A Research Design for the Archaeological Investigation of 14 Sites at Spaceport America, Sierra County, New Mexico

James L. Moore, Nancy J. Akins,
Robert Dello-Russo, and Stephen S. Post

Office of Archaeological Studies Museum of New Mexico

Archaeology Notes 430

2010

MUSEUM OF NEW MEXICO

OFFICE OF ARCHAEOLOGICAL STUDIES

A Research Design for the Archaeological Investigation of 14 Sites at Spaceport America, Sierra County, New Mexico

James L. Moore, Nancy J. Akins,
Robert Dello-Russo, and Stephen S. Post

With contributions by
Jessica A. Badner
Matthew J. Barbour
Stephen Hall
Pamela McBride
Elizabeth A. Oster
Donald E. Tatum
Karen Wening
C. Dean Wilson

Submitted by
Robert Dello-Russo, Ph.D., and Stephen S. Post
Principal Investigators

ARCHAEOLOGY NOTES 430

SANTA FE 2010 NEW MEXICO

Abstract

As requested by the New Mexico Spaceport Authority, this document presents a detailed plan for the archaeological investigation of 14 sites at Spaceport America in Sierra County, New Mexico. These sites include LA 111420, LA 111421, LA 111422, LA 111429, LA 111432, LA 111435, LA 112370, LA 112371, LA 112374, LA 155963, LA 155964, LA 155968, LA 155969, and LA 156877. The project area is located on lands administered by the New Mexico State Land Office and the Bureau of Land Management in the Jornada del Muerto, a large, north-south oriented basin in south-central New Mexico. The Federal Aviation Administration is the lead agency responsible for the National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) Section 106 review of the proposed undertaking, with Section 106 consulting parties including the Advisory Council on Historic Preservation (ACHP), the USDI Bureau of Land Management (BLM; NM State Office), the New Mexico State Historic Preservation Office-Historic Preservation Division (SHPO-HPD), the New Mexico Spaceport Authority, and the New Mexico State Land Office (SLO). This plan includes overviews of the physical environment and culture history of the project area, a theoretical research perspective, a research design that will be used to guide this endeavour, discussions of field and analytic procedures, and descriptions of both the included sites and the proposed level of archaeological effort at each of those sites.

Contents

Figures

Tables

Chapter 1: Introduction and Statement of Purpose

New Mexico's Jornada del Muerto has posed a challenge to human exploration and settlement since the first hunters traversed its broad, and sometimes forbidding, landscapes. Although some variability in the climatic regime through time is evident, xeric environmental conditions have generally prevailed, and evidence of human settlement is sparse, from the campsites and resource-processing locations used by Paleoindian, Archaic peoples and Formative pithouses, to the dust-blown ranches and railroad sidings of the modern era. Even contemporary human users of the Jornada must contend with scarcity of key resources and a corresponding requirement to import necessities, including supplies, materiel, and work crews. Without an assist, the present-day landscape supports only limited occupation.

The archaeological database for the Jornada, described in more detail below, can also be characterized as sparse. This is no coincidence; archaeological fieldwork as conducted in the modern era tends to precede development, and development in the Jornada region has been very limited. For the earliest period of human occupation beginning in Paleoindian times, for example, sites to the north and east are often referenced for discussion in the absence of data more specific to the Jornada, while for the later, Formative phases, considerations of the local Jornada Mogollon sequences tend to be conflated with developments in the Western Mogollon or Mimbres region (Kirkpatrick et al. 2000:1).

The research plan presented in this document proposes focused archaeological investigations within a portion of the Jornada del Muerto, in advance of the creation of the Spaceport America. The project site is in Sierra County near Engle and Upham, New Mexico, at a location approximately 45 miles north of Las Cruces and 30 miles southeast of Truth or Consequences (Fig. 1.1). The Spaceport will be constructed primarily on lands managed by the New Mexico State Land Office (NMSLO) and the U.S. Department of Interior-BLM. Some private land will also be affected. Research-oriented excavations are proposed at 14 prehistoric archaeological sites that will be affected by the construction and operation of the Spaceport. The sites have been identified during surveys conducted in advance of the Spaceport undertaking, and have been evaluated for their eligibility to the National Register of Historic Places. The proposed research signals an opportunity to add significantly to the regional database, while preserving information that could be lost during construction and operation of the Spaceport.

Spaceport America Regulatory Background

In December 2008, the Federal Aviation Administration Office of Commercial Space Transportation issued a Launch Site Operator License to the NMSA to develop and operate a commercial space launch site, to be called Spaceport America. The issuance of a Launch Site Operator License by the FAA is considered a federal undertaking subject to review as required by the National Environmental Policy Act (NEPA) and Section 106 of NHPA. In December 2008 the FAA issued a Record of Decision stating that the FAA had selected the Preferred Alternative, as analyzed in the November 2008 *Final Environmental Impact Statement for the Spaceport America Commercial Launch Site, Sierra County, New Mexico.* The undertaking is subject to review and concurrence by the New Mexico State Historic Preservation Office, Historic Preservation Division (SHPO-HPD) as well as the "Section 106 Consulting Parties" (see below for description of this group).

The FAA is responsible for analyzing the environmental impacts associated with issuing a launch site operator license, and is thus the lead Federal agency responsible for the proposed Spaceport America cultural (and natural) resources compliance review. Cooperating agencies include the Bureau of Land Management (BLM), the National Park Service (NPS), the United States Army White Sands Missile Range (WSMR), and the National Aeronautics and Space Administration (NASA). The Areas of Potential Effects (APEs) identified for the proposed undertaking are

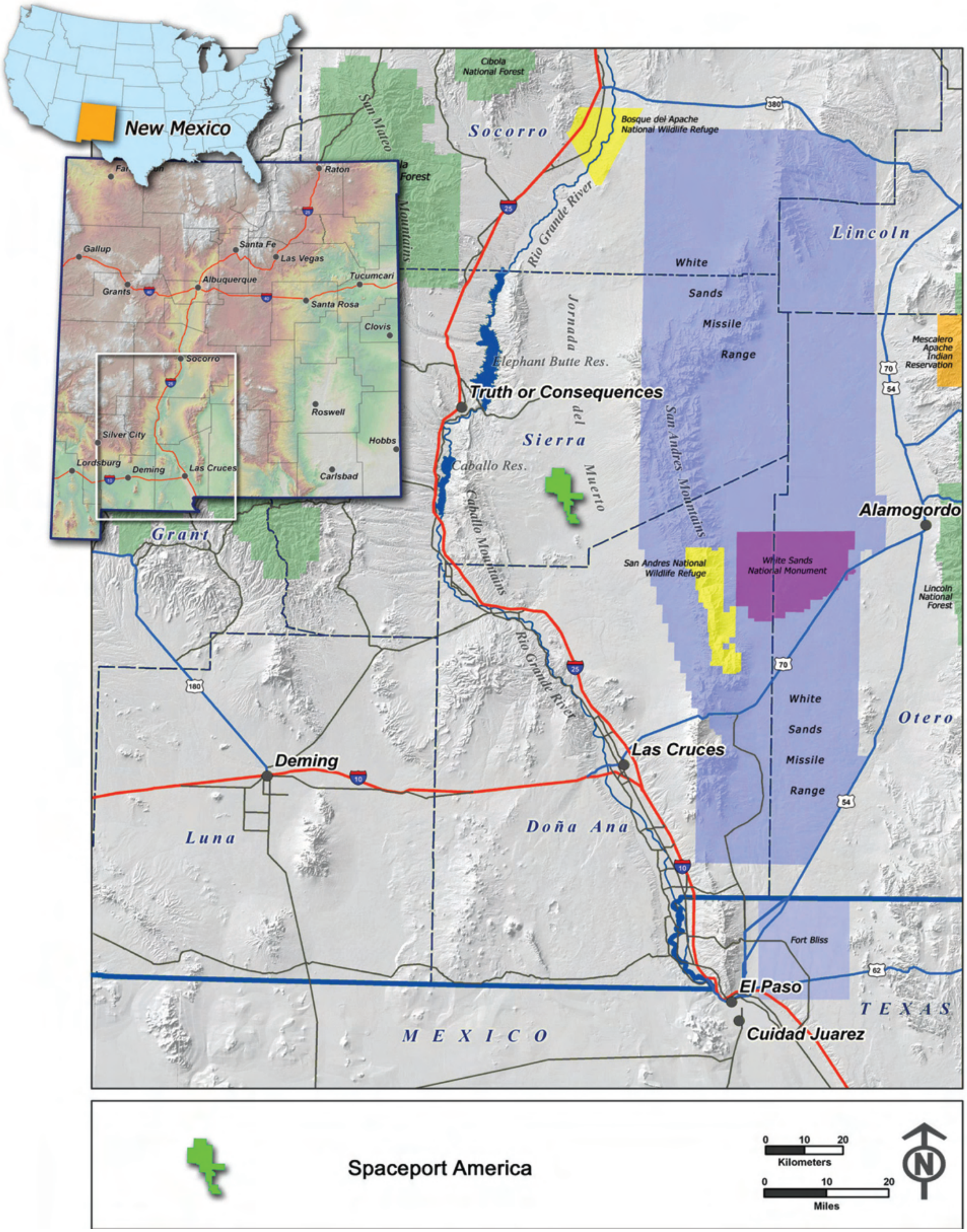

Figure 1.1. Location of Spaceport America with respect to surrounding areas (after FAA 2008:2-2).

located primarily on lands managed by the New Mexico State Land Office (NMSLO) and U.S. Department of Interior—BLM. Some private land will also be affected.

A Programmatic Agreement (PA), finalized in December of 2008, guides the completion of the responsibilities for the undertaking per Section 106: *Programmatic Agreement among the Federal Aviation Administration, Bureau of Land Management, New Mexico State Land Office, New Mexico Spaceport Authority, New Mexico State Historic Preservation Officer, and Advisory Council on Historic Preservation Regarding the Spaceport America Project, Sierra County, New Mexico* (Section 106 PA). The FAA, in consultation with the SHPO-HPD, identified the following nine tribes as potentially having religious or cultural affiliation with the project area and provided each of them with information about the Project opportunities to participate in site visits to the project area and participate in the Section 106 process: the Comanche Indian Tribe; Fort Sill Apache Tribe of Oklahoma; Hopi Tribe; Isleta Pueblo; Kiowa Tribe of Oklahoma; Mescalero Apache Tribe; Navajo Nation; White Mountain Apache Tribe; Ysleta del Sur Pueblo.

The Section 106 PA document was signed by the following agencies and groups:

Federal Aviation Administration
Advisory Council on Historic Preservation
Bureau of Land Management (New Mexico State Office)
New Mexico State Historic Preservation Office
New Mexico Spaceport Authority
New Mexico State Land Office

The Consulting Parties in the Section 106 process listed below were also asked to participate in development of the Section 106 PA, and were asked to review and sign the Section 106 PA as Concurring Parties:

National Aeronautics and Space Administration (NASA)
U.S. Army White Sands Missile Range (WSMR)
National Park Service (NPS)
New Mexico Department of Transportation (NMDOT)
Sierra County
National Trust for Historic Preservation (NTHP)
New Mexico Heritage Preservation Alliance (NMHPA)
El Camino Real de Tierra Adentro Trail Association (CARTA)
Ysleta del Sur Pueblo
Comanche Tribe
Hopi Tribe
Mr. Dennis Wallin (representative for the private property owners)

Together, the Section 106 PA Signatories and Concurring Parties and the nine Native American tribes identified as culturally affiliated with resources in the Spaceport America project area comprise the "Section 106 Consulting Parties" for Spaceport America compliance review. Under the terms of the Section 106 PA, NMSA is responsible for developing plans and submitting them to FAA for approval, including mitigation plans for known historic properties as well as any properties that may be identified as a result of survey and evaluation or monitoring. The FAA, in turn, will submit mitigation plans to the Section 106 Consulting Parties for comment, prior to accepting them. This research design will be submitted for Section 106 review in conformance to Stipulation V(c) i of the Section 106 PA, and for review and issuance of a permit to the Cultural Properties Review Committee (CPRC) in conformance to Stipulation V(d). The State of New Mexico requires that a research design shall be prepared guiding archaeological data recovery excavations according to the specifications of 4.10.16 NMAC, implementing regulations for the "Cultural Properties Act" (§§18-6-1 through 18-6-27, NMSA 1978). Per Stipulation I(a) of the Section 106 PA, in addition to the qualifications required for the issuance of a permit to conduct archaeological investigations in New Mexico (4.10.8.11 NMAC and 4.10.11.9 NMAC), project supervisory staff are required to meet the professional qualifications for archaeology outlined in the Secretary of the Interior's Standards (36 CFR part 61, Appendix A).

Status of Information about Cultural Resources in the Areas of Potential Effects

As defined in the Section 106 PA the APEs for the Spaceport undertaking consist of: "…

the Physical APE, comprised of the areas that may be directly affected by physical ground disturbance and construction of the commercial space launch site, the Setting APE, comprised of the area within five miles of the facility wherein potential visual and audible effects to the historic properties may occur…" (FAA 2008). The *Final Environmental Impact Statement for the Spaceport America Commercial Launch Site, Sierra County, New Mexico* provides additional detail regarding the definition of the APEs as well as the nature of the potential effects, as follows:

> The proposed Project has the potential to affect cultural resources in two ways: through physical impacts to resources, and through changes to the visual and auditory character of the rural setting of resources. For physical impacts, the APE is defined as the areas within which construction or operations activities would occur, hereafter referred to as the Physical APE. Because the Physical APE boundaries include more area (the Project boundary plus a buffer area) than would be specified for construction of the Spaceport America facilities, not all of the resources identified within this APE would necessarily be impacted by the Project. The Physical APE was developed to allow for possible minor shifting of facility locations during Project design and construction to avoid resource impacts and to allow ample area for construction activities. Due to the nature of the undertaking, the potential effects of the Project could also extend to areas outside of, but in proximity to, the limits of disturbance of the proposed Spaceport America facilities. These are areas that may contain resources that could be impacted through the introduction of visible or audible intrusions into the setting by the proposed Project. This area has been defined by the FAA, in consultation with the New Mexico State Historic Preservation Officer (NMSHPO), the BLM, the NPS, and the National Trust for Historic Preservation, as a 5-mile radius surrounding any proposed aboveground infrastructure or facilities, and is hereafter referred to as the Setting APE. (FAA 2008)

The project area is located in the Yost Draw portion of the Jornada del Muerto, a north-south trending basin. Cultural resources in the general project area and vicinity identified during archaeological survey (including recent work conducted in advance of the proposed undertaking) date from the Paleoindian Period up to the twentieth century. The majority of the cultural properties in the APEs are prehistoric Native American sites, but the project area also includes segments of El Camino Real de Tierra Adentro National Historic Trail (El Camino Real NHT; El Camino Real) identified as portions of the Yost Draw Study Area (Marshall 1991) as well as the historic Aleman Ranch complex. The Aleman Ranch complex has been determined as "eligible" for the National Register, and encompasses standing structures as well as archaeological components.

As described above, the FAA (in partnership with NMSA) conducted three intensive cultural resource inventories of the APEs to identify and provide the basis for evaluating the eligibility of historic properties (as well as assessing the effects of the proposed undertaking). These include: (1) an inventory of all construction areas located on the Spaceport site, encompassing the vertical and horizontal launch areas, access roads, wastewater treatment plan, and utility corridors (referred to as the "onsite inventory"); (2) an inventory of all offsite construction areas, including the location of the substation and electrical distribution line, as well as fiber optic cables (the "offsite inventory"); and (3) an inventory of the water well field and associated pipeline corridors. The inventory efforts resulted in the identification of 80 cultural properties, primarily archaeological sites, and 622 isolated occurrences. The following archaeological survey reports capture the results of the field investigations:

Cultural Resources Survey of 2,720 Acres for the Proposed Spaceport America Sierra County, New Mexico (NMCRIS 104538). Zia Engineering & Environmental Consultants, Las Cruces. (Quaranta and Gibbs 2008)

Cultural Resources Survey of 463 Acres of Offsite Fiber Optics and Transmission Lines for Proposed Spaceport America Sierra County, New Mexico (NMCRIS 106719). Zia Engineering & Environmental Consultants, Las Cruces. (Gibbs 2008)

Cultural Resource Survey of 181 Acres of Water Well Field and Pipeline and Transmission Line Corridors for Proposed Spaceport America, Sierra County, New Mexico. Zia Engineering & Environmental Consultants, Las Cruces. (Gibbs 2008)

With respect to the 80 cultural properties (consisting of archaeological, architectural, and other cultural resources) in the Physical and Setting APEs identified as a result of the cultural resources surveys outlined above, 61 have been determined "eligible" for listing on the National Register, 14 are "undetermined" and considered potentially eligible, and the remaining 5 have been determined as "not eligible." Some of the Setting APE eligible/undetermined resources coincide with those identified within the Physical APE. In addition, a collection of four historic properties—including archaeological deposits, architectural buildings and structures and a water control feature—have been grouped together to form the Aleman Draw historic district, which lies partially within the Physical APE and entirely within the Setting APE. None of the isolated occurrences, however, have been determined eligible for listing on the National Register. As such they need not be formally considered further, although they comprise a dataset that may prove to be of value during spatial analyses of the distribution of cultural resources on the landscape.

The identification, evaluation, and assessment activities conducted by the FAA in advance of the Spaceport undertaking also included extensive research of El Camino Real and its setting within the APEs established through Section 106 consultation. These investigations encompassed information derived from previous studies of El Camino Real and aerial photography with data provided by new and previously conducted ground surveys (FAA 2008). The Spaceport America project encompasses approximately 26 square miles, including segments of El Camino and associated cultural resources that are considered among the most important extant manifestations of the storied trail (FAA 2008; NPS 1996). The Congressional addition of El Camino Real de Tierra Adentro to the National Trails System in 2000 has recognized the entire length of the trail in the United States as a significant historic resource, regardless of land ownership, and the portions of the trail in Mexico have recently been added to the UNESCO World Heritage list. El Camino Real resources within the APEs established for the Spaceport undertaking include 10 identified trail segments that, with Yost Crossing, comprise the Yost Draw Study Area and are designated as high-potential route segments, as well as Paraje del Alemán, designated as a high-potential historic site. El Camino Real trail traces and associated cultural resources have not been identified at any of the archaeological sites at which current research is proposed, but it is not inconceivable that such connections may be identified during the research proposed here, or in the future.

The investigative efforts of the FAA in the APEs identified for the Spaceport America undertaking have resulted in a significant increase in the information available regarding cultural resources in the general region of the Jornada del Muerto. Archaeologists involved in the Spaceport identification surveys were able to draw upon the results of some earlier work, including archaeological fieldwork conducted by Duran (1982, 1985, 1986), Hilley (1981), Human Systems Research (HSR 1997), and Kirkpatrick and Hart (1995). The latter two survey projects had been conducted by HSR for earlier proposed locations for a Spaceport, then referred to as the Southwest Regional Spaceport. An innovative study of El Camino Real conducted from 1989 to 1991 by Marshall resulted in the identification of 16 road segment study areas, from Galisteo and La Bajada in the north to the Robledo Paraje near Fort Selden in the south, including the Yost Draw Study Area described above (1991). The SHPO-HPD is currently partnering with the National Park Service to collect additional information about many of the road segments identified during Marshall's survey, and to nominate them to the National Register. Data from the study, when available, may provide a more accurate projection of El Camino Real.

Data recovery (including remote sensing and archival analyses) has already been conducted at four archaeological sites (LA 8871; LA 51205; LA 80070; LA 155962) that are located along the Spaceport entrance road; two of these sites were also examined by means of geophysical survey (Gibbs et al. 2009). The results of these investigations will be provided in the report now in preparation by Zia Engineering and Environmental Consultants, LLC (Zia).

Archaeological testing has been conducted at eight sites by the OAS, and is briefly summarized in this document. Full documentation of this work is currently being prepared.

Previous Consultation Documents

In addition to the Section 106 PA, a number of other documents have been created to guide cultural resources compliance and mitigation conducted for the Spaceport undertaking. These include protocols for discoveries of human remains and other culturally sensitive materials, an initial version of a cultural resources management plan, and an over-arching plan or protocol for archaeology. These documents have already been subject to Section 106 consultation and review, and (along with the Section 106 PA) must be accounted for and adhered to in all subsequent mitigation planning, including this research design. They are as follows:

(1) *Mitigation Plan for Archaeology at the Spaceport America*

(2) *Plan and Procedures for Unanticipated Discoveries of Cultural Resources (Including Human Remains) During Construction and Operation of the Spaceport America, Sierra County, New Mexico*
Specific Procedures to Follow for Discoveries of Human Remains and/or Funerary Objects, Sacred Objects, and Objects of Cultural Patrimony during Intentional Archaeological Excavations, Spaceport America Project

(3) *Cultural Resources Protection, Preservation, and Mitigation Plan for Spaceport America*

The archaeological mitigation plan outlines an investigative framework for all aspects of archaeological fieldwork at the Spaceport, from excavation to site protection and construction monitoring, and includes fieldwork protocols that conform to state and federal regulations. This plan, which has been reviewed by the Section 106 Consulting Parties, identifies a rationale for research-based investigations that is exemplified by this document. The "Unanticipated Discoveries" and "Specific Procedures" documents outline the protection and follow-up consultation and investigation requirements for discoveries of human remains and other culturally sensitive materials during planned excavations and/or construction. The *Cultural Resources Protection, Preservation, and Mitigation Plan for Spaceport America* (CRPPMP) serves as the overall guiding document for cultural resources management, protection, and preservation until such time as a formal cultural resources management plan can be created.

Rationale for the Current Research Design

Using the Section 106 PA and other associated documents as guidance, each site identified within the Physical APE as subject to adverse effects devolving from the Spaceport undertaking has been evaluated on the basis of survey-level data to determine the best course of action for protection and treatment. The *Mitigation Plan for Archaeology at the Spaceport America* outlines a comprehensive approach for continued preservation and mitigation of direct adverse effects to cultural sites in the Physical APE that incorporates strategies such as fencing and monitoring during construction activities as well as further investigation of a subset of sites defined as follows: determined as "eligible" or of "undetermined" eligibility to the National Register; known or likely to be subject to adverse effects directly related to construction and/or operation of the Spaceport; and exemplifying high potential for the recovery of data significant to our understanding of the Jornada region. This document outlines a research-based approach for investigation of the 14 sites located in the Horizontal and Vertical Launch Areas of the Spaceport that fall within this category and that have been identified in the archaeological mitigation plan as appropriate for the treatment proposed.

As described in the *Mitigation Plan for Archaeology at the Spaceport America* and this Research Design, two different approaches to archaeological excavation have been and will continue to be employed at the Spaceport America project site. The first consists of data recovery, an archaeological investigation strategy frequently applied to sites and features that lie in the path of planned disturbance, such as would be associated with widening of a road or installing utilities. The focus of data recovery as proposed herein is the collection of the information that would be lost when the sites (or portions of sites) are disturbed, with the remaining portions of the sites left untouched. The second approach to excavations proposed for the Spaceport sites is fully research-oriented, and will focus on the portions of sites expected to yield data that will be useful for answering specific research questions. Such excavations may take place in loci within archaeological sites wherein construction or other disturbance is planned, but may also occur in other locations that exhibit the most promise for yielding the data needed to address identified research themes or domains. The research plan outlined in the ensuing pages combines these two approaches in a manner that addresses the special challenges and opportunities for the advancement of knowledge about prehistoric and historic lifeways in the Jornada, while taking into account practical concerns related to management, protection, and preservation of these fragile resources during construction and operation of the Spaceport. Analytic techniques and ancillary studies, particularly geomorphological assays, that will be applied to the collection of data need to address the thematic problem domains and research questions are described in detail. It is the hope of the NMSA and the authors of this field research plan that the implementation of the proposed investigations will result in the recovery of information significant to understanding the prehistory (and history) of the Jornada region and New Mexico. These locales were used and occupied by some of the earliest residents of and travelers through North America, and will now launch the journeys of humankind's future.

This document is structured into several interrelated sections. The next two chapters discuss the physical and cultural environments of the project area, setting the stage for later discussions. These are followed by chapters covering the general field methods that will be used, a plan for data recovery and research-oriented investigations, descriptions of the sites, and the methods that will be used during laboratory analyses. Linkages are provided between site descriptions, laboratory analysis methods, and research questions developed in Chapter 5 to show the connections between them, and how investigations at these sites can be used to examine various aspects of the cultural occupation of the Spaceport America region.

Chapter 2: The Physical Environment

James L. Moore

Geology

South-central New Mexico and adjacent parts of Texas and Mexico are in the Mexican Highlands section of the Basin and Range province. Most mountains in this region were formed by uplift and trend from north to south. The East and West Potrillo Mountains, formed by volcanism, are exceptions. The San Andres-Organ-Franklin chain, which flanks the east side of the Rio Grande Valley, and the Doña Ana and Caballo Mountains have intrusive granitic to porphyritic cores formed during Precambrian and Tertiary times (King et al. 1971).

The project area is in the Jornada del Muerto, one of a series of down-warped basins that formed along the continental rift now occupied by the Rio Grande (Chapin and Seager 1975). Episodes of deformation contributed to development of the Rio Grande depression (Chapin and Seager 1975:299). The first of these was during the late Paleozoic (Fig. 2.1) as the ancestral Rocky Mountains were formed, and the second was during the Laramide uplifts of late Cretaceous to middle Eocene times. These events created a north-trending tectonic belt. Chapin and Seager (1975:299) note, "The Rio Grande rift is essentially a "pull-apart" structure caused by tensional fragmentation of western North America. Obviously, a plate subjected to strong tensional forces will begin to fragment along major existing zones of weakness and the developing "rifts" will reflect the geometry of the earlier structure." Thus, the early deformations weakened the continental plate, causing it to split along the Rio Grande depression. Down-warped basins formed as the plate pulled apart. The basins in south-central New Mexico were internally drained until early to mid-Quaternary times (Hawley and Kottlowski 1969).

The geologic history of the Rio Grande Valley is summarized by Hawley and Kottlowski (1969). Major basins in south-central New Mexico include the Palomas and Jornada del Muerto, and the Mesilla and Hueco Bolsons. Materials

Era	Period	Epoch	End Date[1]
Cenozoic	Quaternary	*Holocene*	Modern
		Pleistocene	0.012
	Tertiary	*Pliocene*	1
		Miocene	12
		Oligocene	25.7
		Eocene	34
		Paleocene	55
Mesozoic	Cretaceous	*Late Cretaceous*	78
		Early Cretaceous	
	Jurassic		130
	Triassic		180
Paleozoic	Permian		230
	Pennsylvanian		270
	Mississippian		310
	Devonian		350
	Silurian		400
	Ordovician		430
	Cambrian		490
Precambrian			600

[1]Million Years Ago

Figure 2.1. Geologic periods and time scale.

eroded from surrounding highlands began filling these basins during Tertiary times and continued until the mid-Quaternary. These sources were supplemented by the ancestral upper Rio Grande during the later stages of basin filling. The Rio Grande extended from Colorado to northern Chihuahua by Kansan times, entering the Hueco Bolson through a gap between the Franklin and Organ Mountains during the early Quaternary. It was apparently diverted from the Hueco Bolson to the Mesilla Bolson during the mid-Pleistocene. Until its integration with the lower part of the system, the upper Rio Grande fed a series of lakes in west Texas, Chihuahua, and south-central New Mexico. Several mechanisms for integration of the two river systems have been proposed, including headward erosion and capture by the lower stream, spillover of the upper system, and tectonic uplift and subsidence. Whatever the cause, entrenchment of the river seems to have halted deposition in the basins soon after the systems were integrated.

The Jornada del Muerto is a broad valley flanked by the San Andres Mountains on the east and the Caballo and Fra Cristobal ranges on the west. An internally drained basin, the Jornada del Muerto is about 100 km long by 30 km wide, and is filled with a mixture of fluvial, alluvial, and colluvial sediments derived from the ancestral Rio Grande and the bordering mountain ranges (Wondzell et al. 1996). While the fluvial sedimentation ended when the Rio Grande incised its current valley to the west of the Jornada del Muerto ca. 300,000 to 400,000 years ago, alluvial and colluvial sedimentation is ongoing.

Soils

This discussion of soils is summarized from Quaranta and Gibbs (2008:20-22) and from the USDA Natural Resources Conservation Service webpage (http://ortho.ftw.nrcs.usda.gov; accessed 8-25-10). There are six soils defined within the study area including the Stellar-Continental soil association, the Berino-Doña Ana soil association, the Reakor-Doña Ana soil association, the Wink-Doña Ana soil association, Armijo clay, and the Largo series. However, the Stellar-Continental soil association dominates the study area.

The Stellar-Continental soil association occurs on gentle slopes of less than 9 percent, and typically consists of 45 percent Stellar loam and 25 percent Continental fine sandy loam. Stellar loam is a deep and well-drained soil forming in mixed sediments derived from rhyolite, andesite, shale, and monzonite and tends to occur on basin floors and at the toes of alluvial fans at elevations of 792-1,768 m (2,600-5,800) ft. These are well-drained soils, on which runoff and permeability are both slow. Continental soils are gravelly, deep and well-drained, and formed in mixed alluvium from various sources on slopes of 0-15 percent. These soils occur on fan terraces at elevations of 305-1,524 m (1,000-5,000 ft), and have slow permeability and low to moderate runoff potential. Quaranta and Gibbs (2008:20) noted this association in the proposed Utility Corridor A, Utility Corridor D, Utility Corridor F, and Horizontal Launch areas.

Berino soils occur in combination with Doña Ana soils to form the Berino-Doña Ana soil association. Berino soils are very deep and well-drained, and are forming in mixed alluvium whose surface is often reworked by wind. These soils occur on sandy plains, fan piedmonts, piedmont slopes, and valley floors with slopes of 0-7 percent at elevations of 1,219-1,676 m (4,000-5,500 ft). Besides being well-drained, runoff is very slow, and Berino soils have a moderate permeability. Doña Ana soils are also very deep and well-drained, and are forming in alluvial sediments derived from sedimentary rocks. These soils occur on alluvial fans and fan terraces at elevations ranging from 1,097-1,676 m (3,600-5,500 ft). The runoff rate is moderate, and permeability is moderately slow.

Reakor soils occur with Doña Ana soils to form the Reakor-Doña Ana soil association. Reakor soils are very deep and well-drained, and are forming in alluvium that is mostly derived from limestone, with small amounts of eolian sediments. These soils occur on broad plains and alluvial fans with slopes of 1-5 percent at elevations ranging from 914-1,676 m (3,000 to 5,000 ft). The runoff rate is moderately slow to slow, and permeability is moderate to moderately slow. Wink soils also occur with Doña Ana soils, forming the Wink-Doña Ana soil association. Wink soils are very deep and well-drained, and are forming in calcareous unconsolidated sediments of eolian or alluvial origin. These soils occur on level to moderately sloping uplands at elevations of 823-1,219 m (2,700-4,000 ft). The runoff rate ranges from negligible to low, depending on slope, and permeability is relatively rapid. Quaranta and Gibbs (2008:22) note that sites that seem to occur on these soils are all in the Vertical Launch Area, and mostly in the eastern part of that area.

The Armijo clay is deep and well-drained, and is forming in mixed alluvium on slopes of 0-2 percent. This soil occurs on broad floodplains, usually channelized, and on terraces around playas at elevations of 1,250-1,372 m (4,100-4,500 ft). Permeability and runoff rate are both very slow. Quaranta and Gibbs (2008:22) note that only one project area, the proposed Well Site 1, occurs on this type of soil. Largo soils are very deep and well-formed in loamy calcareous alluvium derived from red bed formations. These soils occur on valley bottoms, terraces, alluvial fans, and piedmont slopes with slopes of 0-5 percent at elevations ranging from 1,219-1,676 m (4,000-5,500 ft) The rate of runoff is moderate, and permeability is moderate to moderately slow. Quaranta and Gibbs (2008:22) indicate that the only exposure of this soil in the project area is along Utility Corridor A.

Vegetation

The Jornada del Muerto falls within the Chihuahuan Desert zone, and is generally classified as a semi-desert grassland, though the vegetation ranges from nearly pure stands of grass, to savannah mixtures of grass and shrubs, to nearly pure stands of shrubs. Most agree that the modern vegetation does not accurately reflect that of the past. Territorial survey records indicate that the mesas of southern New Mexico were dominated by grasslands until at least the 1880s (Dick-Peddie 1975; York and Dick-Peddie 1969). What is now Chihuahuan desert with occasional pockets of grama grass was once a mosaic of grassland-desert scrub (Dick-Peddie 1975:81). This change has most often been blamed on large-scale cattle ranching. The former grasslands were dominated by black grama, blue grama, and side-oats grama. Other common plants included soaptree yucca, tobosa grass, bush muhly, mesquite, four-winged saltbush, creosote, Mormon tea, sacahuista, prickly pear, and cholla cacti (Dick-Peddie 1975:83).

In contrast, Frederickson et al. (2006) feel that mesquite expansion is due to a series of cause and effect relationships occurring over millennia, which might have otherwise occurred in the absence of livestock grazing. Mesquite has been present since at least the Pleistocene, and its dispersion across the landscape during that period may have been partly related to its consumption by megafauna and their patterns of movement (Frederickson et al. 2006:286). The combination of the megafauna extinction and increasing aridity at the end of the Pleistocene may have led to a spread of mesquite during the Paleoindian period. Archaic and Formative period exploitation of mesquite may also have extended its range. Dick-Peddie (1965) notes that Territorial survey notes from the 1840s and 1850s indicate that most pockets of mesquite in southern New Mexico occurred in areas containing prehistoric settlements. Thus, humans have had an affect on the distribution of what is often considered to have been an invader species for millennia.

Information on the modern vegetation of the project area is adapted from Quaranta and Gibbs (2008:18-19), who obtained their information on the structure and extent of vegetative communities from Brown (1994) and Dick-Peddie (1993). Three vegetative communities are defined for the study area: Chihuahuan-Desert Grassland, Chihuahuan- Desert Scrub, and Arroyo Riparian. Most of the project area is dominated by a mixture of Chihuahuan-Desert Grassland an Chihuahuan-Desert Scrub. The Arroyo-Riparian community tends to occur along the three major drainages and some of the minor arroyos.

Chihuahuan-Desert Grassland

Most of the project area, from the northern part of the Horizontal Launch Area south to the Vertical Launch Area, contains vegetation belonging to this community. The Chihuahuan-Desert Scrubland is dominated by a variety of grasses, intermixed with abundant shrubs, forbs, and cacti. The grasses include tobosa (*Pleuraphis mutica*), black grama (*Bouteloua eriopoda*) and burrograss (*Scleropogon brevifolius*). Common shrubs include soaptree yucca (*Yucca elata*) and honey mesquite (*Prosopis glandulosa*), while cane cholla (*Cylindropuntia imbricata*) is a common variety of cactus.

Chihuahuan-Desert Scrub

This vegetative community tends to be inter-fingered with the Chihuahuan-Desert Grassland community throughout the project area, and includes areas of mesquite-stabilized coppice dunes, scattered areas dominated by tabosa and burrograss, four-wing saltbush (*Atriplex canescens*) and soaptree yucca. Low lying areas in which water can accumulate often supports stands of little-leaf sumac (*Rhus microphyllum*) mixed with tarbush (*Flourensia cernua*) and honey mesquite. Areas between stands of shrubs often contain erosional rills, especially in the coppice dunes, and archaeological features and artifacts tend to be more visible in these areas because of the erosion. Rill eroded areas are common in the southern part of the Horizontal Launch Area, and are scattered through the Vertical Launch Area.

Arroyo Riparian Vegetation

This vegetative association occurs throughout the project area along arroyos and in playa basins. In the southwestern part of the Vertical Launch Area, Jornada Draw is a major area of Arroyo Riparian Vegetation. The types of plants that dominate this community include honey mesquite, desert willow (*Chilopsis linearis*), and little-leaf sumac. There are also dense stands of tarbush that often inter-finger with the Chihuahuan Desert Grassland community.

Fauna

Fitzsimmons (1955) provides a brief summary of fauna for the region, and Quaranta and Gibbs (2008) provide lists of expected fauna that were used to construct Table 2.1, as well as a short but useful discussion. Table 2.1 contains lists of bird, reptile, and mammal species that are either known to occur or are expected to occur within the study area, but does not extend to adjacent montane and riverine environments.

The most common types of birds found in this region are the desert sparrow, ash-throated fly-catcher, mourning dove, and quail. Migratory waterfowl often winter along the Rio Grande, and include various types of geese and sandhill cranes, as well as various other species. Most of the birds occurring within the study area that are shown in Table 2.1 are not restricted to any specific vegetative community. Exceptions to this include horned lark, vesper sparrow, and meadow lark, which mostly occur in grassland areas that they prefer as nesting grounds. Chihuahuan ravens and Swainson's hawks usually nest in areas dominated by mesquite, but use the entire area for feeding. Of the reptile species included in Table 2.1, western diamondbacks are most common in arroyo systems, while whiptail and horned lizards tend to be found in upland areas containing Chihuahuan Desert Scrub vegetation. Pronghorn are found within the Jornada del Muerto, while deer are most common in adjacent mountain ranges but also occur within the study area. Mule deer and oryx, the latter a recently introduced species, mostly occupy areas dominated by mesquite and little-leaf sumac, while pronghorn tend to live in grasslands. Rabbits and coyotes are found in all vegetative communities throughout the study area. Black bears and mountain sheep occur in the mountain ranges that border the Jornada del Muerto. Beaver and muskrat live along the Rio Grande, while skunks are ubiquitous to the region. Gray foxes are also sometimes found in this region. Fish are available in the Rio Grande, especially in the modern reservoirs, and include bass, catfish, carp, crappie, and sucker.

Physical Environment of the Rio Grande Rift Province, Mexican Highlands Area: Paleoclimates

Donald E. Tatum

Overview of Regional Studies in Paleoclimate Processes and Events

The Jornada del Muerto (Jornada Basin) is a north-south trending, elongated, closed structural basin that lies on a plain east of the Rio Grande, 100 m (328 ft) above the river (Havstad and Beck 1995). It is bordered to the east by the Organ, San Andres, and Oscura Mountains, to the northeast

Table 2.1. Faunal species known to occur in the project area, or that are expected to occur there (from Quaranta and Gibbs 2008:19-20)

Birds	Reptiles
canyon towhee (Pipilo fuscus)	greater earless lizard (Cophosaurus texanus)
ruby-crowned kinglet (Regulus calendula)	Texas horned lizard (Phrynosoma cornutum)
ash-throated flycatcher (Myiarchus cinerascens)	collared lizard (Crotaphytus collaris)
sage sparrow (Amphispiza bellii)	roundtailed horned lizard (Phrynosoma modestum)
Cassin's sparrow (Amphispiza cassinii)	side-blotched lizard (Uta stansburiana)
vesper sparrow (Pooecetes gramineus)	checkered whiptail (Aspidoscelis tesselatus)
house finch (Carpodacus mexicanus)	western diamondback rattlesnake (Crotalus atrox)
thrasher (Toxostoma spp.)	New Mexico whiptail (Aspidoscelis neomexicanus)
horned lark (Eremophila alpestris)	
western meadowlark (Sturnella neglecta)	**Mammals**
Chihuahuan raven (Corvus cryptoleucus)	black-tailed jackrabbit (Lepus californicus)
ladder-backed woodpecker (Picoides scalaris)	desert cottontail rabbit (Sylvilagus audubonii)
black-throated sparrow (Amphispiza bilineata)	pronghorn (Antilocapra americana)
white-crown sparrow (Zonotrichia leucophrys)	mule deer (Odocoileus hemionus)
chipping sparrow (Spizella passerina)	oryx (Oryx gazella)
loggerhead shrike (Lanius ludovicianus)	coyote (Canis latrans)
scaled quail (Callipepla gambelii)	American badger (Taxidea taxus berlandieri)
greater roadrunner (Geococcyx californianus)	pocket mouse (Perognathus spp. and Chaetodipus spp.)
red-tailed hawk (Buteo jamaicensis)	kangaroo rat (Dipodomys spp.)
northern harrier (Circus cyaneus)	mountain lion (Felis concolor)
mourning dove (Zenaida macroura)	spotted ground squirrel (Spermophilus spilosoma)
turkey vulture (Cathartes aura)	
Gambel's quail (Callipepla gambelii)	
Scott's oriole (Icterus parisorum)	
northern mockingbird (Mimus polyglottos)	
brown-headed cowbird (Molothrus ater)	
lesser nighthawk (Chordeiles acutipennis)	
Swainson's hawk (Buteo swainsoni)	
prairie falcon (Falco mexicanus)	
western kingbird (Tyrannus verticalis)	

by Chupadera Mesa and partially separated from the Rio Grande by the Fra Cristobal, Caballo, and Dona Ana Mountains. To the north it is bounded by the Loma de las Canas hills and an extensive series of arroyos draining west to the river (DeLorme 1998; USGS Loma de Las Canas and San Antonio Quadrangles). The down-faulted basin (graben) is an eastern extension of the Rio Grande Rift geologic province of the Mexican Highland section which, in turn, occupies parts of southeastern Arizona, southern and central New Mexico, western Trans-Pecos Texas, and northern Chihuahua. The basin areas of the Mexican Highlands comprise most of the northern Chihuahuan Desert (Hawley 1993). Now mantled by thick fluvial, alluvial, and eolian deposits derived from sediment transported by ancestral Rio Grande distributaries, from erosion of the tectonically uplifted valley walls, and from deflated, re-worked valley-floor deposits, the basin represents the one of the eastern-most extensional faults of the Rio Grande Rift (Hawley 1993).

Numerous paleoclimate-related studies have been undertaken in the Mexican Highland section and surrounding environs; from these investigations the paleoclimate history of the area can be inferred. Regionally and temporally-specific paleoclimate data have been derived from packrat midden palynology and plant macrofossil studies conducted in the Sacramento, San Andres, and Hueco Mountain ranges of New Mexico and Texas, in the Jornada Basin, and on Otero Mesa, New Mexico (Betancourt, Van Devender, and Martin 1990; Holmgren et al. 2003; Van Devender and Martin 1979). Speciation studies of fossil insects extracted from packrat middens in the northern Chihuahua desert have provided additional insight into climate during the transition from early-to-late Holocene (MacKay and Elias 1992). Studies of Holocene alluvial fan deposits in the Organ and Sacramento Mountains (Frechette and Meyer 2009; Gile 1987; Hawley 2003) and deflation/lag deposit studies at Fort Bliss (Monger 1993) have also contributed correlatable data to the body of paleoclimate knowledge of the region. Other geochronologic evidence for climate change through time includes sedimentation studies of pluvial and perennial lake basins in southern and central New Mexico and in northern Mexico (Allen et al. 2009; Allen 1994; Castiglia and Fawcett 2006; Gile 2002; Hall 2001; Hawley 2003). Stable carbon isotope and soil geomorphology, as paleovegetation indicators have been used to identify and date major climate shifts in the northern Chihuahuan Desert (Buck and Monger 1999; Monger et al. 1993).

The most time-specific, chronologically detailed studies with implications for the recent Holocene in the Mexican Highland area include dendroclimatology data obtained from living old-growth wood samples in El Malpais National Monument, the San Andres, Organ, Oscura, Sierra del Nido, and Gallinas Mountains (Dean and Robinson 1977; Grissino-Mayer 1996; Parks et al. 2006; Stahle et al. 2009). Speleochronology studies also contribute correlatable, high resolution climate data from the late Pleistocene through the late Holocene (Polyak et al. 2007). Finally, Poore et al. (2005) have used comparisons of sedimentation rates and relative abundance of the planktic foraminifer *Globigerinoides sacculifer* in cores from the Gulf of Mexico with dendroclimatology records as corroborative proxy indicators for the southwest monsoon (Mann et al. 1999).

Regional Paleoclimate Overview

Some of the more extensively documented climate events with implications for the Tularosa and Jornada Basins and eastern Mexican Highlands are the major climate shifts of the Late Pleistocene and early- to mid-Holocene that had geographically wide-ranging effects across much of North America. Many climate processes that contributed to more recent paleoenvironmental conditions of these regions are rooted in the Wisconsin Glacial Episode, the most recent glacial maximum in North America. Based on studies of Pleistocene lake expansion as indicated by relict shorelines and sedimentary facies changes in Lake Otero and Lake Estancia, the Wisconsinan ended between about 18,000 and 16,300 calendar years ago (18–16.3 kya) (Allen 2005; Allen et al. 2009).

Studies of packrat midden pollen and fossil insect assemblages (Coleoptera and Hymenoptera) from the northern Chihuahuan Desert indicate that from about 42,000 years ago until about 12,875 years ago, the climate was more mesic than it is today. During the late Pleistocene, average summer temperatures for the region have been estimated to be about 1 degree to 4 degrees Celsius lower than present-day temperatures (Brackenridge 1978; Hawley 1993; Mackay and Elias 1992; Mehringer and Haynes 1965; Phillips et al. 1986; Sebastian and Larralde 1989; Wendorf and Hester 1975). Fossil pollen studies conducted in the region indicate that piñon-juniper-oak woodlands were the dominant vegetation on upland slopes; shrubs (including sage), steppe grass, and sparsely scattered non-coniferous trees grew on the lowland landscapes (Betancourt et al. 1990; Hall 2001; Holliday 1987; Mackay and Elias 1992).

The presence of cienega and spring deposits dating to the late Pleistocene indicates that there was more surface water during this time than at present (Hall 2001). Perennial and pluvial lakes occupied closed playa basins in the southern High Plains and the ancestral Rio Grande valley of southern New Mexico. Wetlands and shallow lakes developed in the valley floor of the Tularosa Basin beginning ca. 49 kya. By about 35,400 calendar years ago the wetland and lake systems hosted dense stands of emergent aquatic vegetation, attracting Pleistocene mammals, as indicated by fossiliferous plant fragments and mammalian skeletal remains and footprints preserved in extensive fine-grained gypsum deposits (Allen et al. 2005, 2009; Allen 1994; Gile 2002; Holliday et al. 2008; Hawley et al. 1976, Lucas et al. 2002, 2007; Morgan and Lucas 2002, 2005).

Geochronology studies of depositional facies in three lakes in the region indicate lake freshening occurring repeatedly, beginning about 29.3 kya for Lake Otero (Tularosa Basin), at about 28.7 kya for Lake Estancia (just north of the Tularosa Basin), and about 27.6 kya for Lake King in the Salt Basin (just southeast of the Tularosa Basin) (Allen and Anderson 2000; Allen et al. 2005; Allen 1994, 2009; Gile 2002; Hawley et al. 1976). This time frame is consistent with playa high stands recorded across the western United States during the late Wisconsinan (Smith and Street-Perrott 1983). Sedimentation records also indicate periods of drought and minimization of lake pooling. For Lake Estancia, a severe desiccative period occurred between about 18,100 and 16,340 calendar years ago, when the lake shrank to its minimum pool. Lake Otero may have completely dried up during the drought. Consequently, wind deflation and erosion obliterated or obscured the sediment record, and any subsequent mesic-period deposition would probably have been inset into the eroded areas. On the Llano Estacado, too, sedimentation rates based on C^{14} date extrapolation at White Lake indicate lake desiccation by 16,400 years B.P. (Hall 2001). The lake sediment record of drought between 18,100-16,340 calendar years ago is loosely corroborated by ground water isotope studies in northwestern New Mexico which infer that between 20,000 and 17,000 calendar years ago, a short period of higher temperatures (3 degrees Celsius higher than the rest of the late Wisconsinan) and decreased precipitation occurred (Phillips et al. 1986). Two more periods of pluvial expansion between about 16,340 and 14,480 calendar years B.P., are indicated by Lake Estancia's sediment record. Magnetic susceptibility measurements recorded in sediments from Hall's Cave on the Edwards Plateau in Texas also indicate a brief time of milder climate and increasing rainfall for the same time period. This mesic interval temporally correlates with a major influx of fresh water derived from melting northern hemisphere ice shelves (Heinrich event H1). The reduced salinity of sea water resulted in changes to oceanic current circulation and atmospheric temperature and weather patterns (Maslin et al. 2001). Event H1 has been geochronologically dated to between 16.5 and 17.5 kya, indicating a climatic event of global proportion (Ellwood and Gose 2006).

The termination of the ~17 kya cooling period signaled the transition from the mesic Wisconsinan period into a more xeric, post glacial late Pleistocene – early Holocene. In the eastern Mexican Highlands and Basin and Range areas, fossil insect, plant, and pollen evidence from packrat middens indicates that the full-glacial Wisconsinan interval was followed by successively warmer and drier intervals alternating with multi-decadal periods of greater effective moisture, cooler temperatures, and diminished evaporation (Betancourt et al. 1990; Hawley 1993, Holmgren et al. 2003; Van Devender and Spaulding 1979). Such short-term, cool, wet weather cycles have been linked to Pacific Decadal Oscillation and El Nino-Southern Oscillation (ENSO) climate cycles and related southward shifts of winter storm tracks—processes still recurrent in modern times (Asmerom et al. 2007; Castiglia and Fawcett 2006; Collier and Webb 2002; Rasmussen et al. 2006).

About 14.5 kya, the first xeric-adapted ant species began appearing on the Mexican Highlands (MacKay and Elias 1992). Sedimentation rates in the drainages leading into the playas began increasing shortly thereafter, indicating more sediment from drying playa basins being re-deposited into the drainage channels and eolian sediments deposited in the playa basins (Hall 2001; Holliday et al. 2008). Piñon pine began disappearing from lower elevation woodland assemblages, retreating to the highlands and leaving oak, juniper and desert-adapted grasslands as the dominant species in areas that formerly also supported piñon (Van Devender 1990; Van Devender and Spaulding 1978).

Younger Dryas. In the final millennia of the late Pleistocene, during the Clovis and Folsom periods, the warming, drying climate abruptly returned to near-glacial conditions in the northern hemisphere (Haynes 2008). This dramatic climate shift, known as the Younger Dryas, lasted from about 12.9 ka to 11.2 ka. From the Lake Estancia basin, the sediment record indicates renewed lake freshening between about 12.9 kya and 11.5 kya. The cooling episode has been theorized to have occurred as a result of a glacial meltwater pulse originating from a thawing Antarctic

Ice Sheet that caused sea level to rise ~ 20m. Consequently, the influx of fresh water altered the flow of salinity currents in the North Atlantic Deep Water (NADW) formation, warming the North Atlantic region and triggering the Bolling-Allerod interstadial (~14.6 kya), which initiated the end of the Wisconsinan glacial stade and contributed to the melting of the northern hemisphere Fennoscandian and Laurentide ice sheets. As a consequence of freshwater forcing in the North Atlantic, the response by the NADW initiated the Younger Dryas cooling event in the northern hemisphere (Weaver et al. 2003).

The Younger Dryas was punctuated by about a 900-year period of climatological vacillation during the Clovis/Folsom transition. The Folsom drought saw fluctuating water levels in playas and marshes and the beginning of sand sheet deposition in upland areas (Holliday 2000). The cooling episodes were accompanied by a resurgence of higher precipitation levels and the recharging of aquifers. Favorable rainfall conditions led to the re-emergence of wetlands and cienegas, environments that were conducive to riparian plant growth.

Wetland and cienega deposits are dark, organically enhanced, sometimes peaty deposits that have been recorded across North America. They can be associated with the Younger Dryas period, or may be Holocene-related. Younger Dryas-aged deposits of this type are referred to as black mat deposits (Haynes 2008). They are sometimes immediately underlain and overlain by eolian silt or fine sand facies that are indicative of warmer, drier depositional environments. The stratigraphic sequence represents the more xeric climate conditions that prevailed after the Wisconsinan glacial terminus, the sudden onset of Younger Dryas cooling, followed by an abrupt shift back to more xeric climate conditions. The black mat deposit, when present in Clovis-period deposits, may be an indication of the apparent termination of Clovis culture and the sudden demise of many Rancholabrean faunal species (Firestone et al. 2007; Haynes 2008; Polyak et al. 2004; Stuiver et al. 1995; Taylor et al. 1997). In the Mexican Highlands area and adjacent environs, some of the extinct paleofauna are represented by the faunal assemblage recovered from Pendejo Cave, in the Sacramento Mountain western foothills, and examined by Harris (1995). The assemblage included *Equus* spp. (horse), *Capromeryx* (midget goat), *Stockoceros* (Stock's pronghorn), *Coragyps occidentalis* (Western vulture), *Hemauchenia* (lamine camelid), *Camelops* (camel), and *Aztlanolagus agilis* (hare) (Harris 1995).

Scharbauer interval. Post-Younger Dryas, the climate in the southern High Plains/northern Chihuahuan Desert continued warming and drying between 11.2 kya and 10.2 kya during a period known as the Scharbauer interval (Sebastian and Larralde 1989; Wendorf and Krieger 1959). Piñon and juniper woodlands disappeared from lowland areas (Holmgren et al. 2003) and moved upslope into the highlands (Sebastian and Larralde 1989). As a result of increased eolian movement of sediment, soil deflation occurred, creating localized accretions of coarse-grained particles known as lag deposits, which have been dated to this drying period (Monger 1993).

Beginning around 10.9 kya, the region experienced increasing rainfall and slightly cooler temperatures during the Scharbauer Interval, a period that would become known as the Lubbock subpluvial. Pollen preserved in packrat middens indicates a brief re-advance of piñon-juniper forest into lowland areas (Betancourt et al. 1990; Sebastian and Larralde 1989). Also evidence for the Lubbock Subpluvial, climate researchers working in caves in the Guadalupe Mountains conducted geochemical and geochronological studies gauging oxygen-stable isotope concentrations and speleothem growth over time. Asmerom and Polyak et al. (2004, 2007) recorded a resurgence of speleothem growth occurring between about 11.1 and 10.8 kya.

Altithermal period. During the middle Holocene, the southern High Plains/Llano Estacado experienced long-term, overall drying and warming conditions during a time known as the Altithermal (Antevs 1948; Holliday 1988; Meltzer 1991). Eolian reworking of playa basin sediments continued as lake replenishment rates slowed (Allen et al. 2005, 2009; Holliday et al. 2008). Drought-related accretionary lag deposits and erosional alluvial fans dating to this time period have been recorded on Fort Bliss and in the Organ Mountains (Monger et al. 1993). During the Altithermal, more xeric-adapted plant and animal species began arriving on the southern High Plains and northern Chihuahuan desert in the time period leading up to the establishment of the modern climate regime about 4,000 years ago (Holmgren et al. 2003). Pollen records infer the final demise of the late Wisconsinan winter rainfall regime during this time period (Betancourt et al. 1990). Desert grass species continued to gain inroads into territory previously dominated by piñon-juniper-oak species, followed by the arrival of Chihuahuan desert scrub vegetation into the region (Buck and Monger 1999). Xeric-adapted ant species began replacing mesic adapted species (Mackay and Elias 1992). Perhaps for the first time on the southern High Plains, people began excavating water wells to replace former surface water sources. Altithermal-period wells have been recorded near former playas, springs, and valley floor stream beds at Blackwater Draw, New Mexico and at Mustang Springs, Texas (Meltzer 1991; Meltzer et al. 1987). Charcoal-rich alluvial fans in the Sacramento Mountains dating between 5.8 and 4.2 kya indicate episodic forest fires and slope failure during the Altithermal period (Frechette and Meyer 2009).

Evidently, this period was punctuated by more mesic climate intervals. For example, Castiglia and Fawcett have recorded the mid-Holocene (~7 kya – 7.6 kya) development of constructional beach ridges for Laguna El Fresnal and Laguna Santa Maria closed playa basins of the northern Mexico Chihuahuan desert borderlands (located southwest of the Jornada Basin; Castiglia and Fawcett 2006) Poore et al. (2005) have used relative abundance of the planktic foraminifer *Globigerinoides sacculifer* in sediment cores from the Gulf of Mexico and comparisons to relative abundance of packrat middens as indicators for the summer monsoon in the southwestern United States. *G. sacculifer* increased in abundance in Gulf sediments during an enhanced monsoon. Conversely, packrat middens decrease in abundance during enhanced monsoon because they are unstable and susceptible to damage by insects (Spaulding et al. 1990). Their research indicates enhanced monsoonal activity during the time of pluvial lake enhancement recorded for Lagunal El Fresnal and Laguna Santa Maria subbasins (located southwest of the Jornada Basin).

Speleoclimatology data from caves in the Guadalupe Mountains provide correlative proxies of increased effective rainfall during the mid-Holocene. Asmerom and Polyak et al. (2004, 2007) recorded a resurgence of speleothem growth occurring ~7.27 kya.

Neoglacial and post-neoglacial periods. For the Mid- to Late Holocene, several data sources provide a somewhat correlative to proximally correlative, chronologically specific, subdecadal record of climate including: stalagmite growth and stable oxygen isotope records from speleothems in Guadalupe Mountain caves; dendroclimatology records from the Sacramento, Organ, and San Andres mountains, the Sierra del Nido in north-central Mexico, the El Malpais National Monument on the southwestern Colorado plateau, the Sevilleta National Wildlife Refuge near Socorro, the Gallinas Mountains, and Chupadera Mesa; and sediment cores from the Gulf of Mexico. The marine sediment cores provide data from the early-Holocene onward, and show an overall drying trend with lower effective precipitation after ca. 7,000 calendar years before present, with multi-decadal and multi-century periods of increased precipitation. The El Malpais chronology begins about 136 BC. The other dendro records begin in the late sixteenth century (AD 1569 and 1597; Sierra del Nido and Organ mountains) and the mid- to late seventeenth century (AD 1644 and 1687; Oscura and San Andres mountains; (Betancourt et al. 1990; Grissino-Mayer et al. 1990, 1996; Naylor et al. 1971; Polyak and Asmerom 2001; Poore et al. 2005; Stahle et al. 2009). Some climate researchers have placed the final establishment of the modern climate regime in the Mexican Highlands area as occurring about 3000 to 4000 years before present. Beginning about 4,000 calendar years ago another cycle of slightly moister, cooler climate took hold. Researchers have recorded magnetic susceptibility variations occurring ~4.4 kya in Hall's Cave sediments (Edwards Plateau), linking them to a North American climate event termed the Neoglacial period (Ellwood and Gose 2006). During the Neoglacial, a resurgence of alpine glacial activity occurred in the North American Cordillera (Pielou 1991; Wood and Smith 2004).

