH NCO & ENL
	10042	FH NCO & ENL
	10043	FH NCO & ENL
	10044	FH NCO & ENL
	10045	FH NCO & ENL
	10046	FH NCO & ENL

Construction Date	Building Number	Description
1952, continued	10050	FH NCO & ENL
	10051	FH NCO & ENL
	10052	FH NCO & ENL
	10053	FH NCO & ENL
	10054	FH NCO & ENL
	10055	FH NCO & ENL
	10060	FH NCO & ENL
	10061	FH NCO & ENL
	10064	FH NCO & ENL
	10065	FH NCO & ENL
	10068	FH NCO & ENL
	10069	FH NCO & ENL
	10070	FH NCO & ENL
	10073	FH NCO & ENL
	10074	FH NCO & ENL
	10075	FH NCO & ENL
	10080	FH NCO & ENL
	10081	FH NCO & ENL
	10082	FH NCO & ENL
	10083	FH NCO & ENL
	10084	FH NCO & ENL
	10085	FH NCO & ENL
	10086	FH NCO & ENL
	10087	FH NCO & ENL
	10088	FH NCO & ENL
	10089	FH NCO & ENL
	10090	FH NCO & ENL
	10091	FH NCO & ENL
	10092	FH NCO & ENL
	10093	FH NCO & ENL
	10094	FH NCO & ENL
	10095	FH NCO & ENL
	10096	FH NCO & ENL
	10100	FH NCO & ENL
	10101	FH NCO & ENL
	10102	FH NCO & ENL
	10103	FH NCO & ENL
	10104	FH NCO & ENL
	10105	FH NCO & ENL
	10106	FH NCO & ENL
	10107	FH NCO & ENL
	10108	FH NCO & ENL
	10109	FH NCO & ENL
	10110	FH NCO & ENL
	10111	FH NCO & ENL
	10112	FH NCO & ENL
	10113	FH NCO & ENL
	10114	FH NCO & ENL
	10115	FH NCO & ENL

Construction Date	Building Number	Description
1952, continued	10120	FH NCO & ENL
	10121	FH NCO & ENL
	10122	FH NCO & ENL
	10123	FH NCO & ENL
	10124	FH NCO & ENL
	10125	FH NCO & ENL
	10126	FH NCO & ENL
	10127	FH NCO & ENL
	10128	FH NCO & ENL
	10129	FH NCO & ENL
	10130	FH NCO & ENL
	10131	FH NCO & ENL
	10132	FH NCO & ENL
	10133	FH NCO & ENL
	10134	FH NCO & ENL
	10135	FH NCO & ENL
	10136	FH NCO & ENL
	10137	FH NCO & ENL
	10138	FH NCO & ENL
	10139	FH NCO & ENL
	10140	FH NCO & ENL
	10141	FH NCO & ENL
	10142	FH NCO & ENL
	10143	FH NCO & ENL
	10144	FH NCO & ENL
	10145	FH NCO & ENL
	10146	FH NCO & ENL
	10150	FH NCO & ENL
	10151	FH NCO & ENL
	10152	FH NCO & ENL
	10153	FH NCO & ENL
	10154	FH NCO & ENL
	10155	FH NCO & ENL
	10156	FH NCO & ENL
	10157	FH NCO & ENL
	10158	FH NCO & ENL
	10159	FH NCO & ENL
	10160	FH NCO & ENL
	10161	FH NCO & ENL
	10162	FH NCO & ENL
	10163	FH NCO & ENL
	10164	FH NCO & ENL
	10165	FH NCO & ENL
	10166	FH NCO & ENL
	10167	FH NCO & ENL
	10170	FH NCO & ENL
	10171	FH NCO & ENL
	10172	FH NCO & ENL
	10173	FH NCO & ENL