Again, the contemporaneous formation of constructional playa beach ridges ca. 4.2-4.8 kya coinciding with playa lake level highstands in the northern Chihuahuan Desert provides corroborative evidence for a mesic interval, this time during the Neoglacial (Castiglia and Fawcett 2006). Goodfriend and Ellis (2000) in a study of stable carbon isotopes from shells of gastropods recovered from Hinds Cave, on the southern High Plains, have recorded a period of progressively moister conditions dating to the onset of the Neoglacial. Geomorphology and geochemistry studies conducted in the Tularosa Basin (Fort Bliss) identified stable geomorphic surfaces with stable pedogenic carbon isotopes dating to the Neoglacial, between 4 kya and 2.2 kya (Buck and Monger 1999).

Asmerom et al. (2007) have recorded low stable oxygen isotope signatures, indicative of Neoglacial pluvial conditions and corresponding to increased speleothem development during moist climate conditions. These pluvial conditions, based on more recent speleothem growth data, were generally similar to the climate during the recent Holocene; that is, lengthy intervals of somewhat more mesic, then less mesic conditions, with intervals of true drought. The middle Holocene pluvial, beginning ~7 kya, continued until ~4.6 kya. This period was followed by a 1,300-year period of decreased effective annual precipitation. By about 3.3 kya somewhat more pluvial conditions returned to the Guadalupe Mountains vicinity, lasting for another 200 years. Decreased moisture and more arid conditions prevailed again for about 300 years. Pluviality returned about 2.8 kya for half a millennium, followed by the onset of aridity beginning about 340 BC. This drier, less mesic interval, according to speleothem data, lasted until about 10 BC (Asmerom et al. 2007); the final decades of it are revealed in the dendrochronology record from the El Malpais Long Chronology, where its effects seem to persist for several more decades (Grissino-Mayer 1996). Another pluvial record appears in the speleothem growth data during the first decade AD and persisting until ~265 AD. This period is also reflected in the El Malpais chronology, as is the xeric period which follows; the stalactite record shows it continuing until about AD 470. The tree ring chronology indicates a period of near-perfect drought lasting between ~AD 250 until ~AD 500 that was punctuated by brief pluvial intervals several years in duration, with most decades being sere. This dry period is also apparent in the sediment core record from the Gulf of Mexico (Poore et al. 2005).

One notable period of reduced tree-ring growth is apparent in the El Malpais record which is not reflected in the stalactite record, either because of small-scale regional climate variations or because the events affecting tree-ring growth did not affect speleothems: the years between AD 536-543, AD 560-570, and AD 577-585 show tree growth as being markedly reduced at El Malpais. Tree-ring chronologies from three old tree sites in Colorado (Almagre Mountain 1 and 2; Mt. Goliath) also indicate a period of greatly reduced growth spanning three to four decades during the same period (Graybill 1983; Lamarche and Harlan 1968). Historic accounts and dendroclimatic evidence from Europe also indicate a major climate event ca. AD 536 which inhibited vegetative growth. Baillie (1994) has referred to the event as a "dust veil" thought to have been the result of a major volcanic eruption or the collision of a cosmic object with Earth.

The so-called Anasazi Drought may be evident in the stalagmite record as a period of reduced speleothem development occurring ~AD 1047 to ~AD 1180. This somewhat xeric interval also shows up in the Long Chronology from El Malpais, although intermittently punctuated by several multi-year pluvial periods. Another lengthy xeric period with pluvial intermissions occurred ca early- to mid-fifteenth century, according to El Malpais dendrochronology records, Gulf sediment cores, and stalagmite annular growth data (Grissino-Mayer 1997; Polyak et al. 2007; Poore et al. 2005). Also evident in the Gulf sediment cores and in at least several dendroclimatology records (the El Malpais tree-ring record, the Sierra del Nido record, the Gallinas Mountains record, and the Organ Mountains record) is the ca AD 1660-1670 drought that contributed to abandonment of the Salinas Pueblos and other cultural upheavals (Grissino-Mayer 1997; Grissino-Mayer and Swetnam 1981; Naylor 1971; Parks, Dean, and Betancourt 2006; Poore et al. 2005; Stahle et al. 2009; Stokes et al. 1970). Parks, Dean, and Betancourt (2006) have contributed additional dendroclimate data from tree-ring samples collected in Sevilleta National Wildlife Refuge near Socorro, from Chupadero Mesa, and from Mountainair. The evidence from these samples also indicates a xeric interval spanning about a decade beginning ~1660. However, this dry period is not quite as apparent in the speleothem data, although a xeric blip occurs in the record ca. AD 1680. This could be because the middle to late seventeenth century drought lasted only about 10 years and the sampling interval for the speleothem was 32 years (Polyak et al. 2007).

Major historic-period xeric climate episodes that are visible in all of the previously cited dendroclimatology records and in the Gulf of Mexico sediment core records include mid-eighteenth century episodic drought and a mid-twentieth century interval of significant drought that have also been documented in dendroclimate studies conducted in northern Mexico by Cleaveland et al. (2003) and Villanueva et al. (2006). The eighteenth century drought episodes were implicated in mass livestock die-offs, river desiccation, and cultural abandonment events that were recorded in northern Mexico and what is now Texas by Spanish colonial settlers and religious officials. The AD 1950-1960 drought had disastrous effects in the trans-Pecos and borderlands regions (Cleaveland 2006; Holden 1928; Villanueva et al. 2006).

Major pluvial periods with implications for human occupation and adaptation in the Mexican Highlands are also documented through dendroclimatology research and may be correlated with the Gulf of Mexico sediment cores, and, to a lesser extent, with the speleothem-stable isotope research. However, some period of lag between the appearance of a pluvial period in annular tree rings and its appearance in the annular rings of stalactites is apparent, possibly because of the time lag between the onset of the pluvial event, the rainfall absorption in the ground, its dissolution of calcium carbonate and the occurrence of mineral deposition and resolution on the speleothems.

Based on Gulf sediment cores and abundance of *G. sacculifer* forms, relative absence of packrat middens, and annular tree ring growth, major pluvial events of multi-decadal duration occurred during the late second to mid-third century AD, late sixth century to the mid-seventh century AD, early to middle eleventh century AD, and from AD 1825-1900. This latter pluvial event may have reached its maximum peak around the turn of the nineteenth-twentieth centuries. The monsoonal indicators from the Gulf of Mexico sediment core records suggest that it was the strongest pluvial period since the late fifteenth century (Poore et al. 2005). Scurlock (1998) has compiled documentation of 13 major- to moderate floods (flow 10,000 cubic feet per second or more) between 1890 and 1911. Tree-ring records from El Malpais, and the Oscura, Sierra del Nido, Gallinas, and San Andres mountains all indicate a pluvial period beginning ~1890 and continuing through the first decade of the twentieth century (Grissino-Mayer et al. 2004; Grissino-Mayer and Swetnam 1991; Stockton 1982, 1991; Stokes et al. 1970).

Implications of Geochronometrics and Climate for Human Occupation and Adaptation in the Mexican Highlands Area, Rio Grande Rift Province, and Beyond: Research Questions and Possibilities

Geochronometrically dated cultural occupations at archaeological sites in the Tularosa and Jornada Basins may reveal correlations between proxy-observable climate regimes and events and cultural activities. For example, pre-ceramic occupations that can be dated to a specific cultural period (e.g., Clovis, or Folsom) may have taken advantage of pluvial conditions during late Pleistocene or early Holocene times to utilize the terraces, lowlands, or other environs around Jornada Draw for the entrapment of game animals. Early Archaic inhabitants, during the Altithermal, may have been motivated away from the midlands to areas closer to the Rio Grande River or to more mesic highland areas in the pursuit of game, mast, or grain. Similarly, early agriculturists, such as Late Archaic forager-farmers and Jornada-Mogollon or other formative groups, may have sought out wet meadows, cienegas or playas to grow domesticates during xeric times or may have taken advantage of mesic conditions ca. 950 BP to pursue dry-land agriculture on lowland or midland terraces, or to gather piñon on upland areas. Detailed studies about paleoclimates and human adaptations have been previously conducted in and around areas of the southern Rio Grande Rift and Mexican Highlands. That information is readily available for comparison to future discoveries in these regions and will reveal more about the continual evolution of ecological dynamics between humans and the environment.

Chapter 3: Overview of the Culture History of the Jornada Mogollon Region

James L. Moore

The first synthesis of archaeological data was completed for south-central New Mexico in 1948. Through survey, excavation, and reevaluation of previous work in the region, Lehmer (1948) defined the Jornada Branch of the Mogollon in a region extending from north of Carrizozo to south of Villa Ahumada, Chihuahua, and from 120 km west to 240 km east of El Paso. This was not only the first comprehensive examination of the region, it was virtually the only such study until large-scale cultural resource investigations began in the 1970s.

Large areas of federally-controlled land in south-central New Mexico and the western Trans-Pecos region of Texas have been examined since this time, and many of the sites recorded by these studies have been tested or excavated. The most extensive investigations have been conducted on land administered by the Department of Defense in south-central New Mexico and adjacent parts of Texas. Thus, a considerable amount of information has become available over the last thirty years, and literally tens of thousands of new sites have been recorded in this area. This has provided us with a considerable amount of data concerning the entire span of human occupation in the region. Following other studies, culture history is divided into five broad periods: Paleoindian, Archaic, Formative, Protohistoric, and Historic. The chronological scheme presented here is summarized in Figure 3.1.

Paleoindian Period (10,000-6,000 BC)

The earliest agreed upon occupation of the Southwest was during the Paleoindian period, which is divided by researchers into two broad temporal divisions: Llano, which includes both Clovis (10,000-9,000 BC) and Folsom (9,000-8,500 BC), and Plano (8,500-6,000/5,500 BC). These dates are by no means exact and fluctuate by several hundred years among researchers (Agogino 1968; Irwin-Williams 1965, 1973; Irwin-Williams and Haynes 1970; Neuman 1967). While Clovis and Folsom are considered to represent distinct cultures, the Plano encompasses a number of individual traditions. At one time all Paleoindians were classified as big-game hunters. Many now consider Clovis to have been more generalized hunter-gatherers, while Folsom and some later groups turned increasingly toward the specialized hunting of migratory game, particularly bison (Stuart and Gauthier 1981). Other Plano groups may have been hunter-gatherers whose lifestyle resembled that of the Archaic. However, even these groups probably placed more emphasis on large-game hunting and less on collecting plant foods that required extensive processing and that were to become staples during the Archaic period.

Some view the break between Paleoindian and Archaic periods as an actual dislocation of populations. This view entails the migration of Late Paleoindian peoples onto the Plains in response to the movement of bison out of the desert Southwest (Irwin-Williams and Haynes 1970). While some groups, particularly those that specialized in big game hunting, probably did follow the retreating bison, it is unlikely that everyone left and the ensuing demographic vacuum was occupied by a new group of people. Instead, later inhabitants of the Jornada region were probably Paleoindian descendants who exploited a more general array of resources. Thus, the Paleoindian period ends with the slow demise of specialized big-game hunting and the movement of most of those specialists out of the Southwest.

Although Paleoindian remains are relatively rare in the Jornada region, they do occur and indicate that south-central New Mexico and western Trans-Pecos Texas were occupied by humans by at least 10,000 BC. However, there are some who feel that the occupation of this region can be pushed back to a much earlier date. From data collected during excavations at Pendejo Cave, MacNeish et al. (1993) propose

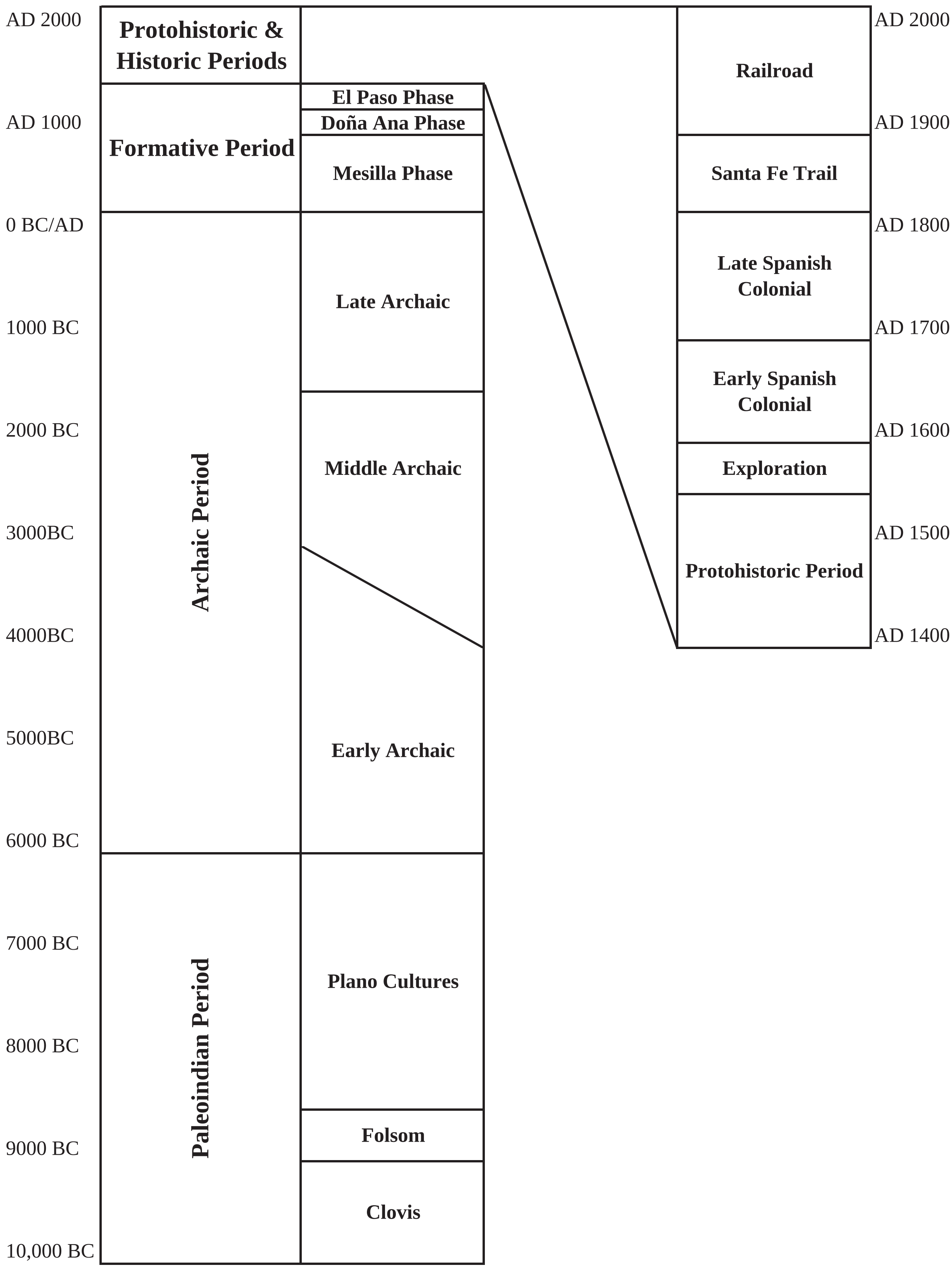

Figure 3.1. Chronological timeline for the project area.

three distinct pre-Clovis complexes dating back to ca. 53,000 BC. As Riley (1995:37) notes, these early dates have been met with some skepticism. Miller and Kenmotsu (2004:211-212) summarize data from the initial study of Pendejo Cave and various re-evaluations of both those data and the site's stratigraphy, and conclude that the precision used during the initial excavation was insufficient to accurately define the stratigraphy and support the argument for Pre-Clovis occupations. Lacking a firm resolution to this controversy, we simply note that possible pre-Clovis remains have been found in the region.

Clovis materials are rare in this region. Sechrist (1994:47) indicates that only three Clovis sites or localities have been found, including the Mockingbird Gap site, the Rhodes Canyon Locality, and the North Mesa site. Other Clovis remains generally consist of isolated points found in southern New Mexico, the western Trans-Pecos region of Texas, and northern Chihuahua (DiPeso 1974; Krone 1976; Miller and Kenmotsu 2004). Evidence of a Folsom occupation is more common. Seaman and Doleman (1988:15) found two Folsom points and many possible spurred scrapers during a survey in the Jornada del Muerto. The only evidence of Paleoindian occupation found by Whalen (1978:14) during surveys in the Hueco Bolson were two isolated Folsom point fragments. Other isolated Folsom points have been found east of El Paso in the Hueco Bolson (Brook 1968a) and north of El Paso in Otero and Doña Ana Counties (Davis 1975; Krone 1975). Ravesloot's (1988a, 1988b) survey of the Santa Teresa area located a single site containing a Folsom component. Quimby and Brook (1967) found a site containing a Folsom point and a tentatively associated hearth along the New Mexico-Texas border. Russell (1968) recorded three Folsom campsites around a dry Pleistocene lake near Orogrande. Stuart (1997) reports a cluster of Folsom sites north of El Paso. A sample survey near the Mockingbird Gap site by Elyea (2004) discussed six other Paleoindian components within 20 km of the study area, and documented five newly discovered Paleoindian (Folsom and Cody) sites. Perhaps more significantly, Amick (1994) reported 526 Folsom artifacts (mostly from private collections) in the northern Jornada del Muerto.

Miller and Kenmotsu (2004:216) note that Folsom assemblages characteristically contain large percentages of high-quality, fine-grained materials, some of which were obtained from sources located up to 450 km from where they were found, including the Texas Panhandle (Alibates and Edwards Plateau cherts), northwestern New Mexico (Chuska chert), the Jemez Mountains (obsidian), and eastern Arizona (Cow Canyon obsidian). In contrast, Elyea (2004) suggests that the majority of Folsom lithic materials in the Jornada Basin originate in the Rio Grande valley, followed by more local materials from the Jornada Basin itself. This pattern, to Elyea, suggests cultural ties between the Rio Grande and the Jornada region during the Folsom period. Miller and Kenmotsu (2004) note that Amick (1994, 1996) suggests that the Folsom occupations in the Hueco and Tularosa basins used residential sites oriented toward hunting game animals other than bison as part of a settlement system that exploited a very wide area, including the Southern Plains (Miller and Kenmotsu 2004:217).

Plano materials also occur in the region. During a survey near Santa Teresa, Elyea (1989:18) found a Cody Complex projectile point and a spurred end scraper. The Cody Complex is comprised of Scottsbluff and Eden projectile point types and associated formal tools dating to near the end of the Plano period. These artifacts occurred on different sites and were associated with no other Paleoindian materials, suggesting they were curated by later peoples. Elyea (2004) also noted the presence of Cody Complex artifacts in the northern Jornada Basin. Hart (1994:39) recorded a Late Paleoindian site in the southern Tularosa Basin that contained an Agate Basin point fragment. A probable Cody Complex site was located during the Border Star 85 survey in the southern Tularosa Basin (Elyea 1988). Brook (1968b) found an isolated Scottsbluff point in a roadbed north of El Paso. Russell (1968) recorded a large Plainview site on the edge of a dry Pleistocene lake near Orogrande, and recovered later Paleoindian points from two of the three Folsom sites he recorded in that area.

A few studies have found large numbers of Paleoindian sites. Carmichael (1986a:107) recorded 50 Paleoindian components in the southern Tularosa Basin. Relative dates were established for 29 components, including 14 Folsom and 15 Plano. Nearly all seemed to be short-term camps and contained similar tool assemblages (Carmichael 1983:151). Anschuetz et al. (1990:87) found four Paleoindian components during another survey in the southern Tularosa Basin. Other than a Plainview point on one component, the only temporally diagnostic artifacts were an unidentified point and spurred scrapers. Miller and Kenmotsu (2004:217) note that most finds of Plano materials have been in basins near major playas or along the margins of the Rio Grande Valley, and indicate that this essentially replicates a pattern noted by Carmichael (1986a) in the Tularosa Basin. This pattern may reflect an adaptation to the hunting of large animals that tended to stay close to these water sources (Miller and Kenmotsu 2004:217). A survey of much of the area encompassing Spaceport America by Human Systems Research (1997) identified Paleoindian components on 9 sites, and included both Folsom and Plano locales.

Unfortunately, the relative rarity of Paleoindian sites in the region precludes a more detailed discussion of settlement or subsistence patterns. Whether this rarity is real or related to patterns of soil deposition, later occupation, or survey location is unresolved. However, it is interesting that most recorded sites from this period are parts of multicomponent locales or occur in badly eroded areas. This suggests that many Paleoindian remains may have been revealed by soils eroded after their occupation or are mixed with the remains of later peoples who either mined their sites for useable materials or chose to occupy the same locations.

Archaic Period (6,000 BC-AD 200)

A tradition based on the use of a broader range of plant and animal foods emerged at the end of the Paleoindian period. These subsistence changes probably occurred because of environmental change coincident with the end of the Pleistocene that involved a long-term pattern of drying that resulted in the extinction of large game animals, the expansion of plant communities adapted to drier conditions, and a reduction in perennial water sources (Miller and Kenmotsu 2004:218). As Miller and Kenmotsu (2004:218) note: "These changes undoubtedly contributed to large-scale changes in subsistence strategies, requiring a diversification of the Paleoindian subsistence base with a greater focus on exploitation of plant foods. Such changes and accompanying shifts in settlement and technology, mark the onset of the Archaic period at ca. 6000 B.C."

Groups utilizing this new adaptation exploited a different range of foods—plant foods in particular—than appear to have been used during the Paleoindian period. Rather than being tied to the migratory patterns of large game, Archaic peoples focused on seasonally available plant foods occurring in a wide variety of environmental zones, supplemented by the hunting of small-to-large game. The project area is within the zone assigned to the Chihuahua Tradition by MacNeish and Beckett (1987) and MacNeish (1993). This tradition extends north from Chihuahua into southeastern and south-central New Mexico and the western Trans-Pecos region of Texas (Miller and Kenmotsu 2004). Many consider the Chihuahua Tradition to be separate and distinct from other Archaic traditions defined to the north (Oshara Tradition) and west (Cochise Tradition) of the project area, though many characteristics are shared between all three of these groups.

Archaic Phases

MacNeish and Beckett (1987) divide the Archaic into five phases. However, the Archaic can also be more simply divided into Early, Middle, and Late sub-periods, based on projectile point typologies, which also correspond to paleoenvironmental and paleoclimatic intervals (Miller and Kenmotsu 2004:218). A correlation between these systems is provided by Miller and Kenmotsu (2004:218), allowing both systems to be used in this discussion.

The Gardner Springs phase is the first in the Chihuahua Tradition sequence, and corresponds to the Early Archaic (6,000-4,000/3,000 BC). Most sites from this phase are small, and a pattern of seasonal scheduling may be indicated. The Gardner Springs population probably exploited a wide range of floral and faunal resources. The chipped stone assemblage includes projectile points, flake and core-choppers, denticulates, planes, and scrapers, while the ground stone assemblage contains basin milling stones, anvil mortars, slab mullers, and pebble hammers or pestles.

The Keystone phase corresponds to the Middle Archaic (4,000/3,000-1,200 BC), and is considered a period of efficient foragers. MacNeish (1993) feels there was a further deterioration of the climate during this period and rainfall became less reliable. Dependence on plant foods may have increased, but this is tentative. Most Keystone phase sites are small, and there are some indications that the use of resources was seasonally scheduled, focusing on the processing and consumption of seeds. The associated assemblage includes small half-moon bifacial side blades, large pointed unifaces, planes, and projectile points. Milling stones and mullers continued to be used, along with manos and metates.

Significant changes occurred during the Fresnal phase, which corresponds to the early part of the Late Archaic (1,200 BC-AD 200) and is better defined than earlier phases. There is definite evidence for the use of domesticated plants during this phase, and as a consequence there seems to have been significant changes in the settlement system. Of equal importance is evidence suggesting that surplus foods were stored in pits. The associated assemblage includes planes, gouges, choppers, projectile points, and bone beads. Though milling stones and mullers continue to occur in the ground stone assemblage, they are now outnumbered by manos and metates.

The Hueco phase represents the late part of the Late Archaic. MacNeish (1993:403) suggests that the population grew rather rapidly during this phase. More sites are recorded that date to this phase than any earlier period. Base camps were larger, suggesting they were either occupied for longer periods or by larger groups. Distinctive scrapers and small disk choppers occur in addition to projectile points. Wedge manos and trough metates dominate the ground stone assemblage, which also includes bedrock mortars. There is also evidence that baskets and sandals were being woven by this time. Importantly, the number and types of storage features appear to increase during this phase.

Miller and Kenmotsu (2004:218-236) provide a detailed overview of the Archaic in the Jornada region, and many of their observations are important to this discussion. As noted earlier, few Early Archaic sites have been found in this region. Early Archaic projectile points are often found on the surface, but are only slightly more common than Paleoindian points. This period is not well dated, and its temporal placement is mainly based on the cross-dating of projectile points with other regions. The rarity of Early Archaic sites may be due to environmental factors, with much of this period's landscape currently buried beneath sediments, eroded away, or in the lower strata of rock shelters and therefore invisible during archaeological survey. One characteristic of the Early Archaic is the first evidence for the use of rock or caliche as cooking stones or heating elements, suggesting that an important change occurred in the subsistence system involving increased emphasis on plant processing. Ground stone artifacts also seem to appear at this time, supporting the increased value of plant processing to the subsistence system. Projectile points changed from the lanceolate styles of the Paleoindian period to stemmed forms. Accompanying this change was the use of coarser-grained materials for projectile point manufacture. These characteristics may indicate a shift in the types of animals being hunted as well as in hunting practices. Differences between the Early Archaic and Paleoindian periods suggest the development of "a seasonally mobile settlement system of small bands, although possibly more restricted than during earlier periods" (Miller and Kenmotsu 2004:223).

The changes in subsistence, settlement, and technology that began in the Early Archaic seem to have continued through the Middle Archaic, perhaps becoming intensified in the second half of the period (Miller and Kenmotsu 2004:223). Population growth is also likely. Continued drying may have caused a more restricted timing and distribution of plant resources, resulting in the development of a seasonal land use pattern focused on the exploitation of specific plants. Some characteristics of excavated sites suggest greater levels of occupational intensity and perhaps the presence of larger groups. Evidence of houses, or huts, has been found for this period at several sites, and this is the first occurrence of definite structures in this region, and predates the arrival of domesticated plants. Few technological changes are visible in chipped and ground stone assemblages, and the same types of thermal features seen in the Early Archaic continued in use. Perhaps the most visible change is in the diversification of projectile point styles. Miller and Kenmotsu (2004:225) suggest that patterns of beveling and serration on point blades that are most common during the Middle Archaic may be indicative of a behavioral change:

> Such patterns may indicate an increased emphasis on the conservation of raw materials, blade modification related to multiple uses of the tools, or an aspect of increased efficiency in felling prey. These possibilities suggest that the design and use of projectile points among Middle Archaic groups reflects different patterns of technological and settlement organization than was the case among earlier and later intervals of the Archaic period. (Miller and Kenmotsu 2004:225)

The argument for general continuity of Middle Archaic settlement, subsistence, and technology with those of the Early Archaic may be incorrect, and may simply be a function of the paucity of basic comparative data from both periods.

In contrast, many important changes occurred during the Late Archaic, especially in the second half of the period. The number of recorded sites represents a dramatic increase over earlier periods, and characterizes the peak of residential use in several environmental zones. Indeed, nearly every major environmental zone was exploited during the Late Archaic, indicating an apparent expansion of the resource base beyond the central basins that formerly were the focus of occupation. This expansion may have been the result of a wet period that ended ca. 500 BC. Population growth seems likely, as represented by the vast increase in number of sites. Cultigens, including corn and beans, were introduced during this period (Miller and Kenmotsu 2004:227), but were most likely a supplement to the diet rather than a focus, as shown by stable isotope analysis of human remains that do not indicate a high level of corn in the diet (MacNeish and Marino 1993). Cultigens were merely one facet of a diet that was primarily based on hunting and gathering. Burned rock features appear to be more common during the Late Archaic, and ring-middens occur in areas outside the Hueco Bolson. Changes in projectile point technology are evident, and include a shift to corner- and side-notched types. A probable reduction in territorial range is suggested both by the large jump in the number of sites from this period and an increased use of local raw materials for the manufacture of projectile points.

Some general observations made by Miller and Kenmotsu (2004:230-236) for the Late Archaic are of particular interest. They note a general correspondence between the introduction of cultigens and an increase in dated features, and suggest that these trends are closely linked. Rather than indicating dramatic growth, these trends could suggest that population levels actually remained stable while land use was intensified because of an increasing restriction of territorial range. Competing groups may have cut off access to resources that were formerly exploited outside the general region, requiring the population to focus on increasingly smaller areas. Late Archaic projectile point types reflect less intensive maintenance and reduced durability and versatility when compared to earlier types. Coupled with evidence for increased numbers of dated features and structures, these patterns suggest more intensive land use, constrained territorial ranges and decreases in mobility, as reflected either in a reduction in the number of residential moves, or an increase in the duration of moves, or both.

Diagnostic Archaic Artifacts

In general, only projectile points are considered temporally diagnostic for the Archaic period. Styles commonly associated with the Early Archaic include Bat Cave, Abasolo, Jay, and Bajada. Miller and Kenmotsu (2004) note that Uvalde points also occasionally occur in the region, but are much more common further to the east in Texas. A different array of projectile points is associated with the Middle Archaic, including Pelona, Amargosa, Todsen, Almagre, Langtry, Shumla, Trinity, and Bat Cave styles. Projectile point styles commonly associated with the early Late Archaic include Chiricahua, Nogales, Augustin, Todsen, La Cueva, San José, Fresnal, Maljamar, and possibly Pedernales. Styles associated with the later Late Archaic include San Pedro, Hatch, Hueco, and Fresnal. As characterized in the Chihuahua Tradition , this array of projectile points reflects a mixture of diagnostics from several different regions. This suggests that, not only was the Jornada Basin area stylistically connected to the general Southwestern Archaic communication system, but it also had ties further to the east and southeast in Texas.

Archaic House Forms and Feature Types

Data on structures and features are available from several excavations. Roney and Simons (1988) excavated Late Archaic pit structures near Santa Teresa that were circular (n=4) or oval (n=1) in shape, and were dish-shaped in profile except for one that was flat-bottomed. All were under 3 m in diameter, three were less than 2 m in diameter, and none were deeper than 30 cm. Interior features included postholes, a basin hearth in one structure, and an informal hearth on the floor of a second. Three similar pit structures were excavated in the same area by O'Leary (1987). These examples were circular (n=2) or oval (n=1) in shape, less than 3 m in diameter, and no deeper than 25 cm. In profile they were dish-shaped and contained no internal features. All three were radiocarbon dated to the Hueco phase.

A similar Middle or Late Archaic structure was excavated on White Sands Missile Range (Swift and Harper 1991). It was shallow (18 cm deep) and less than 2 m in diameter, with no internal features other than a possible posthole (Swift and Harper 1991:115). Gerow (1994) excavated two pit structures near Chaparral that appeared to be Archaic in date, and each was associated with a different cluster of features. They were roughly circular, and while one was dish-shaped the second was incompletely excavated so its profile shape is unknown. Both structures were less than 3 m in diameter and 30 cm deep. One floor was use-compacted, though there was no formal preparation evident, and an informal hearth was found on its surface.

O'Laughlin (1980) excavated twelve pit structures at the Keystone Dam site and found at least eleven more in auger tests. In general, they were small (ca. 3 m diameter), shallow (ca. 10 to 20 cm deep), and circular, with nearly level or dish-shaped floors. Most contained informal hearths. Evidence for a clay or adobe coating on the outside of superstructures was found in at least twelve cases (O'Laughlin 1980:144). This is the only known example in the region of an Archaic site that contains a large number of structures, and is interpreted as a winter village. Several clusters of huts in groups of 2-5 were identified, suggesting the presence of multiple nuclear families. Rather than indicating a single large macroband occupation structured in discrete clusters, the site was probably occupied on several occasions by groups of 2-5 families.

In general, Middle and Late Archaic pit structures were shallow with basin-shaped or flat-bottomed, scooped-out, unplastered floors. Posts usually occur in irregular patterns and were placed around and within floor areas, often occupying both positions in the same structure. Interior hearths are often absent and when present are usually informal concentrations of ash and charcoal on floor surfaces, though at least one shallow basin hearth has been found. Posts formed the base of the superstructure, which was covered with grass stems, yucca stalks, and reeds. Mesquite branches were most commonly used for posts, though other woods were undoubtedly also used when available. A thin layer of clay or adobe may have been applied to the exterior surface, but evidence for this has been found at only one site. Most exterior features are thermal features, both with and without associated fire-cracked rock (Gerow 1994; Hard 1983a; O'Laughlin 1980; O'Leary 1987; Roney and Simons 1988). Between one and four extramural pits were probably used for storage at the Keystone Dam site, and two were reused for trash disposal at a later time (O'Laughlin 1980).

Archaic Ideology and Ceremonialism

Little information concerning Archaic religious beliefs is available. Panels of abstract rock art in the region may have been created by Archaic peoples (Schaafsma 1992), but while this art is probably related to ideology, its nature precludes any interpretation of meaning at this time. However, variation between this style of rock art and later forms suggests that there were great differences between the ideological systems of local hunter-gatherers and farmers.

Archaic Ties to Other Regions

When dealing with a highly mobile population, determining whether the presence of an exotic artifact or material represents the size of the territory exploited or exchange ties with distant groups is difficult. Considering the large distances between the Jornada region and the sources of some of the exotic materials found there, the latter is more likely. Projectile point styles are often used to indicate ties between groups, and in this light the Jornada region seems like a crossroads between the Oshara and Cochise traditions, as well as groups living to the east and southeast in Texas. Evidence from geochemical sourcing suggests acquisition of some obsidian directly from sources in the Jemez Mountains, as well as from sources in Chihuahua (Miller and Kenmotsu 2004:235). A textile analysis by Beckes and Adovasio (1982) concluded that similarities in basketry and weaving techniques between the Jornada region and northern Mexico indicate a close relationship or cultural continuum between those regions. In contrast, Formative period textiles have predominantly Mogollon characteristics (Miller and Kenmotsu 2004:235). These data, combined with obsidian sourcing, suggest that the primarily north-south ties in effect during the Archaic shifted to a westerly focus during the Formative period (Miller and Kenmotsu 2004:236).

Archaic Subsistence

The few subsistence data that are available suggest the use of a broad range of plant and animal foods during the Archaic. Deer and antelope bones are common in Early Archaic deposits, implying heavy dependence on medium-to-large game. The appearance of ground stone tools and burned rock features during the Early Archaic implies that wild seeds, and possibly succulents, were processed and consumed. A shift to the use of coarser-grained materials for projectile point manufacture along with a change in point design may signify the hunting of a different array of animals than was exploited by Paleoindians as well as a change in hunting techniques (Miller and Kenmotsu 2004). Little subsistence information is available for the Middle Archaic, but the continued use of ground stone tools and the association of projectile points from this period with burned rock features suggests a continuity in wild plant exploitation, including four-wing saltbush, chenopodium, purslane, mesquite, rushes and grasses, and cacti (Miller and Kenmotsu 2004:224). Limited evidence for the hunting of rabbits and other small-to-medium mammals has been recovered from Middle Archaic contexts.

Domesticates were certainly available by the Late Archaic, and there is good evidence for the storage of food in pits. The range of domesticated plants increased during the late part of this period and included at least four varieties of corn, cucurbits, and possibly beans and amaranth. The number and types of storage features appear to increase during this phase, suggesting careful planning and storage of surpluses for consumption during the winter rather than any degree of true sedentism. Most of the meat consumed seems to have come from small game, particularly rabbits, with little evidence for reliance on large animals.

The use of several wild plant species has been documented, particularly in Late Archaic contexts. Camilli et al. (1988) found evidence for the use of vetch seeds and flower stalks or pods of a plant from the Liliaceae family. Other economic plants identified during that study include purslane and amaranth seeds, and a probable yucca pod. Gerow (1994) recovered evidence for the Archaic use of chenopodium and purslane. Mesquite seems to have been the main source of fuel wood, but there is also evidence for the use of other shrubs like saltbush (Camilli et al. 1988; Hard 1983a).

A wider variety of woods and economic plants was identified at the Keystone Dam site than at other open air sites. Mesquite wood was recovered from thermal features. Other woods were identified in samples from structures and probably represent construction materials, though use as fuels cannot be ruled out. They include desert willow, Apache plume, creosote, wolfberry, reed, cottonwood, and possible tornillo (O'Laughlin 1980:82). Burned grass stems and yucca stalks were also identified, as were fragments of Turk's cap cactus. The array of charred seeds included saltbush, cheno-am, tansy mustard, Turk's cap, various grasses, creosote, prickly pear, purslane, smartweed, mesquite or tornillo, possible acacia, dock, bulrush, and a plant from the poppy family (O'Laughlin 1980:88).

Excavations at High Rolls Cave near Fresnal Shelter in the Sacramento Mountains, recovered extensive and detailed information concerning Late Archaic subsistence. Three main periods of occupation were defined, beginning with a very late Middle or early Late Archaic occupation, followed by two periods of Late Archaic use (Lentz 2005). Bohrer (2005) identified a suite of wild plants used as food as well as domesticates including corn, a variety of amaranth (*Amaranthus cruentus*), and possibly tobacco. The main wild plants used included cheno-ams, chenopodium, drop seed grass, false tarragon seeds, juniper, mesquite, piñon, prickly pear, and banana yucca fruit (Bohrer 2005:218-219). The use of a wide range of small-to-medium animals was also evident, suggesting a long term Late Archaic trend toward increased use of rabbit and small mammal, concomitant with an increase in the use of deer versus pronghorn and bighorn sheep (Akins 2005:143). However, deer bones consistently dominate the identified taxa, indicating they were probably taken nearby and brought to the cave as intact or nearly intact carcasses (Akins 2005:143).

Some evidence from Fresnal Shelter has been used to suggests a specialized highland Archaic hunting pattern by Wimberly and Eidenbach (1981). Most of the identified bone from this site was mule deer, though some antelope, bighorn sheep, and bison bones were also found. The butchering pattern suggested that meat packages including major long bones and attached muscle were removed and transported elsewhere, while parts that contained less meat were processed and consumed on-site (Wimberly and Eidenbach 1981:27). This would have major implications for low altitude sites, especially since radiocarbon dates suggest the shelter was used throughout the Archaic. If a pattern of this sort was common, there might be little evidence for large game consumption in lowland sites, and when such evidence occurs, only long bones may be present. Thus, the predominance of small mammal remains in lowland Archaic sites might not preclude the consumption of meat from large mammals obtained in the highlands. However, Akins (2005:140) has reexamined these data, and suggests that a large percentage of unidentified long bone fragments and cancellous tissue represent the missing elements, which simply could not be precisely identified during analysis. Akins attributes the fragmented condition of these bones to the extraction of bone grease and marrow, which has important implications for some of the earlier conclusions drawn from this assemblage. Occupations in Fresnal Shelter appears to have been of longer duration than some archaeologists have suggested (e.g. Cameron 1972), and all of the bone grease and marrow produced were probably not consumed during residence at the shelter, as Wimberly and Eidenbach (1981) proposed. Thus, the possibility that highland hunters were transporting parts of carcasses to lowland sites may be unlikely, though this does not rule out the transport of dried meat, marrow, and bone grease.

Formative Period (AD 200/400-1450)

The Jornada Mogollon occupation is collectively labeled the Formative period (O'Laughlin 1980; Ravesloot 1988a; Stuart 1990). Lehmer (1948) defined three phases for this period, which originally spanned the years between AD 900 and 1400. This framework remained mostly unchanged until the 1970s, when large-scale studies were begun in the Hueco Bolson of southwest Texas (Whalen 1977, 1978). Through these and other studies, the temporal framework and settlement and subsistence model developed by Lehmer has been modified and refined.

Mesilla Phase (AD 200/400-1000)

Lehmer (1948) considered the Mesilla phase an outgrowth of the Archaic and dated it between AD 900 and 1100. It was characterized as the "first pottery-making, village-dwelling horizon in south-central New Mexico" (Lehmer 1948:78). Farming was assumed to be of primary importance, despite the lack of cultigens in the sites he investigated (Lehmer 1948:76). These assumptions have been questioned by other researchers.

Dating the phase. Whalen (1977, 1978) initially pushed the beginning of the Mesilla phase back to ca. AD 400, and proposed a generalized settlement-subsistence system. Other beginning dates have been suggested by various researchers, illustrating a continuing uncertainty about when it started. While some (O'Laughlin 1980; Whalen 1980a, 1981) have placed its beginning around 0 BC/AD, others feel it began ca. AD 200 (Batcho et al. 1985; Ravesloot 1988a). O'Laughlin (1985:54) notes that the best evidence for early ceramics in the Hueco Bolson comes from a site radiocarbon dated to the sixth or seventh centuries AD; earlier dates are single samples from limited activity sites. This suggests that an AD 200 or earlier date for the beginning of the phase is questionable, and the beginning of the phase is currently thought to have been sometime between AD 200 and 500. Whalen (1994:23) simply suggests that the Mesilla phase began in the early centuries AD, sidestepping the issue. In contrast, most authors have agreed with Lehmer's ending date of AD 1100. However, Miller and Kenmotsu (2004:238) provide an updated temporal range for the Formative Period, based on analysis of many additional radiocarbon samples from Fort Bliss and a re-analysis of early archaeomagnetic samples obtained from the region. They date the Mesilla phase between AD 200/400 to 1000, though they note it would also be plausible to consider the period between AD 1000 and 1150 as a late extension of the phase. The actual dating of phases can be confusing, and the use of phases tends to emphasize the importance of certain trends that more realistically represent a long-term trajectory (Miller and Kenmotsu 2004:238). Ultimately, examining the development and direction of cultural patterns is more important than dividing a particular time period into phases. However, we use the dates for phases assigned by Miller and Kenmotsu (2004) in this discussion, since they represent one of the most recent evaluations. Since research suggests there were significant differences in settlement and subsistence between the early and late parts of the phase, most researchers now break the Mesilla phase into early and late periods with dating based on ceramic types present.

Mesilla phase pottery. While undecorated El Paso Brown wares dominate throughout the phase, early sites contain intrusive ceramics such as Alma Plain and San Francisco Red, while Mimbres white wares occur in later assemblages. The appearance of the latter provides a good demarcation point, and the late Mesilla phase is considered to have begun ca. AD 750 (Hard 1983b:41; Hard 1986:266; Whalen 1993:481).

The extremely long period during which El Paso Brown was made has led many to search for temporally sensitive variation in vessel form, manufacturing techniques, and stylistic attributes. Whalen (1980b:31-32) suggested that early El Paso Brown vessels tend to have pinched rims, coarse temper, and a coarse, bumpy surface finish. Late El Paso Brown was thought to be dominated by rims that were everted and tapered or direct, with finer temper and a smoother surface finish (Whalen 1980b:31-32). Some of these ideas have been verified and amplified by further research. A regional comparison showed that ceramic densities increase on Mesilla phase sites over time, so there tends to be more pottery on late Mesilla sites than on early Mesilla sites (Whalen 1994:75). Two long-term trends in temper were also identified. Through time, vessels tend to contain more temper, and temper tends to be more finely ground (Whalen 1994:79). While vessel forms were dominated by neckless and short-necked jars throughout the life of this type, changes in vessel shape, volume, and orifice diameters indicate that storage in large containers became increasingly important in the late Mesilla phase (Seaman and Mills 1988a, 1988b; Whalen 1994:86, 89).

Another significant variation identified by Whalen (1994:83) was a change in firing temperatures around AD 700. After that date, vessels seem to have been fired at higher temperatures or for longer periods, producing differences in surface hardness and core characteristics that are distinguishable from earlier brown wares. However, Whalen (1994:83) does not believe this represents a reorganization of ceramic technology. Rather, something as simple as the use of more wood and less grass during firing may have been involved.

House forms and feature types. Pithouses were the only type of structure used during the Mesilla phase. Some differences have been noted between structures in different environmental zones, but there seems to have been little variation in form between the early and late parts of the period. Whalen (1994:46) found that the largest, deepest, and most heavily roofed structures are in the Rio Grande Valley, while those in the desert basins are smaller, shallower, and less heavily roofed. In general, pit structures from the Jornada region are smaller than their contemporaries elsewhere in the Southwest and tend to contain few internal features. Heavily used extramural activity areas are often found in association.

The most detailed information on Mesilla phase structures comes from Whalen's (1994) excavations at Turquoise Ridge, a winter village occupied during both the early and late parts of the phase. While likely that the late Mesilla population was larger and remained at the village for longer periods, the only apparent difference between early and late structures was their depth (Whalen 1994:47). Late structures were somewhat deeper, though it was uncertain whether this was caused by deeper initial excavation or more wear during longer occupations. Some structures were occupied long enough to require remodeling or were used more than once. House abandonments were apparently planned, and abandoned structures were used for trash disposal (Whalen 1994:50). Internal features include postholes, hearths, storage pits, warming pits, and pits of unknown function. Postholes occur both on and around the edge of floors, often in combination. Hearths include formal basins excavated into floors and informal deposits of ash and charcoal or areas of oxidation on floor surfaces. Both large and small storage pits sometimes occur inside structures. Warming pits are found but are rare, and consist of irregular unburned pits that contain burned or heated rock. There was a shift from round to rectangular pithouses between AD 700 and 1000, with round pithouses being almost entirely replaced by rectangular houses by 1000 (Miller and Kenmotsu 2004:240).

Smaller, more ephemeral huts are found at sites occupied for short periods, and are similar in form to those used during the Archaic (Miller and Kenmotsu 2005:239). Huts are represented by small diameter (average 2.5 m), shallow (15-30 cm), circular dish-shaped basins with sloping walls that lack prepared floors (Miller and Kenmotsu 2005:239). The insubstantial nature of these structures in addition to evidence for short occupations suggest that they represent the summer component of a settlement system that mixed a sedentary cold season residence based on stored foods with a mobile warm season exploitation of seasonally productive ecological zones.

Many types of extramural features also occur at Mesilla phase sites. While storage and midden features can be common at winter villages like Turquoise Ridge (Whalen 1994), they are rare at sites occupied during other seasons. Middens are usually shallow and diffuse, with imprecise boundaries (Whalen 1994:61). Burials are rare and usually unaccompanied by grave goods. Thermal features are usually common and take several forms including simple hearths and small and large fire-cracked rock features with and without fire pits. In general, the presence or absence of a pit within fire-cracked rock features probably reflect different degrees of erosion rather than functional differences. Size may reflect functional differentiation with small roasting features potentially more related to household use, while larger features were probably used communally (Whalen 1994). Variety in the types of thermal features peaks by AD 650, either declining or occurring in similar frequencies after that date (Miller and Kenmotsu 2004:250-251).

Ideology and ceremonialism. Little information is available concerning Mesilla phase ceremonialism. Larger than normal pithouses that may reflect a ritual use have been found at only three sites, including Turquoise Ridge (Whalen 1994), Los Tules (Lehmer 1948), and the Rincon site (Hammack 1962). These sites were all occupied late in the phase, leading Whalen (1994) to conclude that this type of structure originated after AD 750. The appearance of such features suggests an accompanying change in social organization. Traditionally, Southwestern communal structures are associated with ritual societies that crosscut community and bind them together. Thus, the appearance of communal structures in the late Mesilla phase suggests that the loose social organization characteristic of the Archaic and early Mesilla phase was giving way to a more cohesive pattern of group identity and membership. However, there is no evidence for any ceremonial organization larger than individual villages.

Ties to other regions. Certain types of artifacts are indicative of ties to other regions, but what form those ties took cannot be determined with certainty. Most imported pottery at Mesilla phase sites is from the Mimbres area to the west. Mimbres pottery occurs on both early and late Mesilla phase sites, suggesting that the Jornada region was tied into an exchange system that centered on the Mimbres area, particularly during the late part of the phase. Marine shell represents another relatively common import, and includes *Olivella* sp. beads and fragments of *Glycymeris* sp. bracelets (Lehmer 1948; O'Laughlin 1977, 1985; O'Laughlin and Greiser 1973; Whalen

1994). Other types of marine shell are rare and include fragments of *Haliotus* sp. and *Pyrene* sp. (O'Laughlin 1985; Whalen 1994). Turquoise also occurs in Mesilla phase contexts and is best reported from Turquoise Ridge (Whalen 1994), where 11 fragments were found. One piece of turquoise was also found at Los Tules (Lehmer 1948). However, without chemical analysis it is impossible to determine whether this material was obtained from local sources, such as those in the Orogrande area, or was imported.

Subsistence. Both wild and domestic foods were consumed during the Mesilla phase, presumably continuing the Archaic pattern of exploiting a broad spectrum of resources. In general, domesticates are rarer than wild foods, and this probably reflects a heavier use of wild species with domesticated plants acting as supplements rather than staples. Corn and beans have been recovered from Mesilla phase sites, but cucurbits have not been found. However, since cucurbits occur at Archaic sites, they were probably used but are poorly preserved. In the most detailed study yet conducted, Whalen (1994) found a differential distribution of corn remains in samples from early and late Mesilla contexts at Turquoise Ridge. Corn occurred in 7.3 percent of early samples and 27 percent of late samples, suggesting increased use after AD 750. One bean was also found in early deposits at this site. However, agriculture most likely played a somewhat more important role in the subsistence system of the Mesilla phase than it did during the Archaic, as evidenced by more intensive occupation at Mesilla phase sites and the appearance of winter villages like Turquoise Ridge.

A wide spectrum of wild plants occurs at both early and late Mesilla phase sites, representing use as food, fuel, and construction materials. Wild plants are mostly represented by seeds including purslane, chenopodium, amaranth, sunflower, acorn, mesquite, tornillo, mallow, yucca, sumac, bugseed, mustard, and various cacti and grasses (Camilli et al. 1988; Dean 1994; Ford 1977; Hard 1983a; O'Laughlin 1979, 1981, 1985; Wetterstrom 1978; Whalen 1980b, 1994). Some evidence for the use of leaf succulents also exists. Scott (1985) found agave fibers in a large roasting pit, and Camilli et al. (1988) recovered yucca leaves from a late Mesilla pit structure; both examples probably represent foods. Fuels were mostly shrubs, mesquite in particular (Camilli et al. 1988; Hard 1983a; Minnis and Toll 1991; O'Laughlin 1979), though there is limited evidence for the use of small trees like oak and juniper (Kirkpatrick et al. 1994; Minnis and Toll 1991). Other fuels include saltbush, Mormon tea, creosote, desert hackberry, and desert willow (Brethauer 1979; O'Laughlin 1979). Mesquite branches are usually assumed to have been the main elements in pithouse superstructures, though there is little direct evidence of this. Materials used to cover superstructures include grass stems and yucca stalks (Gerow 1994; Hard 1983a; Roney and Simons 1988).

Hard and Roney (2005) compare levels of agricultural dependence between the Jornada region and Cerro Juanaqueña, a Late Archaic trincheras site in northern Chihuahua. While there was a heavy investment in the cultivation and consumption of domesticates, especially corn, at Cerro Juanaqueña by 1250 BC, similar levels of agricultural dependency do not occur in the Jornada region until ca. AD 1000. Using optimal foraging theory to examine the data, environmental factors are suggested as the cause of these differences. Before AD 1000, farming in the Jornada region was a risky, low-return proposition. In contrast, shrubs represented high-density, high-return resources, supplemented by the use of succulents and forbs. "The relatively high return of shrub resources and the mobility required to exploit them were favored relative to the lower return and higher risk of farming" (Hard and Roney 2005:173). Thus, this mix of heavy reliance on wild plants supplemented by domesticates continued until conditions were such that the risk and yield associated with the cultivation of domesticates were reduced to levels that made their use economically feasible.

Evidence for the range of animals exploited is more limited. Rabbits, both cottontails and jackrabbits, are the most commonly identified faunal remains (Brethauer 1979; Brown 1994; Foster 1988; Hard 1983a; O'Laughlin 1977, 1979, 1981, 1985; Whalen 1980b, 1994). Other types of animals for which evidence of consumption exists include box turtle, spiny soft-shell turtle, quail, owl, muskrat, deer, possibly antelope, fresh water mollusks, and various rodents and birds (O'Laughlin 1977, 1979, 1981, 1985; Whalen

1994).

Trends in the manufacture of ceramic vessels also provide some information on changing subsistence patterns. Changes in the amount and size of temper in the late Mesilla phase suggests an attempt to produce pottery more resistant to thermal shock (Whalen 1994:11). This implies that vessels were required to withstand longer periods of heating, which could indicate changes in food processing techniques. Changes in firing techniques may have resulted in harder and more durable vessels. This may have been required by new patterns of pottery use or could reflect variation in the types of materials used in firing, possibly as a consequence of environmental change. Finally, the larger average size of late Mesilla vessels may indicate an increase in their use for storage (Seaman and Mills 1988a, 1988b; Whalen 1994). All of these changes in pottery suggest important behavioral differences between the early and late parts of the Mesilla phase.

The behavioral differences visible between the early and late parts of the Mesilla phase probably involved a continuing adaptation to population growth and a concomitant constriction of the area available for economic exploitation, a process that began during the Archaic period. Mesilla phase settlements tend to be scattered across the interior basins, and some villages are located along the margins of the Rio Grande Valley (Miller and Kenmotsu 2004:244-245). Cold season villages seem to have been occupied more intensively during the late Mesilla phase, suggesting the growing importance of stored foods to support longer periods of village occupations, perhaps by larger groups of people. This possibility is supported by the increased size of ceramic vessels seen in the late Mesilla phase. The appearance of probable ritual structures in late Mesilla phase villages may be indicative of population growth, with new elements of social structure being developed to help organize larger populations. Though cold season villages seem to have been occupied more intensively, the warm season pattern of dispersal of part of the village population to basin interiors to exploit food resources in that zone did not disappear, indicating that wild plant foods continued to be an important part of the subsistence economy at the same time that farming assumed increased importance.

Doña Ana Phase (ca. AD 1000-1250/1300)

While the Doña Ana phase was initially defined by Lehmer (1948), it is the most poorly known period of occupation. Lehmer (1948) considered this phase to be transitional between the Mesilla and El Paso phases and dated it from AD 1100 to 1200. No attempt was made to distinguish Doña Ana components in Whalen's (1977, 1978) early studies in the Hueco Bolson because of difficulties involved in distinguishing those remains from survey data alone. Thus, Doña Ana components were combined with the later El Paso phase into the Pueblo period. Whalen (1980a) has also referred to the Doña Ana phase as the Transitional period, again combining it with the El Paso phase in a regional synthesis.

Lehmer (1948:88) used pottery recovered during excavations at La Cueva, which lacked structural remains, to date the Doña Ana phase. The initial definition of this phase was mostly based on guesswork using remains excavated in 15 cm levels from the talus in front of a cave in which the fill was described as "hideously disturbed" (Lehmer 1948:35-37). It is no wonder that there has been so much confusion and speculation about this phase! Nevertheless, Carmichael has proposed a locally extensive Doña Ana occupation in the Tularosa Basin. Unfortunately, his arguments are based on survey data, and some have criticized his logic. Carmichael (1983, 1984, 1985a, 1985b, 1986b) presents a series of attributes he considers diagnostic of a Doña Ana occupation, and integrates these data into a model of nonlinear culture change for the region. First is a mixture of pottery, combining types from the Mesilla and El Paso phases. Initially, sites were only assigned to the Doña Ana phase when this ceramic association occurred in discrete features thought to represent eroded middens (Carmichael 1986a:72). However, once the association was considered valid it was extended to all sites at which it occurred, whether found in discrete features or not. The latter class of sites comprised over two-thirds of his sample. Though no surface evidence of structures were found, they were inferred by the presence of features interpreted as eroded trash-filled borrow pits (Carmichael 1986a:72). The associated adobe pueblos are thought to have eroded away, leaving behind little visible evidence of their existence.

From these data, Carmichael inferred a

locally extensive, short-term occupation during the Doña Ana phase for the southern Tularosa Basin. Many large habitation sites were identified in environmental settings similar to, though slightly different from, those occupied during the El Paso phase. These were alluvial fans, with El Paso phase sites tending to occur at slightly lower elevations. This suggested a climax of population and complexity at an earlier date than was previously thought, and led to construction of a model of development entailing oscillations in the relative intensity of local occupations (Carmichael 1985b). Simply put, Carmichael feels there were peaks in occupation size and intensity during both the Doña Ana and El Paso phases. In his study area, the larger peak is thought to have been during the earlier phase.

While this is an interesting model and certainly deserves consideration, many of its assumptions have been criticized. Anschuetz (1990:24) notes that the framework on which Carmichael builds his definition of the Doña Ana phase is based on excavations at La Cueva and Indian Wells Village (Lehmer 1948; Marshall 1973)—sites that are disturbed or incompletely described. The ceramic association used to define the phase may be more indicative of mixed Mesilla and El Paso phase occupations (Anschuetz 1990:24). While Carmichael originally considered this possibility, he later disregarded it. His logic in concluding that trash deposits represent the remains of eroded trash-filled borrow pits rather than surface middens is also criticized. Anschuetz and Seaman (1987:5) conclude there is no definitive or consistent way to define Doña Ana remains during survey. One of the main problems they point out is the lack of pottery types exclusive to this phase, leading to serious difficulties in discriminating remains from this period from those of earlier or later occupations. Thus, they feel that survey data should not be used to define Doña Ana occupations.