Construction Date	Building Number	Description
1952, continued	10174	FH NCO & ENL
	10175	FH NCO & ENL
	10176	FH NCO & ENL
	10177	FH NCO & ENL
	10178	FH NCO & ENL
	10179	FH NCO & ENL
	10180	FH NCO & ENL
	10181	FH NCO & ENL
	10182	FH NCO & ENL
	10183	FH NCO & ENL
	10184	FH NCO & ENL
	10185	FH NCO & ENL
	10186	FH NCO & ENL
	10187	FH NCO & ENL
	10188	FH NCO & ENL
	10200	FH NCO & ENL
	10201	FH NCO & ENL
	10202	FH NCO & ENL
	10203	FH NCO & ENL
	10204	FH NCO & ENL
	10205	FH NCO & ENL
	10206	FH NCO & ENL
	10207	FH NCO & ENL
	10208	FH NCO & ENL
	10209	FH NCO & ENL
	10210	FH NCO & ENL
	10211	FH NCO & ENL
	10212	FH NCO & ENL
	10213	FH NCO & ENL
	10214	FH NCO & ENL
	10215	FH NCO & ENL
	10216	FH NCO & ENL
	10217	FH NCO & ENL
	10218	FH NCO & ENL
	10219	FH NCO & ENL
	10220	FH NCO & ENL
	10221	FH NCO & ENL
	10222	FH NCO & ENL
	10230	FH NCO & ENL
	10231	FH NCO & ENL
	10232	FH NCO & ENL
	10233	FH NCO & ENL
	10236	FH NCO & ENL
	10237	FH NCO & ENL
	10238	FH NCO & ENL
	10239	FH NCO & ENL
	10240	FH NCO & ENL
	10241	FH NCO & ENL
	10242	FH NCO & ENL

Construction Date	Building Number	Description
1952, continued	10243	FH NCO & ENL
	10244	FH NCO & ENL
	10245	FH NCO & ENL
	10246	FH NCO & ENL
	10247	FH NCO & ENL
	10248	FH NCO & ENL
	10249	FH NCO & ENL
	10250	FH NCO & ENL
	10251	FH NCO & ENL
	10252	FH NCO & ENL
	10253	FH NCO & ENL
	10254	FH NCO & ENL
	10255	FH NCO & ENL
	10256	FH NCO & ENL
	10257	FH NCO & ENL
	10260	FH NCO & ENL
	10261	FH NCO & ENL
	11103	detached garages
	11105	detached garages
	11109	detached garages
	11113	detached garages
	11115	detached garages
	11117	detached garages
	11121	detached garages
	11123	detached garages
	11127	detached garages
	11129	detached garages
	11131	detached garages
	11135	detached garages
	11137	detached garages
	11139	detached garages
	11141	detached garages
	11143	detached garages
	11147	detached garages
	11150	detached garages
	11152	detached garages
	11154	detached garages
	11156	detached garages
	11158	detached garages
	11160	detached garages
	11162	detached garages
	11165	detached garages
	11167	detached garages
	11169	detached garages
	11171	detached garages
	11172	detached garages
	11175	detached garages
	11178	detached garages
	11181	detached garages

Construction Date	Building Number	Description
1952, continued	12201	detached garages
	12203	detached garages
	12205	detached garages
	12207	detached garages
	12209	detached garages
	12211	detached garages
	12213	detached garages
	12215	detached garages
	12217	detached garages
1953	00129	ENL BK W/O DIN
	33130	ENL PERS DINE
	21580	public toilet
	31790	FW runway
	34390	FW runway
	34391	Std taxiway
	34392	Std taxiway
	31789	FW AC PK apron
	34389	FW AC PK apron
	34188	veh fuel Str
	33140	heating fuel Str
	29441	diesel oil Str
	32276	diesel oil Str
	33054	diesel oil Str
	33216	diesel oil Str
	21310	XMTR building radio
	01868	scale house
	23578	other
	23579	other
	34202	VEH MNT SH GS
	01755	FE maintenance shop
	30780	FE maintenance shop
	21630	GM facility
	01550	GM facility
	01690	GM facility
	21582	GM facility
	21620	GM facility
	21780	GM facility
	00714	FH NCO & ENL
	00747	FH NCO & ENL
	00760	FH NCO & ENL
	00762	FH NCO & ENL
	00764	FH NCO & ENL
	00766	FH NCO & ENL
	00761	detached garages
	00763	detached garages
	00713	detached garages
	00767	FH NCO & ENL
	00769	FH NCO & ENL