During a survey on Fort Bliss, Mauldin (1993) recognized and addressed these difficulties. Sites containing pottery types that Carmichael considered diagnostic of the Doña Ana phase were defined as multi-component (Mauldin 1993:24). However, one such site was subjected to a more rigorous examination to test Carmichael's assumptions. While this did not include excavation, it did entail detailed mapping and recording of surface feature and artifact type and distribution. Though several middens on the site contained pottery diagnostic of both the Mesilla and El Paso phases, Mauldin (1993:41) concluded, "The spatial patterning of components . . . suggests that the apparent Doña Ana assemblage actually may represent the overlap of the Mesilla and El Paso phase occupations." Mauldin's (1993) results suggest that Carmichael may indeed be in error, and that his sites represent a mixture of Mesilla and El Paso phase occupations in an area that was eminently suitable for use during both periods. So, where does this leave the Doña Ana phase? Should it be abandoned, or merely reconsidered yet again? Fortunately, a few sites from this phase have been excavated and provide some data (Bilbo 1972; Kegley 1982; Scarborough 1986). Thus, a basic outline of the Doña Ana phase can be sketched.

Dating the phase. Mauldin (1993:41) suggests that this phase should be dated between AD 1100 and 1150 and may have spanned an even shorter period. This is based on Kegley's (1982) work at Hueco Tanks and Scarborough's (1986) excavations at Meyers Pithouse Village, which suggest that the overlap between Mimbres Black-on-white and Chupadero Black-on-white that were originally used to define the phase lasted only 50 years or less. In fact, Mimbres Black-on-white is absent from Meyers Pithouse Village, which has been securely dated to the late Doña Ana phase by radiocarbon and archaeomagnetic samples (Mauldin 1993:41). If the traditional date of AD 1100 to 1200 were to continue in use, then what Lehmer and Carmichael both considered a characteristic ceramic assemblage may only occur at sites occupied early in the phase. Miller and Kenmotsu (2004:237-238) note that recent revisions to the Jornada sequence now place this phase between AD 1000 and 1250/1300. Several changes occurred around AD 1000 that point to the beginning of the transition from residence in pithouses to pueblos, along with an intensification of the agricultural base. This period of transition is now considered to represent the Doña Ana phase.

Changes in architecture mark both the beginning and end of this period. By AD 1000, the transition from round to rectangular pithouses was virtually complete, and the first isolated rooms appeared. These consist of square rooms in shallow pits with prepared floors, central collared hearths, and occasional storage pits and entry steps (Miller and Kenmotsu 2004:239). Roof support was supplied by two main posts along a central axis, supplemented by both interior and exterior post. These structures may be precursors to pueblo rooms, differing mainly in that they are isolated rather than joined together as is common in the later form, and tend to have smaller floor areas (Miller and Kenmotsu 2004:239). After AD 1250/1300 pit structures essentially disappear, and pueblos containing contiguous roomblocks were built. Changes in village location occur coincident with these shifts in structural types. Doña Ana and El Paso phase sites tend to cluster on alluvial fans, with sites of the latter phase occurring at somewhat lower elevations (Miller and Kenmotsu 2004:245).

Because the Doña Ana phase represents a period of transition, there are differences between the early and late parts of the phase (as discussed by Miller and Kenmotsu 2004:246-251). Around AD 1000, use of the central basins declined markedly, and there was an increased use of alluvial fans. This shift also corresponds to the changeover from round to rectangular pit structures. This pattern held until ca. AD 1150, when settlement on alluvial fans reached its apex, and settlement near playas became common. Construction of the more formal isolated rooms was greatly increased, and a major change in the structure of settlements also occurred. Rock-lined thermal features become increasingly common after 1000, and their use peaks after 1150. There is a significant increase in the construction of formal trash pits and storage facilities after 1150, and reliance on agriculture appears to have begun to intensify, as signified by a marked increase in mano size and grinding area (Hard et al. 1996).

Pottery. Traditionally, this phase was defined by the occurrence of El Paso Brown, El Paso Polychrome, Chupadero Black-on-white, St. Johns Polychrome, Three Rivers Red-on-terra cotta, and Mimbres Classic Black-on-white (Lehmer 1948:37). Marshall (1973:53) added El Paso Bichrome to the list. Carmichael (1986a:72) indicates that Playas Red Incised also occurs on Doña Ana phase sites and notes that the variety of El Paso Brown on his sites was late and had thickened rims. An unidentified black smudged ware was found in a probable Doña Ana phase pithouse near El Paso (Bilbo 1972:75).

Mauldin (1993:41) notes that the Hueco Tanks site (Kegley 1982) contained a ceramic assemblage similar to that defined by Lehmer. However, Mimbres Black-on-white comprised only a very small percentage of imported wares, while 90 percent was Chupadero Black-on-white. This type also comprises most of the nonlocal pottery from Meyers Pithouse Village (Mauldin 1993:41). Other intrusive pottery at that site included Three Rivers Red-on-terra cotta, Playas Red, and undifferentiated Chihuahuan wares (Mauldin 1993:41). Again, no Mimbres Black-on-white was found in this assemblage of over 13,000 sherds (Mauldin 1993:41).

Significant changes occur in brown ware assemblages after AD 1000, as discussed by Miller and Kenmotsu (2004:252-253). The manufacture of El Paso Bichrome and Polychrome vessels began around this time, and these types represent increasingly large portions of assemblages until around AD 1275, when the bichrome and early polychrome varieties were replaced by classic El Paso Polychrome. In the plain wares, the predominantly neckless jars of the Mesilla phase were augmented by short-necked jars. These types were replaced by necked jars with everted rims by 1250/1300, and a smaller variety of vessel forms overall were made.

House forms and feature types. This topic was partly addressed in the section on dating the phase, when temporal architectural trends were presented. Marshall (1973:53) indicates that Indian Wells Village contained a mixture of pithouses and surface structures. Round pithouses were common, but square pithouses also occurred. Surface structures had jacal or coursed adobe walls, and rooms often contained hearths. Surface rooms are common late in the period at this site, with small pit rooms being used for storage (Marshall 1973:53). Unfortunately, Indian Wells Village is incompletely described, and little detail is available. Even more unfortunate is that it was assigned to the Doña Ana phase because it contained a mixture of surface and pit rooms, even though the ceramic assemblage is similar to that of the El Paso phase (Marshall 1973:13). The presence of both round and rectangular pithouses is also suspicious, because this is a characteristic of the late Mesilla phase rather than the Doña Ana or El Paso phases. Thus, this site may represent a locale that was occupied from the Mesilla phase to the El Paso phase rather than a Doña Ana phase village.

At Meyers Pithouse Village, Scarborough (1986) found no surface structures, only four rectangular pithouses. One was substantially larger than the others and may have been a communal structure or work area (Scarborough 1986:283). Internal features include irregularly placed postholes and well-defined hearths in at least three structures. Extramural hearths were also found, and storage pits occurred both within and outside pithouses.

Six pithouses were excavated at the Hueco Tanks site, all similar in construction style (Kegley 1982). These pithouses were rectangular, 2.3-5.5 m long by 2.3-4.5 m wide and 0.24-0.95 m deep. Floors were plastered with adobe and had two postholes oriented on a north-south axis and a formal hearth, usually collared. An adobe step was sometimes adjacent to the south wall and may have been related to a wall or roof entrance in that area. Walls appear to have been plastered but were usually so deteriorated that this was not certain. Little evidence of roof construction remained, but in at least one case the roof was covered with a layer of adobe.

A probable pithouse from this phase was excavated at the Castner Annex Range Dam site (Bilbo 1972). It was shallow (10 cm deep) and rectangular, with both interior and exterior postholes (Bilbo 1972:75). Building materials had collapsed into the structure when it was partially burned and showed that walls were made of jacal and slanted inward, and that roof vigas were covered with a similar material (Bilbo 1972:75). A formal hearth may have existed, but the condition of the structure made this difficult to verify.

Ideology and ceremonialism. The late Mesilla ceremonial pattern at least partly continued into this phase. This is suggested by a probable communal structure at Meyers Pithouse Village (Scarborough 1986), which resembles similar structures from late Mesilla phase sites. However, at the beginning of this phase there was a significant change in rock art style that may reflect initial participation in a widespread ideological system with its roots in Mesoamerica. Jornada style rock art seems to appear around AD 1000, and Schaafsma (1992) suggests it began in the Mimbres area and spread to the Jornada. Common motifs include masks and faces, which occur as both carvings and paintings (Schaafsma 1992:67). Schaafsma (1972:122) notes that "As the art represents a significant break with the past, so, too, must the associated ritual have represented a cleavage with the earlier tradition." This new ritual system appears to have been introduced at the beginning of the Transitional period, and was probably closely linked to the changes in Jornada society that began occurring around that time.

Ties to other regions. Significant changes in extraregional ties occurred during this phase, as suggested by pottery imports. Mimbres pottery disappears from assemblages by around AD 1150 (Mauldin 1993), and this closely corresponds to the date of the Mimbres systemic collapse (Stuart and Gauthier 1981). Subsequent pottery imports were dominated by types from the north (Chupadero Black-on-white, Three Rivers Red-on-terra cotta, and St. Johns Polychrome) or the south (Playas Red and various Chihuahuan wares). This indicates a geographical change in interaction from an east-west axis to a north-south axis, similar to the pattern defined for the Archaic and differing significantly from that of the Mesilla phase.

Turquoise was found at Meyers Pithouse Village (Scarborough 1986:283), though whether it was from sources in the Jornada region or elsewhere is uncertain. Turquoise and a *Glycymeris* sp. shell bracelet fragment were found at the Castner Annex Range Dam site and may have been from Doña Ana phase deposits (Bilbo 1972). A small fragment of cloth was recovered from the pithouse at this site (Bilbo 1972:75), which may be a piece of imported cotton cloth. *Olivella* sp. shell beads were recovered from the Hueco Tanks site (Kegley 1982).

Subsistence. Flotation analysis suggests that domesticates continued to comprise only a small part of the diet during the early Doña Ana phase, increasing in use after AD 1150 (Miller and Kenmotsu 2004:248). Wild plant foods were the focus of subsistence activities in the early part of the phase, and were also very important in the late part of the phase. However, the more common occurrences of two-hand manos in addition to increased mano size and grinding area after AD 1000 indicate that corn had assumed a more important role than ever before. This is supported by studies of plant ubiquity conducted by Hard and others (1996) and Miller (1990, 1997) on flotation samples from all phases of the Formative period. This study showed increasing agricultural dependence during the Doña Ana phase, with a pronounced increase after AD 1150 (Miller and Kenmotsu 2004:249). The use of various cacti and succulents may have also intensified during the late Doña Ana phase, peaking by the end of the phase.

Excavation at Meyers Pithouse Village recovered at least one bean, several kernels of corn, and a large amount of rabbit bone (Scarborough 1986). Heavy lagomorph use is evident in three Transitional assemblages for which detailed analysis results are available (Miller and Kenmotsu 2004:250). While bone from medium and large artiodactyls including deer, antelope, and bison, also occur, their numbers are small in comparison to that of rabbits.

El Paso Phase (AD 1250/1300-1450)

Lehmer noted few differences between the El Paso and Doña Ana phases. Rather, he felt that the "difference between the two phases is primarily one of time and of formalization of already existing patterns" (Lehmer 1948:82). Residence was generally in adobe pueblos, with roomblocks grouped around plazas or in east-west oriented rows. Pithouses were thought to have been phased out by this time. However, Miller and Kenmotsu (2004) suggest that the differences between these phases are much more apparent than was initially thought. In addition to shifts in the areas that were occupied around AD 1200, there was a much heavier reliance on farming, and a significantly decreased use of the central basins. Major changes also occurred in ceramic assemblages, house types, village layout, and other aspects of material culture.

Dating the phase. Lehmer (1948) found it difficult to find a break between the Doña Ana and El Paso phases. He considered the occurrence of Mimbres pottery in the former and its absence in the latter to be significant and from this suggested that the transition occurred between AD 1150 and 1250 (Lehmer 1948:87-88). The end of the phase was linked to dates for early Rio Grande glaze wares that were occasionally found in local assemblages and suggested that the El Paso phase ended sometime between AD 1375 and 1400.

Since they were first proposed, these dates have come under scrutiny and are questioned by many. Traditionally, the El Paso phase has been considered to extend from around AD 1200 to 1400, as proposed by Lehmer. As Mauldin (1993:41) notes, if the presence of both Mimbres Black-on-white and Chupadero Black-on-white defines the Doña Ana phase, evidence from the few well-dated sites suggest that phase ended around AD 1150. However, if the construction of adobe roomblocks is also used as a defining characteristic, the El Paso phase probably didn't begin until around AD 1200, as tradition suggests.

However, recent research has added a considerable amount of information concerning the end of this phase. Cordell and Earls (1984) reevaluated manufacture dates for Glaze A in the Piro district and concluded that it was produced or continued in use until at least AD 1500 in that area. This is a hundred years later than the traditional end date for this type (Habicht-Mauche 1993). If most of the Glaze A in the Jornada region was obtained from the Piro district, Cordell and Earls (1984:96-97) suggest that a later ending date for this phase must be considered.

Miller and Kenmotsu (2004:238) have reassessed data for the Formative sequence, and place the beginning of the El Paso phase at AD 1250/1300. This date is based on information that suggests the population became agricultural specialists by this time, rather than simply using cultigens to supplement a diet focused on the exploitation of a variety of wild plant foods. This is viewed as the culmination of a long-term trend beginning in the Mesilla phase, representing a continuum of increasing agricultural dependence and social integration and decreasing mobility (Miller and Kenmotsu 2004:238). The El Paso phase ended sometime after AD 1450, based on a lack of later radiocarbon dates from structures of this phase. Miller and Kenmotsu (2004:258) link the abandonment of the Jornada region by farmers to similar abandonments occurring throughout the southern Southwest in the fifteenth century. Several reasons for this abandonment are proposed including drought leading to the failure of an overspecialized farming economy, or fallout from the demise of the regional system centered on Páquime in northern Chihuahua. Considering the range of data that were examined and evaluated by Miller and Kenmotsu's (2004) study, their dates are used in this discussion.

Pottery. The beginning of the El Paso phase has often been assumed to coincide with the almost exclusive use of polychromes and the virtual abandonment of plain wares. However, Seaman and Mills (1988a:181) suggest that use of El Paso Brown continued into the early El Paso phase and was not replaced by decorated wares as rapidly as many believe. Thus, one cannot assume that an assemblage containing both El Paso Brown and El Paso Polychrome dates to the late Mesilla or Doña Ana phases, as has often been the case in the past.

El Paso Polychrome sherds, both from decorated and undecorated parts of vessels, usually comprise a very high percentage of El Paso phase ceramic assemblages. For example, this type makes up 94 percent of the assemblage from La Cabrana Pueblo, 95 percent from Pickup Pueblo, 90 to 95 percent from the Sgt. Doyle site, 95 percent from the Condron Field site, 94.4 percent from the Bradfield site, 83.3 percent from the Alamogordo sites, and 90 percent from Twelve Room House (Bradley 1983; Gerald 1988; Green 1969; Hammack 1961; Lehmer 1948; Moore 1947). Trace amounts of El Paso Brown were found at the McGregor and Sgt. Doyle sites (Brook 1966a; Green 1969). A few textured El Paso Brown sherds were also noted at the Alamogordo sites (Lehmer 1948).

As noted earlier, El Paso Bichrome and early versions of El Paso Polychrome disappeared by the beginning of this phase, and were replaced by a late or classic variety of El Paso Polychrome (Miller and Kenmotsu 2004:252-253). Trends in these wares include an increasing elaboration of designs, the addition of secondary design elements, and complex multiple band layouts (Miller and Kenmotsu 2004:253). The neckless and short-necked jars that dominated during the Doña Ana phase were replaced by necked jars with everted rims, and this may be related to a desire for greater containment security for processing corn (Hard et al. 1994; Seaman and Mills 1988a, 1988b; Miller and Kenmotsu 2004:253). There is a greater uniformity in vessel form and less variety in assemblages from this phase, which may be related to reduced mobility or a more uniform vessel function (Miller and Kenmotsu 2004:253).

Imported wares from several regions occur in small percentages at sites from this phase; Chupadero Black-on-white is often the most common import. Small amounts of Mimbres Black-on-white occur at a few sites and probably represent an earlier occupation or heirloom pieces (Brook 1966a; Hunter 1988; Lehmer 1948). Other types made in the Mogollon region are Lincoln Black-on-red and Three Rivers Red-on-terra cotta. Pottery from the White Mountain and Zuñi areas include St. Johns Polychrome and Heshotauthla Polychrome (Bradley 1983; Brook 1966a; Gerald 1988; Green 1969; Hammack 1961; Hunter 1988; Lehmer 1948). Rio Grande Glaze A wares occasionally occur and include Agua Fria Glaze-on-red and Arenal Glaze Polychrome (Green 1969; Lehmer 1948). Galisteo Black-on-white has also been reported from a few sites (Brook 1966a; Green 1969).

Wares imported from northern Mexico include Ramos Polychrome, Ramos Black, Playas Red Incised and Corrugated, Casas Grandes Incised, Carretas Polychrome, Villa Ahumada Polychrome, Madera Black-on-red, Babicora Polychrome, and unidentified brown wares (Bradley 1983; Brook 1967; Foster and Bradley 1984; Green 1969; Hammack 1961; Hunter 1988; Kirkpatrick et al. 1994; Lehmer 1948). Since Wiseman (1981) has identified local copies of Playas Incised produced in the Sierra Blanca region, this type cannot always be assumed to be imported. Salado types include Tucson Polychrome and Gila Polychrome (Bradley 1983; Green 1969; Hammack 1961; Kirkpatrick et al. 1994; Lehmer 1948).

Unidentified smudged wares are sometimes recovered and include a polished brown ware from Pickup Pueblo (Gerald 1988) and corrugated wares from La Cabrana Pueblo, the Sgt. Doyle site, the Condron Field site, the Alamogordo sites, and Twelve Room House (Foster and Bradley 1984; Green 1969; Hammack 1961; Lehmer 1948; Moore 1947). Unidentified black and brown incised wares are reported from the McGregor site (Brook 1966a), and a red punctate ware was found at the Tony Colon I site (Hunter 1988).

Thus, while imported wares usually comprise less than 10 percent of El Paso phase assemblages, they occur at many sites, especially those containing adobe structures. Various types were imported from regions to the north, west, southwest, and south and represent a number of groups including the Rio Grande Pueblos, Zuñi, western Mogollon, Salado, and Casas Grandes of northern Mexico.

House forms and feature types. Lehmer (1948:80) claimed that El Paso houses were always adobe-walled surface structures and defined two basic forms: linear roomblocks and rooms grouped around plazas. While his first assertion is not upheld by more recent data, the second is basically confirmed. An example of the first basic form is Hot Well Pueblo, which contains 150 to 200 rooms arranged in a number of discrete linear units (Brook 1966b). Plaza arrangements are rare and include Indian Tank in the San Andres Mountains, House 2 at Alamogordo Site 1, and Alamogordo Site 2 (Lehmer 1948; Miller and Kenmotsu 2004).

In addition to Hot Well Pueblo and House 2 at Alamogordo Site 1, Hubbard (1992) indicates that Escondida and Indian Tank Pueblos contain more than 100 rooms apiece, and Cottonwood Springs Pueblo has over 200. Of these large villages, only Indian Tank is thought to contain more than one story (Hubbard 1992). Foster (1993:11) notes that pueblos containing 8-10 single story-rooms are more common than these large villages. Smaller villages were usually built as linear roomblocks, though a few L-shaped structures also occur. Roomblocks are usually 1-2 rooms wide, and multiple roomblocks often occur at the same site. Descriptions are available for several small linear sites and can probably be considered representative. La Cabrana Pueblo contains 9 rooms, 8 in a double-row roomblock with a single large room at the northeast end (Bradley 1983; Foster and Bradley 1984). Pickup Pueblo contains 6 linear rooms (Gerald 1988). A total of 17 rooms in several blocks of 1-4 rooms was defined at the Sgt. Doyle site (Green 1969). Most roomblocks were a single room wide, but one was 2 rooms wide, and another was L-shaped. The Condron Field site contained 7 rooms in blocks of 3 and 4, each a single room wide (Hammack 1961). Sixteen rooms arranged in a block 1-2 rooms wide were found at the Bradfield site (Lehmer 1948). House 1 at Alamogordo Site 1 contained 15 rooms in a linear block that was 1-2 rooms wide, with an isolated block of 2 rooms (Lehmer 1948). Twelve Room House was built along similar lines, containing 12 rooms in a block that was mostly 1-2 rooms wide, ranging up to 3 rooms wide in one area (Moore 1947). Finally, Anapra Pueblo contained 8 linear rooms (Scarborough 1985). Miller and Kenmotsu (2004:242) note that most El Paso phase room blocks are oriented along an east-west axis, unless they are in riverine settings or are situated along major drainages, in which case they tend to parallel stream orientation. Isolated rooms, similar to those used during the Doña Ana phase, continue to occur during the El Paso phase (Miller and Kenmotsu 2004:244).

Villages probably grew by accretion rather than being built as planned communities. Pueblo walls were usually coursed or puddled adobe; they were commonly set in foundation trenches and often extend below floor levels. Wall heights are impossible to determine, since erosion has usually reduced them to mere stubs. Floors are sometimes slightly sunken, and steps commonly occur, usually just within the presumed locations of doors. Floors are usually adobe, and interior wall and floor surfaces tend to be plastered. A few examples of multiple plaster layers on floors and walls have been noted, indicating that some structures were refurbished (Brook 1966a; Hammack 1961; Lehmer 1948). Little evidence of roof construction is normally either preserved or described in reports. However, data concerning roof construction techniques is available from La Cabrana Pueblo (Foster and Bradley 1984). There, roofs consisted of wooden vigas overlain by mesquite and tornillo limb latillas. This framework was covered with layers of grass and reeds, which were coated with a layer of adobe in at least some rooms. Besides the refurbishing of walls and floors, there is evidence of more extensive remodeling at some sites. Parts of rooms at the Bradfield site and Twelve Room House were partitioned into long narrow bins or rooms (Lehmer 1948; Moore 1947). Remodelings like these could have been done to create secure storage spaces for important objects or supplies, and may be an indication of seasonal residence rather than year-round use. This was almost certainly the case at Twelve Room House, where a cache of ritual objects was discovered in one of the bins/narrow rooms.

Nearly every El Paso phase village contains at least one room that is much larger than other rooms at the site (Hammack 1961; Marshall 1973). Caches of ritual materials are often found beneath the floors of these rooms, and they seem to have served a communal function. At Twelve Room House, Moore (1947:99) notes that the largest room did not show much evidence of use. The hearth was not fired to the extent of similar features in other rooms, and the floor was rough and unpolished. However, another room that was remodeled into four compartments was as large or larger than this chamber before it was subdivided. Thus, the original communal room may have been replaced by a new one and converted to storage chambers for ritual materials.

Postholes and hearths are the most common features in El Paso phase pueblos. Pits for roof support posts are often, but not always, found inside rooms. Support posts were set into walls in at least one case (Brook 1979:27). Interior hearths are normally plastered and often collared and are usually circular in shape, though rectangular examples occur. Storage pits were often built within rooms; their walls are sometimes plastered. Other pits with undefined purposes sometimes occur, as do caches. A possible above-ground storage cist was identified in one room at the Sgt. Doyle site (Green 1969).

Few types of extramural features are recorded for pueblos because most excavation has concentrated on rooms. Extramural hearths containing fire-cracked rock were noted at the Sgt. Doyle site (Green 1969). Middens have been recorded at several sites, as have trash-filled borrow pits. Extramural storage pits occur at a few villages, and small plazas or work areas have been defined at several sites. An exception to the lack of extramural excavation is Firecracker Pueblo, where dozens of extramural features were found including trash and storage pits, hearths, and several types with undefined functions (Miller and Kenmotsu 2004:244). Perhaps the most interesting features are those associated with water conservation and control. At least nine reservoirs are recorded for the area, and all are either associated with El Paso villages or contain materials indicative of use during that phase (Bentley 1993; Hubbard 1987; Leach et al. 1993). Hubbard (1992) has located a possible canal, which he dates ca. AD 900 to 1000 on the basis of nearby sites. However, this date may be too early, and if this feature is real it was probably built during the El Paso phase.

Some variation has been noted between villages along the Rio Grande and those built away from the river, including differences in size, construction techniques, and degree of refurbishing. Foster and Bradley (1984:199) note that riverine sites tend to lack internal floor features, while nonriverine villages often contain a variety of them. Riverine pueblos usually lack internal support posts and do not exhibit evidence of extensive refurbishing. This may reflect variation in the duration of occupation, with little major refurbishing required at riverine villages because of constant attention to maintenance needs (Foster and Bradley 1984:211). The largest villages tend to occur in nonriverine settings.

While adobe villages are considered the main residences of the El Paso population, short-term habitation or task-specific sites also occur. While most seem to be open camps containing ephemeral shelters at best, there are a few examples of more substantial structures. Batcho et al. (1985:54-55) excavated an El Paso phase pithouse at the Santa Teresa Airport. This structure was square, measured 2-by-2-m, and was at least 40 cm deep. At least five large extramural pits were probably used for storage. This site is thought to be a fieldhouse. Moore (1996) excavated a multi-occupational camp at the Santa Teresa Port-of-Entry with some features that may date to the early part of the El Paso phase, including a shallow pit structure, similar in size and form to huts built during the Archaic and Mesilla phase.

Carmichael (1985a, 1985c) excavated numerous pit structures dating to the Pueblo period (Doña Ana and El Paso phases) at Site 37 at Keystone Dam. Between 16 and 23 pit structures were located, generally small and circular with sloping walls, irregular floors, informal internal hearths, and postholes around their peripheries as well as on floor surfaces. Several structures overlap, suggesting that multiple occupational episodes were represented. These structures seem to have been unburned ephemeral brush shelters (Miller et al. 1985:182). Extramural features included large and small hearths containing fire-cracked rock. Carmichael (1986b) feels that these remains represent short-term hunting and gathering occupations. However, it is also possible that they were farming structures.

Other researchers also suggest the existence of farming structures or fieldhouses in this region. Hubbard (1992) feels that many ceramic scatters and smaller pueblos may be fieldhouses. During a survey in the southern San Andres Mountains, Browning (1991:31) identified numerous single-room structures represented by upright slab foundations that are thought to have been fieldhouses. These structures are often surrounded by activity areas containing extramural hearths and middens, and are probably contemporaneous with large El Paso phase villages in the area.

Ideology and ceremonialism. The ideological and ritual system that originated during the late Mesilla phase became more pronounced and elaborate during this phase. The rock art style depicting masks, human faces, and animal forms continued in use, and the two former elements figured predominantly in the art of the Rio Grande Valley and Tularosa Basin (Schaafsma 1972, 1992). Foster (1993:12) feels that the abundant and complex rock art is evidence for increased ceremonialism. This ritual system was probably much different from that of Archaic and early Mesilla times and seems to have been particularly concerned with farming and rainmaking.

Foster (1993) feels that Jornada society became more complex during the El Paso phase, with greater population concentrations and densities resulting in reorganization. The largest villages were built during this phase and were probably at least partly integrated by ritual societies whose activities were centered in the large communal rooms, which Thompson (1988:61) suggests were focal points for activities related to group needs. Further evidence for the increased importance and elaboration of ritual was found at Hot Well Pueblo. There, analysis of features in one room suggests that it functioned as an astronomical observatory (Brook 1979:38). Another room contained a polychrome wall mural of probable ritual significance (Brook 1975:19).

The discovery of ritual caches and objects of religious importance buried beneath the floors of El Paso phase sites is further evidence of the religious system. Ritual caches are documented for several sites and known anecdotally for others. Thompson (1988:61) notes that they are usually found beneath the floors of large communal rooms and often contain ornaments, pigments, and ceramic vessels. Brook (1975:19) indicates that there were jewelry caches under the floors of two rooms at Hot Well Pueblo. Hammack (1961) found a cache in the center of the largest room at the Condron Field site, which contained 99 shell beads in a pit covered with a removable adobe plug and filled with sand that was not native to the area. Lehmer (1948) documents a cache from one of the Alamogordo sites that contained five polished turquoise blanks, several olivella shells, and a quartz crystal buried in a small jar under a floor. More extensive caches are also reported. A subfloor cache at La Cabrana Pueblo contained limonite and kaolin pigments, a large projectile point, three turquoise pendants, and smoothing stones (Bradley 1983:48). Numerous fossils were recovered from the floor of an adjacent room in association with pieces of shaped and unshaped calcite, gypsum crystals, shell beads and pendant, turquoise, pyrite, carved stone shells, a copper ore pendant, a piece of pyrite embedded in a basalt nodule, many olivella shell beads, a fragment of a *Conus* sp. shell, and pieces of kaolin, hematite, malachite, limonite, and copper ore (Bradley 1983:72, 74). There was also a necklace containing an etched fluorite pendant and olivella shell beads, crinoids, turquoise, and sandstone concretions.

Perhaps the most extensive cache was found at Twelve Room House (Moore 1947). Room 2 at that site was partitioned into several bins, one of which contained 3 large jars, 2 "jug form" vessels, 3 El Paso Polychrome bowls with terraced rims, a polished black ware bowl, a small trough metate with yellow ocher stains, 2 round stone balls, a round stone object, 6 pieces of yellow ocher, 2 pieces of travertine, 62 olivella shell beads, 34 shell disk beads, 4 turquoise beads, 15 *Alectrion* sp. beads, 1 tubular shell bead, 1 small charred corn cob, a section of hollow reed containing a soft light green material, a basket fragment, and many burned gourds. The shell beads were stored in one or two of the broken jars. The material in the section of reed was similar to a lump of iron potassium found cached in a shallow pit in another room. Hammack (1961) recovered a similar El Paso Polychrome bowl with stepped rim at the Condron Field site.

Several unique or very rare objects of probable religious function have also been found. Lehmer (1948:53) reports seeing several stone and clay animal effigies in private collections from the Alamogordo area, which were reputedly found in El Paso phase sites. Four stone effigies were found at the Alamogordo sites; three resembled bears and one a mountain sheep (Lehmer 1948). In addition, an elaborate white stone cloud terrace set in a cylindrical base was buried beneath the floor of one room (Lehmer 1948:70). Traces of green, brown, black, and blue paint were all that remained of its decoration. Lehmer (1948) notes that it was similar to another specimen seen in a private collection in Las Cruces.

Thus, an elaboration of the ritual system is visible in the array of objects and materials left behind, usually hidden in caches. They include objects depicting animal forms and cloud terraces, as well as ceramic vessels, especially bowls with cloud terrace rims. Various pigments, numerous species of marine shell, turquoise, and perhaps projectile points also seem to have had ritual significance. These types of objects and caches have not been found in earlier sites and may have assumed a special significance during this phase.

Ties to other regions. There is much evidence for extra-regional contact during this phase, and pottery is one of the best indicators of its areal extent. Though imported types usually comprise only 5-10 percent of ceramic assemblages, they consistently indicate some level of interaction with distant regions. In particular, there was a great deal of interaction with other Mogollon peoples in central New Mexico and east-central Arizona. Pottery types from the Pueblo area indicate contact with the glaze ware producing region in the central Rio Grande, and the Chupadero Black-on-white producing area in central New Mexico. Considering the rarity of most Pueblo pottery, it is likely that there were no direct contacts with the far northern segments of that group. However, the common occurrence of Chupadero Black-on-white suggests a rather high degree of contact with intermediate groups. Some contact with the Salado peoples to the west and southwest are suggested by finds of Tucson Polychrome and Gila Polychrome, but these types are rarely common. Conversely, the array of Mexican pottery types suggests a considerable amount of contact with northern Chihuahua. Numerous polychromes and textured ceramics were imported from that region and are fairly common at sites of this phase, particularly the large adobe-walled villages.

Turquoise is often found at El Paso phase sites, though much of it may have been mined in the Jornada area. Bentley (1993) suggests that at least some of the turquoise from Hot Well Pueblo was mined in the Jarilla Mountains. Similarly, some of the turquoise at La Cabrana Pueblo was from the Jarillas, though other specimens were from undetermined sources. Turquoise fragments or ornaments are reported from other sites but are not sourced (Brook 1966a; Green 1969; Hammack 1961; Hunter 1988; Kirkpatrick et al. 1994; Lehmer 1948; Moore 1947). Thus, it is difficult to determine whether most of the turquoise from this area was imported or mined locally. Preliminary evidence suggests that both possibilities are likely. Finds of copper bells are reported for the region but are rare (Lehmer 1948).

Marine shell, primarily from the Gulf of California, occurs with regularity in El Paso assemblages and suggests the existence of an extensive exchange network. *Olivella* sp. shells were often processed into beads, but unworked specimens also occur. Fragments of *Glycymeris* sp. shell bracelets have been recovered from many sites, though they are never common, and were probably obtained from the Hohokam. *Conus* sp. shells were often used for tinklers and probably dangled from clothing or jewelry. Other types of shell include a mother-of-pearl pendant from La Cabrana Pueblo and a possible abalone shell fragment from the Tony Colon I site (Foster and Bradley 1984; Hunter 1988). Lehmer (1948) reports beads made from marine worm casings and pendants cut from bivalve shells at the Alamogordo sites. Unfortunately, he does not mention whether the bivalves were marine or freshwater. *Alectrion* sp. beads were found at Twelve Room House (Moore 1947). Finally, Southward (1979) reports freshwater mussel shells in an assemblage from Three Rivers, as well as specimens of *Vermitus* sp. and *Spondylus princeps*. The freshwater mussel was either obtained from the Rio Grande (100 km away) or the Rio Pecos (160 km away).

Goods from a large region were moving into the area during the El Paso phase. While there was a degree of contact with other areas during earlier phases, there appears to have been an intensification of exchange ties with distant areas during this period that is represented by a proliferation in the amounts and types of exotic goods at many sites. In particular, there seems to have been quite a bit of contact with northern Mexico and central New Mexico. While direct contact is possible for these areas, indirect contact is probably responsible for the occurrence of raw and processed marine shells, some turquoise, and pottery from the northern Pueblo region.

Subsistence. Though wild plant foods continued to be consumed in this phase, the variety and amounts of domesticates in addition to evidence for the construction of water and soil control systems suggest that cultigens had a vastly increased dietary importance. This is partly suggested by large finds of corn. For example, Scarborough (1985) recovered corn cached in storage pits at Anapra Pueblo, and Brook (1966b:4) notes that a village excavated in 1939 about 64 km north of Hot Well Pueblo yielded 200 bushels of charred corn. The array of cultigens includes corn, beans, and cucurbits. In addition to common beans, tepary and lima beans are reported from a few sites (Bradley 1983; Ford 1977). Cucurbit remains are rare and are often not identified to species. However, Ford (1977) identified warty squash at an El Paso phase site in the Hueco Bolson, and gourds are mentioned as possible cultigens (Bentley 1993).

Many wild plants were used for food, fuel, building materials, and other purposes. Mesquite and tornillo were probably very important supplements to the diet. Beans, pods, seed coats, and stems from these plants have been recovered from many sites (Bentley 1993; Brook 1966b; Bradley 1983; Ford 1977; Scarborough 1985; Southward 1979). Chenopodium and amaranth were also important food sources, and there was some use of grass seeds, though they are not commonly reported. Other wild plants that were consumed include large petal onion, mariola, acorn, at least two species of yucca, spurge, two species of acacia, purslane, buffalo gourd, a member of the pink family, bugseed, Mexican buckeye, and several species of cactus including prickly pear, Turk's cap, cholla, and pitaya (Bentley 1993; Brook 1966b; Bradley 1983; Ford 1977; Kirkpatrick et al. 1994; Southward 1979).

Woody plants were used for fuel and construction. Types of fuel woods reported for El Paso phase sites include mesquite, saltbush, and oak (Kirkpatrick et al. 1994; Southward 1979). Mesquite and tornillo limbs were used in construction, as were ponderosa pine, juniper, reeds, and grass stems (Bentley 1993; Bradley 1983; Foster et al. 1981; Southward 1979). Some plants may have been used for different purposes. Sand Mormon tea stems were found at Hot Well Pueblo (Bentley 1993) and may have been used as medicine. Hoary pea was found at La Cabrana Pueblo. This plant is used to stupefy fish by the Tarahumara and may have served a similar purpose at La Cabrana (Bradley 1983:109). Fish remains are only reported from this site, but they comprise a large percentage of the faunal assemblage and probably represent an important, but often unrecognized, food source. Over 5,000 fish bones and scales were found in trash deposits, including members of the catfish, gar, and sucker families.

Many animal species were eaten, though rabbits remained the dominant source of animal protein. This is true even of La Cabrana Pueblo, where large amounts of fish were consumed (Bradley 1983; Foster et al. 1981). It is possible that turkeys were kept in El Paso phase villages, but direct evidence for this is not good. Turkey bone was recovered at La Cabrana Pueblo, but an overlying historic component also contained turkey remains, suggesting that the turkey bone from prehistoric deposits could have originated in historic levels (Foster and Bradley 1984). Egg shells have been found at some sites and are probably turkey (Brook 1966b; Green 1969). Other mammals used for food include antelope, mule deer, kangaroo rat, white-throated woodrat, and possibly long-tailed weasel (Brook 1966b; Bradley 1983).

Protohistoric Period (AD 1450-1600)

Many assume that the Jornada region was mostly abandoned at the end of the El Paso phase. While few sites from this area are actually assigned a Protohistoric date, Spanish documents show that it was occupied in the sixteenth century, and a reevaluation of dates suggests a continual occupation from the El Paso phase into the Protohistoric period, though residence in adobe-walled villages did not continue past around AD 1450. Upham (1984, 1988) feels that a realignment of subsistence strategies occurred, rather than replacement of the indigenous population. He suggests that the Jornada people adapted to changing environmental conditions by switching to a more generalized settlement and subsistence system. Thus, the Protohistoric economic and settlement systems are thought to have been similar to those of the Archaic or Early Formative periods. This is echoed by Carmichael (1986a), who also suggests that the indigenous people reverted to a hunting-gathering adaptation at the end of the El Paso phase, similar to the subsistence system documented in the early historic period by the Spanish.

While evidence for this transition is visible further south in the part of the Jornada region around modern El Paso, it is not yet documented for the middle Jornada del Muerto region. Thus, we currently do not know whether the residents of the latter also returned to a hunting and gathering lifestyle when they abandoned their villages, continuing to exploit the same region, or if they moved elsewhere, including to the south to join related groups in the El Paso area or north to join Pueblo groups in the Rio Grande Valley or Salinas district. If the former is correct, then by at least the late sixteenth century they had been pushed out of the region and replaced by Athabaskan hunter-gatherers. Whether or not the middle and southern portions of the Jornada del Muerto was also used by Piros during the Protohistoric period is also unknown, but possible. Some evidence of possible Piro occupations are suggested at the Mockingbird Gap site in the northern Jornada del Muerto (Weber and Agogino 1997).

Several different peoples occupied south-central New Mexico and adjacent parts of Trans-Pecos Texas and Chihuahua during the protohistoric period, including the Manso, Suma, Jumano, Jocome, Patarabuye, and various Athabaskan groups. Of these, only the Athabaskans are of interest to this study because none of the others are thought to have lived as far north as the project area. The Manso are considered descendants of the Jornada Mogollon, and lived in the area between El Paso and Las Cruces (Baugh and Sechrist 2001; Beckett 1984; Beckett and Corbett 1992). The Patarabuye and Jumanos lived in the La Junta region to the east and south of the Manso. The Mansos were not the only descendants of the Jornada Mogollon in this region. Beckett (1994:163) has suggested that the Jano and Jocome spoke similar dialects of the Sonoran branch of the Uto-Aztecan language family, while the Suma and Jumanos were latecomers to the region and probably spoke languages that were related to one another but not to those of the other groups. Athabaskans considered ancestral to the modern Mescalero Apaches occupied a region between the Mansos on the south and the Piros on the west and northwest (Baugh and Sechrist 2001:36). This area encompasses the Jornada del Muerto, where Athabaskans were first encountered by the Spanish during Oñate's colonizing expedition in 1598, and were initially named the Apache del Perrillo (Baugh and Sechrist 2001:35). This same group may have later been known as the Sierra Blanca and Faraon Apaches, and eventually became the Mescalero Apache (Baugh and Sechrist 2001:35-36). The modern Mescalero tribe contains three different groups: the Mescalero, Chiricahua, and Lipan peoples (www.mescaleroapache.com/area/history_and_cul.htm; accessed 8/23/10). The project area is within the region encompassed by the sacred mountains of the Mescalero including Sierra Blanca, the Guadalupes, Three Sisters Mountain, and Oscura Peak.

Seymour (2002:393) places the Apache arrival in the area now occupied by the Fort Bliss military reservation between AD 1450 and 1645. A firmer arrival date cannot yet be defined, and this range, which spans the years between the presumed end of the El Paso phase and the earliest Spanish entry into the region, is the best compromise. Apaches became more prominent in the Tularosa and Hueco basins in the 1650s (Baugh and Sechrist 2001:36), and this may indicate an expansion of their traditional range. Raids against the Spanish and Pueblo Indians intensified after the Pueblo Revolt, as the Spanish hold on the region was weakened. Finally, under pressure from Spanish and Comanches, who were encroaching on the plains by the early-to-middle 1700s, the Mescaleros were pushed toward the El Paso area (Baugh and Sechrist 2001:36).

Using primarily survey information and a reexamination of suspected sites on Fort Bliss, Baugh and Sechrist (2001:290) concluded that very little evidence for an Apache occupation of that area was indicated, and considered their conclusions upheld by Miller's (1996, 2001) survey of radiocarbon dates from the area, which found few dates suggesting occupation during the protohistoric period. They considered the normal indicators of probable Apache occupation applied in the region—the presence of rock rings, enclosures, and alignments—to be weak evidence, noting that "the association of grouped rock features with Apache activity is an overworked assumption that has a long, deeply ingrained history among archaeologists" (Baugh and Sechrist 2001:273). However, they do note that protohistoric sites are often components on sites that mainly belong to different cultures and different time periods, and are often discounted as evidence of occupation during that period (Baugh and Sechrist 2002:272).

Seymour (2002), using more detailed information from excavation and material culture analysis, identified a range of probable protohistoric period sites in the same region, often displaying distinctive characteristics thought to be diagnostic of different ethnic groups. As Seymour (2002:395) notes: "It was Baugh and Sechrist's (2001:278) conclusion that the Protohistoric period 'appears to be underrepresented on the Fort Bliss reservation.' It is my position that the Protohistoric period is under-recorded in the region owing to the fact that it has not been recognized. This same factor likely accounts for the low frequency of Paleoindian and Early and Middle Archaic sites on the base."

Archaeologically, Seymour (2002, and Church 2007) identified two complexes at Fort Bliss and elsewhere in south-central New Mexico and the western Trans-Pecos of Texas that are thought to represent the remains of various protohistoric and early historic groups known to have occupied the region. The Canutillo complex is considered a Plains adaptation related to bison hunting, and is related to several similar complexes in Texas (Seymour and Church 2007:99). This complex probably represents sites occupied by groups such as the Jano, Jocome, Suma, and/or Manso, and its chipped stone assemblage is biface-oriented with a distinct range of projectile points and other tools. The Cerro Rojo complex is representative of the early Apache occupants of the region, and has an expedient chipped stone reduction strategy with retouched tools and distinct side-notched and tri-notched projectile points. Since the Canutillo complex is unlikely to extend north into the study area, we focus on the Cerro Rojo complex.

Characteristics of the Cerro Rojo complex include the presence of rock-ringed huts, tipi rings, structural clearings, lean-tos, and sleeping platforms in rock shelters. Throughout the region, a number of pottery types are considered diagnostic of Protohistoric and early Historic period occupations. They include seven types of Apache wares and several Pueblo wares. The currently defined Apache wares are Soledad Plain, Otero Plain, Llano Plain, Sierra Plain, Cerro Plain, Cornudas Plain, and Rustler Plain (Seymour 2002). Except for Soledad Plain and Cornudas Plain these types are brown wares, and the latter is thought to be intrusive from further to the northwest. Pueblo wares include Valle Bajo Red-on-brown from the El Paso region, Piro utility wares and Pueblo glaze wares from the Middle Rio Grande, Tewa Polychrome and Ogapoge Polychrome from the northern Rio Grande, and Tabira gray ware from the Salinas District. Most of the Pueblo types are historic rather than protohistoric, though some types were also made during the Protohistoric period. Apache summer camps and those occupied by large groups of people were mostly located in high-altitude settings in the mountains, while winter camps were in low altitude settings along rivers and in the foothills (Seymour and Church 2007:100). The latter are thought to account for some of the sites in the Santa Teresa area along the Rio Grande and around playas (Seymour and Church 2002:100).

Historic Period

The historic period in New Mexico began with the entrance of the first Spanish expedition into the region in 1540. Several methods have been used to divide the European occupation into shorter periods. One of the most common is to divide this period into politically-based subperiods including Spanish Exploration and Colonization (1540-1692), Spanish Colonial (1692-1821), Mexican (1821-1848), and American (1848-World War II). This is the approach taken in this chapter.

Spanish Exploration and Colonization Period (1539-1692)

Based on information gathered by Cabeza de Vaca and his companions following the Narváez expedition to Florida (Covey 1990), the Spanish Empire became interested in lands north of Mexico in the 1530s. Fray Marcos de Niza was dispatched on a scouting mission into the Southwest in 1539, and a major expedition under Francisco Vázquez de Coronado explored the region between 1540 and 1542. No other contact between New Spain and New Mexico occurred until 1581, when Father Agustín Rodríguez and Captain Francisco Sánchez Chamuscado led an expedition up the Rio Grande (Hammond and Rey 1966). Ostensibly to rescue two priests left by the Rodríguez-Chamuscado expedition, Antonio de Espejo led a party into New Mexico in 1582. Gaspar Castaño de Sosa attempted to illegally found a colony in 1590-1591, but was arrested and returned to Mexico (Simmons 1979). A second attempt at colonization was made by Francisco de Leyva Bonilla and Antonio Gutiérrez de Humaña in 1593, but their party was devastated by conflict with Indians (Hammond and Rey 1966).

Juan de Oñate established the first successful colony in New Mexico at San Juan Pueblo (Ohkay Owingeh) in 1598. The route Oñate's party traveled to reach New Mexico became El Camino Real de Tierra Adentro, and remained the main line of contact between New Mexico and the rest of the world until the Santa Fe Trail was opened in 1821. Oñate was replaced as governor in 1607 by Pedro de Peralta, who moved the capital to the new town of Santa Fe around 1610 (Simmons 1979). The first Spanish settlement in southern New Mexico was at El Paso del Norte, now the city of Juárez in Mexico, where the mission of Nuestra Señora del Guadalupe de los Mansos del Paso del Norte was established in 1659 to serve the Manso and Suma Indians (Baugh and Sechrist 2001:38). The settlement that grew up around the mission was El Paso del Norte, which became a *villa* in 1680 (Baugh and Sechrist 2001:38).

During this period, the colony was poorly and sporadically supplied with goods carried up the Camino Real. The missions were supplied by an inefficient caravan system (Ivey 1993; Moorhead 1958; Scholes 1930), while the secular population was mainly supplied by a few independent traders (Hendricks and Mandell 2002). Trade with the Plains Apaches was an important source of income. Slaves were a particularly important commodity, and were often bought from the Apaches for resale to the mines of northern Mexico. The Spanish often supplemented this source of slaves by raiding Apache villages during the seventeenth century. This antagonized both the Apaches and their Pueblo trading partners, and caused the former to unleash a series of raids against the Spanish and some Pueblos in the 1660s and 1670s (Forbes 1960). This, in turn, exacerbated Pueblo resentment of the Spanish, contributing to several rebellions that finally culminated in the general revolt of 1680.

A combination of religious intolerance, forced labor, the extortion of tribute, and Apache raids led the Pueblo Indians to revolt in 1680, driving the Spanish from New Mexico (Forbes 1960; Hackett and Shelby 1942; Simmons 1979). The surviving colonists retreated to El Paso del Norte, accompanied by the Pueblo Indians who remained loyal to them. Because El Paso del Norte could not accommodate all the refugees, new villages were founded to house them. Difficult living conditions caused by war, drought, and disease caused a population decline that led to the abandonment of several of these villages, until by 1700 only five settlements remained in the area (Baugh and Sechrist 2001:39).

Attempts at reconquest were made by Otermín in 1681 and Cruzate in 1689, but both failed (Ellis 1971). Diego de Vargas eventually negotiated the Spanish return in 1692, exploiting the factionalism that had developed among the Pueblos (Ellis 1971:64; Simmons 1979:186). Vargas returned to Santa Fe in 1693, staging his expedition out of El Paso del Norte, but had to fight several pitched battles. After displacing the Tanos from Santa Fe and pacifying the other Pueblos, Vargas reestablished the New Mexican colony.

Spanish Colonial Period (1692-1821)

Hostilities with the Pueblos continued until around 1700, but by the early years of the eighteenth century the Spanish were again in control of New Mexico. Though failing in its attempt to throw off the Spanish yoke, the Pueblo Revolt caused many significant changes. The system of tribute and forced labor was never reestablished, and the missions were scaled back (Simmons 1979). With the reconquest of New Mexico, much of the earlier economic system was abandoned. The dominance of the church and mission supply caravans eventually ended. The new economic power was the families who prospered by dealing in sheep. By the middle of the eighteenth century a considerable trade developed over the Camino Real between New Mexico and Chihuahua (Athearn 1974), mostly to the benefit of the Chihuahuan merchants. Most trade goods were transported on mule back in annual caravans, carrying raw materials and items produced by cottage industries south and manufactured and luxury goods north.

New Mexico suffered from hostile Indian activity virtually from its founding (Forbes 1960), though certain periods were worse than others. Attacks by Utes and Comanches began as early as 1716, as the Comanches sought to drive the Apaches from the Plains and cut their economic ties to the French colony in Louisiana (Noyes 1993). Having been pushed off the Plains by 1740, various Apache groups were attempting to establish new territories and support themselves in any way possible. Governor Anza concluded a peace treaty with the Comanches in 1786, which included an alliance against the Apaches (Noyes 1993:80; Thomas 1932:75). Later the same year, Anza broke up an alliance between the Gila Apaches and Navajos, and concluded a peace with the Navajos (Thomas 1932:52). This brought New Mexico into a period of relative peace and improved economic conditions (Frank 1992:95). Caravans still followed an irregular schedule, but by the middle of the eighteenth century they operated almost annually (Connor and Skaggs 1977:21). Unfortunately, nationalistic unrest in Mexico cut this period of economic prosperity short, and interfered with the movement of goods throughout Mexico. The war for independence from Spain began in 1810, and continued until 1821.

Mexican Period (1821-1848)

Under the Treaty of Cordova, Mexico gained its independence in 1821, and New Mexico became part of the Mexican nation. Trade between Missouri and New Mexico began that same year, and dominated the New Mexican economy for the next quarter century (Connor and Skaggs 1977). Trade with the United States brought ample inexpensive goods to New Mexico and broke the Chihuahuan monopoly. Trade over the Santa Fe Trail soon expanded to Chihuahua, with most of the goods carried by the Santa Fe traders being transported south over the Camino Real until the Mexican War of 1846-1847. The importance of the Camino Real as a transportation corridor increased during this period with this link to the United States via the Santa Fe Trail providing a new source of manufactured goods and other imports. The Mexican War resulted in the annexation of New Mexico by the United States. The years immediately following the war were characterized by a growing interest in commerce and a market economy that demanded more dependable means of transportation (Pratt and Snow 1988).

American Period (1848-World War II)

After a disruption of trade by the Civil War, a resurgence of trade over the Santa Fe Trail and the Camino Real that occurred after the war ended actually helped doom them. Railroad promoters saw the possibilities of overland routes to the west and began developing their finances (Connor and Skaggs 1977:204). The railroad reached Santa Fe by 1880 (Glover and McCall 1988), effectively bringing commercial use of the Santa Fe Trail to an end. By 1881, the railroad was extended south to El Paso, and by 1882 El Paso was connected by rail to Juarez (Myrick 1990). These developments ended use of the Camino Real as a major commercial route. Thus, both trails were superseded by more efficient transportation systems in the late nineteenth century, bringing to a close their dominance as transportation corridors.

The arrival of the railroad significantly altered supply patterns in New Mexico. With this link to the eastern United States, New Mexico entered a period of economic growth and development, especially in the larger urban areas (Pratt and Snow 1988:441). This link began the process of ending New Mexico's position as a frontier territory by better tying it to a national economy. In addition to increasing ease and volume of supply to the region, New Mexico became more accessible to tourists, who soon became an important part of the local economy. With the availability of rapid and inexpensive transport, several industries boomed in New Mexico. Sheep and wool production expanded, and the cattle business began its climb toward becoming the dominant ranching industry. Mining expanded into the early 1900s, with coal becoming an important export. The transformation of the New Mexican economy into its modern form was well under way by the time it became the 47th state in 1912.

A Brief Survey of Archaeological Sites in the Study Area

According to a search of the records conducted by Quaranta and Gibbs (2008), seven archaeological studies were previously conducted in or near the study area, four of which located sites now within the Spaceport America APE (Duran 1986; Marshall 1991; Human Systems Research 1997, unpublished survey data), and three that did not intersect with the study area (Hester 1977; Hilley 1983; Duran 1985). Additional surveys were conducted by Zia Engineering and Environmental Consultants for Spaceport America (Gibbs 2008; Lawrence et al. 2010; Quaranta and Gibbs 2008). Table 3.1 provides basic information on these studies as obtained from NMCRIS, and contains a total of 317 sites (see Appendix 1 for details), ranging from the Paleoindian period through the recent Historical period. The number of sites in Appendix 1 differs from the totals shown in Table 3.1 because of various revisits to sites that were sometimes examined by other projects on that list, as well as some that were not. Without going into great detail, we can summarize this array of sites and showcase one survey—a sample of the northern Jornada del Muerto reported by Hester (1977)—to provide a partial picture of what types of sites have been recorded in and around the project area. It should be noted that not all of the sites recorded by Marshall's (1991) survey of the Camino Real are actually located in the vicinity of Spaceport America, but those that are in different areas are not culled from Appendix 1. For example, LA 7—La Bajada Pueblo—is included in the list, but is located just south of La Bajada Mesa in the northern Rio Grande Valley. Of the 37 new sites recorded by Marshall's survey, only four are definitely within the study area, and they were reinventoried during a survey conducted by Human Systems Research (1997). Thus, this list is subject to revision.

Only one prehistoric to historic period Pueblo site—the aforementioned LA 7—is included in Appendix 1 and can be ignored because it far north of the project area. Most of the sites (n=263; 87.37 percent) are single component, while the remaining 54 sites contain 116 different components. Paleoindian use is represented by 4 single component sites and 12 components on other sites, for a total of 16 components. These include 3 Folsom locales, 4 Plano locales, and 9 locales that were assigned general Paleoindian dates. While the number of Paleoindian components seems low, this is actually a fairly large number for such a comparatively small region. Unfortunately, from survey data alone it is impossible to determine how many actually represent Paleoindian occupations and how many are simply Paleoindian tools that were salvaged and redeposited on later sites.

Archaic occupations are represented by 29 single component locales and 32 components on other sites, for a total of 61 components. Sites from this long period are much more common than were those of the Paleoindian period, and Archaic components are third most common overall for the project area. Only 2 components

Table 3.1. Previous cultural resource activities within general vicinity of the current project

NMCRIS #	Year	Performing Agency	Acres	Activity	New	# of Sites Revisited	Total
636	1983	New Mexico State University (NMSU) Cultural Resource Management Division	469	Linear Survey	13	0	13
7023	1985	Human Systems Research	57	Block and Linear Survey	4	1	5
26132	1977	University of Texas-San Antonio Department of Anthropology	960	Block Survey	96	0	96
39797	1991	Cibola Research Consultants	1,601	Linear Survey	37	3	40
46610	1986	Human Systems Research	0	Monitoring	0	9	9
49589	1997	Human Systems Research	4,096	Block and Linear Survey	113	13	126
98713	2006	Human Systems Research	41	Unspecified Survey	0	3	3
104538	2007	Zia Engineering & Environmental Cons.	2,710	Block and Linear Survey	18	25	43
106719	2007	Zia Engineering & Environmental Cons.	455	Block and Linear Survey	20	2	22
118255	2010	Zia Engineering & Environmental Cons.	88	Block Survey & Monitoring	0	0	0
Totals			**10,477**		**301**	**56**	**357**

were dated to the Early Archaic period, with 10 assigned to the Middle Archaic and 15 to the Late Archaic. The remaining 34 components are generally dated to the period.

Formative period occupations are represented by 76 single component locales and 24 components on other sites, for a total of 100 components. Formative period components are the most common of those that can be assigned dates, and this is the second most common category overall. Twenty-one components are assigned to the Mesilla phase, 3 to the Doña Ana phase, 13 to the El Paso phase, and the remaining 65 were assigned a general Jornada Mogollon affinity.

Definite Protohistoric components were rare, and are represented by only 1 single component locale and 2 components on other sites. All three components are considered representative of Apache occupations. Combining Hispanic and Anglo locales, a total of 69 historic components are represented in the area, consisting of 42 single component locales and 27 components on other sites. Most of the remaining sites and components could not be assigned to any specific occupational period, and this is overall the most common category. Unknown sites include 109 single component sites and 15 components on other sites. The 4 remaining components are late Pueblo manifestations (2 single component sites and 2 components on other sites), and are probably outside the area of interest.

The study that will be discussed in somewhat greater detail was a sample survey of land administered by the Bureau of Land Management in the northern Jornada del Muerto (Hester 1977). A total of 96 sites was recorded by this study, and included (using their terminology) a felsite quarry, a petroglyph site, 1 historic cemetery, 2 bead caches, 2 ceramic scatters, 5 hearths lacking associated artifacts, 5 ceramic period villages, 8 lithic scatters, 33 lithic campsites, and 38 ceramic period campsites.

Of these sites, the 5 ceramic period villages probably deserve the greatest amount of attention. Three of these villages were damaged by illicit excavation at the time of the survey. One is a large pithouse village located on an alluvial fan a few miles west of the San Andres Mountains (Hester 1977:35). This site has suffered considerably from illegal excavations, and reportedly contained intact roof beams and human remains. Dating to the late Mesilla and Doña Ana phases, this site probably contains multiple pit structures. A second village was located in the Rio Grande Valley, and had also suffered form illicit excavation. Pithouses are present at this site, which may represent a Mimbres rather than Jornada Mogollon occupation. The third site is a very large Mimbres village located along an arroyo draining the San Andres Mountains.