Construction Date	Building Number	Description
1953, continued	00770	FH NCO & ENL
	00772	FH NCO & ENL
	00773	FH NCO & ENL
	00775	FH NCO & ENL
	00776	FH NCO & ENL
	00778	FH NCO & ENL
	00779	FH NCO & ENL
	00781	FH NCO & ENL
	00765	detached garages
	00768	detached garages
	00771	detached garages
	00774	detached garages
	00777	detached garages
	00780	detached garages
	00802	detached garages
	00802	detached garages
	00804	detached garages
	31425	comp Eqp facility
	19472	detect Eqp facility
	21760	electron Eqp Facb
	27170	electron Eqp Facb
	28070	electron Eqp Facb
	28680	electron Eqp Facb
	28731	electron Eqp Facb
	28790	electron Eqp Facb
	28880	electron Eqp Facb
	29442	electron Eqp Facb
	30210	electron Eqp Facb
	31331	electron Eqp Facb
	31620	electron Eqp Facb
	31630	electron Eqp Facb
	31766	electron Eqp Facb
	32971	electron Eqp Facb
	32990	electron Eqp Facb
	33150	electron Eqp Facb
	34181	electron Eqp Facb
	34183	electron Eqp Facb
	34600	electron Eqp Facb
	34870	electron Eqp Facb
	01648	electron Eqp Fac
	29552	electron Eqp Facb
	33152	electron Eqp Facb
	19468	prop sys facility
	19465	vibration test
	19467	vibration test
	23576	GM facility
	21564	ORD facility
	31623	electron Eqp Fac
	33149	electron Eqp Fac

Construction Date	Building Number	Description
1953, continued	23469	GM facility
	23477	GM facility
	23479	GM facility
	23574	GM facility
	23575	GM facility
	19466	prop sys facility
	01840	general purpose warehouse
	01846	general purpose warehouse
	01848	general purpose warehouse
	1787A	Flam Mat Sths
	21623	general storehouse
	00143	administration, general purpose
	29443	PWR PL building OTH
	32991	PWR PL building OTH
	33151	PWR PL building OTH
	34182	PWR PL building OTH
	22256	gas storage tanks
	28071	gas storage tanks
	29382	gas storage tanks
	31327	gas storage tanks
	31428	gas storage tanks
	31622	gas storage tanks
	31629	gas storage tanks
	31767	gas storage tanks
	3217	gas storage tanks
	32989	gas storage tanks
	33121	gas storage tanks
	33133	gas storage tanks
	33154	gas storage tanks
	33199	gas storage tanks
	33210	gas storage tanks
	34178	gas storage tanks
	34184	gas storage tanks
	34236	gas storage tanks
	34604	gas storage tanks
	34872	gas storage tanks
	33157	gas storage tanks
	33158	gas storage tanks
	34185	gas storage tanks
	34201	gas storage tanks
	27171	water pump station BD
	31765	water pump station BD
	27172	grd stor TK
	27592	grd stor TK
	29444	grd stor TK
	32992	grd stor TK
	33145	grd stor TK
	33155	grd stor TK
	34243	grd stor TK
	21626	comp air PL building

Construction Date	Building Number	Description
1954	00312	comm center
	20810	TEL EXCH building
	23320	GM MNT facility
	23511	GM MNT facility
	01649	radar mnt shop
	01650	radar mnt shop
	34244	FE maintenance shop
	01546	Astron Geo Fac
	01544	GM facility
	23451	GM facility
	21745	electron Eqp Facb
	22500	electron Eqp Facb
	23174	electron Eqp Facb
	23264	electron Eqp Facb
	29055	electron Eqp Facb
	29090	electron Eqp Facb
	29381	electron Eqp Facb
	31122	electron Eqp Facb
	31803	electron Eqp Facb
	32009	electron Eqp Facb
	33153	electron Eqp Facb
	34180	electron Eqp Facb
	34990	electron Eqp Facb
	22113	electron Eqp Facb
	25060	electron Eqp Facb
	25261	electron Eqp Facb
	28171	electron Eqp Facb
	28295	electron Eqp Facb
	28730	electron Eqp Facb
	28791	electron Eqp Facb
	29950	electron Eqp Facb
	30211	electron Eqp Facb
	32012	electron Eqp Facb
	21640	ORD facility
	27104	ORD facility
	25262	electron Eqp Fac
	27904	electron Eqp Fac
	28882	electron Eqp Fac
	29323	electron Eqp Fac
	30431	electron Eqp Fac
	31351	electron Eqp Fac
	31574	electron Eqp Fac
	31576	electron Eqp Fac
	32972	electron Eqp Fac
	33471	electron Eqp Fac
	23330	GM facility
	25171	GM facility
	21370	fuse Det magazine
	21372	fuse Det magazine