Two possible village sites did not appear to have suffered from illicit excavation at the time of the survey. The first of these is located in the middle of the Jornada del Muerto basin. While no evidence of structures was noted at this site, the density of the artifact scatter and the number of features exposed by deflation suggested that houses might be present. This site was thought to date to the Doña Ana phase or later. The second site may represent a Mesilla phase occupation, and is located on an alluvial fan of the Caballo Mountains. Again, this site was considered to be a village because of the density of associated artifacts, and the presence of structures is suspected.

The 33 lithic campsites were categorized as such by the presence of chipped stone artifacts and features, and the absence of ceramics. These sites were assigned dates ranging from the Paleoindian through Archaic periods, and may also contain some Apache components. In contrast, no features were seen at the 8 sites categorized as simple lithic scatters. The 38 ceramic campsites were similar to the lithic campsites with the addition of pottery to their assemblages. While some of the larger sites in this category could represent villages, they contained no visible evidence of structures or artifact densities similar to those seen at the 5 village sites. The 2 sites categorized as ceramic scatters contained no visible features or chipped stone artifacts. The remaining categories are represented by only a few examples apiece, and except for the historic cemetery, could not be accurately dated.

The results of Hester's (1977) survey provide a microcosm of the types of sites that occur in the region. Most of these sites appear to be campsites, perhaps repeatedly used, dating to the Archaic and Jornada Mogollon periods. However, the presence of several villages in the region, mostly located on alluvial fans near the mountains, suggests a settlement pattern similar to the models proposed by Hard (1983b) and Whalen (1994), with cold season villages located near permanent water sources and arable land and warm season camps situated in basin interiors. Interestingly, both Jornada and Mimbres villages occur in the region, suggesting a frontier situation. The two possible villages situated in the basin interior may actually represent prime locations for repeated uses through time rather than villages, though this possibility cannot be ruled out without further study.

The sites proposed for further investigation during the present study easily fit the pattern, both temporally and in terms of site classification, that was seen during Hester's (1977) survey. The only types that do not occur among the 14 sites that will be studied in more detail are the ceramic villages and several of the rarer categories. Both the lithic and ceramic campsite categories are represented, though the former is much more common in the current project area.

Chapter 4: Field Methods

James L. Moore

This chapter provides a general overview of field methods that will be used during all phases of investigation at Spaceport America. While the same general methods will be used during each investigative phase, some variations will be necessitated by the different goals of each phase, the type of site being examined, and whether a site is being examined for compliance or research purposes. General methods of excavation that will pertain in most situations are discussed in this chapter, and site-specific applications are presented in the individual site descriptions in Chapter 6.

Phasing and Levels of Effort

Three basic levels of investigation are defined for this study in both the *Cultural Resources Protection, Preservation, and Mitigation Plan for Spaceport America* (CRPPMP hereafter; FAA and NMSA 2110a:27-32) and the *Mitigation Plan for Archaeology at the Spaceport America* (FAA and NMSA 2010b:6-12) including site assessment, testing, and excavation. Assessment and testing have and will be used to help evaluate sites whose eligibility for inclusion on the state or national registers is currently undetermined or to ascertain whether the affected part(s) of an eligible site contains intact cultural features or deposits. In cases where eligibility status is undetermined, insufficient data were available from survey recording to allow a site to be assessed for eligibility for inclusion in the state or national registers. By default, these properties must be considered potentially eligible until sufficient data have been collected to permit a final determination of their status. If construction will encroach on sites of undetermined status, data should be collected that will allow that final determination to be made, if possible. Formal levels of testing effort will be employed in site assessments, noting that these levels of effort will vary in accordance with the management and testing goals, but in no case exceeding 5% of the total area of any site.

Two types of excavation are contemplated: data recovery and research. Data recovery will be completed on sites that are in the path of a planned disturbance, and will focus on areas within construction corridors and adjacent buffer zones. While areas outside the construction/buffer zone will be re-examined and mapped, data recovery excavations will be restricted to the zone of affect. These excavations will permit the recovery of information that would otherwise be lost during construction, and will provide data that can be used to address one or more of a series of research questions that are posed in a later chapter. Research excavations will focus on portions of sites that are not in immediate danger of disturbance by construction, but that are expected to provide information that can be used to address some of the same research questions posed for data recovery, as well as supplemental questions that data recovery excavations may be unable to address. While essentially the same field methods will be used for each phase, there may be some differences conditioned by the level of effort and requirements of the mitigation plan. Each level of investigation is discussed below, followed by a consideration of standards for surface collection and the in-field recording of artifacts on some sites, as proposed by FAA and NMSA (2010b:10-11). Information on which of these procedures is recommended for each site is included in the individual site descriptions in Chapter 6.

Site Assessment

Assessment refers to a review of proposed disturbance areas within sites of eligible or undetermined status in order to provide a recommendation concerning the treatment of cultural materials within that zone (FAA and NMSA 2010b:9). Sites that have an undetermined status and will be affected by construction will be examined in more detail than was possible during survey in order to collect sufficient data to complete their eligibility assessment. The affected parts of sites that have previously been determined to be eligible will be examined to evaluate their potential to contain intact cultural features or deposits within the construction/buffer zone. This phase will begin with a surface examination of the construction/buffer zone to locate the remains of any potential cultural features or areas that may contain intact cultural deposits. If such are located, limited testing involving the use of 50-by-50-cm grids or hand augers may be used to supplement surface observations. If a site is found to contain intact cultural features or deposits during assessment, a change in its evaluation status to "eligible" will be recommended. If the results are negative, a recommendation for a change of its status to "not eligible" will be recommended. These results will be included in written recommendations for any actions that are suggested to follow the assessment phase (FAA and NMSA 2010b:9).

Site Testing

Testing refers to a formal evaluation of a site or an affected part of a site to determine whether intact cultural deposits or features are present. The status of a site scheduled for testing could either be undetermined or eligible for inclusion in the state or national registers. In both cases, testing will be applied only to the part of the site that will be affected by construction activities, including a 15 m wide buffer area outside the construction zone. Testing represents a more intensive way of evaluating a site or part of a site to determine whether potentially important cultural features or deposits might be present. Thus, testing is essentially a more detailed assessment of a site than is possible using the methods discussed in the preceding section. If testing is performed on a site with undetermined status and potentially significant cultural features or deposits are identified, a change in its status to "eligible" will be recommended. Conversely, if no such features or deposits are encountered, a change in its status to "not eligible" will be recommended.

Data Recovery

This is a phase of intensive excavation used to recover information from areas that will be directly affected by construction activities, as well as from buffer areas adjacent to the construction zone. Data recovery is only performed on sites evaluated as eligible for inclusion in the state or national registers, and may or may not be preceded by an assessment or testing phase. When assessment or testing confirm that sites whose status was initially undetermined contain potentially important cultural features or deposits, then areas within construction/buffer zones may be more intensively examined by data recovery. When assessment or testing on eligible sites determines that potentially significant cultural features or deposits are present within a construction/buffer zone, those areas may also be more intensively investigated during this phase. In some cases, survey information indicated that sites were eligible, and that potentially important cultural features or deposits were noted within construction/buffer zones. In cases like these, the sites may go directly to data recovery without further assessment or testing.

Research Excavations

This phase will focus on the investigation of portions of sites expected to yield data that will help address specific research questions, either those that are developed for data recovery investigations, or a separate set of questions directed at specific aspects of the cultural environment, culture history, or site structure. Research excavations may occur at sites that contain areas in which data recovery has occurred as well as sites for which data recovery was not performed. However, investigations conducted during this phase will occur in areas outside any associated construction/buffer zones, and will be targeted at acquiring information specific to one or more of the research questions developed in this plan.

Surface Collection and In-Field Analysis

The collection of artifacts from the surface of a site will only be conducted under specific circumstances as outlined in the mitigation plan (FAA and NMSA 2010b:10-11). Visible artifacts located on the ground surface within construction/buffer zones will be collected before the initiation of any construction activities. This procedure does not include artifacts located on the surface of excavation units, which are collected and provenienced to the excavation unit during excavation activities. Surface collection will be completed during the last evaluation phase applied to a site. Thus, if no potentially significant cultural features or deposits are identified during assessment or testing and no further work is recommended for that site, surface collection will be accomplished as part of these phases. If data recovery is recommended for part of a site that will be affected by construction activities, surface collection will be completed prior to the initiation of archaeological excavations. In most of these cases, artifacts will be point provenienced as they are collected.

Controlled collections of surface artifacts may be made in certain circumstances as recommended by the mitigation plan. This method refers to the systematic collection of artifacts from a series of sample units, either judgmentally or statistically placed on a site. If controlled collection is recommended for a small site and will result in the removal of all or nearly all artifacts from the surface, collection will be made by point provenience. Otherwise, sample units will consist of variably-sized blocks from which artifacts will be recovered in 1-by-1 m grid units. All surface collection units, whether blocks or point provenienced, will be located on site plans to provide a record of their placement at the time of collection.

Another option that might be used involves the in-field analysis of artifacts. This procedure will be accomplished in units similar to those used for controlled surface collections. On small sites where it might be desirable to collect information on all visible artifacts, specimens will be point provenienced. On larger sites where only part of the artifact population will be examined, sample blocks or transects will be defined and all cultural materials contained within them will be analyzed. In-field artifact analysis will be conducted in such a manner as to make the results consistent with those of the more detailed analysis that will be applied to collected artifacts under laboratory conditions. A minimum number of attributes distinguishable under no or very low magnification (5-10X) will be established, and data will be collected in a way that will allow them to be meshed with the results of more intensive analysis. At a minimum this will include artifact/ware type, artifact morphology where appropriate, material type where appropriate, modifications, and dimensions. Other attributes may also be examined if appropriate.

General Excavation Procedures

Horizontal Proveniencing: The Grid System

A Cartesian grid system will be established that will tie measurements for all sites into the NAD 83 UTM projection, allowing precise spatial plotting of excavation areas, features, site boundaries, and any other mapped aspects of archaeological sites. A main site datum and backsight will be established for each site and precisely plotted so that they are tied into the overall project grid system. The project grid system will also be tied, in the field, to existing survey monuments. This will be followed by the imposition of a 1-by-1-m grid system tied to main site datums over each site to facilitate horizontal referencing. Grid lines will be established at even meter intervals within the UTM system. Individual grid units will be referenced by the grid lines that cross at their southwest corners, and grid lines will be labeled according to the last four digits of their UTM designation. Thus, a grid line placed along the E 345567 UTM line will be labeled as the 567E grid line.

While most excavation, except during site assessment, will be accomplished in these 1-by-1-m grids, they may not be used for excavation under all circumstances because they are not always the most efficient unit of excavation. This is especially true when dealing with structures and small features. Except when on or just above floors, excavation by grids may provide a higher level of horizontal control than is needed or desired within structures. It is also very time consuming, which is an important consideration. When a series of strata reflecting a sequence of depositional episodes over time is present, vertical control is often more important than horizontal control. While the soil stratum that is represented needs to be known, the grid location may not be as meaningful, especially if the stratum is of non-cultural origin. Of course, both horizontal and vertical controls are important when deposits reflect specific cultural activities. Thus, excavation units will differ in size and shape depending on the nature of the deposits being investigated.

It must also be remembered that grids are artificially imposed over sites. They are a construct used to provenience cultural materials and features so that their original relationship can be preserved for later study. Rarely do features conform to a grid system. When features are large it may be desirable to excavate by grid to provide detailed information on the placement of materials within them. However, excavation in grids is often awkward in small features, especially when those features extend into one or more grids. Thus, features, rather than the grids in which they occur, may be treated as independent excavation units.

In order to speed excavation during surface stripping and in large areas of excavation, 2-by-2-m blocks may be recorded as single excavation units. However, if this is done, excavation within the 2-by-2-m blocks will still be accomplished in 1-by-1-m grid units, with all artifacts from individual grids provenienced separately. A single form recording excavational data will be completed for all four grids included in the block, referencing the various field specimen numbers assigned to any artifacts that are recovered as well as vertical measurements for the corners of all included 1-by-1-m grid units. This will preserve the precision provided by excavation in 1-by-1-m grids, while reducing the amount of paperwork and the time spent in its preparation.

Vertical Proveniencing: Strata and Levels

Just as the grid system for each site is tied to a main datum linked to its UTM location, so are all elevations; thus, the main site datum is also used to reference all vertical measurements. While the elevation above sea level will be recorded for the main datum, that point will also be assigned an arbitrary elevation sufficient to embrace the elevational range of the site. This arbitrary elevation, and all arbitrary elevations of units and sample locations, will be used during excavation but can be converted to precise elevations at a later date if desired. Since it is often difficult to use one datum to provide vertical control for an entire site, subdatums will be established when needed, and their elevations and horizontal coordinates will be determined relative to that of the main site datum.

The vertical treatment of deposits will vary according to their nature. Cultural deposits will be carefully excavated to preserve as much of the vertical relationship between materials as possible. Such care will not be taken with non-cultural deposits, since the relationship between artifacts in deposits that built up naturally is rarely as meaningful. For example, numerous artifacts can occur in culturally-deposited trash layers as well as in colluvially deposited non-cultural fill in structures, but both of these types of deposit can be interpreted differently. Trash represents materials that were purposely discarded, and can often be separated by stratum to determine the sequence of deposition and allow researchers to look for minute changes in assemblages. Artifacts in colluvially-deposited strata rarely have any similar meaning, and usually consist of materials washed in from eroding cultural features or deposits in adjacent areas. Trash deposits require careful excavation to preserve the relationship between layers of materials discarded at different times. Equal precision is rarely useful in non-cultural deposits, and because they were moved from their original context and redeposited, they tend to be jumbled and mixed and the relationship between artifacts is almost always obscured. Thus, accurate vertical controls may be unnecessary in some cases. While we will always attempt to excavate cultural deposits by stratum, that level of control will only be used in non-cultural strata if it appears that it will provide data of potential importance to site interpretation. However, at the discretion of the site supervisor, massive cultural strata may be subdivided into two or more vertical units.

Two methods will be used to track vertical excavation units: strata and levels. Soil strata will be assigned unique numeric designations as they are encountered, and descriptions of each will be recorded on individual forms. In order to track the sequence of strata from one area to another, each vertical excavation unit will also be assigned a level number, beginning with the surface. Since the surface is an arbitrary level with no thickness, it will be designated

Level 0. The first vertical excavation unit to be dug will be labeled Level 1, the second Level 2, and so on. Since stratum and level numbers represent two completely different series, stratum numbers may not be in sequence as excavation proceeds downward, but level numbers will always be in sequence.

Auger Tests

Soil augers may be used to help locate subsurface cultural deposits, features, and structures during all phases of investigation. The spacing between auger transects or auger tests within transects will depend on conditions encountered at each site for which this technique is used. Under most circumstances, auger transects and auger holes within transects may be spaced no more than 2 m apart, an interval thought sufficient to capture information on any buried structures or cultural deposits that might be present. However, depending on the structure of a site and whether buried soil strata have any potential for containing intact cultural features or deposits, this spacing may be altered to fit the needs of the investigators. Soil removed from auger holes will be screened through 1/8 inch mesh hardware cloth to determine whether cultural materials are present. The results of each auger test will be recorded on a standard form, detailing changes in soil texture, color, and/or content, and what cultural materials (if any) were recovered and from what depths.

Recording Excavation Units

The excavation of a grid or other unit will begin by filling out a form for the surface that provides initial depths and describes other pertinent data. Ending depths for each succeeding level will be recorded on relevant forms, providing a record of all excavations. Recording forms will be completed for each level, including the surface, and will describe soils, inventory cultural materials recovered, and provide other observations considered relevant by the excavator or site supervisor including depths, stratum, and level. A description of soil matrix will also be provided, and should include information on cultural and non-cultural inclusions, evidence of disturbance, and how artifacts and other materials, such as gravels, are distributed if variations are noticed.

Recovery of Cultural Materials

Most artifacts will be recovered in two ways: visual inspection of levels as they are excavated and screening though hardware cloth with variably-sized mesh. Projectile points and other diagnostic formal tools may be collected from the surface during site mapping. Other materials will be collected in bulk samples that can be processed in the laboratory rather than in the field. Regardless of how cultural materials are collected, they will all be inventoried and recorded in the same way. Collected materials will be assigned a field specimen (FS) number, which will be listed in a catalog and noted on all related excavation forms and artifact bags. This will allow the relationship between recovered materials and where they were found to be maintained. All materials collected from a unit of excavation will receive the same FS number. Thus, if chipped stone, ceramic, and bone artifacts are recovered from the same level, they will all be designated by the same FS number, as would any samples taken from that level. Architectural or chronometric samples that are not associated with specific units of excavation will receive unique FS numbers.

Most artifacts will be recovered by systematically screening soil strata. All sediments removed during the hand-excavation of grid units in cultural deposits and features will be passed through screens. Two sizes of screen will be used. Most fill will be passed through 1/4 inch mesh hardware cloth, but 1/8 inch mesh hardware cloth may be used in certain circumstances. While most artifacts are usually large enough to be recovered by 1/4 inch mesh hardware cloth, some that are too small to be retrieved by that size screen can also provide important clues to the activities that occurred at a site. However, there is a trade-off in gaining this additional information. As the size of mesh decreases, the amount of time required to process sediments and recover artifacts increases. Sampling is a way to balance these concerns; thus, smaller mesh will only be used under certain circumstances. Rather than establishing specific guidelines for sampling by 1/8 inch mesh screens, it is considered better to leave this up to the discretion of the site supervisor. Sediments from non-cultural strata may not be screened after the non-cultural nature of that particular deposit has been established. In this case, artifacts seen during excavation will be recovered for analysis, especially if they appear to be temporally diagnostic, complete, or otherwise have potential to expand the data base in a meaningful way. While this will not be a statistically valid sample, it will increase the number of artifacts recovered.

Other cultural materials, primarily botanical in nature, will be recovered from bulk soil samples. Sampling methods for these materials are detailed later. In general, however, sediments for flotation analysis will be collected from culturally-deposited strata and features, and should contain at least 2 liters of soil, if possible. Macrobotanical materials will be collected as individual samples whenever found. Botanical samples will be cataloged by type of sample, and noted on pertinent excavation forms.

Mechanical Excavation

Mechanical excavation using a backhoe or blade may be done in conjunction with testing, data recovery, or research-oriented excavation. In particular, a backhoe may be used to excavate exploratory trenches during these phases in order to look for buried cultural structures, features, or deposits that are not otherwise definable from surface observation. During all investigative phases, mechanical equipment may also be used to blade away non-cultural fill when present in appreciable thicknesses above cultural deposits, structures, or features. Mechanical equipment will also be used to excavate trenches for the recovery of geomorphological data and stratigraphic information including (but not limited to) descriptions of natural soil units and the recovery of chronometric samples. All mechanical excavations will be mapped so their locations can be accurately plotted on site plans, and their documentation will include the dimensions of excavation areas, beginning and ending depths, descriptions of sediment strata and cultural materials encountered, and representative stratigraphic profiles, even if no cultural materials are found.

Specific Excavation Methods

Excavation of the constituent parts of a site will approached in different ways, even though the mechanics of excavation will usually be the same. Most excavation will be accomplished using hand tools. However, as discussed above, in some situations it may be preferable to use mechanical equipment to expedite the removal of non-cultural deposits or to trench through parts of a site to examine soil profiles and look for cultural deposits and features that are deeply buried or are not visible from the surface. Specific methods of excavation will vary depending on whether a structure, feature, or extramural deposits are being examined.

Structures

Individual and unique numeric designations will be assigned to any structures identified at a site, as well as to individual rooms, should multi-roomed structures be encountered. For consistency, single-roomed structures will also receive a room designation. Excavation will usually begin by digging an exploratory trench from one wall to the center of large rooms (more than 4 m in diameter), and completely across small rooms (less than 4 m in diameter). This will permit definition of the nature of internal deposits, and whether they are of cultural or non-cultural origin. An exception to this will be rooms exposed in a mechanically-excavated trench, if the trench extends across the entire room. In this case, an exploratory trench will not be needed because internal strata will have already been exposed for examination and profiling. When used to examine rooms, exploratory trenches will be excavated by grids to provide a cross-section of deposits. When the nature of the fill is defined, the rest of the room will be excavated by grid units or quadrants, depending on room size. Small rooms will be excavated by grid units, while large rooms will be excavated by quadrants. Quadrant boundaries in large rooms will be determined by the locations of the grid lines that cross a room; thus, they will not always be the same size.

All fill from each room will be screened through 1/8 or 1/4 inch mesh hardware cloth. Because of safety concerns, exploratory trenches in deep rooms (should any be encountered) will be excavated no deeper than 1.30 m before being expanded by removing a quadrant (after the exposed wall is profiled). In all cases except exploratory trenches, excavation will be halted 5-10 cm above the floor to prevent damage to its surface, and to permit a more systematic recovery of materials found in contact with or just above the floor. Materials from the last 5-10 cm above floors will be removed by grid in all cases and screened through 1/8 inch mesh hardware cloth.

Architectural details will be recorded on a series of forms following the completion of excavation in a structure. However, when building elements are encountered in fill during excavation they will be recorded on the pertinent excavation form. When wooden roof elements are found during excavation they will be mapped and described, and samples collected for species identification and potential tree-ring dating. Descriptions of individual rooms will include information on wall dimensions, construction materials and techniques, and associated features. Structure descriptions will include information on size and dimensions, a general description, and a sketch plan. In addition to profiles, plans of each structure will be drawn, detailing the locations of any separate rooms and internal features, artifacts found in direct contact with floors, and any other aspects considered important. A series of photographs (digital and black-and-white) will be completed for each structure showing its overall form, any individual rooms that might be present, construction details, and the relationship of features with other architectural elements.

Features

Features will constitute individual units of excavation. As they are encountered at a site, features will be assigned a unique number. Small features (less than 2 m in diameter) will usually be excavated differently than large features (greater than 2 m in diameter). After defining the horizontal extent of small features like hearths and ash pits, they will be divided in half. One half will be excavated in 10 cm arbitrary levels to define internal strata, and a profile of the exposed fill will be drawn. The second half will then be removed by strata. Excavation data for sections removed from small features will be recorded on Nongrid Unit Excavation forms, and the information included on this form parallels those recorded on Grid Excavation forms, with the main variation occurring in how locational information is documented. In general, soil removed from small features will be screened through 1/8 inch mesh hardware cloth. At times, however, it may be preferable to collect all soil from a small feature as a bulk sample to be examined for macrobotanical materials as well as other artifact types. In addition, should feature fill be stained by organic material but no charcoal fragments are visible, much or all of the fill in a small feature may be collected as a bulk soil sample for radiocarbon analysis. Plans showing locations and sizes of excavation units will be drawn for each feature. A second cross-section illustrating the vertical form of the feature perpendicular to the profile will be drawn, as will a plan of the feature. A summary form will be filled out after excavation is completed that describes the shape, contents, and construction details.

Large features will usually be excavated by grid unit. The number of exploratory grids will be kept to a minimum, and as much of the feature as possible will be excavated by soil strata. Standard Grid Unit Excavation forms will be completed for each excavated unit. A sample consisting of one or more grids (at the discretion of the site supervisor) will be screened through 1/8 inch mesh hardware cloth; otherwise 1/4 inch mesh will be used. At least two perpendicular profiles will be drawn, when possible, and summary forms and plans that describe and detail feature shape and contents will be completed. Large features that are not treated in this way will be excavated using the same methods applied to small features. The method of excavation used for a particular feature will be left to the discretion of the site supervisor in consultation with the project director. All features will be photographed before and after excavation, when possible. Other photographs showing construction or excavation details will be taken at the discretion of the excavator.

Extramural Excavation Areas

Areas outside structures and extramural features were often used as activity areas and their examination can sometimes provide important information on site structure and function. Thus, certain zones will be investigated to determine whether such activity areas can be defined. In particular, zones around intact extramural cultural features will be examined in order to determine whether evidence of any activities performed there can be found. Excavation in these zones will proceed by grids. Most sediments encountered during these investigations will be screened through 1/4 inch mesh hardware cloth, though a smaller-sized mesh may sometimes be used to sample the smaller fraction of artifacts that might be present. Plans of each extramural area investigated will be drawn, detailing the excavated grids in relation to any features that might be present. When non-cultural strata occur above cultural strata in extramural excavation areas, they may be removed without screening.

Sediment Samples

Sediment samples will be obtained for three purposes. Samples of any alluvial clays that might be encountered during excavation in non-cultural strata will be collected to determine whether they might have been used in pottery manufacture. Samples of different sediment strata may be obtained from trenches used to investigate site geomorphology and stratigraphy in order to provide detailed information on soil formation processes. Finally, sediment samples may be obtained from both cultural and non-cultural strata, especially the former, for luminescence dating. This will aid in reconstructions of past environments and geomorphological processes.

Botanical Sampling

The collection of samples for botanical analysis will focus on contexts that can provide the best information on plant use and foodways, or that may provide materials amenable to absolute dating. Five types of botanical samples will be collected for analysis—flotation, pollen, radiocarbon, macrobotanical, and dendrological wood. The collection of flotation and pollen samples will be standardized in order to recover consistent data from similar contexts. Within structures, flotation and pollen samples will be taken at floor contacts from alternating grid units within rooms. Pollen samples may also be taken from geological contexts in selected situations as an aid to the reconstruction of soil formation processes and environmental conditions at the time of site occupation. Other flotation samples will be taken at or near the base of deposits in all features that are large enough to produce sufficient material for sampling, and at least one sample will be taken from each cultural stratum, especially trash deposits. Additional pollen samples will be taken from near the base of non-thermal features.

If intact ceramic vessels are encountered during excavation, soil will be left inside them, and will only be removed after the vessels are returned to the laboratory to allow pollen wash samples to be obtained without risking contamination from modern sources. Pollen washes will also be obtained from ground stone tools that are found in place. In addition to these samples, residue samples may also be obtained from ground stone tools to help define the type of plant(s) that were processed.

Macrobotanical samples will be collected to aid in defining prehistoric or historic foodways and botanical resource use. However, there are no standardized strategies for collecting these samples. Rather, the collection of macrobotanical samples will be opportunistic. Seeds, nut shells, and other plant parts will be collected when encountered during excavation or screening if they have potential for providing information on botanical resource use. Unburned materials, especially wood fragments will not be retained for analysis unless they show evidence of having been culturally modified other than by fire, such as building materials. While macrobotanical specimens do not represent a statistically valid sample, they can provide important subsidiary information on how plants were used at an archaeological site.

Two types of botanical samples amenable to providing absolute dates will be obtained when available. Radiocarbon samples will be taken from targeted locations. These primarily consist of thermal features and construction materials, when available, though additional scatter samples may be taken from cultural strata to ensure that sufficient dateable materials were available for analysis. However, this last source is considered to be a less reliable indicator of the actual period of site occupation, and scatter samples usually will not be analyzed if several dates are available from features or architectural materials. Samples of geological charcoal will also be taken for geomorphological and stratigraphic studies, if available. Samples for tree-ring dating will be obtained, when available. This may include comparatively large, intact fragments of charcoal from thermal features as well as structural wood elements. Besides providing temporal data, the species composition of radiocarbon and tree-ring samples should provide data on wood use patterns for construction and fuel.

Residue Analysis

A sample of chipped stone formal tools, such as projectile points and knives, may be submitted for residue analysis if they appear to have potential to provide relevant data. Informally-used chipped stone tools may also be submitted for this type of analysis. Analysis of protein residues adhering to tools of this type could provide supplementary information on the range of animals that were hunted, consumed, and used for the production of leather and other goods.

Backfilling

Upon completion of excavation, all excavated units will be backfilled. Mechanically-excavated trenches will be backfilled using mechanical equipment, while units that were excavated by hand will be backfilled by hand to prevent inadvertent damage to adjacent unexcavated areas. A layer of geocloth will be used to line the bottom of excavation units that are over 20 cm deep, while those that are shallower will not be lined. Shallow excavation units will not be lined because of the possibility that eolian processes could expose the geocloth and spread it across the landscape.

Special Situations

Special situations can arise that were not anticipated before commencing excavation. These can include the discovery of human remains or other items of a sensitive nature. Unless visible from the surface, the presence of human burials can rarely be predicted before excavation begins. An exception to this is historic burials in a marked cemetery plot, but this type of feature has not been reported for any of the sites scheduled to be investigated by this study. The presence of other types of sensitive materials also cannot be predicted with any accuracy. This class of materials includes objects of ritual or religious importance that were either purposely cached at a site, left in place when a site was no longer occupied, or lost. This section discusses the general procedures that will be followed in the event that materials of a sensitive nature are encountered, with more specific information pertaining to the recovery of human remains appearing in Chapter 7 and Appendix 2.

Unexpected Discoveries

Unexpected discoveries are also possible during an archaeological investigation, and the procedures that will be followed in such an event are broadly detailed. Procedures and protocols for dealing with unexpected discoveries of human remains and other cultural resources during construction and facility operation have been developed to comply with pertinent federal and state regulations and guidelines. This plan is detailed in Appendix 4 of the CRPPMP (FAA and NMSA 2010a). While this plan details procedures that will be implemented in case of an unexpected discovery during construction activities and operation of Spaceport America, and specifically does not pertain to intentional archaeological investigations, any guidelines that are pertinent to the current study will also be adhered to. This especially includes those related to the excavation, analysis, handling, and reporting of human remains. These topics are discussed in the following sections.

There is always a risk of finding unexpected deposits or features during an archaeological excavation, and this study is no exception. The procedure that will be followed in the event of an unexpected discovery will vary with the nature and extent of the find. The procedures that will be followed should human remains be discovered were detailed above. Unexpected discoveries are of most relevance during the data recovery phase. Any such finds encountered during site assessment or testing will be discussed in the related documentation for the site or sites involved, and a plan for their investigation will be developed at that time. In essence, this is one of the purposes of site assessment and testing—the discovery of buried remains that were not anticipated from surface observations.

However, unexpected discoveries made during data recovery or research-based studies can present a problem, because they will not have been specifically covered in the plan developed for that investigative phase. Should remains such as deeply-buried strata representing considerably earlier occupations of the area that were not found during site assessment or testing be encountered, they may have the potential to alter the scope and intent of this plan. In this case, we will consult with NMSA, the pertinent land managing agencies, and SHPO to determine the best course of action to address the discovery.

Metal Detector Surveys

Matthew J. Barbour

Metal detectors are electronic instruments that identify or sense the presence of conductive objects, especially those made out of metal, located below the ground surface (Adams et al. 2000a:28). These instruments are often viewed as the tools of relic hunters (Weymouth 1986:317-318; Gaffney and Gater 2004:46). However, hand-held commercial metal detectors can be useful in cultural resource management to aid in the identification, evaluation, and treatment of archaeological properties. Recent research conducted by professionals in New Mexico and elsewhere has proven their effectiveness in documenting historic battlefields, Apache camps and early Spanish settlements (Scott et al. 1989; Haecker and Mauck 1997; Haecker 1998; Adams 2000a, 2000b; Damp and Adams 2008; Mathers et al. 2008; Johnson 2009; Laumbach 2009).

While all sites within the current project area have been previously assigned to the prehistoric period, many of these sites may have been occupied or reoccupied by proto-historic or historic period mobile hunter and gatherer groups. Metal detectors may serve as tools for determining if, when, and to what extent any historic populations utilized these sites and have the potential for recovering artifacts ideal for addressing issues discussed within the current research themes including subsistence activities, military actions and trade.

By the end of the seventeenth century, the majority of mobile hunter and gatherer groups had incorporated at least some metal into their material culture. However, the utilization of metal products was part of a larger cultural tradition which continued to incorporate flaked and ground stone tools. These populations can appear archaeologically very similar to earlier Archaic populations (Seymour 2002; Seymour and Church 2007). This is especially true in the southern most regions of the American Southwest where European and Native interaction was often too infrequent to leave substantial quantities of metal trade goods in the archaeological record. In addition, temporally sensitive pottery that could assist in dating such sites is rarely present.

In these cases, the few metal artifacts present on any one particular site might be buried. Hand excavation of large swaths of land has the potential to recover these buried metal artifacts, but such work is labor intensive and is likely to reveal at most only a handful of items. Conversely, metal detectors have the potential to cover large areas more quickly and more effectively. Furthermore if historic metal objects are found with the detector, the locations of these items can be used to guide more structured hand excavations. However, metal detectors are by no means a silver bullet and may be useful in only a small number of archaeological contexts. This section outlines the methods guiding potential metal detector investigations on all sites that may potentially be impacted by construction activities at Spaceport America, the limitations of this work, and the circumstances under which metal detectors may be employed.

Methods for Metal Detector Surveys

Federal and State land management agencies have been slow to adopt explicit guidelines for how to conduct metal detector surveys. The most rigorous standards are currently applied by Richard Green of Historic Archaeological Research (HAR). The HAR has refined detection methodology in an effort to develop a standardized intensive approach which would permit comparisons among a diverse assortment of archaeological sites (Green 2009). The OAS proposes to use similar methods to keep results comparable to those found elsewhere, but also to modify these methods to specifically deal the current cultural and non-cultural environments.

The most popular type of metal detectors are very low frequency (VLF) instruments (Gaffney and Gater 2004:46). They have an outer transmitter loop and an inner receiver. A current in the transmitter generates a magnetic field that transmits into the ground. If there is conductive material below the sensor, then a weak magnetic field is generated. The strength of the signal is related to the depth of the material and a phase shift between the frequencies of the two coils can be used to discriminate between different materials.

There are three distinct types of VLF instruments. The Type I instrument has an operating frequency at the low end of the VLF band typically in the 5-6 kHz range. The Type I detector has an affinity for ferrous items and is extremely sensitive to artifacts manufactured with materials found on the higher end of the conductivity spectrum (i.e. brass, copper, and silver). The Type II detector operates at a somewhat higher frequency, generally 10-12 kHz. The high frequency detector is intrinsically sensitive to metal targets in the low to mid conductivity range such as lead, nickel, gold, and small irregularly shaped artifacts. The Type II detector is less sensitive to small iron items, making this instrument a better choice for working in concentrations of modern ferrous debris (i.e. fence wire, wire-drawn nails, etc.). The Type III detector operates on a frequency which overlaps that of both Types I and II (Pratt 2009:8).

In this specific instance, the OAS proposes to use only Type I or Type III detectors set within the 5-6 kHz range for survey. Most of the metal artifacts known to be used by indigenous mobile hunter and gatherer populations are made of either iron or copper. These objects are easily identified by machines operating at lower frequencies. However, there is the potential for lead bullets and nickel plated decorative objects. If the initial sweep with the Type I or Type III detector clearly demonstrates the presence of an historic occupation by a Native American group, Type III detectors will be employed to sweep the area at a higher frequency.

Metal detector surveys will be performed by technicians walking in transects roughly 2 m apart. If multiple technicians are used, these transects will be staggered with the second metal detector operator being not only 2 m apart but 2 m behind the first technician to avoid crosstalk or spurious interference between machines. All metal artifacts detected will be mapped, excavated and identified. Artifacts believed to be associated with the site will be assigned a field specimen number and collected for cataloging and laboratory analysis. Fiberglass shaft flags bearing the field specimen number will mark the artifact locations for subsequent mapping with the Nikon Total Station. In situations where multiple metal artifacts are encountered within a 10-by-10 m area, a 1-by-1 m test pit will be hand excavated to provide information regarding stratigraphic context and the relation of the subsurface metal artifacts to other cultural materials. Metal objects deemed of no archaeological significance (such as pull rings, bottle caps, and aluminum pin flags) will be counted, recorded, and discarded off-site.

Limitations of Metal Detector Surveys

While metal detectors have many uses, these instruments also have their limitations, the most obvious of which is the relatively shallow depth at which metal detectors can identify objects. A study conducted by Battelle Pacific Northwest Laboratories (1981) suggests that the detection depth of any given metal detector is only roughly 2 to 4 times the representative dimension of the metal target. Most artifacts are significantly less than ten centimeters (4 inches) in diameter and would likely not be detected more than a few inches or at most a foot below the current ground surface. In a rapid depositional environment, such as an active flood plain, materials may be buried too deep to provide a detection signature. Adams et al. (2000a:31) found at Dark Canyon that most metal artifacts found by their detectors were only 2 to 6 cm below the present day ground surface. However in this example, it is unclear if depths were the result of the limitations of their equipment or the relatively slow accumulation of sediment.

In addition although each detector operator can sweep an area, it is difficult to estimate exactly how much area was directly surveyed in each transect and depends to some extent on coil type (Adams et al. 2000a:28-30). Most metal detectors use a concentric coil from which electronic signals emanate from the coil and converge at the apex of a cone. Double D or wide scan coils are less common but provide a rectangular area of coverage at greater depths. Ultimately, the thoroughness of coverage within any transect depends on the distance between coil and ground surface, the diameter of the coil, and the closeness of the sweeps (Scott et al. 1989:28).

There are also discrimination issues. Limited to at most only surficial and minimally buried deposits, operators must contend with the recently discarded debris such a pull rings and fence nails. This debris can provide rogue signals or mask weaker readings provided by more deeply buried materials. As discussed by Green (2009), these materials should be removed from the site and the area in which they are found should be swept with the detectors a second time. In keeping with the HAR standards, the OAS plans to follow this guideline. However, if too many modern materials are encountered, it may not be advantageous to continue with the metal detector survey.

Furthermore, the ability to detect only metal artifacts has its limitations in addressing questions regarding past cultures. Cultures use a variety of material types and often metal is reserved only for specific tasks. Hence, materials found through metal detection survey rarely, if ever, encompass the entire material record to be found at an archaeological site. In no instance is a metal detection survey a substitute for hand excavation. At best, metal detectors offer a biased perspective of material culture. If for example, a specific Native American group used flaked stone, flaked glass, antler, wood and metal projectile points, only those projectile points made of metal would be detectable within the metal detection survey. Archaeologist must be aware of this bias and the other limitations listed above when interpreting their results.

Performing Metal Detector Surveys at Spaceport America

Given the limitations of metal detectors, it is likely there are many instances when a metal detector survey would be of little or no research value. Areas along modern roadways are a prime example. In these instances, time would be spent primarily uncovering and mapping substantial quantities of modern refuse. In very active eolian environments it may be of benefit to survey in blowouts, but the tops of the dunes themselves may fluctuate too quickly to maintain a surface on which historic artifacts have remained.

Another pressing issue, specifically for Spaceport America, is the fact that two of the sites in the project area are extraordinarily large. Given that it is likely that most, if not all, of the archaeological sites date exclusively to the prehistoric period, it would be inefficient and unnecessary to perform a metal detector survey over all portions of these large sites.

The OAS proposes to perform sample metal detector surveys on each site in the project area. These surveys will be conducted within a 20 square meter area around all known features and in all areas within the potential infrastructure corridor (PIC) with surface artifact concentrations above one artifact per two square meter area. If metal artifacts over 100 years in age are encountered within these sampled areas, the metal detector survey will be expanded to include all portions of the site within the PIC. Conversely if metal artifacts under 100 years in age are found in quantities greater than one artifact per two square meter area, the metal detector survey will be abandoned.

Metal artifacts collected from these sample surveys will be subjected to the analytical and curation treatments described in the Euroamerican Artifact Analysis Section of this document. If metal artifacts are found on any of the sites impacted by construction, these materials may provide valuable information regarding chronology, activities performed at the site, site function, trade contacts, and possibly social standing. Simply the presence or absence of these metal artifacts may aid in developing regional chronologies and the spatial distribution of indigenous populations during the historic period.

Chapter 5: A Plan for Data Recovery and Research-Oriented Investigations at Spaceport America

James L. Moore and Robert Dello-Russo

FAA and NMSA (2010a) developed four general research themes during Section 106 consultations for the Spaceport undertaking that will be used to guide further archaeological investigations at Spaceport America. While we discuss all four themes in this chapter, the likelihood is that only three will be applicable to the array of sites that the OAS will be examining. These research themes represent broad questions that will be addressed by the results of data recovery and amplified by research-based investigations. Following the discussion of each research theme is a set of more specific research questions that will mainly be addressed with information from research-based investigations, but may also be applicable to the results of data recovery. The research themes were not considered to be exhaustive and are best considered as guides to research that are elaborated upon to generate the more specific questions. In addition to the research questions, we provide linkages to the types of data and analyses that should provide the information needed to address these questions, and note which investigative phases may produce applicable information. In essence, data from sites examined during each investigative phase may be applicable to one or more research questions, depending on the level of temporal control and the types and amount of information available. All available data will be considered, thus information from sites determined as "not eligible" for the state or national registers, as well as from "eligible" sites that contained no potentially significant remains within construction/buffer corridors during testing and were not further examined during the research phase may also be used to address one or more research questions if applicable.

Theoretical Research Orientation

Robert Dello-Russo

Following statements in the *Mitigation Plan for Archaeology at the Spaceport America* (FAA and NMSA 2010b) and the *Cultural Resources Protection, Preservation, and Mitigation Plan* (CRPPMP; FAA and NMSA 2010a), the specific research themes and questions outlined in the following Research Design document are informed by a theoretical research orientation favored by the Office of Archaeological Studies (OAS). This research orientation can best be described as an Ecological Landscape approach to the investigation of settlement and subsistence behaviors by human groups. More specifically, we are interested in understanding how human groups utilized different strategies and tactics – such as changes in mobility, changes in technology, or the intensification of subsistence pursuits – to address changes in the various ecological parameters of the landscape in which they existed. In the current project area, this approach will be applied, through archaeological research, to remains produced by foragers (hunter-gatherers) and forager-farmers in the Prehistoric time periods of the Jornada del Muerto region, but will be extended to include groups with similar, and market-related, adaptations during the Historic period, when warranted.

Foragers and Forager-Farmers: Changes in Subsistence and Settlement Behaviors

Of enduring interest to anthropologists throughout the world are the nature of foraging, or hunting-gathering, economies and the apparent relationships that exist between such foraging-based economies and their natural environments. In particular, it is often suggested that the spatial, temporal, and biological variability of resource productivity can influence subsistence-related behaviors and can drive changes in mobility tactics (Kelly 1983), labor organization (Binford 1991, 2001), technology (Kelly 1988; Nelson 1991; Parry and Kelly 1987, Railey 2010, Reed 2008), procurement and processing techniques (Hard 1986; Nelson and Lippmeier 1993), storage practices, and planning depth (Binford 1990, 2001). Put more simply, these adaptations are "about improving accessibility (to subsistence resources)... or making returns more predictable" (Bender 1978:205).

Changes in the accessibility to, or availability of, subsistence resources are often viewed from an ecological perspective, wherein shifts in climatic regimes drive changes in resource productivity which, in turn, affect the nature of human subsistence behavior. Certainly, the observations made in ethnographic and ecological studies have demonstrated the variability of human behaviors in dynamic environmental contexts, but descriptions of variation are insufficient to the goal of explanation in anthropology. In addition, the direct application of historical ethnographic patterns to archaeological data is problematic in that it "merely substitute(s) a description from one point in history for one from another point in history" (Simms 1987:12). As a consequence of the inadequacies of the direct historical approach, it has now become apparent that the study of hunter-gatherer prehistory must "go beyond broad typological categories, such as generalized versus specialized, simple versus complex, storing versus non-storing, or immediate versus delayed return" (Kelly 1995:343) and utilize a framework of interpretation and understanding that addresses why and how changing ecological conditions affect human behavior. If paleoenvironmental information is a powerful predictor of human subsistence decisions (cf. Dean et al. 1994:85) then a local, ecologically-driven approach should avoid the assertion of normative descriptions as explanations for change (Plog et al. 1988; Winterhalder and Goland 1997).

Regional Background

Archaeologists working in the Southwestern United States have also believed that environmental factors underlay changes in the prehistoric subsistence behaviors of forager groups (Berry and Berry 1986; Hunter-Anderson 1986; Irwin-Williams and Haynes 1970; Jennings 1978; Vierra 1994), although the actual mechanisms by which such environmental factors encouraged changes in behavior have often been left unspecified (but see Dello-Russo 2008). Because many of the "interpretations of the prehistoric events in the Southwest rely on climatic and other environmental changes" (Cordell 1984:21), it is important that researchers provide explicit reconstructions of past environments, sufficient explanations of the means by which environmental changes are discerned, and systematic links between these changes and human behavioral responses.

In New Mexico and the surrounding region, archaeologists have often explicitly or implicitly acknowledged a relationship between climatic variables and the settlement and subsistence behaviors of pre-ceramic (Archaic) foragers (cf. Cully and Toll 1983:48). Irwin-Williams, in the Arroyo Cuervo region, proposed that the development of sedentary, agricultural groups in north-central New Mexico from a foraging-based economy was "the result of cultural adjustment to a number of complex and interacting elements, including principally, climatic change, population increase and the introduction and development of new subsistence and processing technologies" (1973:18). Reinhart's study of Archaic cultures on the Ceja Mesa in the Middle Rio Grande valley posited that the "subsistence patterns of… late archaic cultures appear(ed) to show a direct relationship to prevailing environmental conditions" (1968:214). Cordell (1978:23-33), in a review of Archaic cultural manifestations in the Middle Rio Grande valley, suggested that two productive avenues of research should include the definition of the subsistence base both prior to and after the adoption of cultigens, and the monitoring of climatic conditions under which these cultural adaptations occurred. Both Reher and Witter (1977) and Chapman (1980) implied that foragers were responding to the natural constraints of climate and plant productivity when they argued that Archaic foragers in New Mexico had positioned themselves on the landscape in areas where they had access to subsistence resources (although they differed over which suite of resources was involved). Building on this foundation, Hogan (1986:57) proposed that Archaic groups had followed a serial foraging strategy wherein their settlement strategies were constrained by the availability of a "relatively small number of seasonally abundant resources", such as rice grass, dropseed, or goosefoot seeds. As previously, the implicit argument here was that the seasonal abundance of such annual plant seeds would have depended on the effects of climatic variables, such as precipitation.

Thus, while researchers in the Southwest have continually sought to place changes in forager subsistence behaviors into environmentally-driven contexts, the potential for successful research from this perspective has historically suffered from two deficiencies. First, the systemic ecological connections among the variations in climate, plant productivity, and human economic decision-making have been left largely unspecified (but see Dello-Russo 2008); and second, the absence of precise temporal resolution between archaeological and climatic data has precluded all but the most general of assessments (cf. Hogan 1986:114-115; Cordell 1978:29).

Behavioral Ecology

Behavioral ecology represents a subset of evolutionary ecology which, as defined by Winterhalder and Smith (1992:5), is "the application of natural selection theory to the study of adaptation and biological design in an ecological setting." Appropriately, behavioral ecology directs our attention "to the role and characterization of the environment" (Winterhalder and Smith 1992:8) and to the behavioral responses made by individuals in that environment. Consequently, this theoretical perspective must also incorporate an historical perspective, particularly as it pertains to the natural and social contexts in which the individuals behaviors are undertaken. Such a perspective allows not only for the assessment of changes in the distribution and abundance of subsistence resources but also for an understanding of the set of strategic behaviors available to the forager when confronted with such environmental changes.

Optimal Foraging Models

Human subsistence behaviors, which are undertaken in response to variations in natural parameters, can be evaluated through economic measurements of these behaviors. Models of optimal foraging are economic in scope and are utilized to specify theoretical behavioral optimums for certain identified currencies. The prediction of behavioral optimums does not imply that foragers are expected to reach such optimums or to forage at optimum levels. Rather, these optimums are used in a referential capacity to evaluate the constraints and trade-offs involved in reaching a behavioral decision. Neither are optimality models merely descriptions of foraging behavior. Optimal foraging models have the potential to take researchers beyond description toward the discovery of explanations of cultural forms of behavior. The approach to optimality modeling is a cumulative one in that elementary models, incorporating basic currencies such as time, energy, or nutrients, can be modified to address problems with model fit and can be broadened to encompass other currencies, such as the storability of resources. This framework is an asset of the approach in that it provides a method to examine complex behaviors in a way that contributes to general theory.

The diet breadth model. In the diet breadth model the forager chooses from a set of available resources on the basis of their abundance and efficiency rank. Efficiency rank represents a quantitative comparison between handling costs (generally measured in terms of time) and the yield (measured in terms of energy) of an encountered resource. In a fine-grained environment where resources are encountered at random, the model predicts that a forager will take a resource only if the returns from that resource are greater than the returns of other resources. Thus, the model predicts the order in which resources are added to or deleted from the diet.

Following Simms (1987:15-16, 40-43), our definitions of costs are briefly summarized as follows:

(1) Search time is the time required to travel to and locate a resource patch or a resource within a patch containing more than one resource. Search time is dependent on the general environmental abundance of the resource.

(2) Pursuit time is the time required to pursue or collect a resource after it has been encountered. With immobile plant resources, pursuit time represents gathering time and the efficiency of it is affected by technology and technique.

(3) Processing time is the time required to process a resource into a useable form which is, in turn, entirely dependent on the efficiency of processing.

(4) Handling time is the sum of pursuit and processing time and is generally used in conjunction with search time to bring about predictions concerning the relative contributions of different resources to a subsistence diet.

The issue of efficiency ranking for subsistence resources implies two important points: (1) higher ranked resources will always be taken when they are encountered; and (2) the inclusion of lower ranked resources in the diet will depend on the abundance of higher ranked resources. The latter statement implies that as the abundance of higher ranked resources decreases, lower ranked resources will be included in the diet, or, as the abundance of higher ranked items increases, lower ranked items will be eliminated from the diet, regardless of their abundance (Charnov and Orians 1973; MacArthur and Pianka 1966).

An important distinction exists between search time and pursuit time. While both measures vary with resource abundance, search time abundance refers primarily to the frequency of resource patches on the landscape and pursuit time abundance specifies density within the resource patch once it is encountered. Procurement time for plants, however, is primarily governed by gathering efficiency, with density playing a secondary role. In contrast, individual density within a patch is more important for assessing the procurement costs of mobile animals.

In effect, foraging decisions represent contrasting assessments of search time relative to handling time. That is to say, as resources with a high rank (high energy yield per handling time) are utilized, their abundances decrease, their search times increases, and their overall procurement costs increase. By expanding the diet to include lower rank items (low energy yield / handling time), handling time per unit of energy increases and search time decreases. Thus, the theoretically optimal diet is reached where decreasing search times equals increasing handling times. This is an important point because it implies that the overall abundance of a given resource on the landscape does not, in and of itself, predict its inclusion in the forager's diet (cf. Winterhalder and Goland in 1997). As an example, this is reflected in a forager's decision to collect storable seeds, even though they are costly to harvest and may not be less abundant than other, less storable, resources. Their value, in terms of delayed consumption, controls the decision to harvest. These concepts may have implications for the current project in terms of the adoption of cultigens (from Archaic to Formative), the level of storage technology employed by human groups, the changes in processing technology, the suite of subsistence resources sought by foragers, and changes in the location of sites on the landscape (settlement patterning).

The central place foraging model. By adding a spatial dimension to the analysis, foraging can be modeled as a trip with a given point of departure and return. This central place foraging model (Orians and Pearson 1979) characterizes the expected energy return from a given prey item and the expected foraging time for that prey item in terms of travel time to and from a hypothetical central place. An increase in the central place-to-patch round-trip time requires increases in patch foraging time, minimal required prey size, and expected energy intake. In contrast, given a constant round-trip travel time, an increase in prey abundance generates an increase in the minimum prey size and a decrease in the patch foraging time. The implication here is that the ranking of dietary items will vary with the distance from central place to patch, such that low-ranked items in nearby patches may rank quite highly in distant patches. This approach may have implications for the current project in terms of changes in hunting-related technology over time, the body size of the animals that were targeted by hunters, and possibly the locations of different site types on the landscape. For example, this could enable an investigation of the shift from the Paleoindian lifeway to the Archaic that transpired across the Pleistocene–Holocene climatic transition.

Optimization Approaches and Archaeology

Winterhalder and Smith (1992:22) have suggested that evolutionary ecology models in general, and optimal foraging theory in particular, are useful because they open the way for a synthesis between cultural and biological concepts. Consequently, our attention has been directed to the relationships between a localized and varied environment, on the one hand, and the suite of flexible human behaviors, on the other. In his summary of optimality models and archaeological applications, Simms (1987:21-25) argues strongly for models that are matched to their respective test data in terms of complexity. As such, diet breadth models, which predict the order in which particular subsistence resources are added or removed from the diet, provide an excellent match for the changes in archaeological subsistence data observed for a single location or region over a period of time. In addition, central place foraging models can be used effectively when examining archaeological data at a regional scale.

In an interesting example, Jochim (1976) constructed an economic behavior model for hunter-gatherers that incorporated decision-making processes. His model, which was based on a ranking of subsistence resources, assumed that settlement decisions were based primarily on the proximity of economic resources and the availability of shelter. Consequently, Jochim (1976:53-56) argued that an index of resource diversity should provide a useful measure for the subsistence value of a given area. This use of a diversity index to predict foraging behavior was subsequently refuted by Chapman (1980) in a study of Archaic adaptations in the Middle Rio Grande valley, and was qualified by Cully and Toll (1983:390-391). The latter researchers suggested that resource diversity may be useful as a guide in understanding forager mobility and settlement on a regional scale but, for more localized situations, the evidence suggests that foragers responded to the presence of a relatively narrow spectrum of subsistence resources.

In order to address issues about diet variations during the Holocene, Simms (1984, 1987) used archaeological and ethnographic data from the Great Basin, experimental data on handling times and encounter rates for plant resources, and estimates from ethnographic and current hunting descriptions for animal resources. His investigations sought to examine the roles of plant and small mammal resources in both men's and women's foraging strategies, and the conditions under which large game species would have comprised most of the diet. As great variability in seed harvesting return rates was implied by this pattern, Simms stressed the importance of in-patch characteristics, such as intra-patch density, harvest timing, and variations in annual seed production. The unpredicted presence of low ranked seeds in ethnographic diets also underscored those seed attributes which might favor delayed consumption or storage. The diet model assumes that energy is maximized on a daily basis but, with the issue of storage, behavioral decisions must also consider subsistence requirements beyond the daily time frame.

More recent work by Christopher Raven and Robert Elston (Raven and Elston 1989; Raven 1990) at the Stillwater Wildlife Management Area tested a suite of predictions about prehistoric human settlement behavior with data retrieved through archaeological reconnaissance. Their predictive model, which was based on assumptions from optimal foraging theory, attempted to "relate variation in the spatial and temporal distribution of subsistence resources ... to a theoretically effective subsistence strategy" (Raven and Elston 1989:i). They assumed that the differential use of the landscape by prehistoric foragers was primarily conditioned by the spatial and temporal distribution of subsistence resources. In concordance with foraging theory, they also assumed that foragers made behavioral decisions based on efficiency (most energy per unit of effort). Finally, using the patch choice model, data collected by Simms (1984, 1985, 1987) on the caloric returns of many Great Basin resources, and some information on regional environmental change, Raven and Elston were able to rank resource patches at Stillwater and develop expectations about the locations of prehistoric subsistence-related activities and the content of archaeological assemblages. While it was concluded that prehistoric subsistence patterns covered an area larger than the Stillwater Marsh, Raven and Elston's expectations were largely upheld.

The Ecological Landscape approach underscores the idea that different landscapes would have presented foragers with different subsistence resource constraints at different spatial and temporal scales. Thus, the archaeological research proposed for Spaceport America can apply this idea to examine: 1) the climatic mechanisms that controlled changes in the prehistoric botanical communities, faunal communities and hydrological regimes of the Jornada del Muerto region; and 2) how such ecological changes affected the economic behaviors of human foragers during the Paleoindian, Archaic, Formative and, if applicable, Historic occupations of the regions surrounding the project area. Importantly, the Ecological Landscape approach corresponds well with the basic Research Themes outlined in the Mitigation Plan and the CRPPMP (FAA and NMSA 2010a:13-22) and, by extension, points to the Research Questions expressed in the body of the Research Design. Together, this concordance will allow the Research Design, and results of the current study, to serve as a foundation for future archaeological research in the region.

Theme 1: Development of Prehistoric and Historic Chronologies, Cultural Histories, and Historic Contexts for All Time Periods of Occupation/Use in the Region

Currently, discussions of chronology and culture history for the project area are mainly based on survey data, and the local sequence is often conflated with that of the Mimbres region to the west (FAA and NMSA 2010a:14). As the overview of culture history in Chapter 3 made clear, we fit our project area into the general Jornada Mogollon region, homeland to a culture that probably developed out of an Archaic base. However, most of the chronological and culture historical information available for the Jornada Mogollon has been generated by studies in the El Paso region and in the Tularosa Basin. More detailed information that may be recovered by the investigations outlined in this plan can be used to amplify the survey data, and help begin the process of determining how cultural developments in this area compare with those elsewhere in the Jornada region and general Jornada Mogollon culture history, or with frameworks that cover wider spatial areas for the Paleoindian and Archaic occupations. While no definite Protohistoric or Historic components have been noted for the sites examined by this study, there is a possibility that they exist and could not be recognized at a survey level. Thus, the sites in this study may also be useful in examining questions of chronology and culture history for those periods of adaptation, and can again be compared with the results of intensive investigations elsewhere in the region.

This general understanding of how people used and adapted to a certain region through time can be developed with a variety of data generated during data recovery and research-based investigations. Constructing solid chronologies and outlining cultural histories are perhaps the most important building blocks in this process. This, in turn, will allow us to see how this region fits into the more general Jornada Mogollon framework.

Research Question 1: What Are the Chronologies of Occupation/Use for the Various Cultural Components within the Project Area?

More specifically stated, how do the sites examined by this project fit the chronological frame developed in the overview of cultural history in Chapter 3? Are they, for example, synchronized with similar developments elsewhere in south-central New Mexico, or are there potentially important differences? Our expectations are that these sites will fit well into the chronological scheme presented in the overview of culture history. If so, this research will both confirm and strengthen conclusions made by other researchers for the region. If they do not fit, this might mean that developments in the middle Jornada del Muerto region did not exactly parallel those elsewhere in the region. In this case, we could perhaps look to other adjoining regions for a closer fit.

Thus, strong chronological controls are needed for this study, and should be provided by a number of different analyses. Chronological data will be collected using (when available) ceramic assemblages, projectile point assemblages, radiocarbon samples, tree-ring samples, archaeomagnetic samples, thermoluminescence samples, and optically stimulated luminescence (OSL) samples. Each of these potential dating methods will be applied in different ways.

The analysis of ceramic assemblages from Formative and later period sites should provide critical information concerning where those locales fit temporally. As discussed in the culture history overview, studies completed elsewhere in the Jornada Mogollon region have developed seriations of pottery types, and in some cases the forms and other characteristics of vessels and sherds allow a relatively precise placement of an assemblage into a particular period. In many cases, this may be a more desirable way of dating Formative period components than the use of radiocarbon samples, because of problems inherent in the latter with the use of old wood and the likelihood that many decades of growth are being averaged in samples of tree wood, thereby reducing the precision of the date (Browman 1981; Taylor 1987). These problems can be nullified by dating materials from annuals and shrubs with much shorter lives than trees, but these types of materials are not always available. Conversely, when dealing with Archaic or Paleoindian period components, radiocarbon dates can be quite useful, even with the problems discussed above. This is because the occupational periods defined for the Archaic tend to be much longer than those of the Formative and later periods, and, thus, require a lower degree of precision.

Despite the potential problem mentioned above, analysis of radiocarbon samples can be useful for all periods of occupation. Miller (1996, 1997) provides a detailed analysis of radiocarbon dates for much of the Jornada region, and those data were used by Miller and Kenmotsu (2004) to provide more accurate date ranges for Formative period occupations. Radiocarbon dates are currently uncommon for the middle Jornada del Muerto region, and could provide critical information concerning the timing of events and trends in comparison with other parts of the region. Radiocarbon samples, if available, may be the only way to determine dates for components lacking temporally diagnostic artifacts. In some instances, the availability of radiocarbon dates may allow the relationship between certain types of diagnostic artifacts and other cultural materials to be explored. For example, does the presence of a few Paleoindian artifacts on a site indicate an occupation during that period, or were those artifacts salvaged and curated by a later group? Charcoal samples will be obtained from features, structures, or cultural strata when available, and will be used to provide important temporal data.

Tree-ring dates can provide the most accurate and precise temporal information available. Unfortunately, tree wood does not tend to be well preserved in the open sites that typically occur in the project area, both because of exposure and deterioration through time and because prehistoric occupants of the region may have reused or burned datable materials from abandoned structures. Thus, we do not anticipate being able to recover many (if any) suitable tree-ring samples from any of these sites.

Other sources of chronometric data include archaeomagnetic, thermoluminescence, and OSL samples. The first two of these sample types are heat-related. Archaeomagnetic samples may be available from well-burned thermal features, including hearths and roasting pits, and fired materials like sherds and burned rock are amenable to thermoluminescence dating. While neither of these techniques are as precise as tree-ring dating, they can provide dates that are more informative of actual cultural occurrences than radiocarbon dating. OSL samples will be obtained from geological trenches, and should aid in the dating of soil formation events and help identify the time periods during which certain sediments were deposited. This will aid in understanding site formation issues and in developing a more detailed paleoenvironmental reconstruction for the project area.

Identification of diagnostic projectile points can provide broad temporal information, but the level of precision is very low. While projectile points will be used to date general periods of occupation for Archaic and Paleoindian components in the absence of other materials amenable to temporal analysis, the possibility that prehistoric people salvaged and reused this type of artifact is very high. Since this also leads to the inaccurate or low precision dating of occupational components, other approaches to dating are much more desirable.

Research Question 2: How Does the Chronology of Site Occupation in the Project Area Fit the Regional Culture History Framework?

This question is closely tied to Research Question 1, because the first step in seeing how these sites fit into the regional culture historical framework is to provide them with accurate dates. Without accurate chronological controls, it will be very difficult to address this question in detail. As discussed in Chapter 3, a detailed culture history is available for the Jornada region, but is primarily based on research conducted in the region around El Paso and in the Tularosa Basin. Using data from the sites in this study, how does the chronology of landscape use and cultural developments over time compare with trends in these other parts of the region? Do we see similar events and transitions occurring at about the same time in all parts of the region, or are there potentially important differences?

The examination of chronology represents one of the main focal points of this study. In essence, this question links nearly all of the other research questions posed in this chapter, and provides a way in which to summarize the results of this study. Defining culture history is important to regional studies because it provides a framework in which to examine cultural changes and adaptations through time. For instance, detailed information on the Formative period is available from the El Paso region and the Tularosa Basin and, while somewhat less detailed, similar data on the Paleoindian, Archaic, and Protohistoric occupations are also available from those areas. By examining cultural historical developments in the project area we may be able to determine whether they parallel those in other parts of the region, or sometimes deviate from them. Deviations, if definable, can be important because they are an indicator of variation within a broadly linked cultural area that could be evidence for differing constraints, such as environmental conditions, resource availability, or the presence of unique outside influences. These possibilities can be examined by data recovered from ancillary investigations, such as paleoenvironmental studies, or from the presence of exotic materials or objects in assemblages that point toward ties with specific regions, including imported tool stone, pottery, or materials used for ornaments like turquoise and shell.

Theme 2: Interaction of Settlement, Land Use, Access to Scarce/Desired Resources, and Subsistence Practices in the Region for All Time Periods and All Cultures

As FAA and NMSA (2010a) notes, water has been the most critical resource in the Jornada del Muerto throughout the entire period of human occupation. Water availability conditioned the movement of Pleistocene megafauna, and hence the movement and settlement patterns of the human cultures that preyed upon them. Similarly, the availability of water during the Archaic and Protohistoric periods helped determine where camps would be placed, and where the plants and animals that were targeted for exploitation would be located. While the subsistence needs of the Formative period population were somewhat different from those of the earlier and later occupants of the region, they too depended on water availability to determine where to establish a settlement or temporary camp, and where to farm. Water sources were critical to the Spanish travelers who crossed the Jornada del Muerto on the Camino Real, and was equally critical to the Anglo ranchers who represent some of the latest occupants of the region, though the latter are also able to supplement naturally-occurring water with wells.

The seasonal availability of water, climatic fluctuations that affected the availability of water, and the distribution of locations where water was available all would have affected patterns of land use over time. But, while water was obviously a critical resource, it was not the only resource that would have conditioned land use patterns. During prehistory, access to tool stone was also an important consideration, for the manufacture of both chipped stone tools and ground stone tools. During the Historic period, access to manufactured goods would have varied according to the transportation system in use and changing governmental controls through time (Moore 2001, 2004, n.d.).

Thus, access to critical resources would have been an important aspect of the settlement systems or patterns of landscape use, and must be taken into account. For all time periods, the locations of water sources including springs, erosional cuts, and playas could have represented potential residential areas. While residential sites may not have been established solely to exploit tool stone sources, those areas would have been exploited as quarries and, if a water source was located nearby, may have increased the attractiveness of a specific location for settlement. For part-time forager-farmers, or full-time agriculturalists, the location of potentially arable soil with sufficient water for farming could have constituted a major settlement location in all time periods after the late part of the Middle Archaic.

So, how did the distribution of critical resources condition settlement systems and patterns of land use in the project area? How did these patterns vary among time periods, and do those variations fit the patterns seen elsewhere in the Jornada Mogollon region? These are the main questions that can be explored in the more specific research questions posed below.

Research Question 3: How Do Site Locations/Types and the Availability of Water Vary through Time?

The settlement patterns proposed for the Jornada region, as discussed in Chapter 3, varied considerably through time in accordance with changes in both the physical and cultural environments. The former began with the transition from wet, cooler terminal Pleistocene conditions to the warmer and drier Holocene, and continued with variations in temperature and rainfall regimes through the later periods of human occupation and up to the present. Variations in the cultural environment coincided with those in the physical environmental, and were linked to them in part. The people who lived in this region had to change their ways in order to adapt to the new environmental conditions. A successful adaptation or improving environmental conditions often resulted in population growth, and that type of increase often causes changes to occur in the cultural environment that must be adapted to. As there were more and more people living on the landscape, the size of areas available for exploitation decreased in size, requiring the development of ways in which to intensify food production. Often, those ways were tenuous in the desert Southwest, and only proved to be workable as long as environmental conditions did not change for the worse.

While very few sites from the Paleoindian period have been found and investigated in the Jornada region, it is possible that different patterns of landscape use may be discerned for the human groups from those times than for subsequent hunter-gatherer populations during the Early, Middle and Late Archaic periods. Permanent or semi-permanent water sources would have attracted the megafauna prey of

Paleoindians, and hunting may have been easier where animals could have been incapacitated in bogs or driven into streams or ponds. Thus, the archaeological remains of camps and kill sites from that era may be located in areas that would have contained active streams, ponds, or marshy ground. However, in such cases, it may have been the presence of faunal resources that were the main attraction rather than the presence of water itself.

Early Archaic sites are expected to fit a general pattern of land use and adaptation similar to that seen during later Archaic periods, although this assumption may be incorrect. This uncertainty is because the Early Archaic is not well represented by excavated sites, so the settlement and subsistence system in use during that period remain mostly unclear. The appearance of thermal features containing rock during this period, which are absent from Paleoindian sites, may indicate a major change in the subsistence system, with floral resources assuming an increased dietary role. Changes in projectile point technology, including in the materials used to manufacture these tools, also point to a major change in the subsistence system, perhaps corresponding to the disappearance of the megafauna that was hunted during earlier times. Miller and Kenmotsu (2004:223) suggest that a seasonally settlement system based on small bands developed during this period, with the level of mobility perhaps more restricted than that of the Paleoindian period. These changes continued into the Middle Archaic, when seasonal timing apparently became more restricted and focused on the availability of certain plants, and the first structures occur. Despite the current state of the archaeological record, which suggests that few changes occurred between Early and Middle Archaic, major differences may become apparent with further research because most evidence for those changes are currently obscured by a paucity of data.

In many ways, the Middle and Late Archaic patterns of settlement and land use are expected to mirror that of the Formative Mesilla phase, which has been modeled by Hard (1983) and Whalen (1994a, 1994b). In this model, cold season settlements are expected to be situated on alluvial fans and piedmonts at the base of mountains as well as in riverine settings. These are the locations where reliable supplies of water and firewood were both available. These are also areas in which arable land is most available, and where some farming could have been accomplished. During the warm season, much of the population would disperse across the landscape to exploit seasonal resources. Foraging camps would be established where there were suitable supplies of food, water, and firewood. The onset of the monsoon season would provide water in seasonal playas, and make parts of the interior basins accessible that could not be used at other times due to a lack of water. Surplus foods collected during this season would be transported back to cold season camps for storage, thereby augmenting any crops that were grown.

Whalen's (1994a, 1994b) model is not as detailed as Hard's, but it incorporates some of Hard's ideas and takes both the early and late parts of the Mesilla phase into account. Whalen believes that the early Mesilla people maintained a basically Archaic settlement and subsistence system, with one major difference: a more intensive use of cold-season camps. This pattern was sustained by large-scale food storage. While there is some evidence for food storage at Archaic cold-season camps, it was at a much smaller scale. The storage facilities at both Mesilla phase and Archaic cold-season camps were probably filled with cultigens and wild foods gathered at warm-season camps, although the proportional mix of each type of food probably varied with precipitation. The remainder of the Archaic settlement system probably resembled that of the Mesilla phase and included small camps and resource extractive locales (Whalen 1994a:142).

This pattern apparently continued into the late Mesilla phase with little change, though there is evidence for increased storage capacity at cold-season camps. Subsistence throughout the period relied on wild resources supplemented by domesticates. However, there is some evidence for an increase in the use of cultigens during the late Mesilla phase (Whalen 1994a:119; Whalen 1994b:634). Other changes suggest a slight reorganization of society late in the phase that included larger groups using cold-season camps and construction of communal structures.

By the Doña Ana and El Paso phases, there were major changes in how the landscape was used. Villages from these periods were more permanent and tended to cluster on alluvial fans or around playas, and those of the El Paso phase occurred at slightly lower elevations than those of the Doña Ana phase (Miller and Kenmotsu 2004:245). While Mesilla phase structures are found across most environmental zones, the isolated houses of the Doña Ana and El Paso phases are generally only found around playas or in the riverine zone (Miller and Kenmotsu 2004:245). This suggests that interior basin areas may have been used differently in the late part of the Formative period.

The location of our project area in a basin interior suggests that we can expect to see mainly evidence of warm season use during those periods when water and seasonal foods were available. The most intensive use of the interior basin is expected to have occurred during the Middle and Late Archaic and the Mesilla phase, with sites expected to demonstrate a similar pattern of transient use, though specific locations may evidence repeated occupations through time because critical resources are conveniently located nearby. Temporary structures may occur at these sites, but would be of insubstantial construction and might only be found if they were burned. Middle and Late Formative (Doña Ana and El Paso) sites may occur in this zone, but are not expected to exhibit the kind of intensive use seen at the earlier sites. In all cases, sites should be situated near a water source. Foraging camps may mostly be located at playa margins and along intermittent streams. Any more substantial or permanent settlements are not expected, but if they occur they should be located adjacent to a permanent water source in an area where arable land was also available.

Protohistoric Apache sites are expected to follow a settlement pattern similar to that of the Archaic, since a similar hunting and gathering lifestyle is represented. However, the acquisition of the horse sometime after AD 1600 and conflict with Spanish, Mexican, and American governments may have affected the earlier Protohistoric pattern. However, since no Apache components have been identified on any of the sites being investigated by this project, our ability to examine this question may be severely limited. Should Protohistoric Apache components be identified, they will be compared with those of the prehistoric period to see if they compare favorably, or differ significantly, in terms of land use and settlement type.

Other than the chronological data mentioned earlier, we will also need fairly detailed information on site type and function, subsistence, and seasonality to address this question. Site type and function can be determined using data from most of the planned analyses. Site type will be defined using such data as the presence or absence of structures, the types of features present, evidence for single or multiple uses, and evidence for the types of activities that occurred there. Site structure will be examined using the spatial distribution of various material classes and tool types across a site in relation to the locations of any related structures and features.

Site function can be defined from a similar suite of information, especially the types of chipped and ground stone tools, ceramic vessels, and structures and features that are present. Subsistence information will be obtained through analysis of faunal bone and perhaps blood residue analysis, and paleobotanical materials obtained from flotation, charcoal, pollen wash, and pollen samples from cultural deposits or available as macrobotanical specimens. The results of the faunal and botanical analyses will also help in defining the season(s) of use for sites, and will be important adjuncts to the characteristics of any structures that might be present, as well as the types of features identified. Soils analysis in addition to geomorphological and paleohydrological studies should provide information on the location of water sources and potential arable land. While the latter is not being planned for this endeavor, a separate study will be conducted for Spaceport America and will hopefully provide data useful to the archaeological study.

Research Question 4: How Do Site Locations and the Access to Other Critical Resources Vary through Time?

Other critical resources include outcrops of tool stone, habitats for the animals that were hunted, and areas containing useable floral resources. Did the location of suitable outcrops of tool stone affect choice of site location? If so, what types of sites are located near tool stone outcrops? Is there evidence for the use of these sites as residential locales, or did they simply function as resource extractive locations? This question can only be addressed by an examination of areas that may contain tool stone deposits, including outcrops and gravel beds along streams. Pertinent information can be gleaned from survey reports, in which likely sources were noted, and from the geomorphological study, which may identify likely landforms. Using these data, researchers can target areas for further examination, collect samples to be used for identification purposes during analysis, and complete a cursory examination of known nearby sites that might be related to the exploitation of these resources. In addition, the sites scheduled for examination by this study and the areas surrounding them will be examined for raw material sources that could be used for the manufacture of either chipped or ground stone tools. If such are found, the likelihood that the presence of these resources may have affected the site selection choice will be evaluated, using information on occupational type, site structure, and structure of the chipped and ground stone assemblages. If a source of raw materials suitable for chipped stone reduction is located near a site, we expect to see evidence of extraction and preliminary reduction including a high percentage of primary cortical flakes, discarded tested cobbles, discarded hammer stones, and a comparative lack of extensively reduced cores. If a source of raw materials suitable for ground stone tool manufacture is located nearby, we would also expect to see evidence of extraction and perhaps preliminary shaping. This may be indicated by a large percentage of flakes from materials that do not break conchoidally, like sandstone, and were therefore used for ground stone rather than chipped stone tools.

Did the availability of animal and plant resources also factor into site location selection? This possibility has already been proposed for Paleoindian sites. Examination of available data suggest that greater densities of animals in certain plant communities and near water sources may have affected site location choice during the Archaic and early Formative periods. Some of those plant resources are likely to have been the same that were desired for exploitation by the human population including grasslands and mesquite thickets, where edible seeds from various grasses and mesquite beans were available. Many of the attractive plant communities would have been located where there was sufficient moisture available to support them. Thus, once again we are probably looking at the juxtaposition of sites and water sources. These factors may have been of somewhat less importance when selecting site locations during the later parts of the Formative period, when there was presumably a higher reliance on dry land farming. However, if exploitation of the inner basins actually continued during the late Formative, counter to the current state of knowledge, the archaeological presence of small resource extractive camps from the Doña Ana and El Paso phases would demonstrate that a similar set of locational selection criteria were in operation and would indicate a continued reliance on hunted and gathered foods in basin interiors.

Data necessary for the examination of this question will come from several sources. Soil attributes derived from geomorphological examinations of site locations, OSL dates obtained from sediment horizons, and both palynological and stable isotope analyses of samples recovered from geomorphological trenches may provide information on environmental conditions and the structure of plant communities during some periods of occupation and, by extension, information on past climatic conditions, such as temperatures and precipitation. Analysis of animal bone and plant remains obtained from sites should provide critical information on the specifics of resource use, as well as information on seasonality. Site structure will again play an important role where, for example, seasonal camps contain insubstantial structures suitable for warm season use, features used to process collected foods, storage features, and evidence for occupation duration, derived from definable middens and assemblage densities and characteristics.

Research Question 5: What Evidence Is There for Either Continuity or Changes in Land Use Patterns through Time and between Regions?

Why are some sites or general areas containing many sites reoccupied repeatedly while others are not? Is the presence of critical resources an important attraction for site occupation through time? Are there differences in occupational areas through time that might point to variation in the types of resources considered critical to the settlement system? Do sites that are more isolated appear to function differently in the settlement and subsistence system than do those that demonstrate repeated reoccupations? These questions are closely related to Research Questions 1, 2, and 4. Good chronological controls, information on site structure, and the nature and seasonality of resource exploitation are needed to address these inquiries. These data should be available from stratigraphic assessments during site excavations, analyses of the chipped and ground stone assemblages, and floral and faunal analyses. A reconstruction of the paleoenvironment should also provide important information on variations in the physical environment through time to which changes in site locational requirements might be seen as responses.

A persistent drying trend that began in Clovis times eventually led to the disappearance of perennial water sources including the lakes and marshes that occupied many of the large basins, the replacement of woodland communities by Chihuahuan desert, and the demise of large game animals (Miller and Kenmotsu 2004). These trends caused major changes in human settlement and subsistence patterns that marked the beginning of the Early Archaic period. At this time, we should see a shift to a focus on a diverse suite of plant foods from a reliance on the hunting of large game that characterized the Paleoindian period. Changes in the settlement system should be visible, and were necessitated by the spotty distribution of reliable water sources that would have restricted access to much of the interior basins during the dry season. A seasonal pattern of resource exploitation should become visible during this period. Continuity in these adaptations should continue through the Middle Archaic period, perhaps intensifying during the later part of the period (Miller and Kenmotsu 2004:223). This intensification may have involved a need to adapt to continued drying conditions that resulted in a more restricted and variable distribution of food resources (Miller and Kenmotsu 2004:223). A more intensive pattern of seasonality is expected, focused on areas that produced critical plant food resources and was adjacent to a seasonal source of water.

Our expectations are that environmental changes between the Middle Archaic and the Mesilla phase of the Formative period were not extreme enough to cause major variation in the locations of water sources and floral and faunal resource distributions that would result in visible changes in the settlement system. This should be evidenced by repeated occupations of the same or similar locales through time, creating palimpsests at many sites comprised of debris from multiple overlapping occupations, potentially including components from the Early Archaic through the early Formative period. Considering the culture historical reconstruction summarized in Chapter 3, major changes in settlement patterns may be visible after the Mesilla phase, because of an increased dependence on farming and a reduction in the use of basin interior areas as resource extractive zones. During the Protohistoric period, we would expect to see a return to the Archaic and Mesilla phase pattern, suggesting that components from this period might also overlap with those from earlier periods of occupation.

Research Question 6: What Can Site Structure Analyses Tell Us about Occupational Patterns through Time?

Knowledge of how sites are physically structured is critical to this investigation yet, for some sites, sufficient information may not be available from site assessment, testing, or excavation within construction/buffer limits. This is where research-oriented excavation should provide important information. The targeted investigation of areas thought to contain discrete occupations on sites can provide good information on how an area was utilized at various times. Considering the multi-component nature of several of the sites being investigated by this study, the probability is that we will encounter palimpsest distributions indicative of repeated overlapping occupations. Attempting to unravel those data and determine whether discrete occupations can be defined and what they represent will be the focus of site structure analysis. Since none of the larger sites will be fully investigated, certain areas that appear to contain the best potential for providing site structural information will be targeted. Excavation will concentrate on visible, preferably intact, features, clusters of artifacts that might be indicative of activity or discard zones, and areas that have the potential to contain structural remains. If possible, portions of sites exhibiting characteristics or artifacts diagnostic of different time periods will be examined in this way. Of particular importance will be areas suspected of containing Paleoindian, Early Archaic, or Protohistoric remains, because these periods are severely under-represented in the archaeological record for the region.

As with most of the other research questions discussed to this point, addressing this question will require data from a variety of sources. Provenience information from excavations will be used to establish the vertical and horizontal relationships between features (especially those that have been dated), habitation structures (if any are found), and artifact distributions. Those relationships, in turn, should aid researchers in assessing 1) the spatial organization (site structure) of the various occupations; 2) evidence for potential mixing with materials from other occupations; and 3) geomorphological processes that might have affected the distribution and associations of recovered materials. Analysis of the chipped stone, ground stone, and ceramic assemblages should provide information on site function and the presence of potential activity zones. Floral and faunal analyses should amplify the results of these studies by providing critical data on subsistence and seasonality. Chronometric data for features, related artifact scatters, and activity areas will be critical to an adequate exploration of overlapping occupations, as well as a determination of where a given component fits in the culture history of the region. While it is likely that the larger sites represent palimpsests created by repeated overlapping occupations, targeted examination of likely areas within the boundaries of these sites may provide data that can be used in this detailed analysis of site structure and function.

Theme 3: Military History, Encompassing Native American Military Activities as Well as Spanish, Mexican, and American Military Actions and Settlements Including Historic Forts and Camps

An almost total lack of significant historic components on any of the sites proposed for examination in this plan will make this research theme difficult, if not impossible, to examine using data provided by this study. This difficulty was recognized by FAA and NMSA (2010a) when proposing this research theme, and it was noted that both archaeological surveys and archival research have provided no indications of known forts, major military encampments, or battle sites within the Spaceport America facility. Most military activities for this area, including those of the Spanish, Mexican, and American governments are expected to have been in the vicinity of the Aleman Ranch, an archaeological site that is not included in this study. Thus, we expect to find no direct evidence for military activities in our study area, though isolated military artifacts might be found, reflecting transient military use of the project area while bivouacked elsewhere. However, while no definite Apache sites or components are among those to be examined by this project, some evidence of Apache activities may be found among them. The presence of components of this nature can be recognized in three ways — the recovery of pottery diagnostic of a Protohistoric or Historic period Apache occupation, absolute dates indicating that features or structures were built and used during the Protohistoric or Historic periods, and the presence of diagnostic Euroamerican artifacts related to an Apache presence. Thus, only one rather simple research question can potentially be addressed for this theme by the current project.

Research Question 7: Is There Evidence of an Apache Presence in the Project Area that Can Be Tied to Concurrent Military Activities?

Since, as noted earlier, no evidence for this type of occupation was recognized during survey, we may or may not be able to address this question. However, considering the potential evidence for Apache occupation identified in the Fort Bliss area (Seymour 2002; Seymour and Church 2007), a possibility that was thought to be low before actual field studies began (Baugh and Seychrist 2001), the likelihood that some of our sites may exhibit evidence for an Apache occupation must be considered. While the presence of ring middens at LA 111429, LA 111435, and LA 155964, may suggest Protohistoric or Historic Apachean occupations, the possibility that these features are actually prehistoric must also be considered. The possibility of Apachean occupations on these and other sites will be approached in two ways. First, as discussed in Chapter 4, sites will be examined for metal artifacts using a metal detector. Such artifacts might include metal projectile points as well as debris generated by their manufacture. Second, a sample of ring middens will be examined during the research phase, or when they occur within affected portions of sites.

Should evidence of Apachean occupations be found, the context of and the date reflected by such evidence will be important. Protohistoric Apache sites are expected to reflect a very similar settlement and subsistence system to those of the Middle Archaic through early Mesilla phases, when subsistence is thought to have mainly been based on hunting and gathering, and supplemented by some farming. Those Historic Apache sites occupied after the acquisition of the horse and when the Apache economy was based partly on raiding, are expected to reflect much different settlement and subsistence systems. Using absolute dates indicative of a Protohistoric or Historic period occupation, the presence of diagnostic pottery or chipped stone tools (as defined by Seymour [2002] and Seymour and Church [2007]), or the presence of metal tools and other Euroamerican artifacts to define Apache components, we can begin examining questions of site structure, settlement type, and similarities in landscape use with prehistoric periods. The identification of Historic Apache components could allow for the evaluation of their relationship to known or theoretical military operations.

Theme 4: Dynamics of Trade, Interaction, and Economy throughout All Time Periods, Including a Focus on El Camino Real as a Transportation Corridor, Exploration of the Development of Railroads in the Region, and the Development of Aerospace Exploration in New Mexico

The current project should be able to examine the dynamics of trade, interaction, and economy through the prehistoric period and perhaps into the Protohistoric and early Historic period, but examination of the Camino Real, and the development of railroads and the aerospace industry cannot be addressed because we do not expect to recover any data that would be pertinent to these areas of inquiry. The presence of materials that are not native to the project area should provide information on the extent of ties that the inhabitants of this region had with other peoples, and might also give us an idea of where people were living during other parts of the year. Such materials would not only provide an idea of what types of exotic goods may have been considered important to acquire, but also the direction of trade and exchange ties. For instance, pottery from the Mimbres area commonly occurs on sites in the Jornada Mogollon region throughout the Mesilla phase, disappearing after about AD 1150, a date consistent with the collapse of the Mimbres regional system. After that approximate date, new trade links seems to have been established with two regions. One of these was the Casas Grandes regional system to the south, as indicated by the occurrence of pottery from that region on El Paso phase sites, as well as a few copper bells (Lehmer 1948). The second was the region in central New Mexico where Chupadero Black-on-white was manufactured. These changes represent adaptations to the changing social and cultural scene, and might also be represented in middle Jornada del Muerto sites. Only very small amounts of pottery from the Pueblo area seem to occur in the Jornada region, though rare Glaze A and Galisteo Black-on-white sherds have been recovered from a few sites. Rather than direct acquisition, the Pueblo sherds probably represent down-the-line exchange. Was this exchange facilitated by human groups further north in the Jornada region, or were these exotic ceramics acquired from somewhere else?

Other types of trade goods can include raw materials used in the manufacture of chipped and ground stone tools. For example, the presence on middle Jornada del Muerto area sites of rock types that could only have been acquired from Rio Grande gravels or in the highlands surrounding the Jornada del Muerto basin may be more indicative of seasonal movement patterns by indigenous peoples than of exchange and trade. Similarly, bone from animal species that had not been native to the study area could also be regarded as evidence of seasonal movement rather than exchange, unless the bone had been fashioned into a tool type that was not native to the region. In contrast, marine shell or shell from non-native freshwater mollusks would be good evidence for trade and exchange. As noted in Chapter 3, several species of imported shells have been found at numerous sites elsewhere in the Jornada region. The presence of plants found only in other ecological zones would also most likely be considered indicative of seasonal movement, as could the presence of cultigens. The occurrence of exotic lithic materials on sites may also have different implications for different occupational periods. For example, the presence of rocks that outcrop in the Texas Panhandle like Alibates and Edwards Plateau cherts might be considered indicative of movement patterns for a Paleoindian period component, while it would be evidence of spheres of trade and interaction during later occupational periods. Thus, as with other research themes, information on chronological placement and context will be important in examining this theme.

Research Question 8: With What Areas Did the Residents of the Study Area Interact during Various Periods of Occupation?

Were exchange and trade ties in the project area similar to those seen elsewhere in the Jornada Mogollon region, or were they different? Can we see any evidence of interaction with other regions during the Archaic or Protohistoric period? Miller and Kenmotsu (2004) suggest that exchange ties in the Jornada region were aligned along a north-south axis during the Archaic, shifting to an east-west alignment during the Mesilla phase, and back to a north-south alignment during the Doña Ana and El Paso phases. Exotic obsidians imported from the Jemez region to the north and from Chihuahua to the south occur in some assemblages. Is a similar pattern of interaction reflected in our sites, or might there be subtle differences conditioned by a greater distance from the Chihuahua sources and a smaller distance to those in north-central New Mexico than is the case for sites further to the south in the El Paso region? Obsidian sourcing can be used to help determine where obsidian found on sites in the project area originated, but in the case of the Jemez sources, must be augmented with information on cortex type and nodule size, since Jemez obsidian nodules are common in Rio Grande gravels.

As noted earlier, Jornada interaction patterns seem to have shifted to an east-west axis during the Mesilla phase, and exchange seems to have been primarily with the Mimbres regional system to the west. Analysis of ceramic assemblages from the project area sites in the middle Jornada del Muerto should provide the information needed to determine the direction of interaction that the site occupants there were engaged in. The presence of small percentages of Mimbres wares in local assemblages would be indicative of the east-west tie, while the presence of pottery from a range of other regions may suggest that trade and exchange ties were more widespread than those elsewhere in the region. A total lack of Mimbres pottery on sites of this time period, coupled with the occurrence of exotic types from elsewhere, would suggest that trade and exchange ties in the middle Jornada del Muerto differed from those in other parts of the region.

With the collapse of the Mimbres system around AD 1150, exchange ties shifted back to a pattern similar to that of the Archaic, with a north-south alignment. This is indicated by the occurrence of pottery from the Casas Grandes regional system as well as Chupadero Black-on-white from central New Mexico. Similar trends in our data would indicate a equivalent adaptation to regional interaction.

The analysis of various artifact classes could also provide evidence for examining this question. One of the aims of chipped stone analysis is the definition of material types, especially those that can be recognized as coming from other regions. This type of visual identification can be augmented by more specialized analyses, including the use of x-ray fluorescence (XRF) to define obsidian sources, and the use of infrared light to help identify cherts from the Texas Panhandle. These techniques will be applied to samples of potential exotic materials recovered from project area sites. While some pottery types can be visually recognized as imports, the sources of others can often be determined using more specialized studies including neutron activation and petrographic analyses. These may be used to more confidently define the source of particular sherds or wares. The types of materials and sometimes styles represented in assemblages of ornaments can also be used to define the presence of exotics. Should materials like turquoise be found, chemical analysis may help determine whether it came from a local or distant source. Shell ornaments, should any identifiable specimens be found, can be particularly useful in this type of inquiry, since certain species, such as marine shells, have very specific source areas. Analysis of faunal assemblages will help determine whether any non-native species are represented, and what their presence might mean.

Questions Unrelated to the Research Themes

A single question is proposed for examination that does not directly intersect with the four research themes, yet can contribute greatly to our knowledge of the human use and the effects of that use on the project area, as well as to our understanding of how physical forces shaped the formation of archaeological sites.

Research Question 9: What Is the History of Geomorphic Changes in the Middle Jornada del Muerto, and How Do Those Changes Relate to the Archaeological Record?

This question is mainly aimed at defining prehistoric landscapes by examining the relationship between the overall geologic stratigraphy of the project area and the locations of archaeological remains from various periods of occupation. By examining stratigraphic profiles for each site in relation to the dates for any archaeological remains that occur within them, along with luminescence (OSL) dates for the sediment deposits themselves, an idea of how the landscape of this region has changed through time can be derived. These data can be used to develop a model for predicting which sediment strata might contain intact archaeological remains from various time periods, as well as to evaluate how intact those remains might be. For example, the presence of Mesilla phase artifacts with no associated intact features on a surface layer comprised of a Pleistocene age B soil horizon would be indicative of erosional processes. These processes would have impacted the vertical and, possibly, the horizontal distributional relationships among those artifacts, severely reducing their utility in a site structural analysis. These data can also provide important information on soil formation processes occurring through time, which in turn can provide data on the paleoenvironment.

Chronological controls are critical to this investigation, and will be provided by dates obtained for archaeological features, as well as OSL dates for the sediments and soils within which they occur. A range of other data will be needed for this evaluation including documentation of the stratigraphy for each site, texture and chemistry of sediments, and the presence of soils and paleosols. These data should all be available from the geomorphological studies that will be conducted at each of the investigated sites.

Chapter 6: Site Descriptions, Testing Results, and Field Approaches

Nancy J. Akins, Stephen S. Post, James L. Moore, and Matthew J. Barbour

This chapter presents site descriptions, testing results, and brief plans for research-driven excavation. Tables 6.1 and 6.2 summarize the testing that has been completed and proposed excavation plans. Table 6.1 gives the work completed during the 2010 testing and a brief summary of the planned work. Any substantive deviation from the excavation plans presented in this chapter will be made in consultation with NMSA, SHPO, and appropriate land managing agencies. Rationale for changes to the excavation plans will be described in all reports. Table 6.2 estimates the number and cumulative length of the geomorphological trenches, the estimated number of features and how many will be excavated, the maximum area that will be surface stripped by hand, and whether surface artifacts will be collected from a site during the second phase of the project. More specific information on mapping, screen size, feature and grid excavation, and sample collection can be found in Chapter 5, the field methods section of this document. The *Site Investigation Plan* section is a summary of the *Treatment Recommendations* presented in the *Mitigation Plan for Archaeology Spaceport America 2010* (FAA and NMSA 2010a). Site locations for the Horizontal Launch Area (HLA) and Vertical Launch Area (VLA) are provided in Appendix 4 (Figures A4.1 and A4.2) and legal descriptions in Appendix 4.

Prior to preparing this plan, OAS archaeologists Nancy Akins, Jessica Badner, Matthew Barbour, Robert Dello-Russo, James Moore, and Stephen Post, along with Elizabeth Oster (NMSA cultural resources contractor) and Stephen Hall (geomorphologist), visited the sites (September 8-10, 2010). Test excavations were completed at eight of the sites between November 8 and December 17, 2010. This was done following a plan approved by the SLO and NMSHPO (Moore et. al 2010). Results of the testing phase are summarized for each of the tested sites. A report describing the results of the testing at these eight sites is forthcoming. Data collected during the testing phase of the research will contribute to addressing the questions posed in this plan for investigation of Spaceport America's cultural landscape, as research-oriented investigations continue.

Horizontal Launch Area (HLA)

LA 155963

LA 155963 is a large prehistoric artifact scatter with features that date to the Late Archaic or the Early Mesilla through the Doña Ana phases of the Jornada Mogollon. It is located on NMSLO trust land and has been determined as "eligible" under Criterion "d" for NRHP based on the assessment that it has integrity (between 51 and 75 percent), has the potential for subsurface deposits including potential dating material and possible habitation features, and has a significant artifact assemblage. For these reasons, it has the potential to address research domains within regional prehistory (Quaranta and Gibbs 2008:133, 393, 402).

The site lies just west of the HLA in the vicinity of the entrance road. A power line runs along the southern boundary of the site and County Road A-021 lies less than 100 m to the south paralleling the southern site boundary. Potential construction effects include: construction of the entrance road, a primary access road, a security and perimeter/ game fence, a potential infrastructure corridor, and the tank and associated booster station (FAA and NMSA 2010b:19).

Previous work. The site was originally recorded by Zia in 2007 and described as a large prehistoric artifact scatter with features dating from the Late Archaic and Mesilla phase of the Jornada Mogollon (Quaranta and Gibbs 2008:132-133). Features were located and described and a sample of 37 pieces of lithic debitage was analyzed (Quaranta and Gibbs 2008:132). Additional visits to locate the site boundaries and mark a protective buffer occurred in 2009 and 2010. The area within a proposed waterline corridor along

Table 6.1. Summary of 2010 testing and proposed 2011 research excavations	
LA	Description of work
Horizontal Launch Area	
155963	TESTED: mapped, located and field analyzed 202 artifacts and collected 44 diagnostic artifacts, located 131and recorded 55 features, tested 4 features, 5 geomorphology trenches
	RESEARCH: record the remaining features, excavate or partially excavate up to 20 features, field analyze artifacts within clusters, test excavate within the clusters
155964	RESEARCH: map, partially excavate features and surrounding areas, geomorphology trench
155968	RESEARCH: map, collect surface artifacts, excavate feature and surrounding area, hand excavations in other areas, geomorphology trench
155969	RESEARCH: map, collect surface artifacts, excavate feature and surrounding area, geomorphology trench
156877	RESEARCH: map, surface collect artifacts, excavate feature and surrounding area, geomorphology (monitor construction)
Vertical Launch Area	
111420	TESTED: mapped, hand excavated 5 test pits, 22 auger holes, 1 geomorphology trench, field analyzed 330, collected 21 artifacts.
111421	TESTED: mapped, hand excavated 4 test pits, 22 auger holes, 1 geomorphology trench, field analyzed 58 artifacts, collected 5 artifacts.
111422	RESEARCH: map, excavate features and surrounding area, hand excavate near diagnostics artifacts, field analyze artifacts, geomorphology trench
111429	TESTED: mapped, located and field recorded 76 artifacts, collected 6 artifacts, located and recorded 24 features, tested 10 features
	RESEARCH: excavate a range of features, collect within artifact clusters, test excavation within artifact clusters, up to 5 geomorphology trenches
111432	TESTED: mapped, hand excavated 5 test units, 22 auger holes, field analyzed 124 artifacts, collected 106 artifacts within potential infrastructure corridor, 1 geomorphology trench.
111435	RESEARCH: map, field analyze artifacts, excavate features with dating potential, hand excavations in artifact concentrations, geomorphology trench
112370	TESTED: mapped, excavated 28 auger holes, hand excavated 4 test pits, located and analyzed 14 artifacts, collected 1 artifact, 1 geomorphology trench.
112371	TESTED: mapped, excavated 27 auger holes, hand excavated 4 test pits, located and analyzed 61 artifacts, collected 17 artifacts, 1 geomorphology trench.
112374	TESTED: mapped, excavated 29 auger holes, hand excavated 4 test pits, located and analyzed 11artifacts, collected 1artifact, 1 geomorphology trench.

the east edge was checked for undocumented features and the documented features were examined to determine if any would be affected by the proposed construction. The corridor was staked and the integrity of features within the corridor assessed. The features were determined to lack integrity and the portion of the site within the corridor was found to be unlikely to exhibit subsurface cultural manifestations. Monitoring of the waterline construction found no intact subsurface features. A second construction corridor along the south edge of the site was assessed and found to be unlikely to contain subsurface cultural manifestations. Monitoring of construction found no intact cultural features (FAA and NMSA 2010b:19).

OAS visited the site in September 2010 to evaluate the current condition of the site. They observed additional diagnostic artifacts and unrecorded features and were unable to locate the middens. Following the approved testing plan (Moore et. al 2010), testing level investigations at this site took place between December 13 and 17, 2010.

Site setting. LA 155963 is located on the south and southeastern slopes of a low, gently-sloping hill. Soils are of mixed depths with exposed caliche nodules associated with shallow deposits. In the northern portion of the site the eastern slope is actively eroding with minor drainage channels running into a more major arroyo along the eastern site boundary. A shallow southeast-

Table 6.2. Summary of proposed trench, hand excavation and surface collection areas.										
LA number	Area*	Maximum number of. geomorphology trenches	Maximum length of geomorph trenches (m)	% of site for geomorph trenches	Estimated number of features	Maximum number of features to be investigated	% of features to be investigated	Maximum nonfeature hand excavation units (1X1 m)	% of hand excavations	% of site systematic surface collection
155963	533,139	0 additional	(25m completed)	0	131	30	22.9	700	0.13	0
155964	*3,300	1	5	0.15	*3	3	100	13	0.04	0
155968	*8,866	1	5	0.06	*1	1	100	8	1.09	100
155969	*1,065	1	5	0.47	*1	1	100	16	1.5	100
155877	*1,920	1	5	0.26	*1	1	100	16	0.83	100
111422	*2,274	1	5	0.22	*3	3	100	80	3.5	0
111429	177,940	5	25	0.01	24	10	41.7	200	0.11	< 10
111435	*14,778	2	10	0.07	*9	9	100	80	0.13	0
*Zia estimate, else OAS										

trending drainage bisects the central portion of the site. Vegetation is mainly creosote bush, four-wing saltbush, and mesquite. Mesquite stabilized coppice dunes with active eolian accumulation occur with limited grass cover between dunes (Quaranta and Gibbs 2008:132-133). The site is about 800 m east of the Aleman Ranch. Southeast-trending Aleman Draw lies 200 m southeast of the site boundary.

Site description. Zia described LA 155963 as large, covering an area approximately 1,075 by 498 m (501,654 square meters, 50 hectares, 124 acres) (Fig. 6.1) with two core areas (Fig. 6.2) and over 35 fire-cracked rock (FCR) features (Appendix 3). The FCR features range from 0.5 to 4.0 m in diameter. Core Area 1 is described as an approximately 100 square meter area with about 20 FCR features and chipped and ground stone artifacts. Most of the features are eroded and scattered. Core Area 2 is the same size but has only one defined feature, a burned caliche and FCR feature. It also has dense concentrations of FCR, charcoal stains, midden deposits, numerous small brown ware ceramics, two gray ware ceramics, 10 pieces of ground stone, abundant flaked stone, a San Pedro projectile point, and the potential for buried pit structures. The surface artifact assemblage was estimated in the 10,000s of lithic artifacts with up to 40 cm of cultural deposits visible in erosion channels. A sample of the ground stone (5 manos, 4 or 5 metate fragments, a boulder with grinding, and 2 hammerstones), lithic tools (the projectile point, 3 flake tools, 3 scrapers, a graver, a chopper, and a drill), and lithic debitage (2 pieces of angular debris and 35 flakes) were analyzed (FAA and NMSA 2010b:18, Quaranta and Gibbs 2008:139-142).

OAS observed a number of additional tools, including two projectile points in the ceramic concentration, Archaic projectile points, a biface, and a drill in the northern area. Few artifacts occur in the intervening area between the core areas and the northern cluster of artifacts and features and the 40 cm deep midden described on the site form as exposed in the arroyo was not found. A possible slab-lined fire pit was observed in an area noted for several tools, and other unrecorded features were observed, including a dark stain outside of the core areas.

The artifact assemblage and features indicate multiple use episodes and could represent some of the earliest Formative use of the area. The proposed Late Archaic or Early Mesilla phase component is based on the presence of a San Pedro projectile point that could represent an early agricultural period occupation (Quaranta and Gibbs 2008:141). El Paso Brown ware and Chupadero Black-on-white ceramics in Core Area 2 suggest a later occupation with a midden and possible structures (FAA and NMSA 2010b:18).

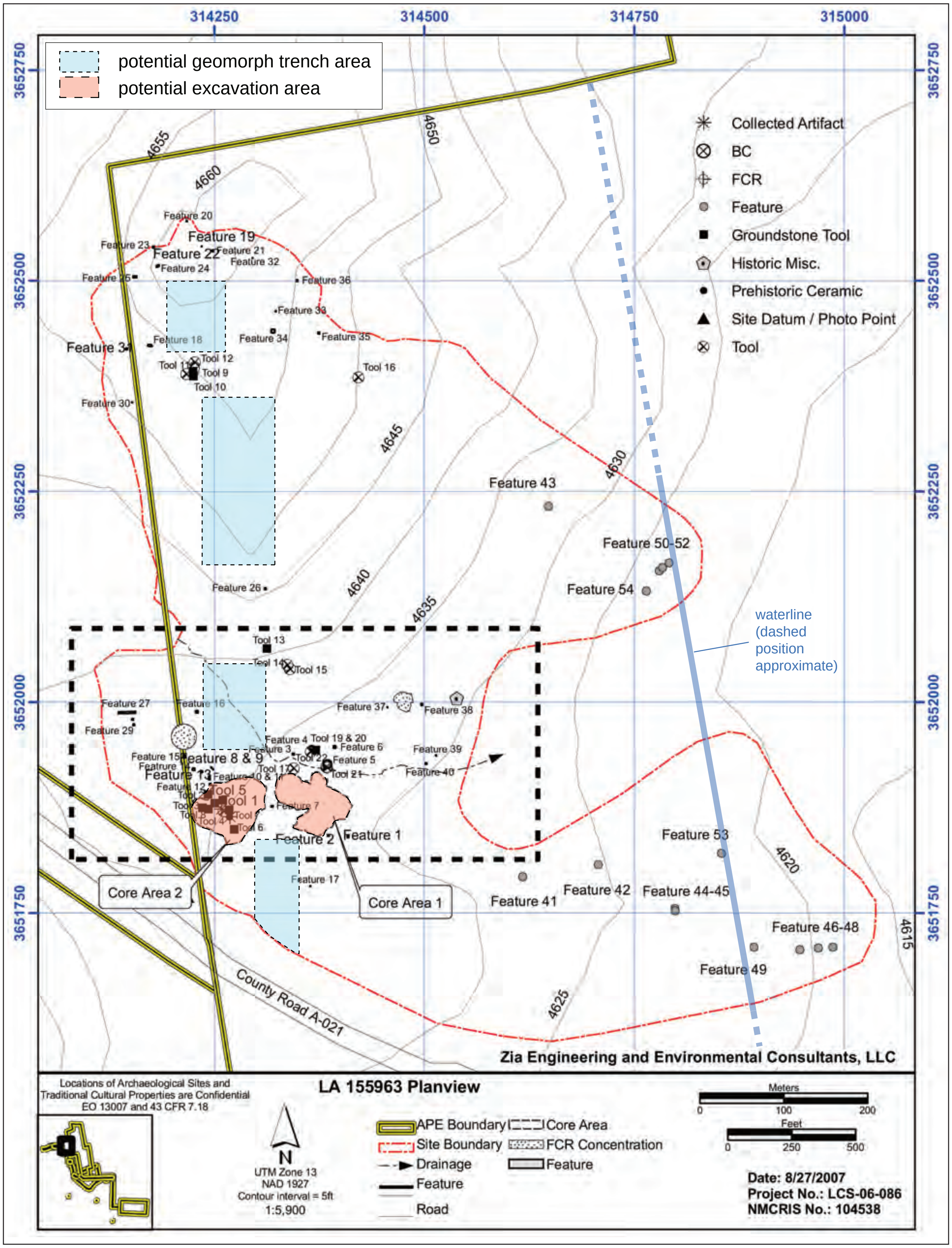

Figure 6.1. Plan of LA 155963 (after Zia 2008) showing the recent road extension and potential archaeological work areas.

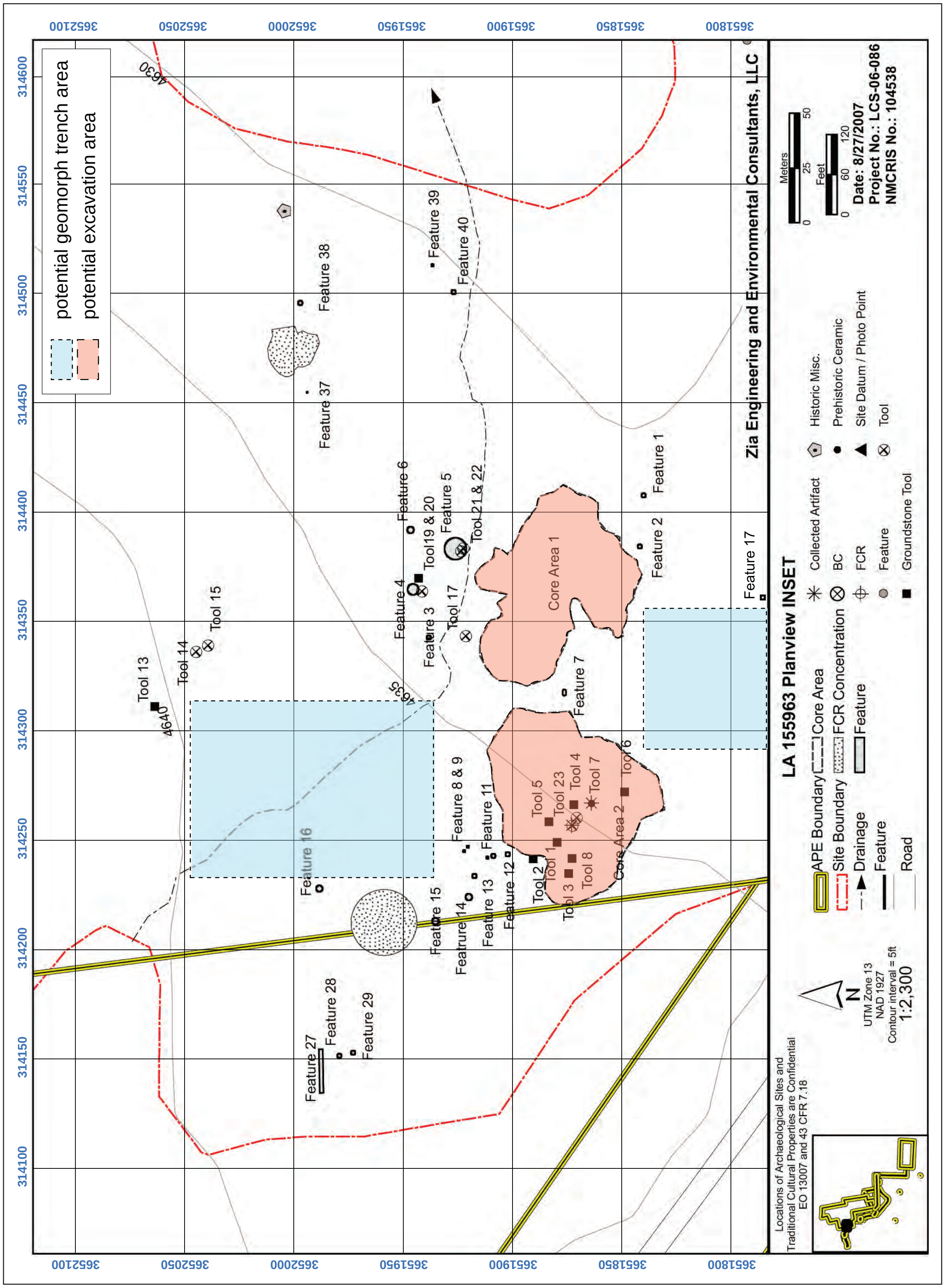

Figure 6.2. Detail of core areas at LA 155963 (after Zia 2008) showing potential archaeological work areas.

Testing results. Before work at LA 155963 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. Testing at LA 155963 consisted of locating features and diagnostic artifacts, identifying artifact clusters, and determining the site boundaries. The surface artifact distribution suggests that site boundaries extend slightly farther north than those initially proposed by Zia (Figs. 6.3–6.6), increasing the estimated site size (Zia=501,654 m^2, OAS=533,139 m^2). OAS investigations added a Paleoindian component to the site and identified a possible Protohistoric and a recent Historic activity area.

Artifact assemblage. No attempt was made to examine all surface artifacts at LA 155963 because of their large number. Instead, the locations of visible formal tools and atypical artifacts were plotted, and they were briefly described. Temporally diagnostic specimens were collected for further examination. The recorded stone tool assemblage included 49 ground stone fragments, 36 bifaces, 26 projectile points, 19 metates, 17 manos, 6 choppers, 4 scrapers, 2 thumbnail scrapers, and single examples of a drill, spokeshave, denticulate, core-hammerstone, projectile point preform, quartz crystal, and modified hematite object (Table 6.3). Other temporally diagnostic specimens included 30 historic artifacts and 6 sherds. The projectile assemblage included specimens dating to the Paleoindian, Archaic, and Formative periods. Of Paleoindian age were 3 Folsom points and 2 late Paleoindian point bases that are not yet further identified. Three points were assigned a general Archaic affiliation, and a San Pedro point and an Augustin point completed the Archaic assemblage. The Formative points included 4 corner-notched arrow points, 2 side-notched arrow points, 2 small point fragments, and 3 unnotched points. While the unnotched points could indicate a Protohistoric component, this is uncertain. In addition to the points that could be assigned to a general time period were 4 unidentifiable fragments. While four of the recorded sherds were plain brown wares, a piece of Chupadero Black-on-white was noted, as well as a possible second example of this type that was small and undecorated. All historic artifacts date to the late nineteenth through mid-twentieth centuries and include various cans (several of which are sanitary seal types), barrel hoops, galvanized steel strapping, numerous square nails, cartridge cases in a variety of calibers, and a wagon part. Forty-four artifacts were collected from the surface of LA 155963, and mainly included specimens that were temporally diagnostic or had other importance and might not be relocated during later studies if left in place. Collected prehistoric artifacts included all 26 projectile points, 2 thumbnail scrapers, 2 white ware sherds, and single examples of a biface, drill, projectile point preform, quartz crystal, modified hematite object, and a shaft straightener. The remaining 8 artifacts were historic in date and included 5 cartridge cases (3 .44 cal., 1 .50 cal., and 1 .45-.70 cal.), 2 lard pails, and a steel link from a .50 cal. machine gun belt.

In general, the northwest quadrant of LA 155963 appears to mainly contain Paleoindian and Archaic materials, though there is some evidence of Formative period use as well (Fig 6.4.). The southwest quadrant appears to be dominated by Formative period materials, though there also appears to have been some Archaic use of this area (Fig 6.5.). The northeast and southeast quadrants contain scattered features and widely scattered artifacts, and were not as heavily used as the western quadrants appear to have been (Fig. 6.6). Four general areas of particular interest were defined for their research potential. With the exception of one of the Folsom points, Paleoindian materials seemed to be concentrated in the northwest quadrant. That area mainly contains chipped stone artifacts, and sherds are comparatively rare. Two Folsom points were found in fairly close proximity in this quadrant, suggesting the presence of a definable Paleoindian component. A second area of interest in the north part of the site is a burned rock feature with several brown ware sherds in association (Feature 8). This seems to represent a discrete short-term Formative period occupation area. The concentration of Formative period materials in the southwest quadrant is in an area that has suffered heavy erosion, but should still contain enough data potential to permit exploration of the Formative period use of this region. Finally, a small cluster of features with three small unnotched points in close proximity was noted in the southeast quadrant, and potentially represents a discrete Protohistoric or Formative

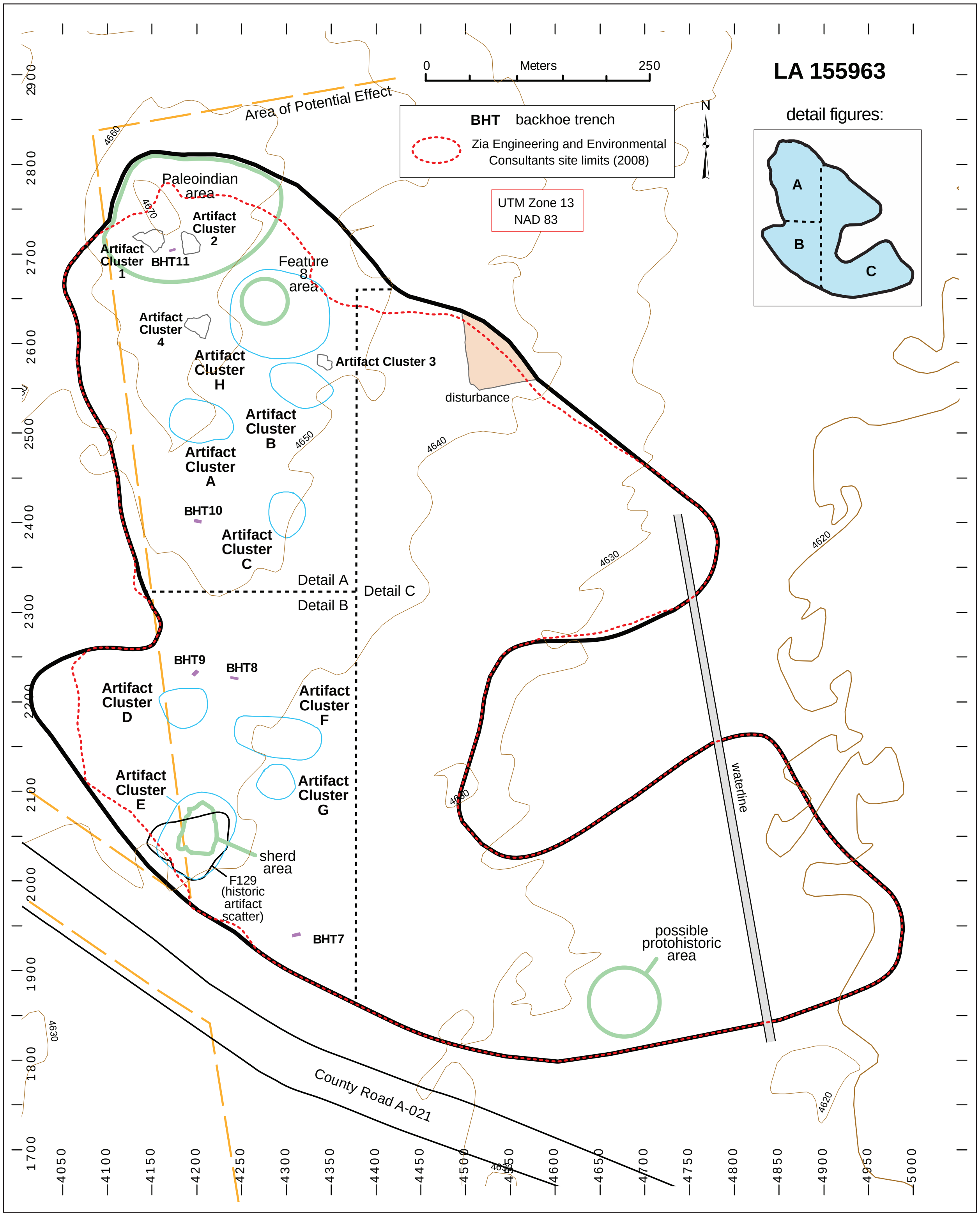

Figure 6.3. OAS plan of LA 155963, showing locations of excavation areas and artifacts. Artifact clusters labeled with letters represent groups created for ease of presentation, and are not analytic subdivisions. Numbered clusters are those defined in the field.