Construction Date	Building Number	Description
1954, continued	21352	high explosives magazine
	21366	sm arm pyro magazine
	21368	sm arm pyro magazine
	21346	GM magazine
	21348	GM magazine
	21350	GM magazine
	21575	storage shed general purpose
	01817	general storehouse
	21236	general storehouse
	27108	general storehouse
	01733	FE storehouse
	22118	target storage
	34252	storage shed general purpose
	34219	GNTR workshop
	34221	GNTR workshop
	34227	GNTR workshop
	32010	GNTR workshop
	21576	heat plant gas
	23321	heat plant gas
	23322	gas storage tanks
	25260	gas storage tanks
	29338	gas storage tanks
	29564	gas storage tanks
	32743	gas storage tanks
	31755	sept tk Drn Fld
	00375	water trmt Pl
	00387	water well

APPENDIX D
COMMITMENT MANAGEMENT SUMMARY

APPENDIX D
COMMITMENT MANAGEMENT SUMMARY OF SUPPLEMENTAL DOCUMENTATION

1.0 BACKGROUND

The White Sands Missile Range Environmental Impact Statement (WSMR EIS) is lacking in several areas of both baseline documentation and impacts analysis. It is stated in the EIS and the Comment Response Document that these insufficiencies will be rectified by the preparation of supplemental documentation. A general approach for technical support analysis documents is offered in the Commitment Management Summary. Specific approaches for the individual analyses are described in more detail in the section titled Technical Support Documents (TSD).

As specified in 40 CFR 1502.22: When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking. The Commitment Management Summary documents the areas where information is lacking in the WSMR EIS and takes this regulatory requirement a step further in specifying how WSMR will remedy the problem through the preparation of TSDs.

The benefits of EIS supplements in the form of TSDs are obvious in that a missing or insufficient baseline will be remedied and impacts can be analyzed in deeper detail than is possible within the limitations of the EIS. Additionally, the series of currently identified TSDs and future supplements will ensure the living document platform of the WSMR EIS as a dynamic component of the WSMR Decision Analysis System. The environmental baseline will be regularly updated by the incorporation of supplemental information resulting from the specified TSDs and by other tiered NEPA documentation.

2.0 COMMITMENT MANAGEMENT SUMMARY

The following is a general description of the Commitment Management Summary (CMS) as a plan for augmenting the WSMR EIS.

- For the insufficient resource area baseline, follow-on analyses are planned. These analyses will either be based on specifically proposed/funded investigative programs (e.g., emissions analysis) or, when possible, based on data generated by future environmental documentation. A third approach to generating these analyses will be a consolidated effort by one or more WSMR directorates or tenants to sponsor the effort (e.g., comprehensive missile and debris recovery actions analysis).

- Where it is identified that a specific type of baseline data for modeling will not result from foreseeable planned projects, it is proposed that organizational sponsors (e.g., WSMR directorates) or several programs be pooled to support an EIS-listed follow-on analysis or other data-gathering commitment.
- The follow-on analyses are being undertaken to enhance the EIS's programmatic, "living" document orientation that not only satisfies the NEPA compliance requirement but also serves as a dynamic environmental resource baseline.
- An annual written summary of NEPA documentation, other environmental regulatory compliance documentation, and the TSDs will be made available to the agencies and public. Annual and as-needed informational meetings will be held to involve the community. Quarterly written information will be available to provide the public a regular status update and findings of the TSDs specified below.

3.0 TECHNICAL SUPPORT DOCUMENTS

3.1 APPROACH

Technical Support Documents (TSD) will utilize program and project data from the WSMR Universal Documentation System (UDS, years 1985-1995, and UDS projections). Existing NEPA and other environmental documentation will be reviewed for programmatic, systematic, or classification applicability. The data will be reviewed in current WSMR-specific documentation (e.g., EAs and EISs) as well as other appropriate program documentation prepared for other locations.