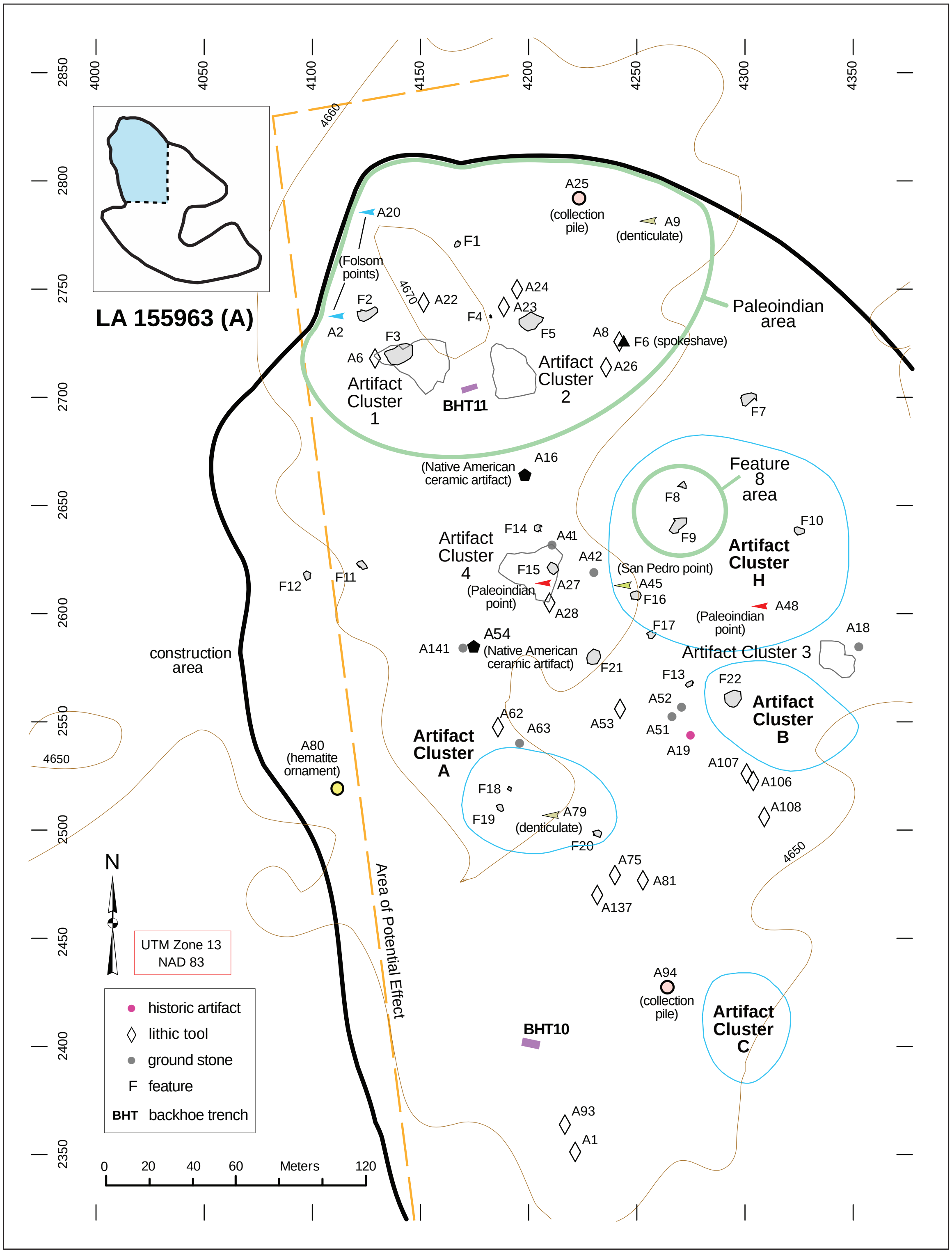

Figure 6.4. Plan of northwest quadrant of LA 155963 showing features, artifact clusters, and artifacts analyzed. Artifact clusters labeled with letters represent groups created for ease of presentation, and are not analytic subdivisions. Numbered clusters are those defined in the field.

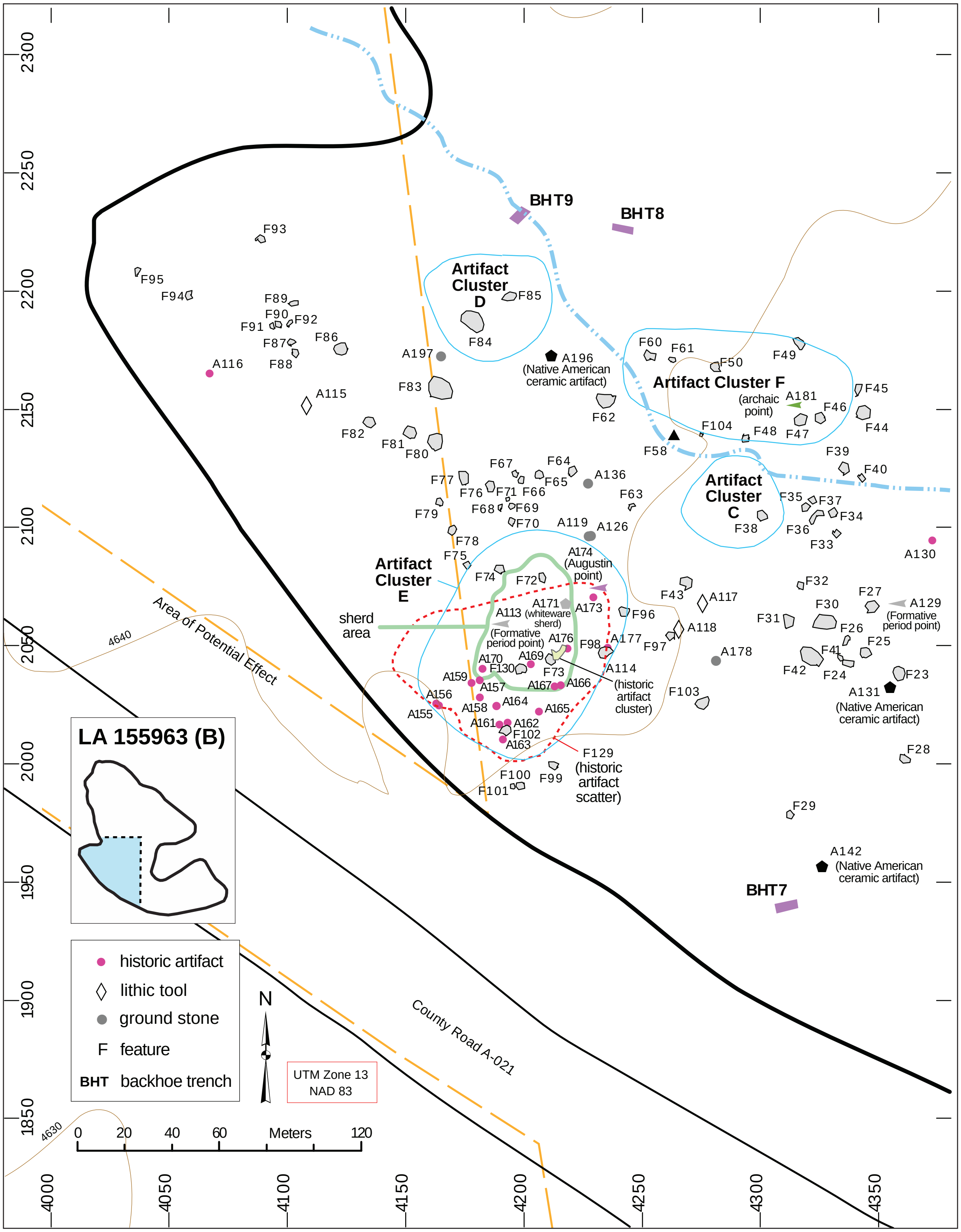

Figure 6.5. Plan of southwest quadrant of LA 155963 showing features, artifact clusters, and artifacts analyzed. Artifact clusters labeled with letters represent groups created for ease of presentation, and are not analytic subdivisions. Numbered clusters are those defined in the field.

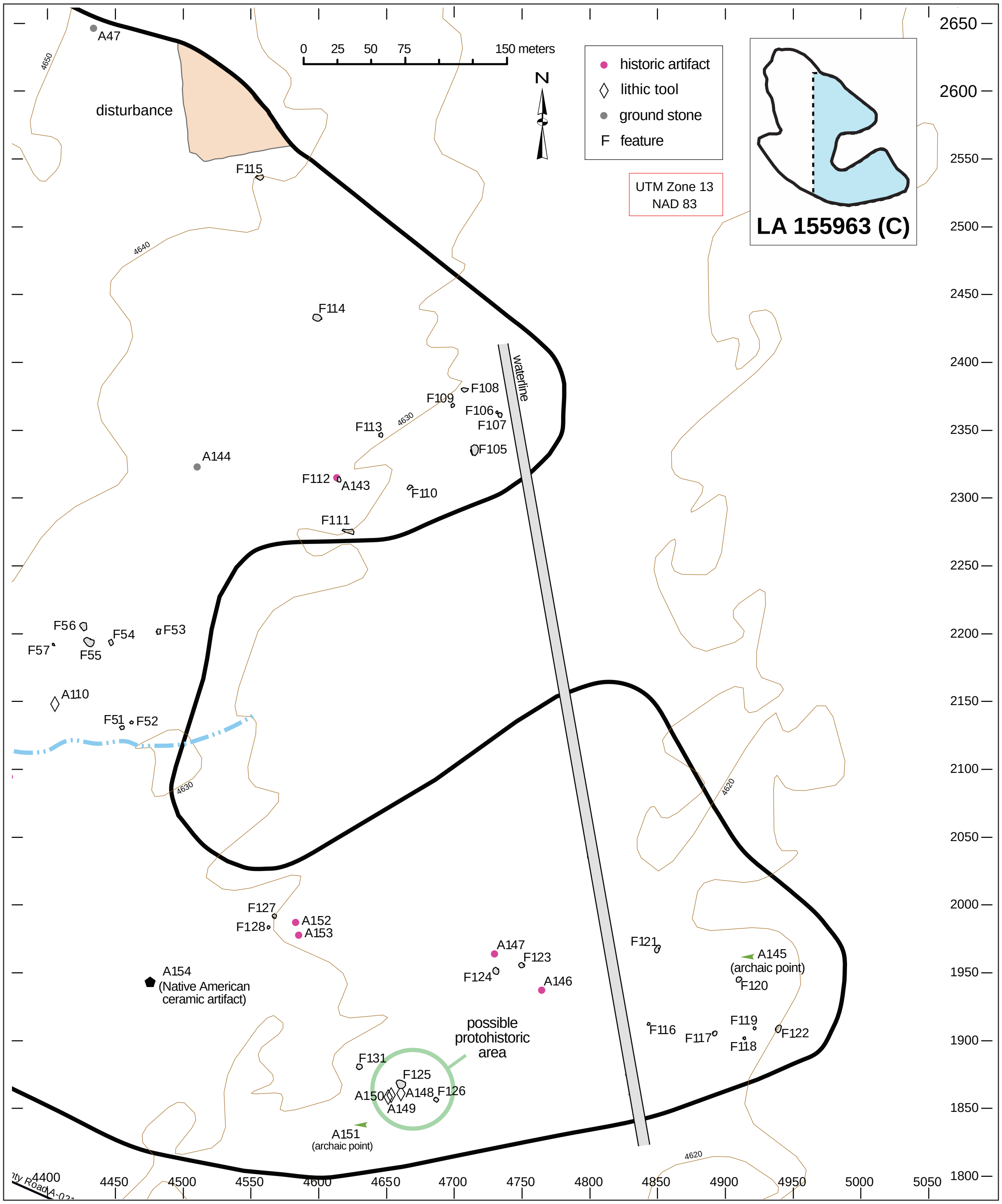

Figure 6.6. Plan of the east half of LA 155963 showing features, artifact clusters, and artifacts analyzed. Artifact clusters labeled with letters represent groups created for ease of presentation, and are not analytic subdivisions. Numbered clusters are those defined in the field.

Table 6.3. Material type by morphology for chipped and ground stone artifacts recorded at LA 155963; counts and column percentages.

Material Type		Overshot flakes	Cores	Cobble tools	Unifaces	Bifaces	Ground stone	Totals
Unknown/not applicable	Count				2	15	2	59
	%				33.33%		2.35%	28.78%
Chert	Count	1		2	5	43		51
	%	100.00%		33.33%	83.33%			24.88%
San Andres chert	Count				1		1	2
	%				16.67%		1.18%	0.98%
Silicified wood	Count					1		1
	%							0.49%
Obsidian	Count					2		2
	%							0.98%
Igneous	Count						4	4
	%						4.71%	1.95%
Basalt	Count						7	7
	%						8.24%	3.41%
Rhyolite	Count		1	2			2	5
	%		100.00%	33.33%			2.35%	2.44%
Limestone	Count			1		1		2
	%			16.67%				0.98%
Sandstone	Count						66	66
	%						77.65%	32.20%
Metaquartzite	Count			1		1	3	5
	%			16.67%			3.53%	2.44%
Quartz	Count							1
	%							0.49%
Totals	Count	1	1	6	6	63	85	162
	%	0.62%	0.62%	3.70%	3.70%	38.89%	52.47%	100.00%

period occupation area. At least some future research-oriented work is anticipated in all four of these parts of the site.

Features. Zia located and described 41 features at LA 155963 (Quaranta and Gibbs 2008:139-140). OAS located 131 features. Features were numbered sequentially and each was marked with an aluminum tag on a steel nail. For consistency, the same two individuals recorded all of the features that were closely examined. Digital photographs were taken of each feature. Zia shape files loaded onto the Trimble were used to locate some of the features but no attempt was made to determine the Zia equivalents to the OAS numbered features. Feature Inventory Forms were completed for 55 of the features (Table 6.4) and 4 of these were examined by a 20 by 20 cm test. In addition, Feature 129, a historic artifact scatter, was described by Matt Barbour.

Our experience at LA 111429 led to an improved form that was used at LA 155963. It required less verbal description and more information on artifact associations. Thus, there are some differences in the data fields recorded at each site. Feature Inventory Data recorded for the 55 features at LA 155963 includes:

- Feature number
- Feature type
- Feature size (north-south maximum extent and core, east-west maximum extent and core)
- Estimated number of FCR
- Maximum FCR density (50 by 50 cm area)
- Fragmentation of FCR (large or cobble, highly fragmented, mixed)
- FCR rock types and proportions (caliche, igneous, quartzite, limestone, sandstone, other)

Table 6.4. Features inventoried at LA 155963

Number	Type	Estimated FCR count	FCR maximum density	FCR fragmentation	% caliche	Feature tested?	Comment	Information potential
1	dispersed fcr with concentration	< 50	8	highly fragmented	90	yes	subsurface rock present	fair
2	dispersed fcr with concentration	50-100	6	cobbles and highly fragmented	82	no		very low
3	dispersed fcr scatter	< 10	2	mostly cobbles	90	no		none
4	fcr concentration and dispersed scatter	< 50	12	cobbles and highly fragmented	55	no	part under dune	low to fair
5	dispersed fcr with concentration	50-100	5	cobbles and highly fragmented	90	no		low
6	fcr concentration and dispersed scatter	< 50	20	cobbles and highly fragmented	50	no	stain present	good
7	dispersed fcr with concentration	50-100	18	cobbles and highly fragmented	90	no	part under dune	low
8	dispersed fcr with concentration	20	4	cobbles and highly fragmented	60	no	stain and subsurface rock	fair to good
9	dispersed fcr with concentration	50-100	6	cobbles and highly fragmented	50	yes	stain and subsurface rock	fair to good
10	dispersed fcr with concentration	50-100	4	cobbles and highly fragmented	90	no	subsurface rock present	low to fair
11	dispersed fcr with concentration	< 50	6	cobbles and highly fragmented	50	no	quary area	very low
12	collector's pile	absent	0	absent	0	no	quary area	none
13	artifact concentration	< 50	2	highly fragmented	90	no		low to fair
14	fcr concentration and dispersed scatter	> 200	18	cobbles and highly fragmented	50	yes	stain present	fair to good
15	dispersed fcr scatter	< 50	3	cobbles and highly fragmented	80	no	stain present	fair to good
16	dispersed fcr scatter	50-100	5	cobbles and highly fragmented	85	no	associated with an artifact cluster	very low
17	dispersed fcr with concentration	< 50	6	cobbles and highly fragmented	70	no		low
18	slab-lined feature	absent	0	absent	0	no	associated with an artifact cluster	low to fair
19	dispersed fcr with concentration	100-200	6	highly fragmented	70	no	associated with an artifact cluster	low
20	fcr concentration and dispersed scatter	100-200	10	cobbles and highly fragmented	40	yes	stain present	good
21	dispersed fcr with concentration	100-200	10	highly fragmented	85	no	associated with an artifact cluster	low
22	dispersed fcr scatter	20	2	highly fragmented	40	no	associated with an artifact cluster	low
23	fcr concentration and dispersed scatter	50-100	16	cobbles and highly fragmented	10	no	subsurface rock present	low to fair
26	fcr concentration and dispersed scatter	50-100	19	mostly cobbles	20	no	associated with an artifact cluster	low
27	dispersed fcr with concentration	100-200	17	cobbles and highly fragmented	60	no	< 2 cm of fill	low
33	dispersed fcr with concentration	< 50	4	cobbles and highly fragmented	20	no	associated with an artifact cluster	low
34	dispersed fcr with concentration	50-100	5	cobbles and highly fragmented	50	no	associated with an artifact cluster	low
40	dispersed fcr with concentration	50-100	10	cobbles and highly fragmented	70	no	< 5 cm fill	low
42	dispersed fcr scatter	100-200	12	cobbles and highly fragmented	45	no	< 2 cm of fill	none
43	historic burned rock pile/scatter	300	50	mostly cobbles	5	no		none
44	dispersed fcr with concentration	50-100	12	cobbles and highly fragmented	70	no	associated with an artifact cluster	low
48	fcr concentration and dispersed scatter	100-200	35	cobbles and highly fragmented	50	no	subsurface rock present	low to fair
49	dispersed fcr with concentration	50-100	15	cobbles and highly fragmented	30	no	< 5 cm fill	low
50	charcoal stain	20	3	highly fragmented	50	no	stain present	low to fair

Number	Type	Estimated FCR count	FCR maximum density	FCR fragmentation	% caliche	Feature tested?	Comment	Information potential
55	dispersed fcr with concentration	50-100	10	cobbles and highly fragmented	40	no	< 2 cm of fill	very low
56	dispersed fcr scatter	50-100	8	cobbles and highly fragmented	60	no		low
58	fcr concentration	< 50	6	mostly cobbles	0	no		none
59	fcr concentration and dispersed scatter	50-100	8	cobbles and highly fragmented	30	no	part under dune	low to fair
66	fcr concentration	30	19	cobbles and highly fragmented	45	no	subsurface rock present	low to fair
67	fcr concentration and dispersed scatter	50-100	10	cobbles and highly fragmented	5	no		low
68	fcr concentration	20	12	cobbles and highly fragmented	40	no		low
69	fcr concentration and dispersed scatter	< 50	14	mostly cobbles	5	no	< 5 cm fill	low
70	fcr concentration and dispersed scatter	50-100	12	cobbles and highly fragmented	15	yes		very low
71	fcr concentration	40	6	mostly cobbles	25	no		low
72	historic burned rock pile/scatter	< 50	15	cobbles and highly fragmented	5	no	< 5 cm fill	none
73	historic burned rock pile/scatter	100-200	42	mostly cobbles	5	no		none
74	dispersed fcr scatter	> 200	50	highly fragmented	30	no	< 2 cm of fill	low
75	dispersed fcr with concentration	< 50	24	cobbles and highly fragmented	60	no	stain present	fair
77	dispersed fcr with concentration	< 50	8	cobbles and highly fragmented	10	no	< 2 cm of fill	very low
84	fcr concentration and dispersed scatter	100-200	14	cobbles and highly fragmented	10	no	< 2 cm of fill	none
85	fcr concentration and dispersed scatter	< 50	9	cobbles and highly fragmented	20	no	< 2 cm of fill	very low
96	historic burned rock pile/scatter	100-200	30	mostly cobbles	5	no	< 2 cm of fill	none
98	dispersed fcr scatter	< 50	6	highly fragmented	70	no	stain present	fair to good
104	stain?	< 10	1	highly fragmented	100	no	stain present	very low
130	dispersed fcr with concentration	50-100	15	cobbles and highly fragmented	20	no	stain present	good

note: cobble includes rounded cobble forms and large chunks of caliche

- Whether there were ceramics in association
- Whether there was ground stone in association
- Whether there were lithics in association
- Whether any of the lithics were heat treated
- Whether the feature was tested
- Locale and soil association
- Potential for artifact association information
- Potential for subsurface deposits
- Potential for chronometric samples
- Potential for subsistence remains

Feature types were assigned after the field session using the Feature Inventory Form and the digital photographs. The FCR features form more of a continuum than absolute types. These were defined as: dispersed FCR scatter without a concentration that suggests a single origin; dispersed FCR scatter with a core or concentration suggesting an origin; FCR core or concentration; or FCR core or concentration with dispersed scatter. The main criteria were how dense and concentrated the core areas is and whether the scatter extended well beyond the core area.

Most of the LA 155963 features inventoried are FCR scatters (8 FCR scatters, 21 FCR scatters with a concentration, 4 FCR concentrations, and 13 FCR concentrations with scatters). In addition, the site has a slab-lined feature, a charcoal stain, a charcoal or dark A horizon stain, a collectors pile, an artifact concentration, and 4 historic burned rock concentrations.

Only four of the features were tested. Many are deflated and testing would not provide additional information. When stains were evident they were not tested so as to conserve any intact fill. Two of the dispersed FCR scatters with concentrations were tested (Features 1 and 9). Feature 1 is at a dune edge and fill up to 9 cm deep produced small pieces of burned caliche but no evidence of ash or charcoal. The Feature 9 test revealed both subsurface FCR and charcoal. The other tested features are FCR concentrations with scatters (Features 14 and 70). Feature 14 is a large compact concentration of mainly limestone cobbles. The test located one, possibly two lenses of charcoal as well as large unburned or lightly burned pieces of caliche and a small piece of angular debris. The test of Feature 70, located in a deflated area of red paleosol, was less productive. No subsurface rock was observed in the test, and carbonate flecks and hard nodules suggest there are no subsurface deposits associated with this feature. A test was started in Feature 20, a FCR concentration and scatter, but stopped almost immediately as the upper fill was burned and contained small lithics.

Features that have the potential to provide information that will aid in answering the questions posed in the research design include:

- Feature 1 subsurface rock may indicate intact deposits outside of the test.
- Feature 6 has a stain and could provide radiocarbon and subsistence samples.
- Feature 8 has brown ware ceramics, a variety of material, subsurface rock and a stain at the periphery.
- Feature 9 has ground stone, a chopper, and subsurface rock and charcoal.
- Feature 13 is a broken metate that may have a pit in association.
- Feature 14 has ground stone, charcoal and subsurface rock, and is being destroyed by a drainage and will disappear.
- Feature 15 is near a lithic reduction area and has an ash stain extending beyond the concentration.
- Feature 18 is a small slab-lined feature that could be a storage feature.
- Feature 20 is in an area with numerous pieces of ground stone, a wide variety of lithic material, and has subsurface rock and a charcoal stain.
- Feature 23 has substantial subsurface rock.
- Feature 50 is a good-sized charcoal stain with a few pieces of FCR, ground stone, and lithic artifacts and could produce radiocarbon and subsistence samples.
- Feature 75 has a variety of lithic material and ash and charcoal.
- Feature 98 is in an area with ceramics and ground stone and has a charcoal stain.
- Feature 130 has lithic artifacts, subsurface rock, and a charcoal stain.

Features that were not inventoried should be evaluated with the Feature Inventory Form. Some of these may also have the potential to provide information applicable to the research questions.

Mechanical excavation. The geomorphology of this site is quite complex. Five 1-by-5-m mechanically excavated geomorphology trenches suggested substantial desiccation of the ground surface over time. While coppice dunes are present, these landscape features are believed to be relatively recent (~100 years old) and no archaeological materials were found residing on the sand. Based upon the geomorphology, it is believed that many of the artifacts and features at LA 155963 are lying on top of Bt or Bk soil horizons dating to the Pleistocene. More recent soils or sediments have presumably been eroded away. This has formed a vertical palimpsest of archaeological materials on the current ground surface dating from roughly 9,000 BC to present.

Excavation plan. Under the current plans, the site should not be directly impacted by additional construction. Mapping, locating surface artifacts to aid in identifying temporal components, recording a sample of the features, and geomorphology trenching have already been completed and a detailed account of these investigations will be produced as a testing report. Anticipated further work at this site will be research oriented.

Research objectives for this site will be primarily directed toward obtaining datable material, subsistence samples, information on site structure, and materials that will provide information on interactions within and outside the project area. This information can then be used to address broader question concerning the fit with regional culture history, settlement patterns, site location with respect to a variety of resources, and on continuity and change throughout the occupation of the area.

The features that have not been evaluated through a Feature Inventory Form will be located and inventoried. Then, between 14 and 30 of the 131 features (23%) will be excavated. These will include features that will be or already have been determined to have the potential to provide subsistence or dating samples (testing section above) (Research Questions 1 and 4) or are in locations where they could provide information on site structure (Research Question 6) within an artifact cluster. Excavations will include a sample of the feature when very large or the entire feature when small and will be conducted as described in the field methods section (Chapter 4). In addition, fill may be excavated from grids around features to obtain information on possible activity areas and site structure.

Hand excavated units, in blocks up to 10 by 10 m^2, with a minimum of 10 grid units being excavated in each block, will be placed in up to 7 artifact clusters to obtain information on activity areas, site structure (Research Question 6), range and interaction (Research Questions 3, 5, 8) and, perhaps, chronology (Research Question 1). One or two of these will be placed in areas with Paleoindian artifacts, one to four in areas with ceramics, and one will be in a possible protohistoric area (Fig. 6.3). Excavations will be shallow, removing only the Holocene soils. Additional areas will be surface collected to provide similar information.

Once the targeted excavations have been completed, any future construction disturbance would require assessment of the area of potential disturbance, surface collection within it, and monitoring of fencing and construction (FAA and NMSA 2010b:21).

LA 155964

Located less than 200 m southeast of LA 155963, this site is a small prehistoric artifact scatter with features that could date to the Middle Archaic and Formative periods. It is on NMSLO trust land and has been determined as "eligible" under Criterion "d" for NRHP. The site has integrity (51 to 75 percent), has the potential to contain dating and subsistence related materials, and has thermal features and a possible habitation structure. This gives it the potential to produce important information on settlement and subsistence during the Middle Archaic and Formative periods and to contribute to our knowledge of regional prehistory (FAA and NMSA 2010b:21, Quaranta and Gibbs 2008:144, 402).

LA 155964 is situated on the west edge of the HLA. Fencing and a utility corridor described in earlier construction plans are not currently being contemplated. It is near the entrance road, a runway that is currently under construction, and an area used as a staging area for construction trailers (FAA and NMSA 2010b:20-21).

Previous work. LA 155964 was recorded by Zia in April of 2007. Features were described and the three flaked stone tools, 14 pieces of debitage, and two ground stone tools were analyzed in the field (Quaranta and Gibbs 2008:144-145). In

2009 a 50-foot protective buffer was identified by Zia archaeologist Victor Gibbs and marked with metal stakes by a fencing crew. Orange mesh fencing was draped around the fence posts to protect the site (FAA and NMSA 2010b:10). OAS revisited the site in September of 2010 to evaluate the current condition of the site.

Site setting. The site is on the nearly flat southeastern slope of a southeast trending gravel hill. Active eolian deposition occurs with mesquite stabilized dunes, creosote, and grass between the dunes (Quaranta and Gibbs 2008:144).

Site description. The site covers an area of approximately 52 by 80 m (3,300 square meters, 0.33 hectares, or 0.81 acres) (Fig. 6.7). It was described as a sparse and dispersed scatter of stone artifacts with two visible FCR features and a depression that could indicate the presence of a small structure. The FCR features were 1.0 and 5.0 m in diameter and the larger one could be a ring midden (Appendix 3). The evidence for a possible structure consisted of 10 rocks around the edge of a depression. Artifacts described include a complete Archaic projectile point, a projectile point fragment, and a unifacial scraper, 11 flakes (7 with retouch or use wear), a core, 2 tested cobbles, a basin metate fragment, and a mano. Few surface artifacts were observed and analyzed but these indicate a range of activities (Quaranta and Gibbs 2008:144-145).

Excavation plan. Current construction activities should not impact the site. However, it is possible that future installation of fencing or utilities, or the site's proximity to the entrance road and staging area could result in disturbance of and impact to the site. Regardless, additional research should clarify whether there is a Formative component as suggested by the possible ring midden and structure. A lack of surface ceramics could indicate it is Early Formative. Investigations will include excavation of portions of the ring midden and potential structure, which will provide information on chronology, settlement, land use, access to resources, and subsistence practices that can be used to address questions presented by the research design. Once the targeted excavations have been completed, future construction disturbance would require assessment of the area of potential disturbance, the surface collection within it, and monitoring of fencing and construction (FAA and NMSA 2010b:21).

LA 155964 will be investigated in conjunction with excavations at nearby LA 155963. It will begin with total station mapping of the site, and will include point plotting of diagnostic artifacts, artifact clusters, and features. The possible ring midden (Zia's Feature 1), the FCR feature (Zia's Feature 2), and possible structure (Zia's Feature 3) will be partly excavated to obtain samples for dating and subsistence studies. If intact cultural deposits are present, 1-by-1-m units adjacent to features will be hand excavated (up to 13 square meters) to obtain a sample of artifacts that are associated with these features. Research excavations should provide data that informs on Research Questions 1, 2, 4, 5, and 6. More specifically, excavations in the potential ring midden and structure may provide information on how the area fits within the regional chronology and culture history framework, how Late Archaic/Early Formative groups utilized the area, and aspects of regional interaction. Excavation may yield samples for dating (radiocarbon and thermoluminescence) and subsistence information in the form of macrobotanical, flotation, and pollen samples, and faunal remains that could aid in identifying which plant and animal resources were available, which resources were utilized, how resource selection changed over time, and how these behaviors were conditioned by access to critical resources.

A 1-by-5-m mechanically excavated trench will be placed in a location chosen by the geomorphologist. This will allow the geomorphologist to examine and characterize soils at the site, collect OSL and soil samples and to determine if cultural deposits at LA 155964 could be temporally related to those at nearby LA 155963.

LA 155968

LA 155968 is described as a prehistoric lithic artifact scatter with features. It is located on NMSLO trust land and has been determined as "eligible" under Criterion "d" for NRHP. The site has integrity (between 51 and 75 percent), the potential for subsurface deposits including features with dating potential, and a significant artifact assemblage. For these reasons, it has the potential to address research questions concerning

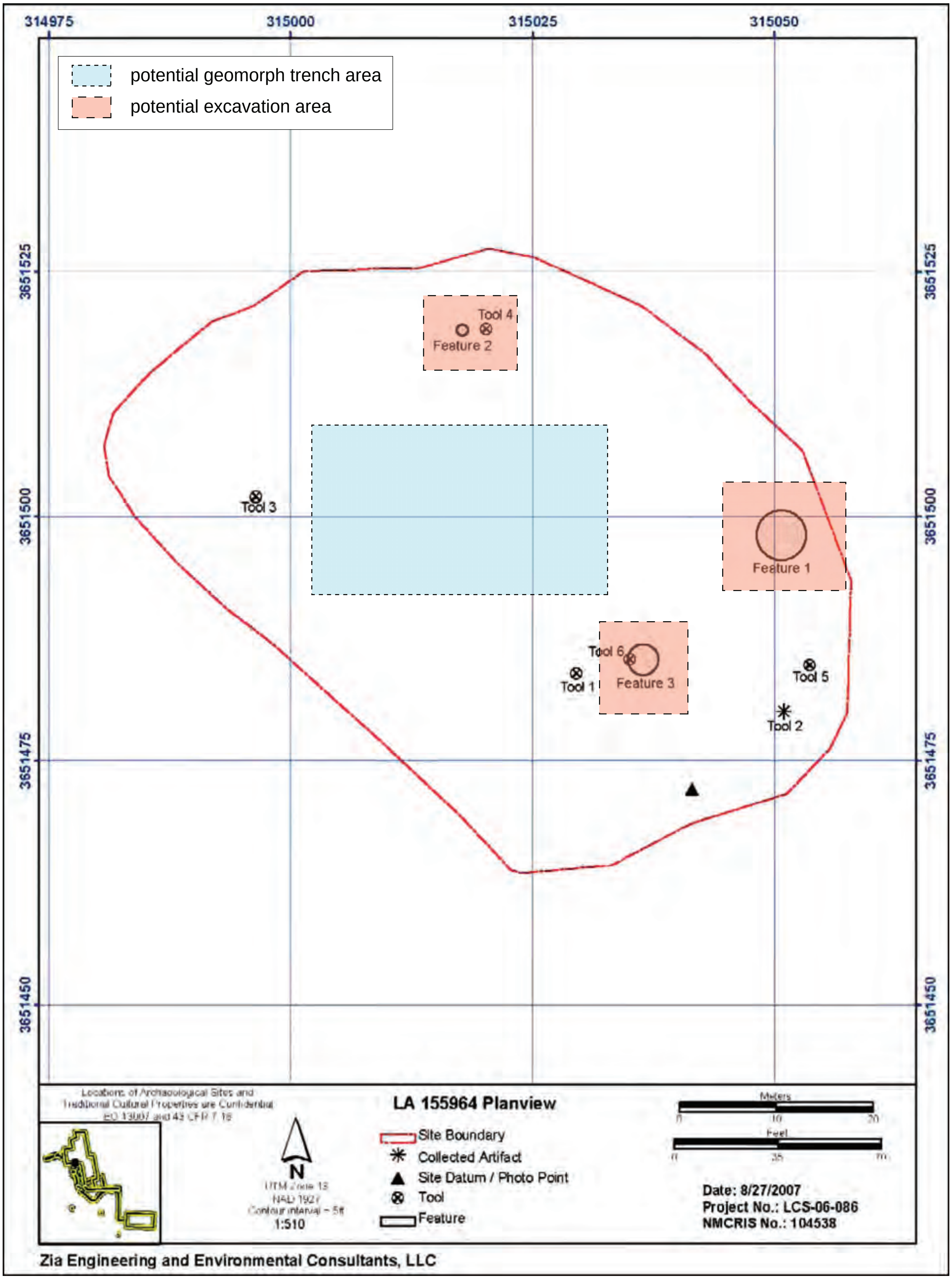

Figure 6.7. Plan of LA 155964 (after Zia 2008) showing potential archaeological work areas.

regional prehistory. The site is southeast of the HLA and lies within Utility Corridor F and Road Segment 2 (Quaranta and Gibbs 2008:183, 404).

Previous work. LA 155968 was first recorded by Zia in 2007. One feature was described and the tools and a sample of debitage were analyzed. The site was revisited by Victor Gibbs of Zia in 2009 to locate the site boundaries and mark a 50 foot protective buffer. The buffer was delineated with metal stakes by the fencing crew and orange mesh fence draped around the fence posts (FAA and NMSA 2010b:22).

Later in 2009 the site was revisited and the map revised. Boundaries of a proposed road construction disturbance corridor were staked by professional surveyors within the site area. The staking was monitored by NMSA's cultural resources contractor Elizabeth Oster and Zia archaeologist Victor Gibbs. Re-examination of both the site surface in the southern third of the site and the buffer resulted in the discovery a fragment of a Folsom point made of gray chert, which was collected. A series of auger holes were excavated in the southern area, three each adjacent to two FCR scatters and at 10 m intervals just within the northern edge of the proposed construction disturbance corridor and the proposed fence location. The auger tests indicated that the unconsolidated FCR scatters lack subsurface context and it is unlikely that subsurface cultural material is associated with these features.

After consultation with the NMSLO and NMSHPO, in November of 2009, Elizabeth Oster monitored the construction of a wastewater line within the 50 foot buffer area just outside the southern site boundary. No features or artifacts were exposed and no deposits with staining, charcoal flecks, or other indications of cultural deposition were observed (FAA and NMSA 2010b:23).The FAA determined, and the Section 106 consulting parties agreed, that the construction of the road would not adversely affect the site eligibility as long as the site was fenced the construction monitored. Surface artifacts in the area were collected and construction monitoring conducted in March of 2010 did not expose intact subsurface features (FAA and NMSA 2010b:22-23).

OAS revisited the site in September of 2010 to evaluate the current condition of the site.

Site setting. Situated on near level ground, with a slight slope to the southeast, the site is an area of mesquite-stabilized dunes. The ground is covered by naturally occurring gravel and is somewhat deflated and eroded. It is surrounded by tobosa grassland (Quaranta and Gibbs 2008:183).

Site description. LA 155968 is described as a medium-sized prehistoric artifact scatter of unknown affiliation (Fig. 6.8). It covers an area approximately 100 by 175 m (8,866 m, 0.89 hectares, 2.19 acres). The only feature described by the Zia surveyors (Appendix 3) was a 3.0 m diameter stain with a few FCR fragments along the periphery and a mano fragment at the edge. It was interpreted as the remains of a small habitation structure (Quaranta and Gibbs 2008:183). Three unconsolidated FCR scatters occur to the southeast and southwest of the stain. The plotted tools (1 biface fragment, 6 scrapers, 1 utilized flake, 1 one hand mano, and 4 metate fragments) were scattered throughout the site area. The sample of debitage included 4 pieces of angular debris, 16 flakes, and two cores. The surface artifact assemblage was estimated at about 100 artifacts and includes lithic artifacts and ground stone (FAA and NMSA 2010b:22). The presence of a Folsom point fragment could signal the presence of a Paleoindian component at the site.

Excavation plan. The proposed utility corridor along the western edge is no longer being considered. Monitoring construction disturbance along the southern border has already taken place. The core area with a possible structure could have considerable time depth and could provide data to interpret some of the earliest phases of occupation in the project area (FAA and NMSA 2010b:23).

Work at this site will begin with total station mapping of what remains of the site, and will include point plotting and collecting the few remaining artifacts. Hand excavation will focus on the feature and its extramural area. Eight 1-by-1-m units will be excavated to the base of the vertical artifact distribution or potential cultural deposit-bearing soil as determined by the geomorphologist. The potential structure will be excavated and the immediate extramural area will be bisected by five of the eight 1-by-1-m units. Radiocarbon or other chronometric

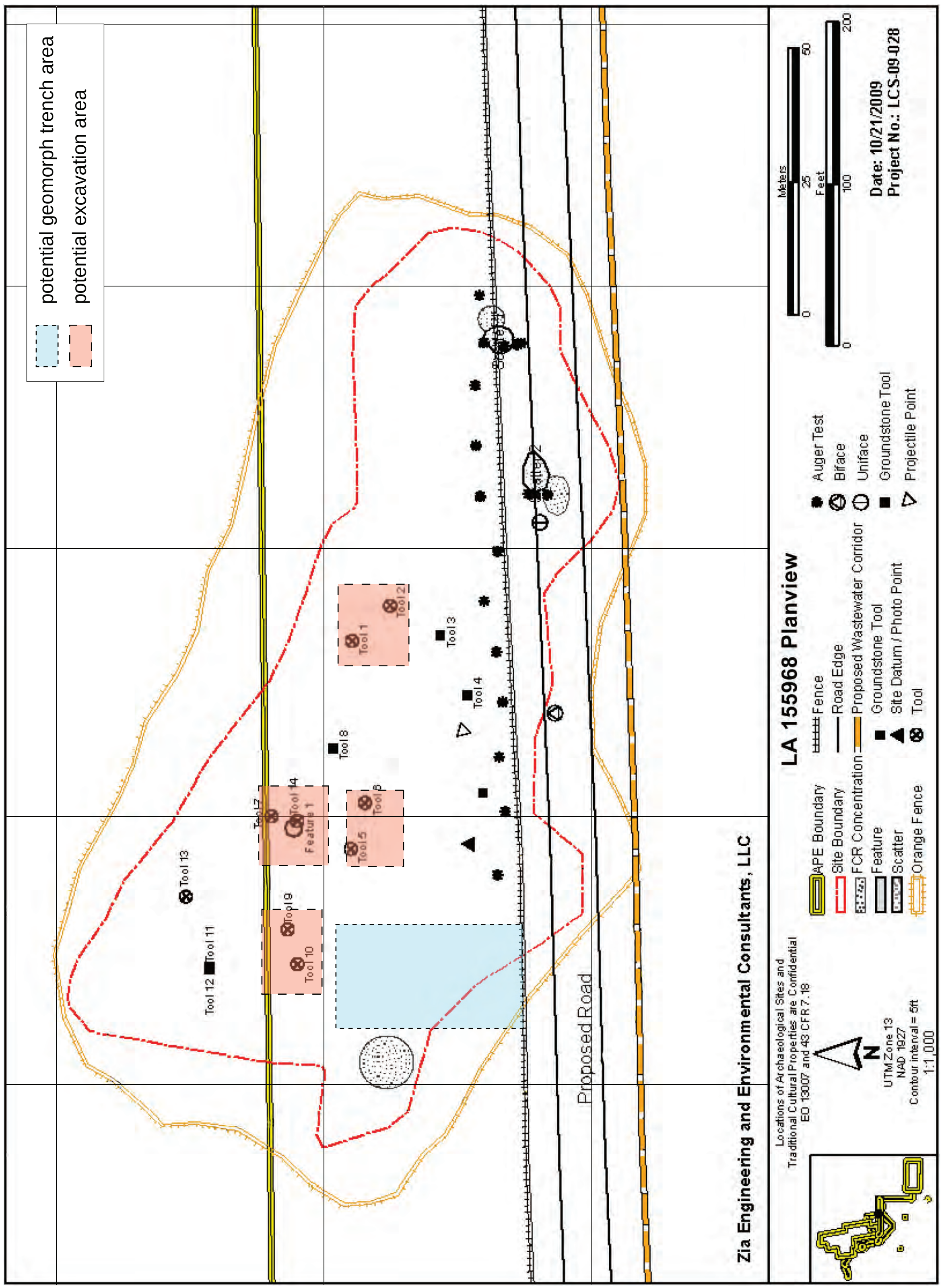

Figure 6.8. Plan of LA 155968 (after FAA and NMSA 2010) showing potential archaeological work areas.

and ethnobotanical samples will be collected if appropriate contexts are encountered. All hand excavations and sample collections will follow procedures outlined in Chapter 5.

Research excavations at LA 155968 should provide data on Research Questions 1, 2, 3, 4, 5, and 6. More specifically, detailed analysis of the collected lithic artifacts should provide information on the nature of the site occupations including Paleoindian use of the site and project area and the range of lithic material acquisition/ interaction. This is one of only two project sites that are not along either Aleman Draw or Jornada Draw and has the potential to provide information on how different landscape settings were used. If the stain contains adequate charcoal and subsistence remains, these could provide information on chronology (radiocarbon and thermoluminescence) and could aid in identifying which plant and animal resources were available, which resources were utilized, and questions concerning access to critical resources (botanical and faunal).

A 1-by-5-m mechanically excavated trench may be placed in a location chosen by the geomorphologist. The trench will allow the geomorphologist to examine and characterize soils at the site, collect OSL and soil samples and to determine how the cultural deposits might relate to those at other sites in the project area.

LA 155969

LA 155969 is a small artifact scatter with a possible structure of undetermined date. It is located on NMSLO trust land and has been determined as "eligible" under Criterion "d" for NRHP based on site integrity (51 to 75 percent), the possible presence of a structure, and the potential for recovering datable material. These factors suggest the site has the potential to aid in answering questions posed in the research design and contribute to our knowledge of regional prehistory (Quaranta and Gibbs 2008: 150, 404). This site is adjacent to the runway.

Previous work. Zia archaeologists recorded the site in 2007. They observed a single feature with about 30 pieces of FCR and documented all visible artifacts (Quaranta and Gibbs 2008:150, 155). The site was revisited by Zia archaeologist Victor Gibbs in 2009 in order to relocate the site boundaries and mark a 50 foot buffer area for protection from potential adverse effects during construction of the runway. Metal stakes were placed by a fencing crew and orange mesh fencing draped around the fence posts. Elizabeth Oster visited the site in September to check the location of the site datum and the FCR feature (FAA and NMSA 2010b:24). OAS visited the site in September of 2010 to assess the current condition of the site.

Site setting. The site is on near level ground with a slight slope to the southeast. It is in an area of naturally occurring gravels with mesquite stabilized dunes and is surrounded by wide areas of tobosa grassland. The site surface is somewhat eroded and deflated (Quaranta and Gibbs 2008:150).

Site description. LA 155969 is described as a small prehistoric artifact scatter and feature of unknown cultural affiliation (Fig. 6.9). It covers an area approximately 45 by 32 m (1,065 square meters, 0.10 hectares, or 0.26 acres). A single FCR feature 1.25 m in diameter comprised of about 30 pieces of FCR was observed (Appendix 3). Few artifacts were visible on the surface and all (2 cores and 2 flakes) were analyzed. The site recorders felt the potential for buried deposits was high, although the site appears substantially deflated (Quaranta and Gibbs 2008:150-151).

Excavation plan. The site has not been directly impacted by runway construction. However, future installation of protective fencing for the runway or activities associated with construction or maintenance could adversely affect the site. Given the small size, single feature, sparse artifacts, and proximity to the runway, data recovery is preferred over avoidance, which would require permanent fencing (FAA and NMSA 2010b:25).

LA 155969 is located approximately half way between Aleman Draw and Jornada Draw and cultural material collected from this site could provide information on use of the project area away from the major arroyos. The site will be mapped with a total station to document spatial relationships between the feature and the artifacts. All artifacts will be point plotted and collected to allow for the examination of associations that may inform on feature function and site activities.

Sixteen square meters (a 4-by-4-m area) centered on the feature will be hand excavated. Any associated features not visible on the surface

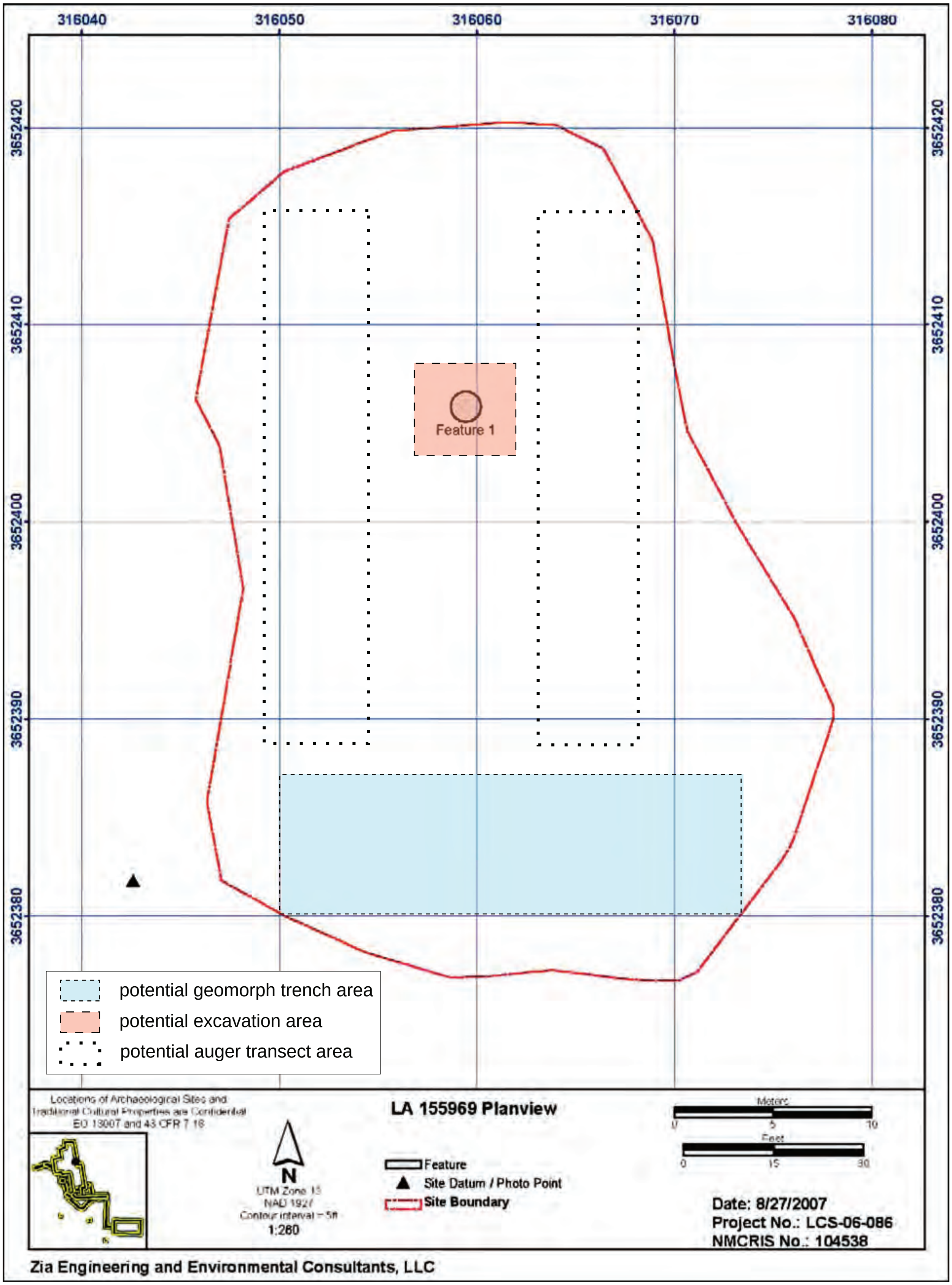

Figure 6.9. Plan of LA 155969 (after Zia 2008) showing potential archaeological work areas.

should be exposed by excavation. Systematic recovery of artifacts from within and around the feature will add to the surface artifact distribution information and potentially yield temporally or functionally diagnostic artifacts.

Excavation at LA 155969 may provide data relevant to Research Questions 1, 2, 4, 5, and 6. More specifically, recovery of chronometric or subsistence samples or remains would allow for site dating and provide additional information on subsistence, respectively. Subsistence remains may aid in identifying which plant and animal resources were available, which resources were utilized, how resource selection changed over time, and how these behaviors were conditioned by access to critical resources. All excavation and sample collection will follow procedures outlined in the Chapter 5 section.

A 1-by-5-m mechanically excavated trench may be placed in a location chosen by the geomorphologist. The trench will allow the geomorphologist to examine and characterize soils at the site, collect OSL and soil samples and to determine how the cultural deposits might relate to those at other sites in the project area.

LA 156877

LA 156877 is a small artifact scatter of unknown temporal affiliation. It is located on NMSLO trust land and has been determined as "eligible" under Criterion "d" for NRHP as it appears to have integrity (51 to 75 percent) and may have subsurface deposits with dating and subsistence-related materials that are need to address questions posed in the research design and to contribute to our knowledge of the prehistory of this part of New Mexico (Quaranta and Gibbs 2008:188, 406). The site is located west and southwest of the HLA (Quaranta and Gibbs 2008:188; FAA and NMSA 2010b:25). Road Segment 2 has been built and bisects the site. A planned bar ditch will impact an additional portion of the site.

Previous work. The site was recorded by Zia in 2007 as a sparse scatter of lithic artifacts and a low density FCR scatter with a potential concentration that could indicate buried features. A sample of 16 of the 30 pieces of lithic debitage on the surface was analyzed (Quaranta and Gibbs 2008:188-189). The site was revisited in 2009 by Zia archaeologist Victor Gibbs to relocate the site boundaries and mark a 50 foot buffer to protect the site from potential effects of construction. The outer edge was marked and monitored when metal stakes were placed by the fencing crew. Orange mesh fencing was draped around the fence posts. Later that year, Elizabeth Oster and Victor Gibbs revisited and assessed the site. The datum and boundaries were relocated and adjusted increasing the site size, a number of artifacts and the FCR scatter location were relocated and plotted as were two additional unconsolidated FCR scatters. A small projectile point of probable Middle Archaic age was collected. A new map showing the feature and artifact locations and adjusted site boundaries was produced. In 2010, with NMSLO and NMSHPO concurrence, Zia archaeologist Victor Gibbs monitored the excavation of a waterline corridor within the protective buffer. No features or artifacts were exposed by the monitoring and no deposits exhibiting staining, charcoal flecks or other indications of cultural origin were observed (FAA and NMSA 2010b:26). OAS visited the site in September of 2010.

Site setting. The site is in an area that is flat with a very slight southeastern slope. Low creosote and mesquite stabilized dunes occur in the vicinity of the site with grass between the dunes. Active eolian deposition provides a degree of stability (FAA and NMSA 2010b:25).

Site description. Zia described the site as a small artifact scatter with a low density FCR scatter. A sample of the lithic debitage was analyzed (3 cores, 12 flakes, 1 piece of angular debris) (Quaranta and Gibbs 2008:188-189). The reassessment of LA 156877 characterized the site as a prehistoric limited use area covering an area approximately 1,920 square meters (0.19 hectares, 0.47 acres). One FCR feature and three FCR scatters were spread throughout the northeast half of the site area (Fig. 6.10). Surface artifacts included two cores, a hammerstone, a potential Middle Archaic projectile point, a piece of ground stone, angular debris, and flakes (FAA and NMSA 2010b:14, 26, 57).

Excavation plan. Research-oriented investigations, consisting of surface stripping around Feature 1, are proposed. The presence of a possible feature and formal flake tools, suggest good potential for the recovery of data that could aid greatly in interpreting some of the earliest

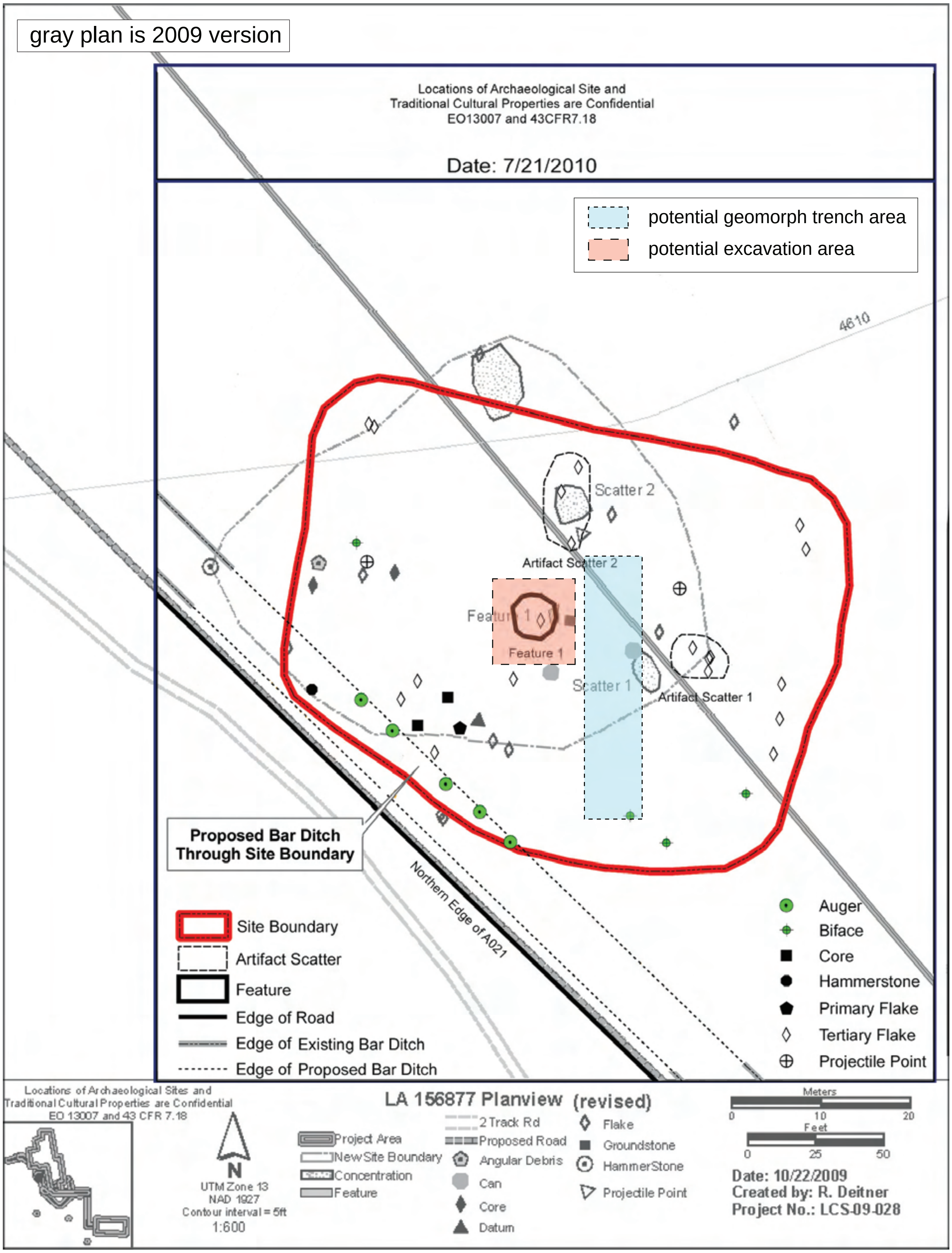

Figure 6.10. Plan of LA 156877 (after FAA and NMSA 2010) showing potential archaeological work areas.

phases of occupation for the cultural landscape of the Spaceport America project area. At this time, the access road corridor has been moved to just outside the southern boundary of the site. A drainage ditch will be placed in a small portion of the site and has already been assessed. The archaeologists have recommended that the disturbance would not adversely affect the eligibility of the site. Excavation of the drainage ditch will be monitored (FAA and NMSA 2010b:2627).

Research-oriented excavations are planned for spring 2011. The Middle Archaic projectile point suggests potential for considerable age, although the relationship between the projectile point and the feature and artifact scatter is unknown. The site will be mapped with a total station to document spatial relationships between the feature and the artifacts. All artifacts will be point plotted and collected to allow for examination of associations that may inform on the feature function and site activities.

Sixteen square meters (a 4-by-4-m area) centered on the feature will be hand excavated. Buried feature morphology and any associated features not visible on the surface should be exposed by the excavation. Systematic recovery of artifacts from within and around the feature will add to the surface artifact distribution information and potentially yield temporally or functionally diagnostic artifacts.

Research excavations at LA 156877 should yield data relevant to research questions 1, 2, 4, 5, and 6. More specifically, recovery of chronometric or subsistence samples or remains would allow for site dating and provide additional information on subsistence, respectively. Subsistence remains may aid in identifying which plant and animal resources were available, which resources were utilized, how resource selection changed over time, and how these behaviors were conditioned by access to critical resources. All excavation and sample collection will follow procedures outlined in the Chapter 5 section.

A 1-by-5-m mechanically excavated trench may be placed in a location chosen by the geomorphologist. The trench will allow the geomorphologist to examine and characterize soils at the site, collect OSL and soil samples and to determine how the cultural deposits might relate to those at other sites in the project area.

Vertical Launch Area (VLA)

LA 111420

This lithic artifact scatter with Early and possibly Middle Archaic components is mainly located on NMSLO trust land with a very small portion on BLM public land. LA 111420 has been determined as "eligible" under Criterion "d" for NRHP because it has integrity (76-99 percent) and the presence of Early and possible Middle Archaic projectile points and ground stone suggest it has the potential to provide information on the prehistory of area. Located northwest of the VLA, Utility Corridor F passes through LA 111420 (Quaranta and Gibbs 2008: 194, 395).

Previous work. LA 111420 was first recorded by HSR in 1997 as a large chipped and ground stone artifact scatter with most of the exposed artifacts in two non-vegetated partially deflated areas along the fence line. An estimated 200 artifacts were present on the surface, of which a sample of 25 was analyzed (FAA and NMSA 2010b:28).

Revisiting the site in 2007, Zia was unable to locate the more southern artifact scatter and found the other scatter was now a disturbed area. They located about 40 artifacts in this disturbed area and analyzed 26 (FAA and NMSA 2010b:28, Quaranta and Gibbs 2008:194 -196). In September of 2010 OAS revisited the site to assess current conditions and observed artifacts that could be part of the HSR southern scatter. OAS conducted test excavations at the site in November of 2010 on state trust land managed by the NMSLO following an approved testing plan (Moore et. al 2010).

Site setting. The site is on a stabilized grassy plain bordering a mesquite dune/blowout area caused by seasonal sheet washing. Limestone and quartzite nodules and gravels are dispersed throughout the site. Tobosa grasslands surround the site and Jornada Draw is 400 m east of the site. East-west and north-south trending fences separate the NMSLO and BLM property with most of the site on NMSLO trust land. A mostly abandoned two-track road parallels the fence on the east side and impacts the site along the eastern boundary on NMSLO trust (FAA and NMSA 2010b:28, Quaranta and Gibbs 2008:194, 197).

Site description. HSR archaeologists described the site as larger than Zia (approximately 11,755 square meters, 1.18 hectares, 2.9 acres) and noted that most of the artifacts were exposed in two partially deflated areas along the fence line. The sample of analyzed artifacts included two biface thinning flakes, a tested cobble or core, a scraper, and a mano fragment (FAA and NMSA 2010b:28).

Zia archaeologists adjusted the site boundaries considerably, reducing the estimated site size (158 by 105 m, 9,071 square meters, 0.91 hectares, 2.24 acres). The surface artifacts include an Early Archaic Jay-style point and two Early to Middle Archaic Bajada-style projectile points, of which two were collected. Other recorded artifacts included flakes (n=21), a tested cobble, and a tested cobble/chopper. They observed three cobble manos that are described as small and unmodified, but well used and could be associated with an Archaic component or could be from LA 111422, a Jornada Mogollon site that is virtually adjacent to this site (Quaranta and Gibbs 2008:194-196).

Neither survey observed any surface features, only an artifact concentration or concentrations (Fig. 6.11). Both felt the site has the potential to contain buried deposits. HSR archaeologists did not observe any temporally diagnostic artifacts but Zia archaeologists recovered an Early and an Early to Middle Archaic projectile points. The site was interpreted as short-term, special-use site by HSR (FAA and NMSA 2010b:28).

Testing results. Before work at LA 111420 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. OAS began with mapping and field-analyzed all visible surface artifacts. The site size was increased to 16,616 square meters based on the artifact distribution (Fig. 6.12).

Artifact assemblage. Surface examination of LA 111420 located 330 artifacts, all of which were mapped and recorded in the field. Two specimens were projectile points, which were collected as temporally diagnostic materials. An additional 19 chipped stone artifacts were collected during subsurface investigations and have not been analyzed. The surface assemblage contained 320 pieces of debitage, 2 cores, 6 formal tools, and 2 one-hand manos (Table 6.5). The formal tools included a scraper, a scraper-spokeshave, 2 bifaces, a Chiricahua point, and a Bajada point. A very fine-grained metaquartzite dominated this assemblage, and ranged in color from yellow to gray and brown. Single specimens of possible Alibates chert, San Andres chert, and Polvadera obsidian were identified. Cortex was noted on 11 chert and 5 metaquartzite artifacts, and was predominantly waterworn, with a single piece of chert exhibiting nonwaterworn cortex. This suggests that materials were mainly procured from gravel beds.

Hand excavations. Five 1-by-1 m test units were excavated 20 to 30 cm through eolian sediment and into Pleistocene age soils. These excavations recovered 15 chipped stone artifacts, all from the upper 15 cm of fill. Two of the 22 auger holes encountered chipped stone artifacts in the first 10 to 20 cm.

Mechanical excavation. A 1-by-5-m mechanically excavated geomorphology trench suggests substantial desiccation of the ground surface over time. This has been subsequently followed by limited aggradation caused by the accumulation of wind-blown silts. The overlying 10 to 15 cm of eolian silt is relatively recent and covers an earlier Pleistocene Bt horizon. The majority of the surface artifacts occur on top of this earlier Pleistocene horizon, reflecting the complete erosion of the original A horizon (surface) with which the artifacts were initially associated.

Summary. Archaeological testing indicates that LA 111420 has considerable data potential. Projectile point styles identified from previous survey and current OAS testing suggest occupations occurred throughout the Early to Middle Archaic periods. These artifacts are located on a secondary geologic horizon, but still represent a discrete deposit likely to yield information on site structure and local subsistence strategies in the Jornada del Muerto during the Archaic period.

No further work is planned for this site at the present time. Data collected at the site during testing will, however, contribute to addressing the research questions posed in this plan for investigation of Spaceport America's cultural landscape. If the site will be impacted along the infrastructure corridor, a plan for monitoring consistent with the mitigation plan (FAA and NMSA 2010b) should be prepared for work

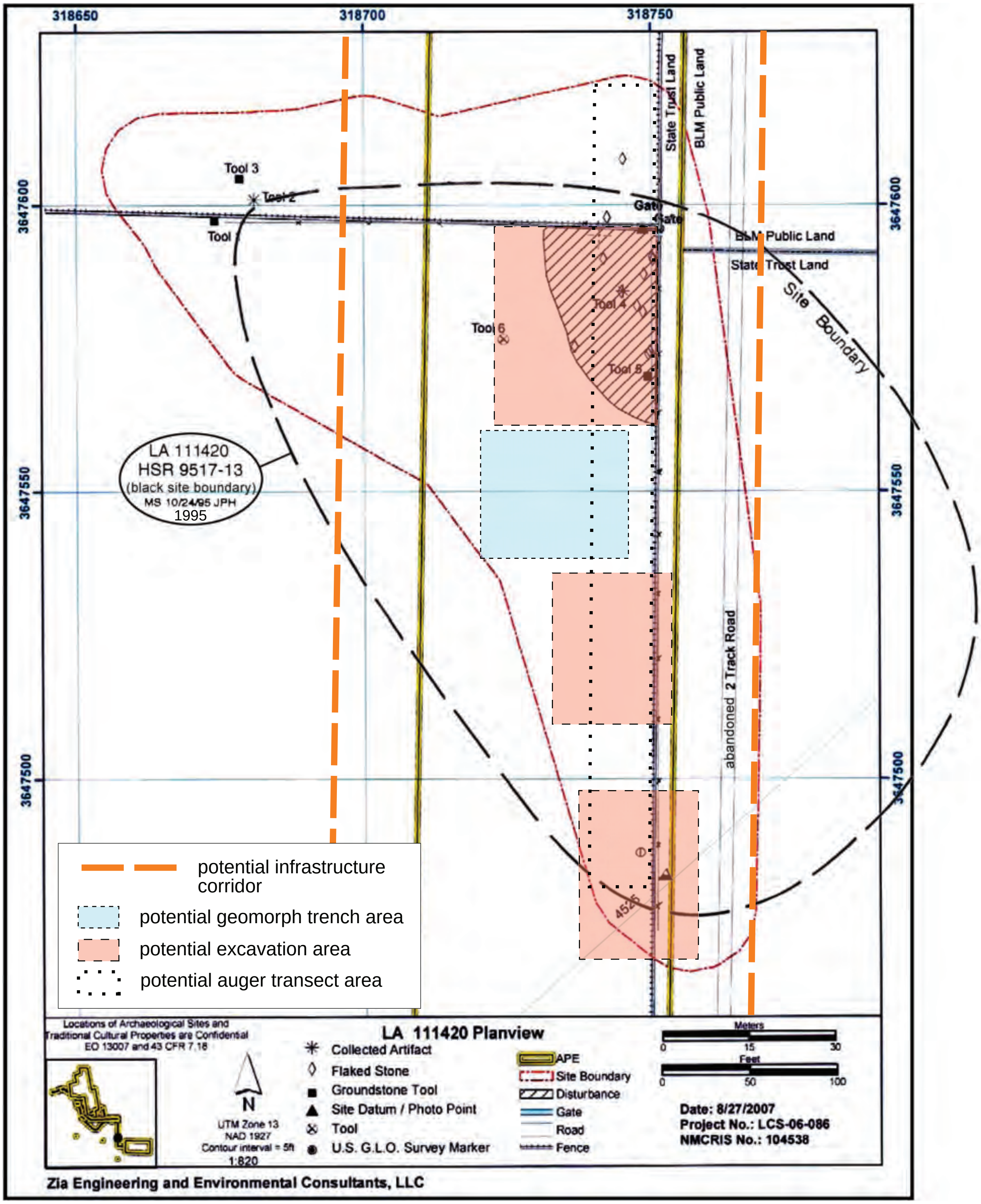

Figure 6.11. Plan of LA 111420 (after HSR 1995 and Zia 2008) showing potential archaeological work areas.

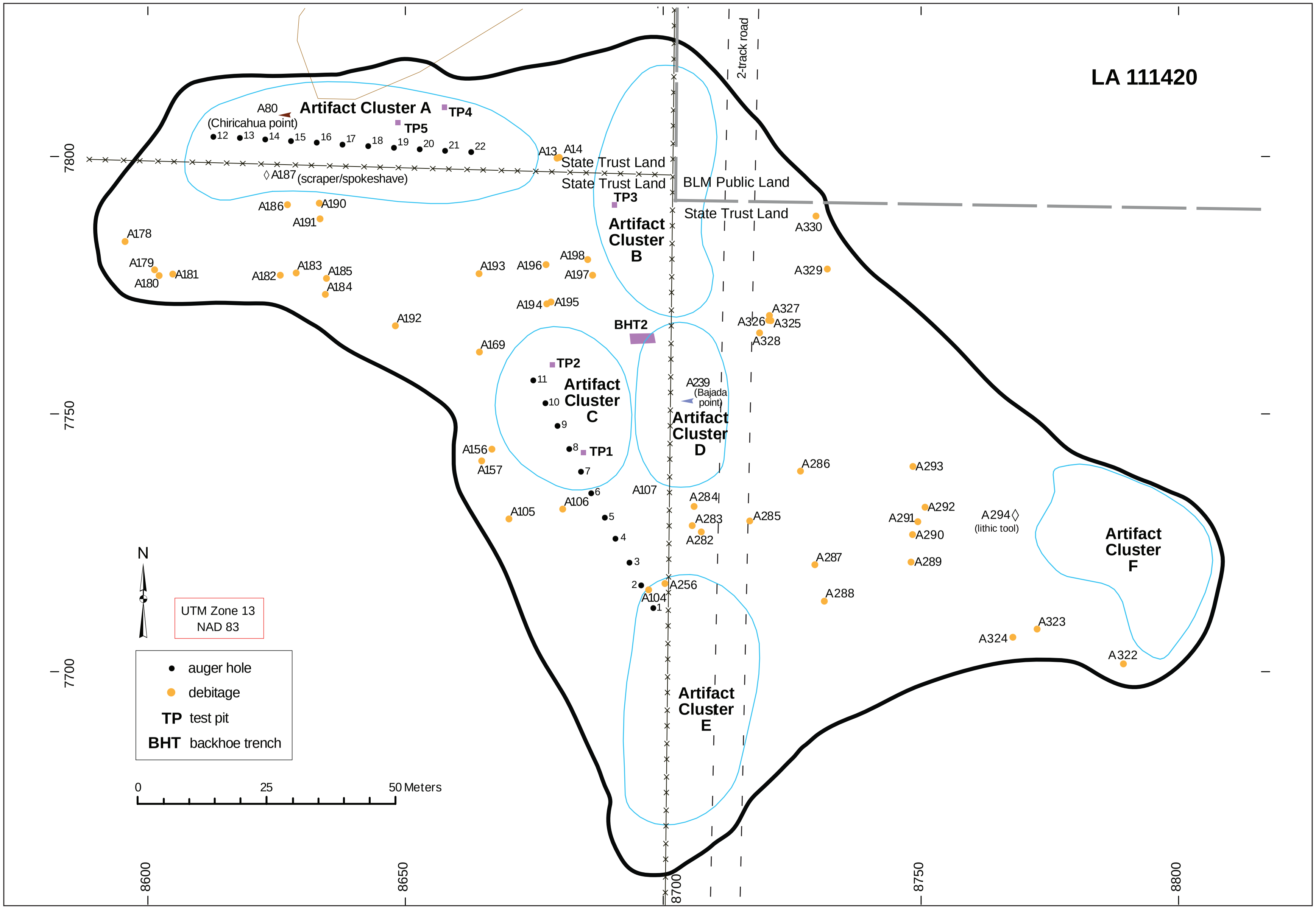

Figure 6.12. OAS plan of LA 111420 showing excavated areas and artifact distribution. Artifacts were grouped into clusters for ease of presentation, and do not represent analytic subdivisions.

Table 6.5. Material type by morphology for chipped and ground stone artifacts recorded at LA 111420; counts and column percentages.

Material Type		Angular debris	Core flake	Biface flake	Tested cobble	Core	Uniface	Biface	Ground stone	Totals
Chert	Count	18	72	3	1	1	1	1		97
	%	51.43%	25.99%	37.50%	100.00%	100.00%	50.00%	25.00%		29.39%
Alibates chert	Count		1							1
	%		0.36%							0.30%
San Andres chert	Count		1							1
	%		0.36%							0.30%
Silicified wood	Count		3							3
	%		1.08%							0.91%
Polvadera Peak obsidian	Count		1							1
	%		0.36%							0.30%
Basalt	Count	1								1
	%	2.86%								0.30%
Rhyolite	Count	4	29					1		34
	%	11.43%	10.47%					25.00%		10.30%
Limestone	Count		1							1
	%		0.36%							0.30%
Sandstone	Count								1	1
	%								50.00%	0.30%
Metamorphic	Count	1	3							4
	%	2.86%	1.08%							1.21%
Metaquartzite	Count	11	165	5			1	2	1	185
	%	31.43%	59.57%	62.50%			50.00%	50.00%	50.00%	56.06%
Quartz	Count		1							1
	%		0.36%							0.30%
Totals	Count	35	277	8	1	1	2	4	2	330
	%	10.61%	83.94%	2.42%	0.30%	0.30%	0.61%	1.21%	0.61%	100.00%

within the corridor.

LA 111421

A prehistoric lithic artifact scatter, LA 111421 is located on NMSLO trust land. Previously documented by HSR and Zia and inferred as having a possible Archaic period component, the eligibility of LA 111421 for inclusion in the NRHP was considered as "undetermined" (FAA and NMSA 2010b:30-31). The site is located northwest of the VLA where its west half is occupied by proposed Utility Corridor F and an abandoned north-south trending two-track road and a fence bisect it (Quaranta and Gibbs 2008: 200, 203, 395). The road was no longer visible in September of 2010.

Previous work. HSR originally documented the site in 1995. They described it as a moderate-sized flaked and ground stone scatter lacking temporally diagnostic artifacts. They estimated that 50 lithic artifacts could be present on the surface (FAA and NMSA 2010b:29-30).

Zia archaeologists revisited the site in 2007 and described the site as medium-sized temporally unknown artifact scatter. They estimated that 40 lithic artifacts were present on the surface (Quaranta and Gibbs 2008:200-205). OAS visited the site in September of 2010 to assess its current condition. Testing following an approved testing plan (Moore et. al 2010) took place in December 2010.

Site setting. LA 111421 is situated on near-level ground with a slight slope to the southeast. The site is covered with low, mesquite stabilized dunes within an area of naturally occurring gravels surrounded by wide areas of tobosa grassland. Jornada Draw lies approximately 400 m to the east (FAA and NMSA 2010b:29; Quaranta and Gibbs 2008: 200).

Site description. HSR archaeologists recorded the site as occupying an area approximately 3,888 square meters (0.39 hectares, 0.96 acres) in size. They observed a prehistoric scatter of lithic artifacts including two biface fragments, debitage, a core, and a one-hand mano. The flakes were generally large and complete. Few had cortex and three exhibited retouch or use-wear. No features were associated with the scatter suggesting to HSR archaeologists that it was as a short-term processing site (FAA and NMSA 2010b:29).

In revisiting the site, Zia archaeologists slightly reduced the size of the site, estimating it measured 107 by 46 m (3,787 meters square, 0.38 hectares, or 0.94 acres) (Fig. 6.13). They noted that artifacts were most visible in patches of broken topsoil along the fence. Formal chipped stone artifacts included a complete early stage biface and a late stage biface tip. Other recorded artifacts included a piece of angular debris, 15 flakes, a core, and 2 metate fragments. At least one flake was identified as a biface thinning flake and another flake exhibited unidirectional utilization. Zia archaeologists proposed that the evidence for bifacial technology and heat treating indicated tool production and a hunting focus for the site. Based on these observations they suggested the presence of an Archaic component. They further speculated that grass, mesquite beans, or cholla seeds could have been gathered near the site (FAA and NMSA 2010b:30, Quaranta and Gibbs 2008:200-201).

Testing results. Formal testing was necessary to evaluate whether LA 111421 is eligible for inclusion in the state and/or national registers. Low artifact counts, the absence of temporally diagnostic materials, and deflated contexts limit data potential. An eligibility recommendation will be provided in the final testing report.

Before work at LA 111421 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. Surface artifact distribution suggests site size similar to that proposed by Zia (Zia=3,787m^2, OAS=4,289 m^2).

Artifact assemblage. Surface examination of LA 111421 located 58 artifacts, all of which were mapped and recorded in the field. No temporally diagnostic materials were located. Additional specimens of chipped stone and ground stone (n=1 apiece) were collected from the surface of an excavational unit, while 3 other pieces of chipped stone were recovered from subsurface investigations. These artifacts have not yet been analyzed. The surface assemblage contained 52 pieces of debitage, 2 cores, and 3 formal tools (Table 6.6). The formal tools included an end/side scraper, a biface discarded during manufacture, and the tip of a dart point. A very fine-grained metaquartzite dominated this assemblage, and ranged in color from gray to yellow and brown. Cortex was noted on 3 metaquartzite, 2 chert, and 1 silicified wood artifacts, and was predominantly waterworn, with a single piece of chert exhibiting nonwaterworn cortex. This suggests that materials were mainly procured from gravel beds.

Hand excavations. Four 1-by-1 m test units were excavated 20 to 30 cm through eolian sediment and into Pleistocene age soils, retrieving five flaked and one ground stone artifact from the upper 15 cm of fill. Twenty-two auger holes yielded no artifacts or charcoal.

Mechanical excavation. A 1-by-5-m mechanically excavated geomorphology trench suggests substantial desiccation and aggradation of the ground surface over time. The overlying 10 to 15 cm of eolian silt is relatively recent and covered an earlier Pleistocene Bt horizon. The majority of the surface artifacts occur on top of this earlier Pleistocene horizon reflecting the complete erosion of the original A horizon (surface) with which the artifacts were initially associated.

Summary. Archaeological testing indicates that LA 111421 has limited data potential. No further work is planned for this site at this time. Data collected at the site during testing will, however, contribute to addressing the research questions posed in this plan for investigation of Spaceport America's cultural landscape.

LA 111422

This small Mesilla phase Jornada Mogollon artifact scatter with features and a possible Late Archaic component is located on NMSLO trust land. BLM public land lies about 13 m to the east of the site boundary. LA 111422 under Criterion "d" is determined "eligible" to the NRHP because it has integrity (76-99 percent), the presence of features and temporally diagnostic artifacts, and the potential to yield subsistence remains and dating materials. The site is northwest of the VLA and, under the current plans, Utility Corridor F bisects the site and would impact just over half of the eastern portion of the site including two of

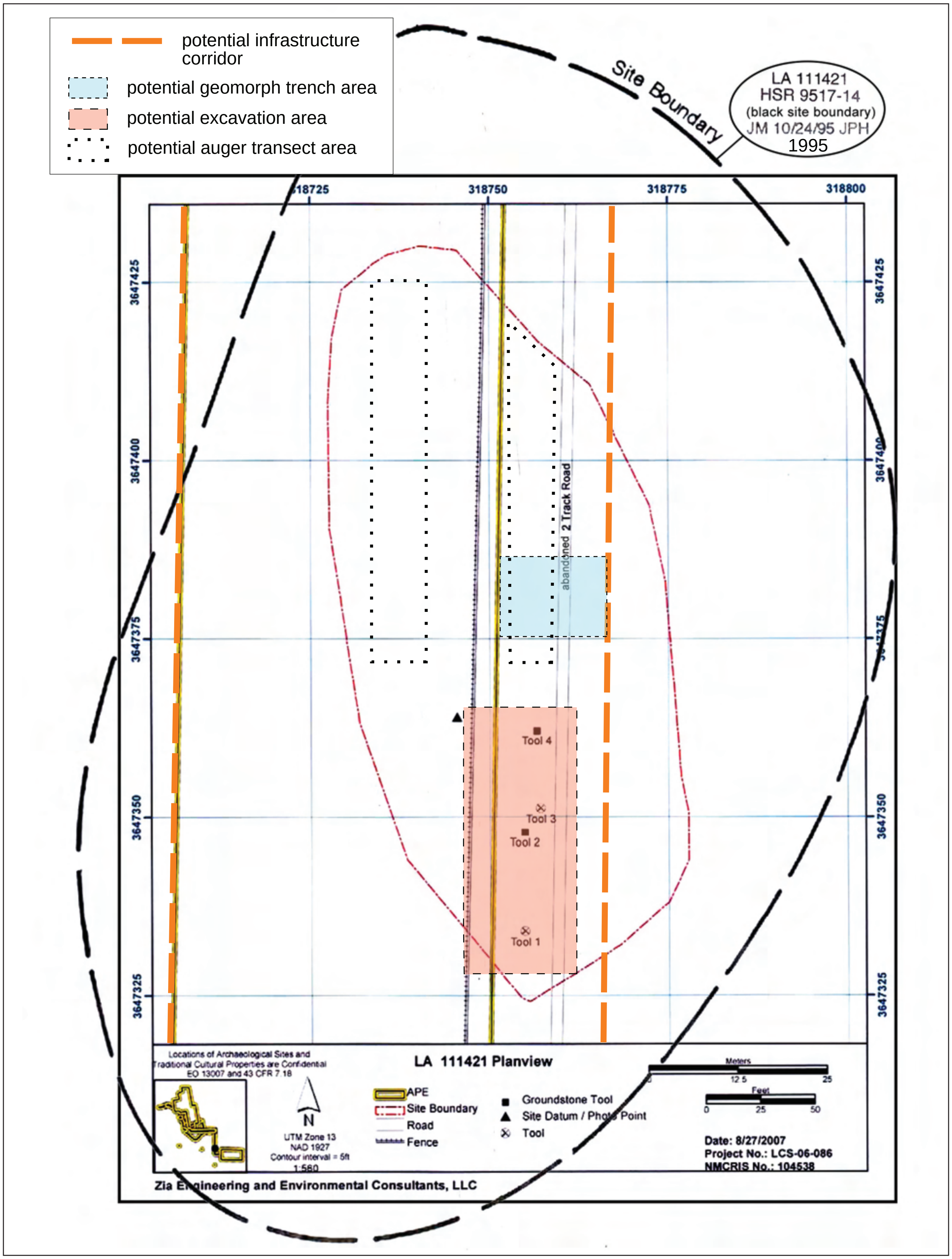

Figure 6.13. Plan of LA 111421 (after HSR 1995 and Zia 2008) showing potential archaeological work areas.

Table 6.6. Material type by morphology for chipped and ground stone artifacts recorded at LA 111421; counts and column percentages.

Material Type		Angular debris	Core flake	Biface flake	Tested cobble	Core	Uniface	Biface	Totals
Chert	Count	1	13				1	1	16
	%	25.00%	28.26%				100.00%	50.00%	27.59%
Silicified wood	Count	1	1						2
	%	25.00%	2.17%						3.45%
Rhyolite	Count		5						5
	%		10.87%						8.62%
Siltstone	Count	1	1					1	3
	%	25.00%	2.17%					50.00%	5.17%
Metaquartzite	Count	1	25	2	1	1			31
	%	25.00%	54.35%	100.00%	100.00%	100.00%			53.45%
Orthoquartzite	Count		1						1
	%		2.17%						1.72%
Totals	Count	4	46	2	1	1	1	2	58
	%	6.90%	79.31%	3.45%	1.72%	1.72%	1.72%	3.45%	100.00%

the three features. A fence marks the boundary between NMSLO and BLM land and, according to Quaranta and Gibbs (2008:206, 209, 395), an abandoned two track road parallels the fence on the BLM side. At present, the two track road is no longer visible.

Previous work. In 1995, HSR recorded the site as a small diffuse lithic scatter with ceramics and FCR but no FCR features. An estimated 100 surface artifacts were noted and a random sample of 19 artifacts were analyzed (FAA and NMSA 2010b:31).

Zia revisited the site in 2007. Only 16 artifacts were located, including a sherd and a piece of ground stone. However, they found a possible Late Archaic projectile point and three FCR features and analyzed 14 of the lithic artifacts (Quaranta and Gibbs 2008:206-211). OAS revisited the site in September of 2010 to assess the current conditions at the site.

Site setting. The site is on a flat area covered with low undulating dunes that are stabilized by mesquite, soaptree yucca, broom snakeweed, bush muhly, and range grasses. Jornada Draw is approximately 800 m to the east (FAA and NMSA 2010b:31).

Site description. HSR archaeologists estimated the site size as 7,850 square meters (0.76 hectares, 1.9 acres). They describe the site as a small, diffuse, lithic artifact scatter with eight El Paso Brown ware sherds. Surface artifacts included nine pieces of ground stone (four basin and one slab metate fragment), 3 cores, and 19 pieces of debitage including flakes and angular debris, four pieces of which were unifacially utilized. Scattered FCR were observed but no FCR features. HSR proposed that the site dates to the Mesilla Phase of the Jornada Mogollon culture based on the ceramics and they suggested that it may have been a temporary campsite or short-term processing area (Site form; FAA and NMSA 2010b:31).

Zia archaeologists shifted the boundary 31 m to the south and farther west of the fence (FAA and NMSA 2010b:31, 62) resulting in a site measuring 50 by 60 m (2,274 square meters, 0.23 hectares, 0.56 acres) in size (Fig. 6.14). They were unable to locate most of the lithic artifacts observed by HSR and they described the site as a sparse scatter of lithic artifacts with a single brown ware sherd, a Late Archaic projectile point, and a boulder metate fragment in an area with three FCR features. The FCR features (Appendix 3) range from 0.50 to 2.0 m in diameter with a fairly low degree of fragmentation from thermal alternation. Two of the features are within the stabilized dunes and have the potential for subsurface cultural deposits. Analyzed lithic artifacts included three pieces of angular debris, eight flakes, two cores, and a tested cobble. Zia felt the features and artifacts, including the wear on the boulder metate fragment, suggest a somewhat extended

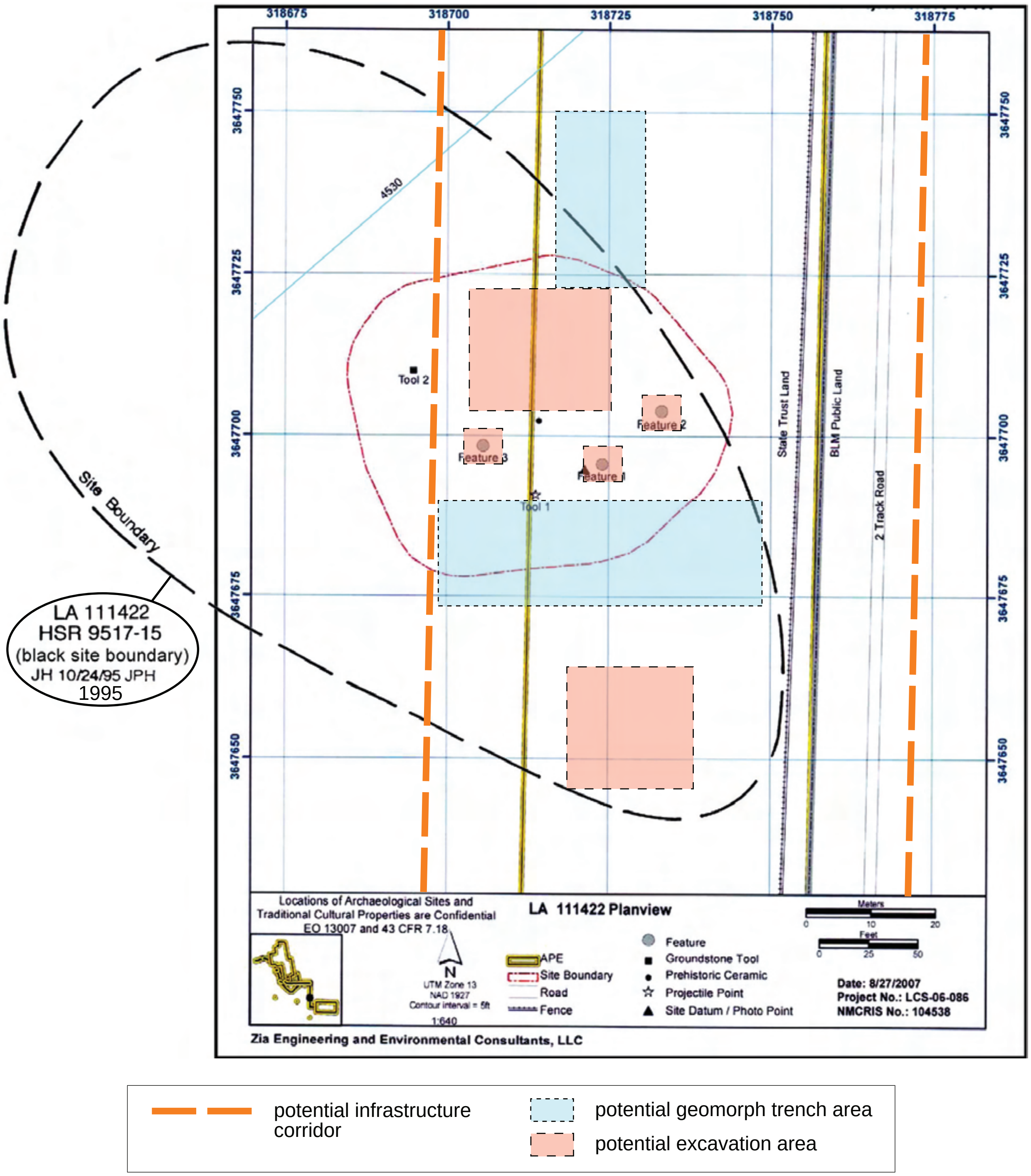

Figure 6.14. Plan of LA 111422 (after HSR 1995 and Zia 2008) showing potential archaeological work areas.

duration or repeated occupations (FAA and NMSA 2010b:21; Quaranta and Gibbs 2008:207).

Excavation plan. LA 111422 is a potential Late Archaic and Mesilla phase dispersed artifact scatter with three FCR features. Research-driven excavation will focus on examining temporal and functional relationships between the features, the projectile point, pottery, and metate and other surface artifacts and seek to determine if additional buried cultural features or deposits exist.

The site will be mapped with a total station, locating the features and tools within the site area. Surface artifacts will be flagged, plotted, and field analyzed. All three of the features will be excavated, and a one meter wide buffer area around each will also be excavated to recover associated artifacts. Excavation of features may provide information on chronology (radiocarbon and thermoluminescence) and subsistence (macrobotanical, flotation, pollen, and fauna) information, which might aid in identifying which plant and animal resources were available, which resources were utilized, and questions concerning access to critical resources (Research Questions 1, 2, and 4).

Excavation areas up to 2-by-2-m in size and encompassing 20-80 square meters will be placed near diagnostic tools and within artifact concentrations to determine if higher density subsurface artifact distributions are masked by the loose, eolian soil covering the site. These units will be hand excavated to the base of the vertical artifact distribution or potential cultural deposit-bearing soil as determined by the geomorphologist. All hand excavations will follow procedures outlined in the Chapter 5 section. Recovery of artifacts from these units may provide additional data to address research design questions, including Research Questions 5, 6, and 8.

A 1-by-5-m mechanically excavated trench may be placed in a location chosen by the geomorphologist. This will allow the geomorphologist to examine and characterize soils at the site, collect OSL and soil samples and to determine how the cultural deposits might relate to those at other sites in the project area.

LA 111429

LA 111429 is a very large artifact scatter with features. Temporally diagnostic artifacts indicate the site may contain Paleoindian, Archaic, and Jornada Mogollon components. The site is located on NMSLO trust land and under Criterion "d" is determined "eligible" to the NRHP because it has integrity (51-75 percent), a large number and diverse array of features, temporally diagnostic artifacts, and the potential for subsistence and dating material that can be used to address research questions concerning the prehistoric use of the area from the Paleoindian through the Jornada Mogollon periods. It is located within and just outside of the northwest corner of the VLA. County Road A020, along with a series of bar ditches, passes through the eastern portion of the site and may require improvements (FAA and NMSA 2010b:34; Quaranta and Gibbs 2008:236, 396). If perimeter fencing is ever placed around the VLA it will impact the site in those areas.

Previous work. HSR recorded the site in 1995. They estimated that about 5,000 lithic artifacts were present on the surface along with a few ceramics. These include artifacts dating to the Paleoindian, Middle Archaic, Late Archaic/Early Formative, and Jornada Mogollon periods, as well as the modern era. Lithic debitage samples from five areas and about half of the tools were analyzed and many collected. Of the eight FCR features described, two had charcoal stains (FAA and NMSA 2010b:33; Quaranta and Gibbs 2008:236).

In 2007, Zia adjusted the site boundaries based on the surface artifact distribution observed at that time. Zia archaeologists reported temporally diagnostic artifacts dating to the Archaic and Jornada Mogollon periods and they analyzed a sample of 127 artifacts. In all, 21 FCR features were located and described (Quaranta and Gibbs 2008:239-241). OAS revisited the site in September of 2010 to assess the current conditions at the site. Testing following an approved testing plan (Moore et. al 2010) occurred during December 2010.

Site setting. LA 111429 lies on a flat plain that slopes gently towards Jornada Draw, a wide arroyo that lies 200 m west of the site. The north end of the site has about a five percent slope with rocky, caliche, and sandy soils supporting a combination of grass and occasional mesquite and sumac. The central portion of the site is flat, gravely, and grass covered hardpan. The west, south, and southeastern areas are gravely and flat, and low sandy mesquite-stabilized dunes are present along the east side. Plants observed include honey mesquite, burro grass, alkali sacaton, soaptree yucca, broom snakeweed, and cacti (Quaranta and Gibbs 2008:236, 243).

Site description. LA 111429 is a large artifact scatter with a diverse artifact assemblage and features. HSR estimated that the site covers an area of approximately 151,190 square meters (15.12 hectares, 37.4 acres). Artifacts recorded or collected by HSR include a Clovis point base, 6 Folsom point fragments, Paleoindian and other scrapers (11 were collected), a Middle Archaic-like point, a Late Archaic/Early Formative projectile point, a biface midsection, a core tool, a uniface, tabular choppers, knives, core tools, a hammerstone, fragments of nine manos, five metates, and other ground stone, Jornada Mogollon corrugated ceramics, and modern metal artifacts (two movie film reels and a sanitary-seal metal food can). Eight FCR features were described, of which two had charcoal stains. Because some of the lithic artifacts exhibit evidence of heat treatment, HSR archaeologists speculate that some of the FCR features could have been used to heat treat raw materials (FAA and NMSA 2010b:33-34).

Zia archaeologists adjusted the borders and slightly increased the estimated size to 730 by 290 m (159,801 square meters, 15.98 hectares or 39.48 acres) (FAA and NMSA 2010b:32). They observed Formative, Archaic, and Middle Archaic projectile points, a knife blade, and a variety of scrapers (n=9), but no ceramics. A sample of 155 pieces of lithic debris was analyzed in the field (8 cores, 8 pieces of angular debris, and 139 flakes) and 15 pieces of ground stone (complete and fragments of one hand manos, fragments of slab and basin metates, and a hammerstone) were described. They also documented 21 FCR features (Appendix 3) that are scattered throughout the area (Fig. 6.15). The features ranged in size from 1.75 to 7.0 m in diameter and consisted of as few as 10 to thousands of FCR. Most of the rocks are highly fragmented igneous cobbles or caliche and four or five of the features may constitute ring middens. The largest midden (7.5 by 5.0 m) has thousands of FCR and is mounded 60 cm above the ground with stained soil and chunks of charcoal. Several of the FCR features are partially buried. Zia archaeologists ascribe a communal food processing function to some of the thermal features. In addition to the described features, there are a small number of anomalous depressions. These, and others on the east side of the Jornada Draw are postulated as kill and/or meat processing locations for Paleoindian hunters and favorable locations for Archaic and Formative groups (FAA and NMSA 2010b:33-35; Quaranta and Gibbs 2008:239-240). OAS found that artifacts extended beyond the revised boundaries of the site and the HSR delineation of the site area may be more accurate in the northeastern site area.

Testing results. Before work at LA 111429 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. Investigations at the site included mapping the site (Figs. 6.16-6.17), defining the distribution of surface artifacts, locating, renumbering and describing the features, locating and field analyzing tools and diagnostic artifacts, and the excavation of test units along the road corridor. The surface distribution of artifacts suggests that site size is substantially larger than that proposed by Zia (177,940 m^2).

Artifact assemblage. No attempt was made to examine all surface artifacts at LA 111429 because of their large number. Instead, the locations of formal tools and atypical artifacts were plotted, and they were briefly described. Temporally diagnostic tools were collected for further examination. In addition, artifacts within 15 m of each side of the existing road bed were analyzed in the field. The recorded stone tool assemblage included 21 manos, 14 bifaces, 8 choppers, 8 scrapers, 4 pieces of unidentified ground stone, 3 projectile points, 2 thumbnail scrapers, and single examples of a denticulate, scraper-spokeshave, uniface, and metate (Table 6.7). The projectile points included fragments of a Folsom point, a late Paleoindian point, and the midsection of an unidentified type of point. Three pieces of debitage located in the projected road corridor were examined, as were 6 cores and an overshot flake removed from a biface that were located elsewhere on the site, and two metal Historic period artifacts. Only six artifacts were collected from LA 111429 including the two Paleoindian period projectile points, both

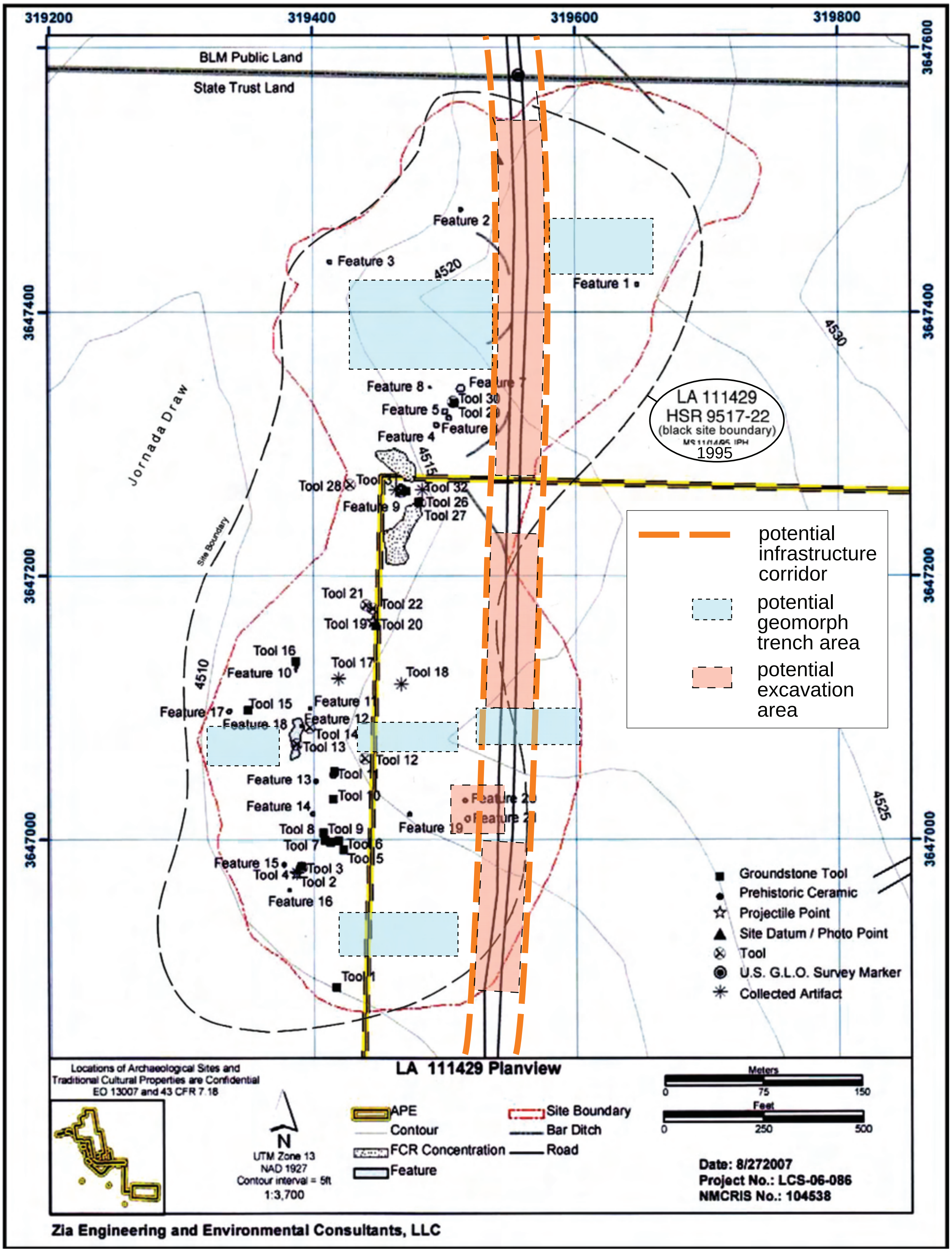

Figure 6.15. Plan of LA 111429 (after HSR 1995 and Zia 2008) showing potential archaeological work areas.

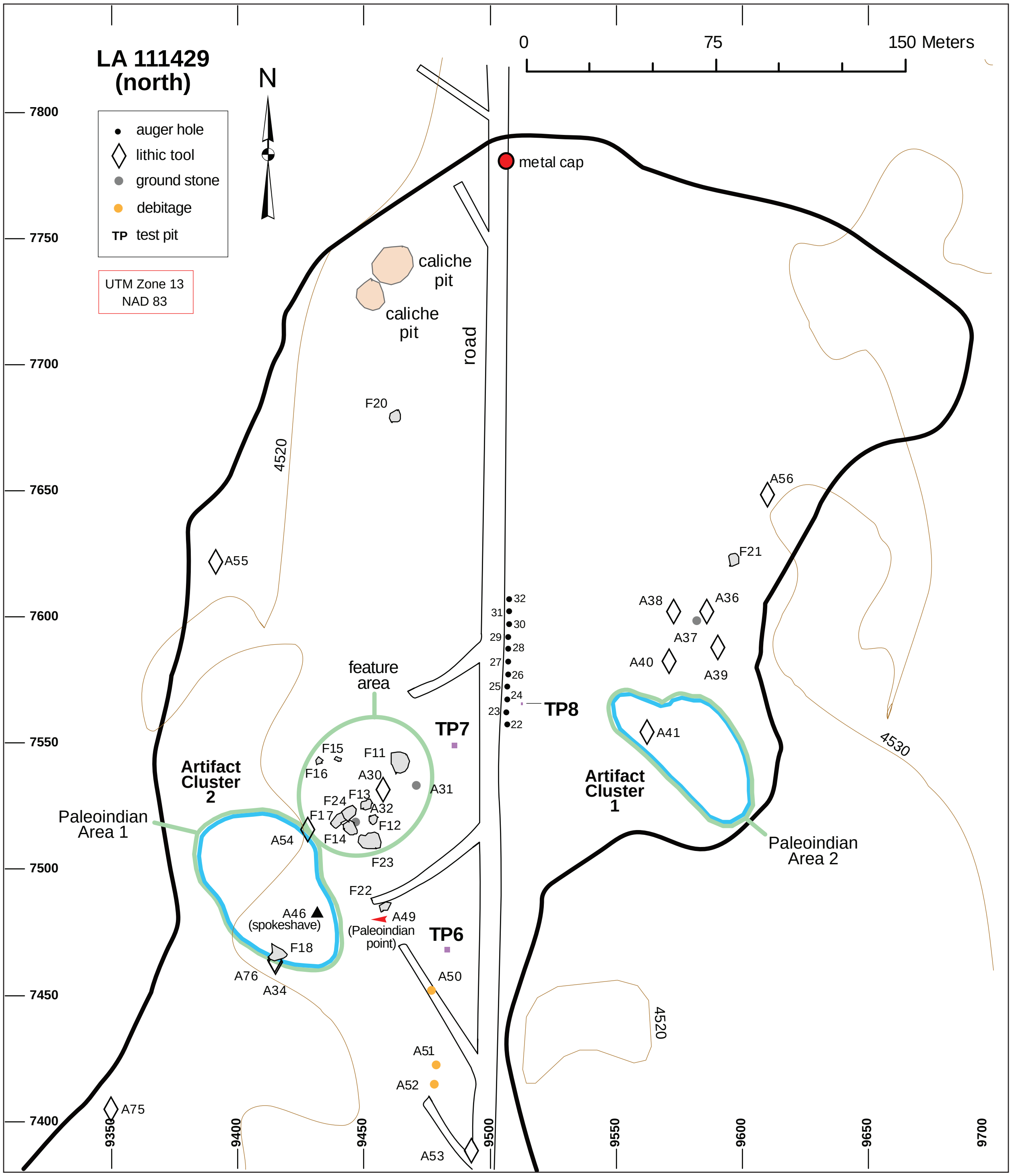

Figure 6.16. OAS plan of the north area of LA 111429 showing excavated areas and artifact distribution. Artifact clusters were defined in the field.

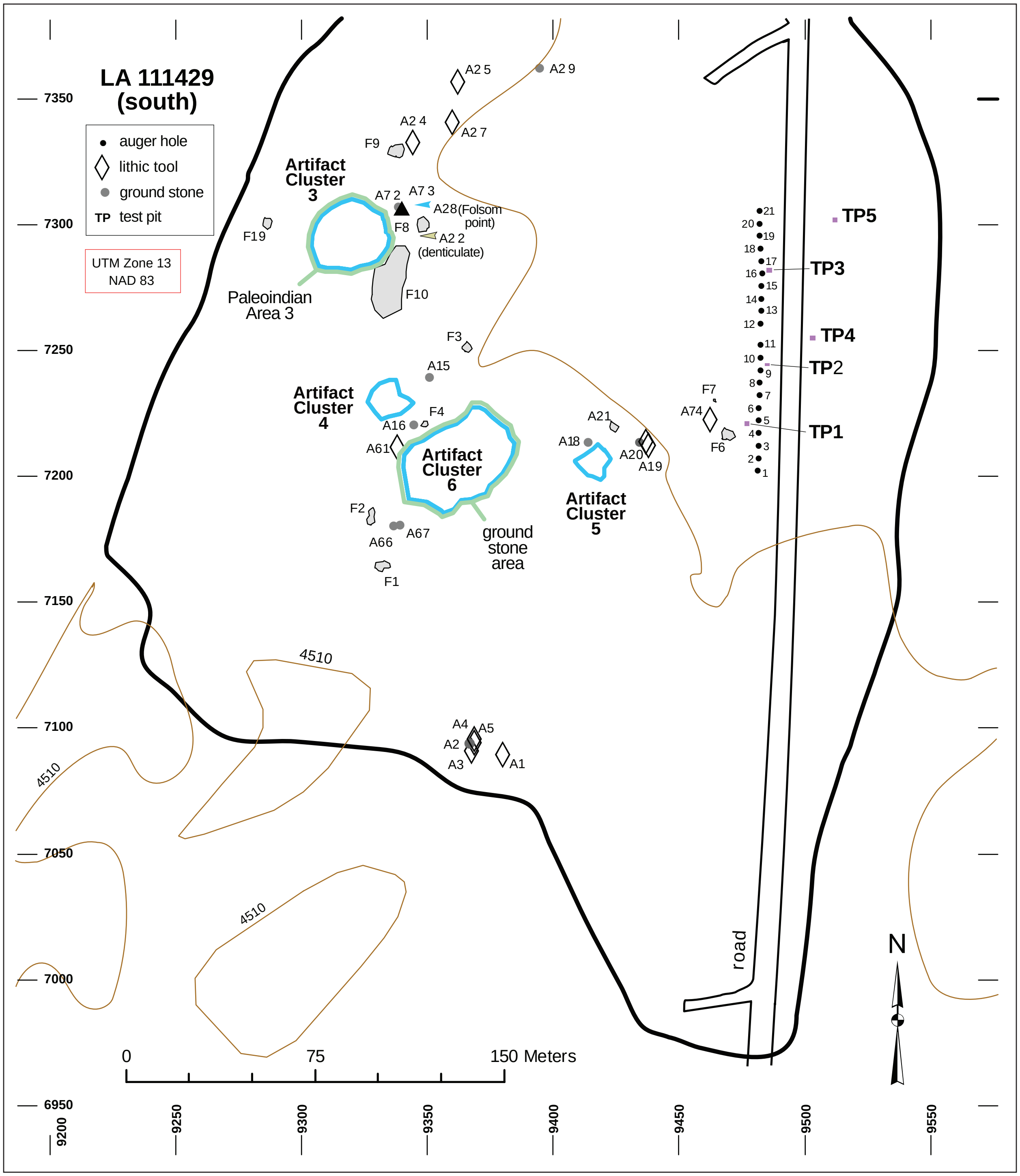

Figure 6.17. OAS plan of the south area of LA 111429 showing excavated areas and artifact distribution. Artifact clusters were defined in the field.

Table 6.7. Material type by morphology for chipped and ground stone artifacts recorded at LA 111432; counts and column percentages.

Material Type		Core flake	Overshot flake	Core	Cobble tool	Uniface	Biface	Ground stone	Totals
Unknown	Count							1	1
	%							3.85%	1.35%
Chert	Count	2	1	1	2	13	14		33
	%	50.00%	100.00%	16.67%	14.29%	100.00%	82.35%		44.59%
Alibates chert	Count			1					1
	%			16.67%					1.35%
Igneous	Count							3	3
	%							11.54%	4.05%
Basalt	Count				1			10	11
	%				14.29%			38.46%	14.86%
Rhyolite	Count			2	1		1	1	5
	%			33.00%	14.29%		5.88%	3.85%	6.76%
Limestone	Count			2	3				5
	%			33.00%	42.86%				6.76%
Sandstone	Count							6	6
	%							23.08%	8.11%
Metamorphic	Count	2						1	3
	%	50.00%						3.85%	4.05%
Metaquartzite	Count						2	3	5
	%						11.76%	11.54%	6.76%
Orthoquartzite	Count							1	1
	%							3.85%	1.35%
Totals	Count	4	1	6	7	13	17	26	74
	%	5.41%	1.35%	8.11%	9.46%	17.57%	22.97%	35.14%	100.00%

metal Historic period artifacts, and two pieces of debitage recovered from test pits. No analysis of the latter has yet been conducted. While ground stone artifacts were noted across most of the site, they were particularly concentrated in the southwestern sector (Fig. 6.17, Ground Stone Area), suggesting that occupations in that part of the site were mostly focused on vegetal food processing. An area in the northwest part of the site contains a concentration of thermal features and associated chipped and ground stone artifacts (Fig. 6.16, Feature Area). The chipped stone artifacts from this area appeared to differ in the amount of thermal alteration present and, perhaps, the types of materials used from other parts of the site. Paleoindian projectile points were recovered all along the western flank of the site during survey as well as the current study, but three areas in particular contained heavy concentrations of thermally altered cherts, a few spurred end scrapers or thumbnail scrapers, and a Folsom point that might be indicative of Paleoindian occupational zones. These were in the northwest sector of the site (Fig. 6.16, Paleoindian Area 1), the northeast lobe (Paleoindian Area 2), and the southwest area (Paleoindian Area 3; Fig. 6.17).

Features. Zia located and briefly described 21 FCR features at LA 111429 (Quaranta and Gibbs 2008:240). Using Zia's feature shape files loaded onto the Trimble, OAS relocated most of the Zia features. To avoid difficulties with accurately relocating previously numbered features, the features and potential features at examined by the current study at LA 111429 were given new numbers. At least one of the Zia features was eliminated as a feature, two were combined into a single feature, others could not be located in the area indicated in the Trimble shape files, and features were found in areas not indicated on the Zia shape files. Ultimately, OAS located and numbered 24 features at this site (Tab. 6.8).

All of the features were inventoried with the initial version of the Feature Inventory Form devised before the testing phase of field work. This form was designed to provide a written description of the feature and includes the following categories of information:

- Feature number
- Feature size
- Estimated number of fire-cracked rocks (FCR)
- Types and proportions of FCR
- FCR distribution and density
- Soil horizon
- Condition of feature
- Potential for subsurface deposits
- Potential for chronometric samples
- Potential for subsistence remains.

Features were numbered sequentially and marked with an aluminum tag on a steel nail. These were placed either in a plant stabilized area within the feature or near the core of the feature. For consistency, the same two individuals recorded all of the features. Digital photographs were taken of each feature. Feature types were assigned after the field session using the Feature Inventory Form and the digital photographs. The FCR features form more of a continuum than absolute types. For this reason individual features could be assigned to different types by other observers or those viewing the actual feature. The FCR features were categorized as: dispersed FCR scatter without a concentration that suggests a single origin, dispersed FCR scatter with a core or concentration suggesting an origin, FCR core or concentration, or FCR core or concentration with dispersed scatter. The main criteria were how dense and concentrated the core area is and whether the scatter extended well beyond the core area.

Most (64.0 percent) of the features at LA 111429 are dispersed FCR scatters with a concentration (Table 6.8). Only one (4.0 percent) is a core or concentration. The remainder have no core concentration (12.0 percent) or have a concentration with some scatter (20.0 percent).

Ten features were tested with 20 by 20 cm hand excavated units. These were placed in locations that should have revealed whether there is subsurface rock, ash, or charcoal, if such exists. The feature with the most potential (Feature 11) has a large associated stain with charcoal on the surface. Feature 11 was not tested since we already knew it has the potential to provide radiocarbon and subsistence samples. Feature 3 has a stain down slope from the core area and the core area was tested. No charcoal was observed in the test. No other features have evident stains and only Feature 1 had charcoal in the fill investigated by a test. There was also a small biface flake in the fill of this feature. One other feature had a small biface flake in its fill.

Features that have the best potential for providing samples for radiocarbon dating, artifact associations, or intact features are:

- Feature 1 had ash and a biface flake in the test.
- Feature 3 has a stain near the FCR concentration.
- Feature 6 has subsurface rock.
- Feature 11 has a substantial ash deposit with charcoal on the surface.
- Feature 17 has subsurface rock.

Other features could be determined to have potential based on proximity to artifact clusters.