- The data will be reviewed for appropriate program or system classification (i.e., do the data represent a generic enough system to be used for tiering or follow-on baseline modeling?; e.g., <u>typical</u> solid fuel propellant constituents for air quality or hazardous material analysis).
- Where they exist, baseline modeling techniques originally used in the EIS will be reviewed and modified if necessary. The techniques will be examined for their utility in statistical analysis, quantitative, and qualitative comparative analysis. In some cases where statistical or scientific data do not exist, generalized "like for like" comparisons have been documented and will continue to be used in the TSDs in the absence of quantitative analyses. Necessary quantitative data missing in the qualitative comparisons would potentially result in the requirement for a longer term data gathering process than that originally prescribed for the TSD.

TSDs may be prioritized by immediate need, schedule, or current availability of funding.

3.2 EMISSIONS ANALYSIS TECHNICAL SUPPORT DOCUMENT

The Emissions Analysis TSD would nominally consist of the following components:

- the identification of all federal, state, local, and military regulations, Executive Orders, and other guidance applicable to the analysis, control, and abatement of noise;

- the identification and definition of noise thresholds, parameters, and data collection requirements for WSMR operations;
- the identification of areas (zones) in and adjacent to WSMR that may be affected by existing levels and incidents of noise, and the projection where and when future noise will become a problem;
- the identification and prioritization of areas, by need, use, and potential impact which require noise monitoring;
- the recommendation of environmental impact elimination, reduction, and mitigation procedures delineated. These recommendations will be specified in relation to the above referenced identification and prioritization of areas, by need, use, and potential impact which require noise monitoring;
- non-ionizing radiation (radio frequency radiation) analysis: inventory and document all sources for baseline; research other studies for impacts analysis;
- laser use inventory and impacts analysis;
- National Radio Astronomy Observatory electromagnetic interference interface, assessment of impacts, and recommendations for mitigation; and
- Global Positioning System Interference Program input; and light pollution analysis and mitigation recommendations.

A number of noise analyses will be performed as described above and will develop the noise modeling program for this project. Impacts analyses in the area of noise effects on wildlife, including raptors and other species of concern will be incorporated in this TSD.

Additional components of the Emissions Analysis will likely include:

- sonic boom analysis requirements;
- monitoring noise with sound meters and data recorders at launch sites (3-5 year monitoring period); and
- ambient noise monitoring at the San Andres National Wildlife Refuge, White Sands National Monument co-use area, other "sensitive" areas, and in non-sensitive remote areas that are frequented by intermittent testing programs; and
- compilation of comprehensive data from WSMR's National Range Directorate and Materiel Test Directorate for missile test noise emissions.

3.3 WATER RESOURCES TECHNICAL SUPPORT DOCUMENT

The Water Resources TSD will include:

- compilation of all existing hydrological survey data into one report which will serve as the baseline for all WSMR water quantity and quality information;
- well and spring data for the range;

- preparation of aquifer testing protocol including methodology, frequency, water level measurements for production wells;
- aquifer delineation and mapping (lithology);
- preparation of a comprehensive analysis of existing data concerning water quantity, supply, and quality and the impact of all WSMR programs and projects on this resource; and
- analysis of potential future impacts to water quality and quantity, and impact reduction procedures.

3.4 NATURAL RESOURCES TECHNICAL SUPPORT DOCUMENT

Natural resources data were compiled during the preparation of the WSMR EIS and in the Draft Integrated Natural Resources Management Plan (INRMP, 1994). The current Draft INRMP provides a useful baseline for specific natural resources management. A comprehensive Natural Resources Technical Support Document (NRTSD) will be completed which will serve to remedy inadequacies in the Draft INRMP baseline and will complete analyses for various impacts on natural resources that could not be sufficiently addressed in the WSMR EIS.

The NRTSD will be based upon reviews of the WSMR GIS database, existing NEPA and other environmental regulatory compliance documents, and existing Memoranda of Understanding or Agreement among WSMR, the U.S. Fish and Wildlife Service, the National Park Service, the Bureau of Land Management, the New Mexico State Game and Fish Department, and the New Mexico Division of Forestry.

3.5 CHAFF USE ANALYSIS TECHNICAL SUPPORT DOCUMENT

Chaff is generic name for a material that is introduced into the air at relatively low altitude to act as a "countermeasure" to various acquisition equipment including radar and infrared sensors. The material is commonly composed of simple aluminum foil bonded to a light plastic film. Another type of chaff is a "flare" material that consists of small pieces of metal that when exposed to air release a relatively large quantity of infrared energy in a short period of time.
The TSD addressing the use of chaff on WSMR will consist of documentation of all types, uses, locations, and projects that currently require or propose to use chaff. Coordination with various WSMR directorates, including National Range and Materiel Test Directorate will be undertaken to obtain data on this use. Currently used areas or historically used areas will be mapped from this data.

An analysis of the types of chaff and their impacts on the natural and spectral electromagnetic environment will be undertaken. A specific impacts analysis would focus on the spectral electromagnetic interference characteristics of chaff on adjacent uses such as those related to the operation of the National Radio Astronomy Observatory's (NRAO) Very Large Array (VLA) Radio Telescope. Coordination with NRAO will be undertaken during this analysis. Another analysis focus will be that related to cumulative soil contamination effects of repeated chaff use and the consequent potential for harm to the flora, fauna, and human occupants of WSMR.

3.6 CUMULATIVE IMPACTS ANALYSIS TECHNICAL SUPPORT DOCUMENT

Current and past programs, projects, and activities occurring at and adjacent to WSMR were briefly analyzed in the WSMR EIS to address the potential for cumulative effect. The focus of these analyses was on land use, water resources, air quality, and hazardous waste. Due to the lack of comprehensive baseline information for these and other resources at WSMR, only estimates and qualitative analyses of the interactions were possible in this EIS. The TSD will remedy the lack of a comprehensive baseline and a definitive statement of impacts and continue to assess cumulative effects. Follow-on analyses of activities, as defined in the WSMR Final EIS under proposed action major categories, will be instituted to remedy the insufficiencies in the baseline information and to deepen the assessment of cumulative effects.

The reviewers of the Draft EIS identified four areas of specific cumulative impacts concern. These areas are land use, water resources, air quality, biological resources, and hazardous waste. The focus of this analysis will be on these resources, the relationship among one another and the relationship with other resources that did not receive the same level of scrutiny. Potentially adverse cumulative impacts are anticipated in the areas of biological resources and cultural resources. The cumulative impacts on biological and cultural resources are particularly but not exclusively associated with recovery operations. Much of the recovery actions analysis of the Cumulative Impacts TSD will be focused on these two resource areas.

No major studies or surveys will be conducted for this TSD. Existing environmental data to be analyzed include environmental assessments (EAs); environmental impact statements (EISs) and scoping documents; installation master plans; specific resource management plans (e.g., cultural or biological resource management plans); resource inventories and survey reports; resource models and monitoring reports; mitigation and monitoring plans; recovery actions databases, and geographic information system (GIS) databases.

3.7 AIR QUALITY BASELINE ANALYSIS TECHNICAL SUPPORT DOCUMENT

Activities at WSMR generate constant, fluctuating, and intermittent air emissions that, collectively and when added to other past, present, and reasonably foreseeable future actions, might cause cumulative impacts to the public, to site personnel, and to the environment. WSMR will use the methodology below to evaluate the nature and the extent of potential direct and cumulative impacts on air quality.

- First, WSMR will collect air emissions data from all WSMR and WSMR-related activities. WSMR-related activities may include the landing and take-off emissions from Holloman AFB aircraft that fly missions for WSMR as well as emissions from idling vehicles at WSMR-activated roadblocks. Air emissions data will include estimated amounts of regulated air pollutants and hazardous air pollutants (HAPs) from stationary sources and mobile sources at WSMR, and baseline concentrations of PM_{10}, SO_2, and NO_2. Stationary and mobile sources at WSMR include laboratories, missile component production and assembly facilities, aircraft, rockets, electrical generators, and ground vehicles. In addition to providing data for cumulative impacts analysis, air emissions data will be used for compliance with WSMR's 40 CFR Part 70 operating permit (Title V of the Clean Air Act) and for prevention of significant deterioration (PSD) evaluations (Title I of the Clean Air Act).

- Concurrent with air emissions data collection, WSMR will determine the types of cumulative impacts that are possible. Such impacts could include regional air quality degradation; the long-term health effects to site personnel and the general public from inhalation, dermal contact, and ingestion of airborne species; and the long-term health effects to plants, wildlife, crops, and livestock from inhalation, dermal contact, and ingestion of airborne species.

Once the types of cumulative impacts are defined, WSMR will determine the geographical and temporal limits for such impacts and will determine the fate and transport of the airborne species involved. WSMR will then analyze and document the extent of cumulative impacts to air quality using guidance from the EPA and other agencies, as appropriate. It is anticipated that the cumulative impacts analysis will include impacts to WSMR from air quality control region (AQCR) 153 near El Paso, Texas.

3.8 HAZARDOUS MATERIALS/WASTE MANAGEMENT ANALYSIS TECHNICAL SUPPORT DOCUMENT

The Hazardous Materials/Waste Management Analysis TSD would nominally consist of the following:

Solid Waste Management Unit (SWMU) Inventory Information

A discussion of the inventory of the SWMUs identified at WSMR would be included in the TSD. This would include a description of the location, nature of contaminants, level of assessment and characterization studies performed to date and that proposed, and an assessment of the potential risk to human health and the environment.

RCRA Permit Information

The hazardous materials treatment, storage and disposal sites at WSMR are required to be permitted under the Resource Conservation and Recovery Act. The TSD will include a discussion of these sites, location, the quantity and nature of materials at each site, spill control procedures and any special requirement of the permit. The section will also include training requirements for individuals working with hazardous materials.

Obscurant and Simulant Use

Obscurants are substances that are used to simulate extreme weather conditions or battlefield settings such as explosives-generated smoke and dust. Simulants are relatively harmless materials used to replicate the dispersal and travel characteristics of chemical and biological weapons. Although neither of the materials are composed of toxic or hazardous materials, it is unknown if their use may have an undefined or cumulative environmental impact. The TSD will define the types of obscurants and simulants, discuss their uses, and an analysis of potential impacts will be summarized.

Waste Minimization/Pollution Prevention

A discussion of goals for hazardous waste minimization and pollution prevention will be included in the report. This will include the evaluation of the use of non-hazardous materials alternatives where practicable, the evaluation of solvent and other hazardous materials recycling programs, and mixed-waste separation techniques.

Pesticide and Herbicide Information

Management practices for pesticide and herbicides for use in Main Post beautification programs will be addressed; including nature of materials, frequency of application, and the feasibility of using non-hazardous alternatives. The TSD will also provide an analysis of herbicide application at weapons impact areas.

Integrated Hazardous Materials Management Center

An analysis will be included of hazardous materials issue practices, consumable items versus recyclable or disposable materials, procedures for use, storage and transport of materials at the center, location of material safety data sheets, and spill control procedures.

Defense Reutilization Management Office

This component will consist of an analysis of procedures to temporarily treat, store, dispose of hazardous waste, the identification of temporary and satellite storage locations, and normal and alternate disposal sites will be addressed.

Computerized systems such as the WSMR Decision Analysis System, the Hazardous Waste Tracking System, and those being used by the Integrated Hazardous Materials Center will be accessed and used to prepare this analysis. These data management systems will also be used to better plan the use and disposal of hazardous materials.

3.9 PROJECT SPECIFIC ANALYSES TECHNICAL SUPPORT DOCUMENTS

A number of project specific analyses will be tiered from the WSMR EIS and will be prepared to expedite the planning process. These analyses and their resulting documentation will comply with the requirements of the NEPA implementing guidelines and AR 200-2. The information proceeding from the documentation will enhance the WSMR EIS as a living, programmatic compliance vehicle. Examples of these analyses may include, but not be limited to, mission activities, missile and debris recovery actions, projects such as infrastructure upgrades, and routine Range-wide maintenance and repair.

The analyses will be based upon the WSMR Decision Analysis System/GIS and will result in enhancing that system's data baseline. The results of the analyses will be reported in the proposed quarterly EIS updates and annual WSMR Environmental Program Summary.

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