Hand excavations. Test excavations consisted of 6 2-by-2 m test units, one 1-by-1 m test unit, and one 1-by-2 m test unit placed within the road corridor. Excavation extended up to 80 cm below the current ground surface through eolian sediments and into Pleistocene age soils. Only two chipped stone artifacts from different test units were recovered. Both came from the upper ten centimeters of excavation. Thirty-two auger holes yielded no artifacts, charcoal, or evidence of buried cultural strata.

Most of the artifacts were found on a Pleistocene Bt horizon. However, a buried A horizon of indeterminate age was encountered in Test Unit 3 immediately below sand deposits associated with a dune running east-west across the site. Optically stimulated luminescence (OSL) and bulk radiocarbon samples were collected from the A Horizon. The preserved paleosol was not identified in other test units. However, the presence of ash and charcoal within two of the documented features suggests potential in situ preservation.

Mechanical excavation. No geomorphology

Table 6.8. Features identified at LA 111429

Number	Type	Estimated FCR count	FCR maximum density	FCR fragmentation	% caliche	Feature tested?	Comment	Information potential
1	dispersed fcr with concentration	50-100	5	cobbles and highly fragmented	30	yes	ash and biface flake in test	fair to good
2	dispersed fcr with concentration	50-100	5	cobbles and highly fragmented	60	yes	part under dune	very low
3	fcr concentration and dispersed scatter	50-100	8	mostly cobbles	20	yes	stain present	fair to good
4	dispersed fcr with concentration	< 50	10	cobbles and highly fragmented	80	no	< 5 cm fill	very low
5	dispersed fcr with concentration	< 50	7	highly fragmented	100	no		very low
6	fcr concentration and dispersed scatter	50-100	15	cobbles and highly fragmented	75	yes	subsurface rock present	fair to good
7	fcr concentration	12	7	cobbles and highly fragmented	90	yes		low
8	dispersed fcr with concentration	300	26	highly fragmented	96	yes	< 5 cm fill	very low
9	dispersed fcr with concentration	> 200	24	cobbles and highly fragmented	94	no		low
10	dispersed fcr with concentration	50-100	21	highly fragmented	94	no	large scatter with 2 core areas	low
		100-200	16	highly fragmented	80	no	large scatter with 2 core areas	low
11	fcr concentration and dispersed scatter	> 200	50	cobbles and highly fragmented	80	no	stain present	good
12	dispersed fcr with concentration	100-200	27	cobbles and highly fragmented	95	yes	biface flake in test	fair
13	fcr concentration and dispersed scatter	50-100	25	cobbles and highly fragmented	80	yes	< 5 cm fill	very low
14	dispersed fcr with concentration	> 200	16	highly fragmented	95	no		low
15	dispersed fcr scatter	11	4	cobbles and highly fragmented	10	no		low to fair
16	fcr concentration and dispersed scatter	75	16	cobbles and highly fragmented	60	yes	< 5 cm fill	low
17	dispersed fcr with concentration	50-100	12	cobbles and highly fragmented	90	no	subsurface rock present	fair
18	dispersed fcr with concentration	< 50	4	cobbles and highly fragmented	80	no		low
19	dispersed fcr with concentration	50-100	3	highly fragmented	95	no		low to fair
20	dispersed fcr with concentration	300	50	cobbles and highly fragmented	95	no	< 5 cm fill	very low
21	dispersed fcr scatter	50-100	20	cobbles and highly fragmented	95	no		very low
22	dispersed fcr scatter	20	8	highly fragmented	0	yes	subsurface rock present	very low
23	dispersed fcr with concentration	< 50	10	mostly cobbles	90	no	< 5 cm fill	very low
24	dispersed fcr with concentration	100-200	20	cobbles and highly fragmented	90	no	part under dune	low

Note: cobble includes rounded cobble forms and large chunks of caliche trenches were excavated at this site.

Excavation plan. LA 111429 will not be directly affected by Spaceport America construction activities. However, County Road A020 passes through the site and provides access to the VLA. The road may require improvement that would adversely affect adjacent portions of the site. Regardless, the site has considerable time depth (as much as 12,000 years) and is well preserved. Targeted research-oriented investigations in areas that could have deep deposits, or that have an abundance of surface materials, could yield information on site chronology, settlement, land use, access to resources subsistence practices, and would allow us to fully characterize the site occupations. Excavation units will be placed in locations most likely to yield material for radiocarbon dating, organic food material, and other cultural material (FAA and NMSA 2010b:34).

If any disturbance along the road is contemplated, the disturbance corridors will be assessed through formal testing and, at a minimum, surface-collection and monitoring during construction (FAA and NMSA 2010b:34).

To aid in identifying specific temporal or functional components investigations at LA 111429 will include feature excavation, infield analysis of surface artifacts in selected areas, surface collection within artifact clusters, and hand excavations within the artifact clusters. Artifacts from five of the clusters identified during the testing phase will be sampled through surface collection and hand excavated units. Clusters to be targeted include the three possible Paleoindian artifact clusters, the ground stone area, and the feature area. In addition, 10 to 40 square meters will be excavated in each of the five clusters to recover data on subsurface artifact content, density, and distribution. Placement of these units will focus on high density artifact areas, the location of temporally diagnostic artifacts or both. These units will be hand excavated to the base of the vertical artifact distribution or potential cultural deposit-bearing soil as determined by the geomorphologist. All hand excavations will follow conventions provided in Chapter 5.

Features selected for excavation will be those with the most potential to provide chronometric samples, subsistence samples, or are associated with diagnostic artifacts. These will include the five listed in the Testing Results section and up to five additional features chosen on the basis of unique characteristics or proximity to the artifact clusters. A one meter wide buffer area will be excavated around part or all of the feature to recover artifacts associated with the feature. Features will be excavated as described in Chapter 5.

Up to five geomorphology soil trenches will be mechanically excavated. Three or four of these will be placed in an east-west direction across the center of the southern lobe of the site. They will be discontinuous to avoid surface features and artifact clusters and may extend west beyond the site boundary toward Jornada Draw. These will allow the geomorphologist to collect soil and OSL dating samples and investigate soils at the site.

OAS expects that investigations will yield data relevant to Research Questions 1-8. At least three of the features have ash stains that could produce charcoal for determining chronology (Research Question 1) and could provide information on subsistence (Research Question 4) and the characteristics of the landscape that attracted these groups to this area (Research Questions 3, 4, and 5). Artifacts from around the features and in the clusters should inform on site structure (Research Question 6), the range of the groups using the site area and their interaction with groups in other areas (Research Question 8), perhaps on chronology (Research Question 1), on continuity and change within the site area (Research Question 5), and on how the region fits with regards to the regional culture history (Research Question 2).

LA 111432

This prehistoric lithic artifact scatter with a Paleoindian projectile point is located on NMSLO trust land (western third) and BLM public land. LA 111432 has been determined "eligible" to the NRHP under Criterion "d" because it has integrity. While the artifact assemblage is small, the tool forms are Paleoindian, so it is possible that the site has the potential to contribute to our knowledge of this early period of use in the area. It is northwest of the VLA in the path of Utility Corridor F, which is located in the NMSLO portion of the site. County Road A020 parallels the fence separating the two types of land on the

BLM side and a bar ditch (6 by 15 m) extends east from the road in the southern part of the site (Quaranta and Gibbs 2008:212, 215).

Previous work. The site was recorded by HSR archaeologists in 1995 as a single-component chipped stone scatter that may have been occupied during the late Paleoindian period based on an Eden-like projectile point base. They estimated that about 50 artifacts were present on the site surface and analyzed a sample of 25 of the artifacts (FAA and NMSA 2010b:35-36).

Returning to the site in 2007, Zia archaeologists noted that some of the artifacts may have been redeposited when the road was bladed. They observed fewer artifacts and analyzed a sample of 18 pieces of debitage. No tools, ground stone artifacts, or features were identified (Quaranta and Gibbs 2008:212-213). OAS revisited the site in September of 2010 and observed no artifacts on the BLM portion of the site and few on the NMSLO property. OAS conducted test excavations on the NMSLO portion of the site following an approved testing plan (Moore et. al 2010) in November 2010.

Site setting. LA 111432 is situated on a flat plain covered with burro grass, curly mesquite, and grama grass interspersed with occasional mesquite, soaptree yucca, and cholla. Jornada Draw lies approximately 100 meters to the west (FAA and NMSA 2010b:35).

Site description. HSR archaeologists estimated that LA 111432 covered an area of approximately 4,320 square meters (0.43 hectares, 1.70 acres). The lithic materials in their sample were of high quality and included a unifacial scraper, an expedient core, and a biface with grinding on one side. The site was interpreted as a probable hunting or kill/processing site due to the high quality of the material and presence of non-local raw material (FAA and NMSA 2010b:35-36).

Zia archaeologists enlarged the site by moving the eastern boundary approximately 70 m to the east (Fig. 6.18). This resulted in a site area of 64 by 200 m (10,555 square meters, 1.06 hectares, 2.61 acres). Fewer artifacts were observed and they surmised that some could have been turned up when the road was bladed. Artifacts analyzed in the field included 5 pieces of angular debris and 13 flakes. The flakes were thin with little cortex and the archaeologists suggested these were from tool refurbishing or from detaching blanks for use. They felt it could be a single use site (FAA and NMSA 2010b:35-36; Quaranta and Gibbs 2008:212-213).

Testing results. Before work at LA 111432 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. OAS mapped (Fig. 6.19) and inadvertently collected all surface artifacts within the proposed utility corridor because of a misreading of the testing plan. The surface artifact distribution suggests that site size is substantially larger than that proposed by Zia (Zia=10,555 m^2, OAS=17,501 m^2).

Artifact assemblage. Surface examination of LA 111432 located 124 artifacts, all of which were mapped. Seventy-nine artifacts were collected from NMSLO land and have not yet been analyzed, and the remaining 44 were analyzed in the field. No formal tools were noted during field analysis. An additional 27 chipped stone artifacts were collected during subsurface investigations and also have not been analyzed. The surface field-recorded assemblage contained 45 pieces of debitage (Table 6.9). Cherts, and especially gray chert, dominated this part of the assemblage. Very fine-grained metaquartzites were also relatively common, but comprised only about 18 percent of this part of the assemblage. Cortex was rare, occurring on only three pieces of chert debitage. In two cases the cortex was waterworn and in the third it was indeterminate, so we can tentatively suggest that materials acquisition was primarily from gravel deposits.

Hand excavations. Five 1-by-1 m test units were excavated 20 to 30 cm through eolian sediment and into Pleistocene age soils, retrieving 28 chipped stone artifacts from the upper 25 cm of fill. Twenty-two auger holes yielded no artifacts or charcoal.

Mechanical excavation. A 1-by-5-m mechanically excavated geomorphology trench suggests substantial desiccation of the ground surface over time. This has been subsequently followed by limited aggradation caused by the accumulation of wind-blown silts. The overlying 15 to 25 cm of eolian silt is relatively recent and covers an earlier Pleistocene Bt horizon. The majority of the surface artifacts occur on top of this earlier Pleistocene horizon, reflecting the complete erosion of the original A horizon (surface) with which the

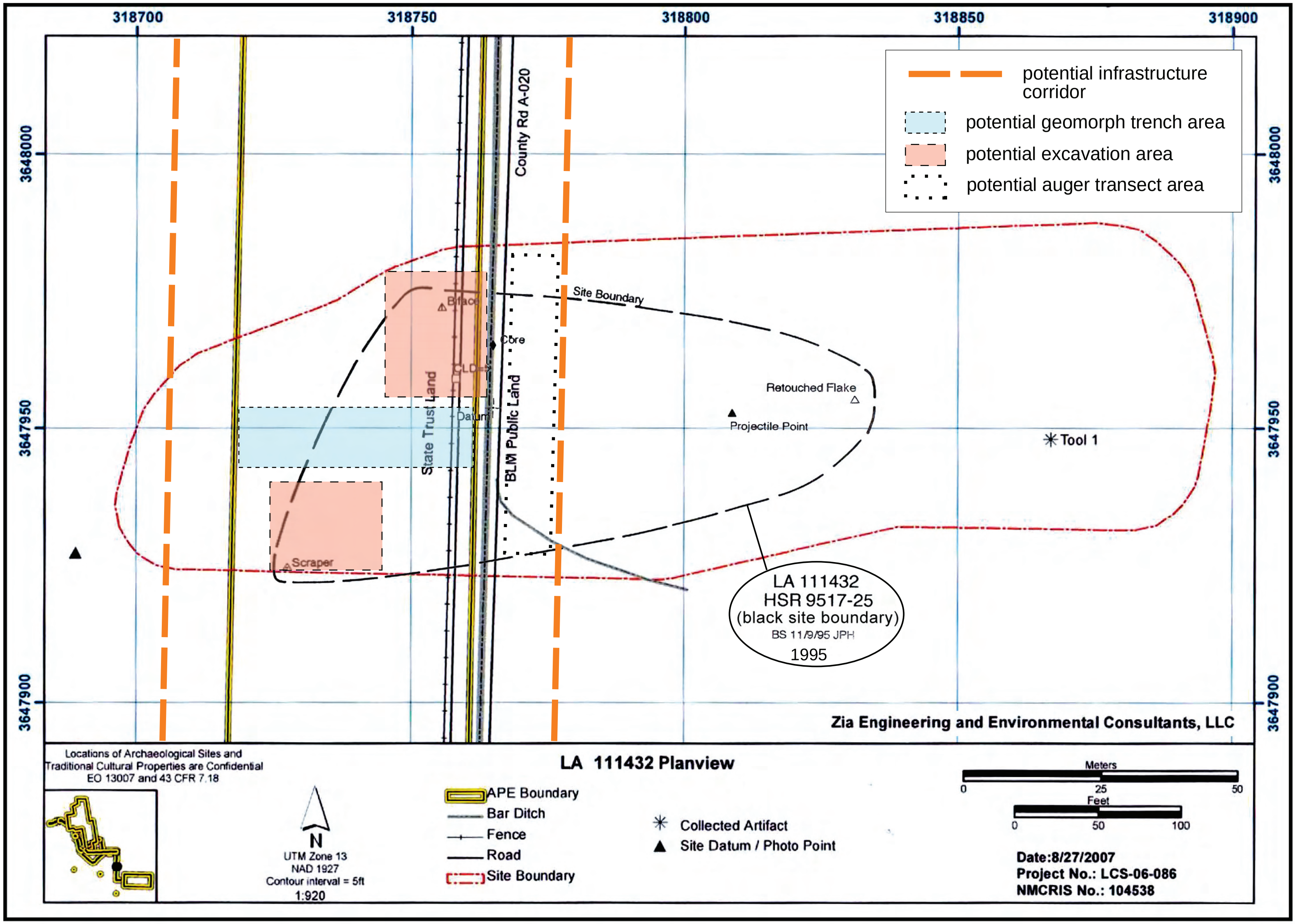

Figure 6.18. Plan of LA 111432 (after HSR 1995 and Zia 2008) showing potential archaeological work areas.

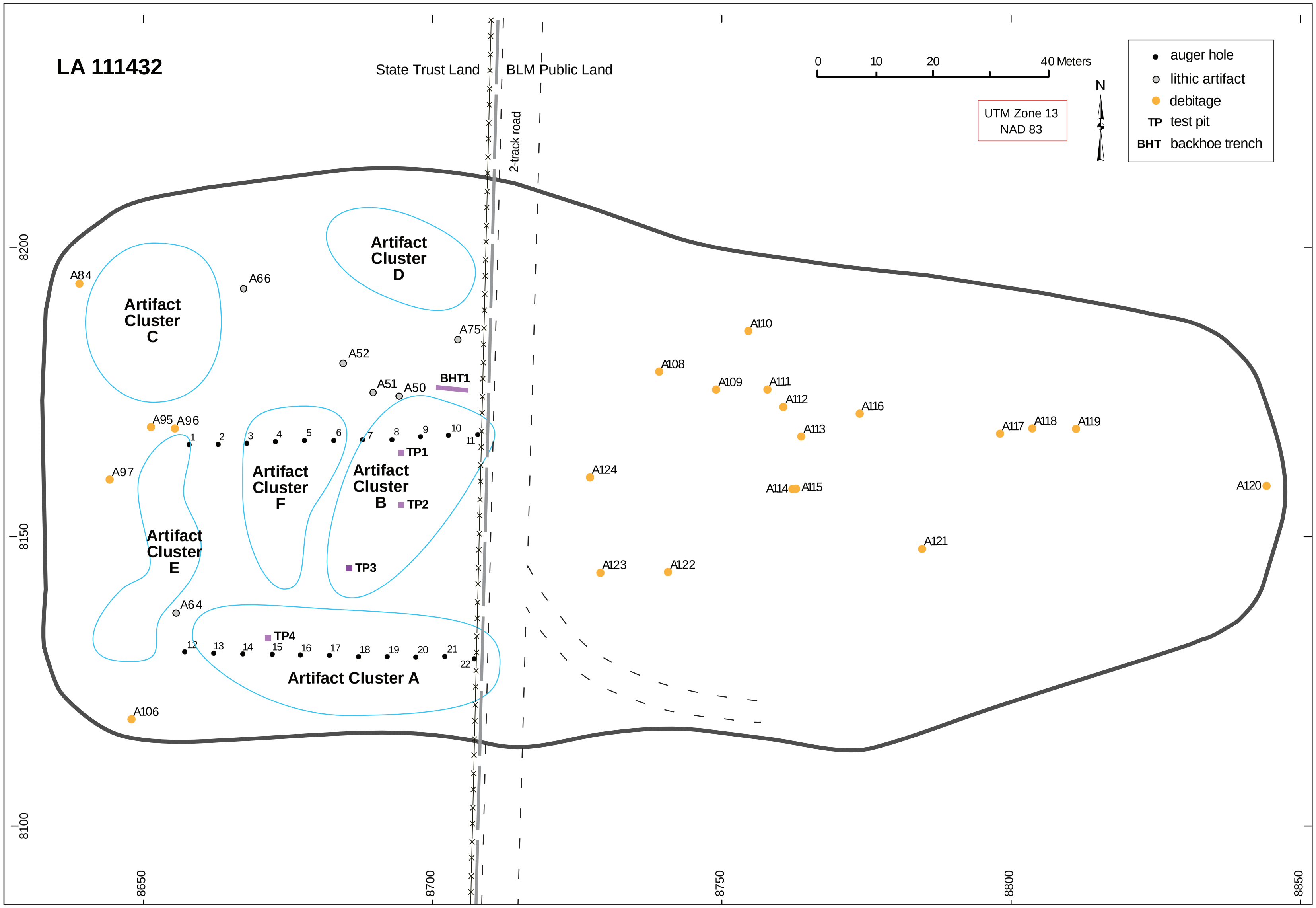

Figure 6.19. OAS plan of LA 111432 showing excavated areas and artifact distribution. Artifacts were grouped into clusters for ease of presentation, and do not represent analytic subdivisions.

Table 6.9. Material type by morphology for chipped and ground stone artifacts recorded at LA 111432; counts and column percentages.

Material Type		Angular debris	Core flake	Biface flake	Totals
Chert	Count	6	26	2	34
	%	100.00%	72.22%	100.00%	77.27%
Silicified wood	Count		1		1
	%		2.78%		2.27%
Limestone	Count		1		1
	%		2.78%		2.27%
Metaquartzite	Count		8		8
	%		22.22%		18.18%
Totals	Count	6	36	2	45
	%	13.33%	80.00%	4.44%	100.00%

artifacts were initially associated.

Summary. Based upon the substantial quantity of subsurface artifacts recovered during testing, LA 111432 has the potential to contribute to our understanding of the Paleoindian period. While artifacts are located on a secondary geologic horizon, these artifacts represent a discrete deposit from which information regarding site structure and the nature of subsistence strategies in the Jornada del Muerto during the Paleoindian period can be ascertained. No additional research is proposed for this site at this time. Data collected at the site during testing will, however, contribute to addressing the research questions posed in this plan for investigation of Spaceport America's cultural landscape. If the site will be impacted along the infrastructure corridor, a plan for monitoring consistent with the mitigation plan (FAA and NMSA 2010b) should be prepared for work within the corridor.

LA 111435

LA 111435 is a Mesilla phase Jornada Mogollon artifact scatter with features. It is located on NMSLO trust land and under Criterion "d" is determined "eligible" to the NRHP because it has integrity (76 to 99 percent), has a number and diversity of features and tool types, and has the potential to contain datable material that could be used to address research questions concerning regional prehistory. The site is west of the VLA in Utility Corridor F. The proposed utility corridor passes through the west central portion of the site, an area containing several features. A fence and abandoned two track road run through the center of the site (Quaranta and Gibbs 2008:217, 396). The road was no longer discernable in September of 2010.

Previous work. In 1995, HSR archaeologists recorded the site as a moderately dense artifact scatter with 400 to 600 surface artifacts, five FCR features, and two ash stain features. Random samples of the lithic artifacts (10 percent), most of the tools and ground stone (80 percent), and the ceramics were analyzed. Based on the artifact assemblage HSR archaeologists suggested that the site functioned as a Late Mesilla phase Jornada Mogollon food preparation and processing area, a seasonal base camp, or a habitation site (FAA and NMSA 2010b:36).

Zia archaeologists revisited the site in 2007. They were unable to locate two of the features recorded by HSR but found two that they felt could represent the remains of shallow, burned basin or pit brush structures. The Zia archaeologists felt the site was used for plant processing and was probably a wet season residential base camp (Quaranta and Gibbs 2008:217-223). OAS revisited the site in September 2010 to assess the current condition of the site.

Site setting. The site is on a low ridge of active, mesquite stabilized hummock dunes. Prickly pear cactus and grasses grow on the site. Jornada Draw is at the east edge of the site. Areas of dense mesquite thickets lie east of the site area (Quaranta and Gibbs 2008:217, 221).

Site description. The site area was estimated as 30,233 square meters (3.02 hectares, 4.47 acres) by HSR and reduced to 14,778 square meters (248 by 80 m, 1.48 hectares or 3.65 acres) by Zia. HSR archaeologists described the site as a scatter of artifacts and seven distinct features on the south face of a low dune. Ceramic types included El Paso Brown ware (n=1), Mimbres Red washed (n=2), and Alma Plain or Western Mogollon corrugated (n=2). HSR analyzed a 10 percent random sample of lithic debitage and most (80 percent) of the tools (a scraper and a piece of an agave knife or retouched tabular piece of limestone) and ground stone (n=14 manos, slab, and basin metates, anvil). Their map shows the features clustering on the southern slope near the ridge top with FCR scatters, tools, and ground stone scattered in an east west direction along the ridge. They noted that at least the ash stains indicate subsurface materials and could yield significant amounts of charcoal for radiocarbon dating (FAA and NMSA 2010b:36-38, Quaranta and Gibbs 2008:217).

Zia archaeologists considered this a large artifact scatter and described nine features (Appendix 3) that included small thermal features, ring middens, and charcoal stains (Fig. 6.20). The small thermal features were probably for domestic use (n=5) and ranged from 1.0 to 4.0 m in diameter with the scattering of the stones influencing the recorded sizes. The stains (n=2) are about 1.0 m in diameter and lack FCR, and Zia suggested that these could represent burned shallow brush structures. The ring middens, which may represent communal use, are 7.0 and 8.0 m in diameter and mounded 30 cm high. An agave knife fragment, 5 slab metate fragments, a cobble pestle, an anvil, a core, 2 tested cobbles, and 11 flakes were analyzed. They also noted that El Paso Brown ware and Jornada Brown ware sherds were sparsely scattered over the site area. To the Zia archaeologists, the artifact assemblage and feature morphology suggested extended occupations and multiple use episodes, and they, too, felt that the site would contain dating and subsistence-related materials (Quaranta and Gibbs 2008:217-222).

Excavation plan. Research driven investigation at LA 111435 will begin by mapping the site with a total station. Artifacts will be flagged, piece plotted, and field analyzed. All nine features will be examined by hand excavation of a 1-by-1-m unit to determine if intact deposits are present. If intact deposits are present that may yield chronometric and subsistence samples, the feature and fill that can provide chronometric and/or subsistence data. a one meter wide buffer zone will be excavated to recover associated artifacts.

One-by-one-meter excavation areas will be placed within artifact clusters and adjacent to feature areas to obtain additional data relevant to research design questions. Between 20 and 80 square meters will be hand excavated to the base of the vertical artifact distribution or potential cultural deposit-bearing soil as determined by the geomorphologist. All hand excavations will follow procedures outlined in the Chapter 5 section.

Excavation may yield data relevant to Research Questions 1, 2, 3, 4, 6, and 8. Systematic recovery of artifacts from within and around the features will add to the surface artifact distribution information and potentially yield temporally or functionally diagnostic artifacts. Analysis of the collected lithic artifacts could provide information on Mesilla phase household and communal use of the site area through the variety of ceramic vessel forms, lithic tool types, and ground stone tools and their distributions across the site and in relation to the different features. Recovery of chronometric (radiocarbon or thermoluminescence) or subsistence (ethnobotanical and faunal) samples or remains should enhance site dating and provide additional information on plant and animal resources that were available, as well as differences in resources that were gathered and processed in support of household or communal activities.

Up to two 1-by-5-m mechanically excavated trenches may be placed in locations chosen by the geomorphologist. This will allow the geomorphologist to examine and characterize soils at the site, collect OSL and soil samples and to determine how the cultural deposits might relate to those at other sites in the project area.

LA 112370

LA 112370 is a prehistoric lithic artifact scatter located on NMSLO trust land. The site status of the site was considered as "undetermined" under NRHP based on the limited artifact assemblage and impacts from an improved gravel road

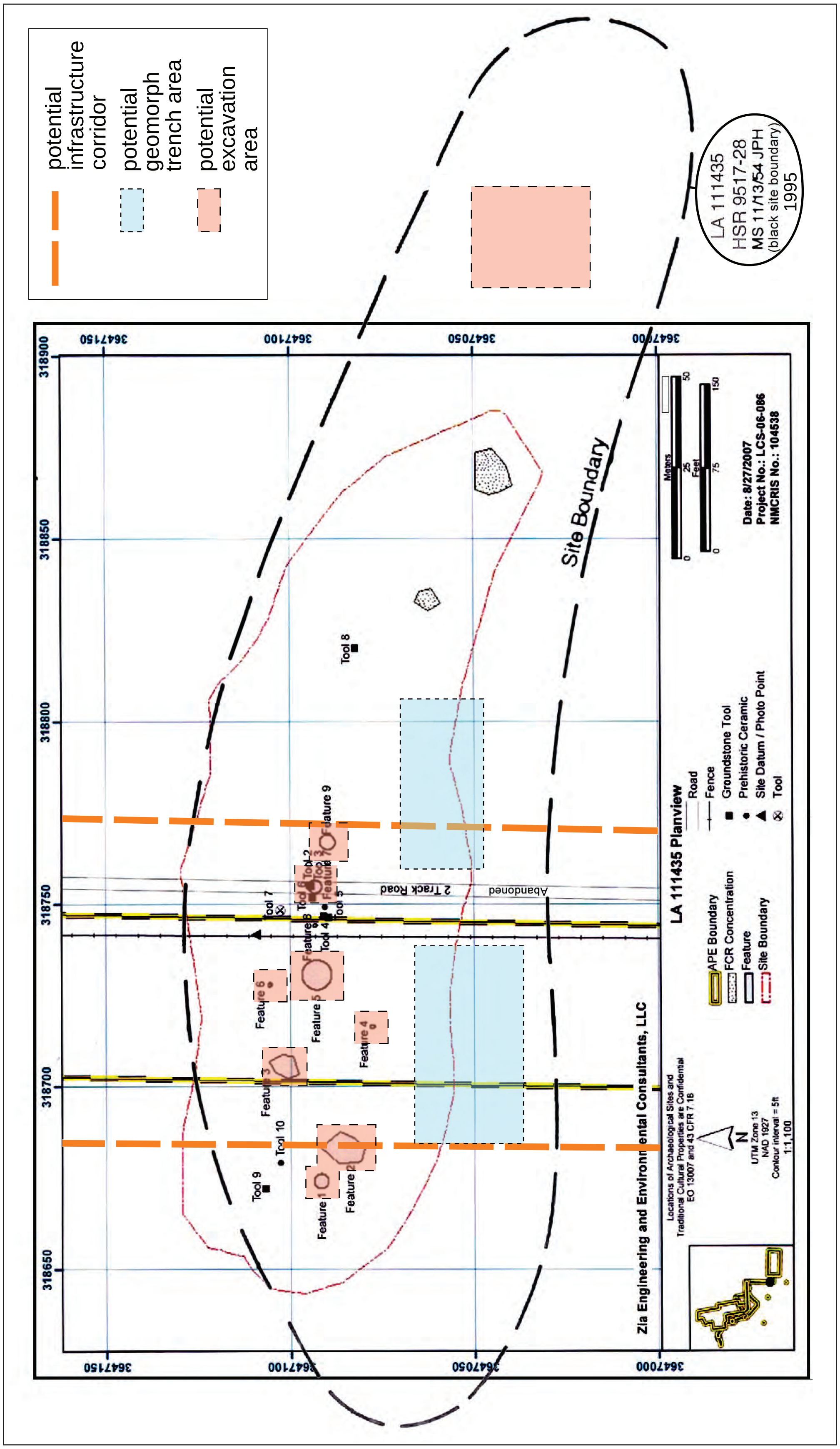

Figure 6.20. Plan of LA 111435 (after HSR 1995 and Zia 2008) showing potential archaeological work areas.

constructed within the site area since it was first recorded. The site is within the VLA and is bisected by both an east-west trending fence and the improved gravel road (Quaranta and Gibbs 2008:253-255, 398). The original HSR survey map also shows a two track road passing through the northern portion of the site and an abandoned road cut in the southeast corner of the area originally designated as the site (FAA and NMSA 2010b:70).

Previous work. HSR initially recorded the site in 1996. The sparse artifact assemblage (n=16) was analyzed and a lack of FCR noted (FAA and NMSA 2010b:38-39). Between the time that HSR recorded the site and Zia revisited the site, an improved gravel road 3.0 m wide and 0.5 m deep bisected the area designated as the site. Zia moved the southern boundary of the site about 60 m to the north, eliminating almost half of the lithic artifacts plotted by HSR. Surface visibility outside of the road bed was low due to dense grass and Zia was able locate only four lithic artifact on the surface of the site (Quaranta and Gibbs 2008:253-254). OAS revisited the site in September 2010 to assess the current condition of the site. Testing following an approved testing plan (Moore et. al 2010) occurred during November of 2010.

Site setting. *The site is on a fairly eroded plain with a gentle western slope. Ground cover consists of intermittent patches of fairly dense tobosa grass, and with low mesquite, soaptree yucca, and cacti in the stabilized areas. Jornada Draw lies 300 m to the west (FAA and NMSA 2010b:38).*

Site description. HSR archaeologists recorded the site area as a sparse artifact scatter in an area 4,241 square meters (0.42 hectares, 1.05 acres). Most of the artifacts were observed near the two-track roads and fence or at the edges of stabilized hummocks. The observed artifacts included a scraper that could be Paleoindian, biface flakes, a biface fragment, and a core fragment. No FCR was observed. Although the assemblage was sparse, HSR felt that the variety of materials and their distribution suggested the presence of subsurface deposits, while speculating that the site reflects Paleoindian or Archaic processing activities (FAA and NMSA 2010b:39).

Zia archaeologists reduced the site size to 80 by 35 m (2,561 square meters, 0.26 hectares, 0.63 acres), eliminating the site area lying south of the gravel road (Fig. 6.21). The artifact assemblage they observed was sparse (9 flakes, a middle to late stage biface fragment, a flake scraper, and a core fragment). Zia archaeologists speculated that the small assemblage indicated a limited activity area or short-term camp from the Archaic period (Quaranta and Gibbs 2008:253-254). OAS observed artifacts, including a quartzite biface tip, south of where Zia redrew the boundary and within the former boundary specified by HSR.

Testing results. Before work at LA 112370 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. OAS mapped and field-analyzed all visible surface artifacts. Surface artifact distribution suggests that site size is substantially larger than proposed by Zia (OAS=6,768 m^2).

Artifact assemblage. Surface examination of LA 112370 located 14 artifacts, all of which were mapped and recorded in the field. One specimen was a biface fragment, which was collected for more detailed analysis. The remainder of the surface assemblage consisted of debitage from the reduction of cores and bifaces (Table 6.10). No temporally diagnostic materials were noted, and no tools other than the biface were located. Gray chert dominated this small assemblage, followed distantly by silicified wood. Waterworn cortex was noted on a single basalt flake. This suggests that materials were probably mainly procured from gravel beds.

Hand excavations. Four 1-by-1 m test units were excavated 20 to 30 cm through eolian sediment and into Pleistocene age soils in conjunction with 28 auger holes. Neither, the test units or auger holes yielded artifacts or charcoal or encountered cultural strata.

Mechanical excavation. A 1-by-5-m mechanically excavated geomorphology trench suggests substantial desiccation of the ground surface over time. This has been subsequently followed by limited aggradation caused by the accumulation of wind-blown silts. The overlying 10 to 15 cm of eolian silt is relatively recent and covers an earlier Pleistocene Bt horizon. The majority of the surface artifacts occur on top of this earlier Pleistocene horizon, reflecting the complete erosion of the original A horizon (surface) with which the artifacts were initially associated.

Summary. Archaeological testing indicates

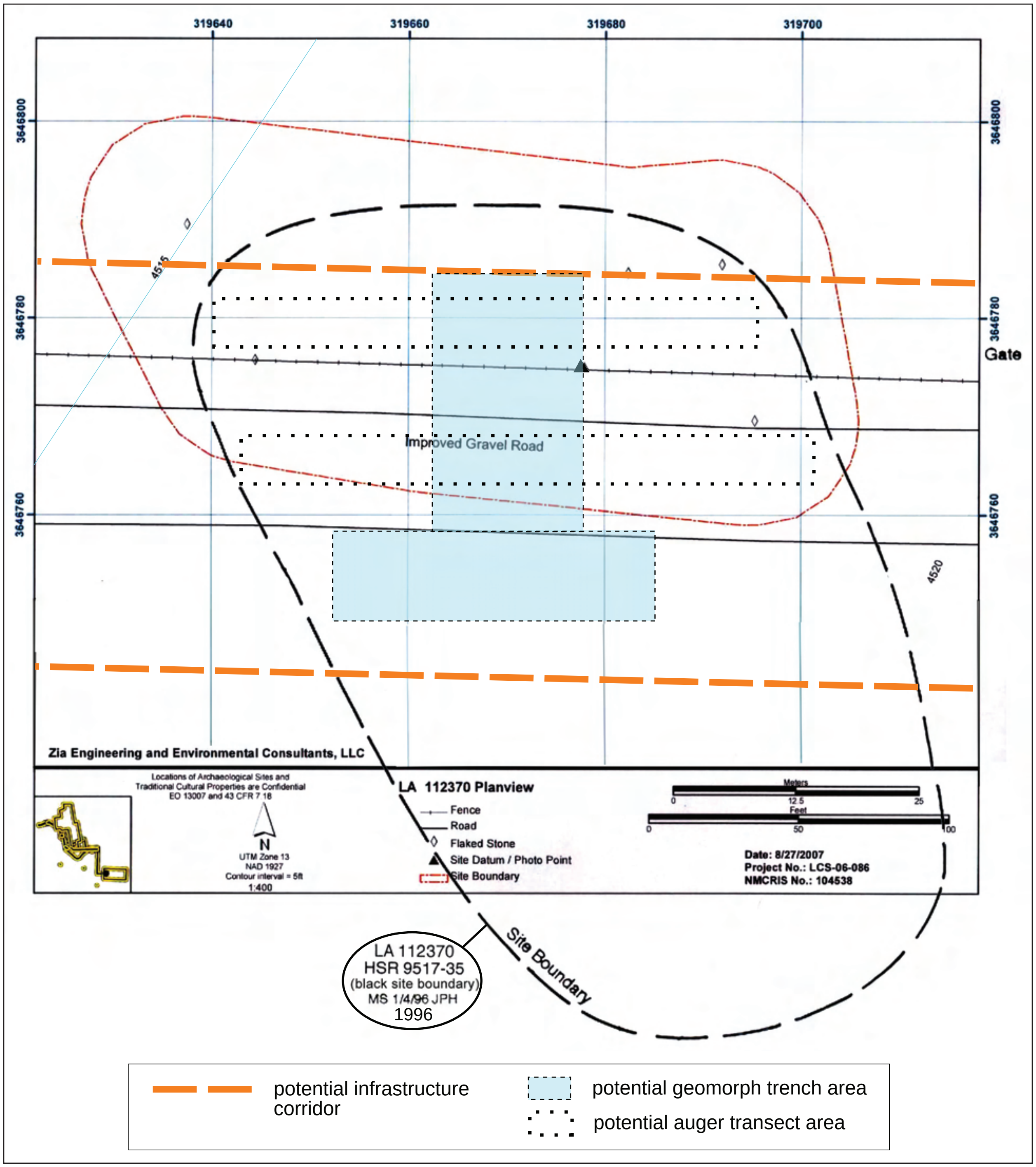

Figure 6.21. Plan of LA 112370 (after HSR 1996 and Zia 2008) showing potential archaeological work areas.

Table 6.10. Material type by morphology for chipped and ground stone artifacts recorded at LA 112370; counts and column percentages.

Material Type		Angular debris	Core flake	Biface flake	Biface	Totals
Chert	Count		8	2		10
	%		80.00%	100.00%		66.67%
Silicified wood	Count	1	1			2
	%	100.00%	10.00%			13.33%
Basalt	Count		1			1
	%		10.00%			6.67%
Metaquartzite	Count				1	1
	%				100.00%	6.67%
Totals	Count	1	10	2	1	14
	%	7.14%	71.43%	14.29%	7.14%	100.00%

that LA 112370 has limited data potential. No further work is planned for this site at this time. Data collected at the site during testing will, however, contribute to addressing the research questions posed in this plan for investigation of Spaceport America's cultural landscape.

LA 112371

This sparse prehistoric lithic artifact scatter with FCR is located on NMSLO trust land in the western portion of the VLA. An improved road and a fence lie just north of the site area as it was defined. The status of the site was considered as "undetermined" under NRHP based on the limited artifact assemblage and because an improved gravel road constructed after the site was recorded in 1995 has heavily impacted the northern portion of the site (Quaranta and Gibbs 2008:257-259).

Previous work. Surveying the site in 1996, HSR observed 30 surface artifacts, analyzed 25 of those, and located 2 FCR clusters that did not exhibit sufficient rock to be considered features. From the assemblage, they interpreted the site as a short-term hunting and gathering site of unknown age and affiliation (FAA and NMSA 2010b:40).

Returning to the site in 2007, Zia found that a large road had been built since the original recording. They observed 15 surface artifacts and no features. They interpreted the site as limited- or even single-use (Quaranta and Gibbs 2008:257).

OAS revisited the site in September of 2010 to assess the site. Testing following an approved testing plan (Moore et. al 2010) was completed in November 2010.

Site setting. LA 112371 lies on a flat, gently west-sloping area overlooking Jornada Draw 420 m to the west. Vegetation consists of grasses with occasional mesquite, soaptree yucca, and cacti where soils are stabilized (FAA and NMSA 2010b:40).

Site description. HSR archaeologists estimated that LA 112371 covered an area measuring 3,181 meters square (0.32 hectares, 0.79 acres), extending from just north of an east-west trending fence and two-track road to about 70 m south of the fence. The 30 artifacts on the surface were scattered throughout the site and the FCR clusters along the eastern edge. The sample of 25 surface artifacts were flakes, three with unifacial retouch, and a ground stone fragment. They estimated that cultural material could occur up to 10 cm below the surface (FAA and NMSA 2010b:40, 72).

Zia archaeologists reduced the site size to 71 by 56 m (2,947 square meters, 0.30 hectares, 0.73 acres), placing the northern boundary south of the improved gravel road. This probably replaced the two-track road noted by HSR (Fig. 6.22). All 15 surface artifacts (12 flakes and three pieces of angular debris) were analyzed. The Zia map shows an FCR concentration and a tool, neither of which are mentioned in the text (Quaranta and Gibbs 2008:257-259).

Testing results. Before work at LA 112371 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. OAS mapped and field-analyzed all visible surface artifacts (60 flaked stone and 1 ground stone). The surface

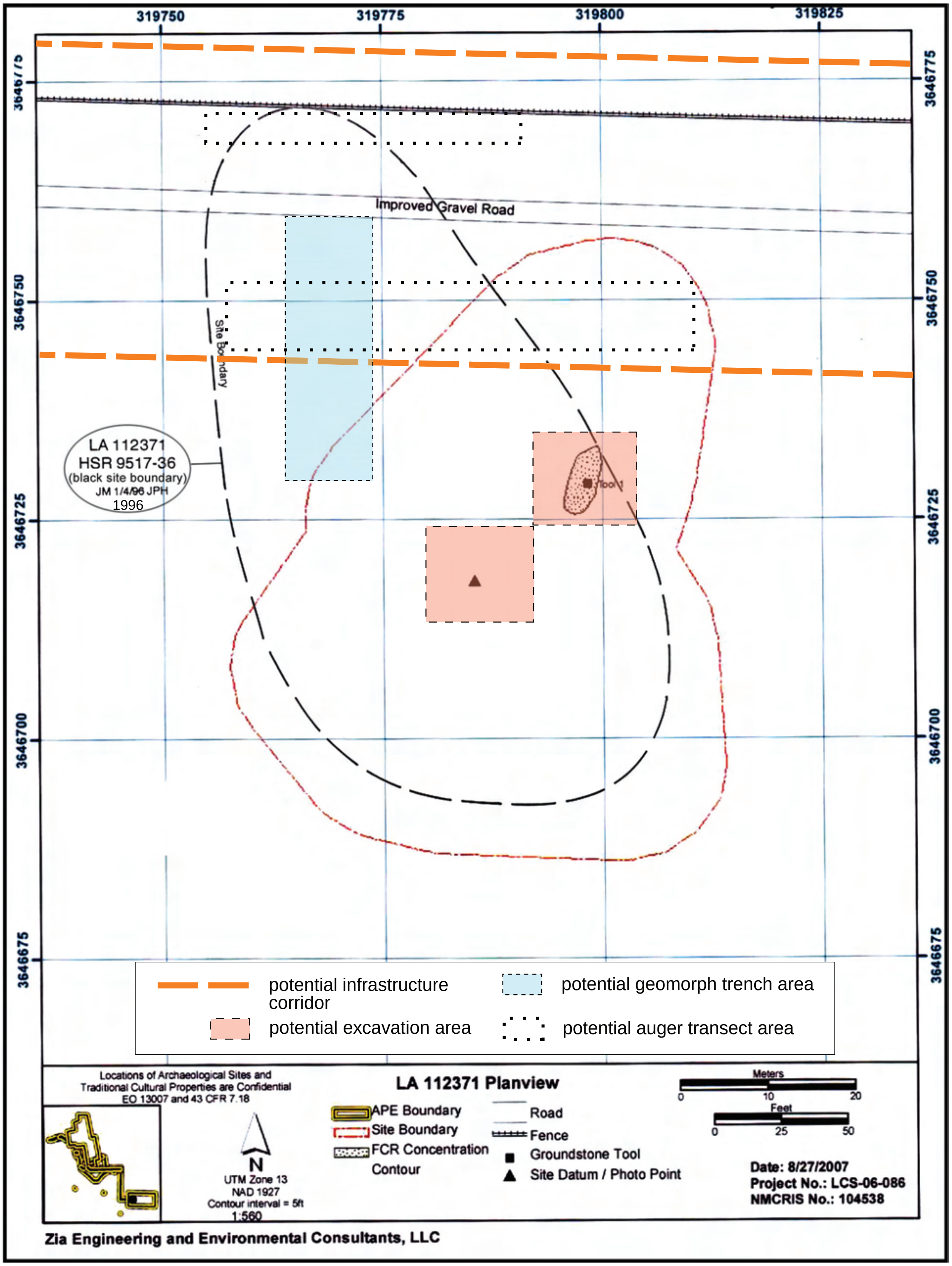

Figure 6.22. Plan of LA 112371 (after HSR 1996 and Zia 2008) showing potential archaeological work areas.

artifact distribution suggests that site size of 4,614 m^2 is substantially larger than that proposed by Zia.

Artifact assemblage. Surface examination of LA 112371 located 61 artifacts, all of which were mapped and recorded in the field. No temporally diagnostic materials were located. One additional specimen of chipped stone was collected from the surface of an excavated grid unit, and 15 pieces of debitage were recovered during subsurface investigations. These artifacts have not yet been analyzed. The surface assemblage contained 56 pieces of debitage, 1 core, 1 scraper, an edge bite from a biface, and a piece of ground stone (Table 6.11). A variety of cherts dominated this assemblage. Cortex was noted on 3 chert and 1 metaquartzite specimens, and was predominantly waterworn, with a single piece of chert exhibiting nonwaterworn cortex. This suggests that materials were mainly procured from gravel beds. A scraper was collected from the surface for laboratory analysis.

Hand excavations. Four 1-by-1 m test units were excavated 20 to 30 cm through eolian sediment and into Pleistocene age soils, retrieving 14 flaked stone artifacts from the upper 10 cm of fill. Twenty-seven auger holes yielded no artifacts or charcoal.

Mechanical excavation. A 1-by-5-m mechanically excavated geomorphology trench suggests substantial desiccation of the ground surface over time. This has been subsequently followed by limited aggradation caused by the accumulation of wind-blown silts. The overlying 10 to 15 cm of eolian silt is relatively recent and covers an earlier Pleistocene Bt horizon. The majority of the surface artifacts and all FCR occurred on top of this earlier Pleistocene horizon, reflecting the complete erosion of the original A horizon (surface) with which the artifacts were originally associated.

Summary. Archaeological testing indicates that LA 112371 has limited data potential. No further work is planned for this site at this time. Data collected at the site during testing will, however, contribute to addressing the research questions posed in this plan for investigation of Spaceport America's cultural landscape.

LA 112374

This site is a small prehistoric artifact scatter of unknown cultural affiliation. It is located on NMSLO trust land in the west-central portion of the VLA. The status of the site was considered as "undetermined" under NRHP based on the limited artifact assemblage and impacts from an improved, nearly 10 m wide, gravel road built after the site was recorded in 1996. The road disturbed nearly half of the site (FAA and NMSA 2010b:42; Quaranta and Gibbs 2008:267-269).

Previous work. The site was recorded by HSR in 1996 as a low density artifact scatter. Their archaeologists observed and analyzed 10 lithic artifacts with attributes suggestive of Archaic period occupation. They speculated that the lithic debris remained from finishing or resharpening of tools (FAA and NMSA 2010b:42).

Zia returned to the site in 2007 and the archaeologists were unable to locate any of the

Table 6.11. Material type by morphology for chipped and ground stone artifacts recorded at LA 112371; counts and column percentages.

Material Type		Angular debris	Core flake	Biface flake	Core	Uniface	Edge Bite	Ground stone	Totals
Chert	Count	3	48	3	1	1	1		57
	%	100.00%	96.00%	100.00%	50.00%	100.00%	100.00%		93.44%
Basalt	Count							1	1
	%							100.00%	1.64%
Siltstone	Count		1						1
	%		2.00%						1.64%
Metaquartzite	Count		1		1				2
	%		2.00%		50.00%				3.28%
Totals	Count	3	50	3	2	1	1	1	61
	%	4.92%	81.97%	4.92%	3.28%	1.64%	1.64%	1.64%	100.00%

artifacts described by HSR. They did find three pieces of FCR and a core (Quaranta and Gibbs 2008:268). OAS revisited the site in September of 2010 and observed additional artifacts outside of the boundaries designated by Zia. Testing following an approved testing plan (Moore et. al 2010) was completed in November 2010.

Site setting. LA 112374 is located on a grassy plain that slopes gently westward towards Jornada Draw. When HRS visited the site, it had a dense cover of bunch grasses with small denuded areas between the grassy patches. Grasses include curly mesquite, burro grass, and fluff grass along with mesquite, cholla, and soaptree yucca within 100 m of the site. Denser shrub zones lay to the north and east. The improved gravel road, almost 10 m wide, cuts through the site diagonally. Surface conditions outside of the construction are similar to those recorded by HSR (FAA and NMSA 2010b:41-42).

Site description. HSR archaeologists recorded the site as encompassing an area approximately 1,885 square meters (0.19 hectares, 0.47 acres). The few artifacts (10 flakes, including one biface-thinning flake, and two biface fragments) were widely scattered and indicated that several non-local materials were worked at the site. Some exhibited a gloss suggestive of heat treatment. One of the biface fragments may have been a stem or base portion of an Archaic projectile point. Since nearly all of the observed artifacts were found in open, deflated patches, they surmised that the probability of buried deposits and artifacts was high (FAA and NMSA 2010b:42).

Zia archaeologists reduced the size of site considerably to 27 by 25 m (517 square meters, 0.05 hectares, 0.13 acres), noting that the redefined site is the southwestern portion of the original site (Fig. 6.23). Except for a core, no lithic artifacts, ground stone, or ceramics were observed within the site area (Quaranta and Gibbs 2008:268). Artifacts observed by OAS suggest that the HSR boundaries may have been more accurate than those redrawn by Zia.

Testing results. Before work at LA 112374 began, a professional surveyor established datums and backsights for horizontal and vertical control for accurate mapping of the landscape, cultural features, and artifact distributions. Surface artifact distribution suggests a site size that is roughly seven times larger than that proposed by Zia (Zia=517 m^2, OAS=3,651 m^2).

Artifact assemblage. Surface examination of LA 112374 located 11 artifacts, all of which were mapped and recorded in the field. No temporally diagnostic materials were identified. A single additional piece of debitage was recovered from an excavation unit, and has not yet been analyzed. The surface assemblage contained 7 core flakes, 2 biface flakes, and 2 pieces of angular debris, all of which were made from various cherts. No cortex was noted on any of these artifacts, so there is no evidence of where these materials were obtained.

Hand excavations. Four 1-by-1 m test units were excavated 20 to 30 cm through eolian sediment and into Pleistocene age soils, retrieving one flaked stone artifact from the upper 15 cm of fill. Twenty-nine auger holes yielded no artifacts or charcoal.

Mechanical excavation. A 1-by-5-m mechanically excavated geomorphology trench suggests substantial desiccation of the ground surface over time. This has been subsequently followed by limited aggradation caused by the accumulation of wind-blown silts. The overlying 10 to 15 cm of eolian silt is relatively recent and covers an earlier Pleistocene Bt horizon. The majority of the surface artifacts occur on top of this earlier Pleistocene horizon, reflecting the complete erosion of the original A horizon (surface) with which the artifacts were initially associated.

Summary. Archaeological testing indicates that LA 112374 has limited data potential. No further work is planned for this site at this time. Data collected at the site during testing will, however, contribute to addressing the research questions posed in this plan for investigation of Spaceport America's cultural landscape.

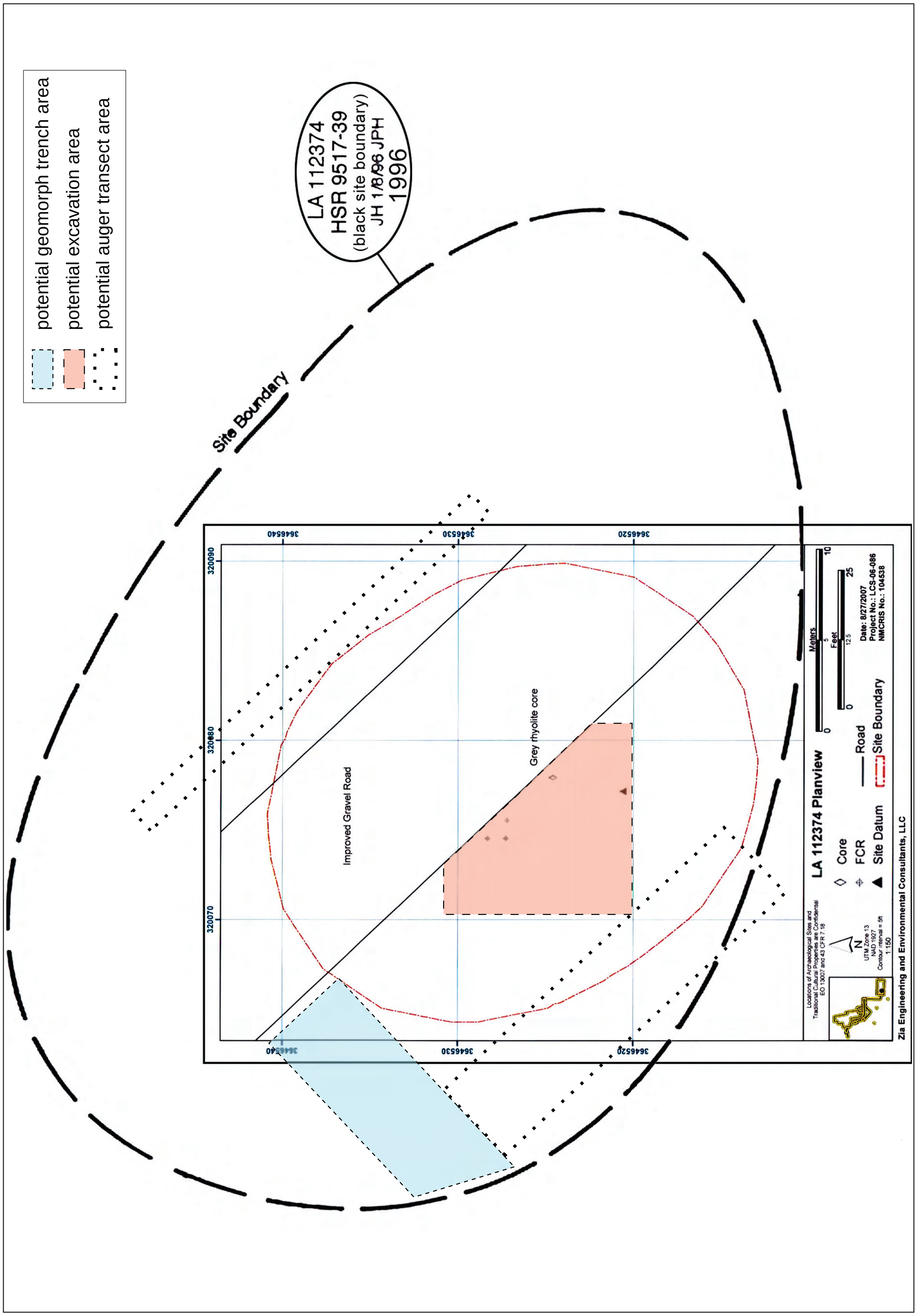

Figure 6.23. Plan of LA 112374 (after HSR 1996 and Zia 2008) showing potential archaeological work areas.

Chapter 7: Analytic Methods and Material Culture: Subsistence, Chronometric, and Environmental Inquiries

James L. Moore, Nancy J. Akins, Jessica A. Badner, Matthew J. Barbour, C. Dean Wilson, Pamela McBride, Stephen Hall, and Karen Wening

Laboratory analysis will be conducted by OAS staff and qualified professional consultants. Discussions of general analysis methods are provided in this chapter for all material culture classes, subsistence and chronometric samples, and environmental data we anticipate will be recovered. Specific research questions are also detailed, where applicable.

Whenever possible, 100 percent of the artifacts that are collected in the field will be fully analyzed. However, it may be necessary to sample artifacts in certain categories, such as chipped stone or ceramics, if very large numbers are recovered. If this procedure is implemented, a full detailed analysis will be conducted on a sample of artifacts, while those that are not included in the full analysis sample will be examined using an abbreviated analytic format. The abbreviated analysis will consist of the collection of a minimum amount of data, including (but not limited to) count and general classification. The selection of samples will target data that are directly applicable to the project research questions. Sample size will vary according to the raw numbers of artifacts in a category, and the amount of information needed to address research questions. In the following sections, analyzed attributes are presented in bold lettering.

Reference Collections

Reference collections will be made of lithic material types (both chipped and ground stone) and pottery types identified during analysis of artifacts recovered from archaeological studies conducted at Spaceport America. These will include common lithic material and pottery types as well as rare or unique types that are demonstrated or thought to represent economic links to other regions. The reference collections will be used to consistently record lithic material and pottery types during analysis, and will be kept separate from the general artifact collections after analysis is done, allowing other researchers to recreate the types used during our analysis. Additionally, a reference collection of chipped stone artifacts representing different technological stages will also be constructed. In particular, this will include examples of debitage types, especially those representing various manufacturing stages, as well as formal tools indicative of different stages of manufacture and possibly use.

Treatment and Processing of Collected Materials

Artifacts collected during field investigations will be returned to the laboratory for cleaning and processing in accordance with standard practices for each material type, as discussed below. After processing, artifacts and field labels will be transferred to mylar bags of appropriate size, and artifacts will be boxed for storage. Processing procedures will vary by material type, because certain cleaning methods can destroy important characteristics on some material classes. Each material class whose recovery is possible during the course of this project is discussed separately, noting any specific exceptions to the general processing methods that will be used.

Stone artifacts, including both chipped and ground stone specimens, are likely to be the most abundant artifact classes and will be washed to remove any sediments adhering to them. However, prior to washing, these artifacts will be assessed for their potential for residue analyses. The first level of this assessment involves location of recovery. Since surface artifacts are expected to retain little potential for any residue analyses, they will simply be washed. Only artifacts recovered from intact cultural deposits will be considered for any type of residue analysis. Certain types of chipped stone tools recovered from such contexts may be stored separately for potential blood residue analysis, including but not limited to projectile points, knives, and scrapers. In addition, any chipped stone artifacts on which potential residues are visible will also be retained for this type of analysis, and treated in a like manner. Ground stone tools recovered from intact cultural deposits, especially those in features or structures, will also be stored separately for pollen washes and examination for the presence of adhesions or pigment stains on use surfaces. None of the artifacts selected for specialized residue analyses will be washed prior to the extraction of those residues. Following that extraction, these artifacts can be washed and treated like other specimens.

Ceramic items, both locally produced and of Euroamerican manufacture, will be washed to remove adhering sediments. Exceptions will be made if any residues are observed during excavation or the initial stages of processing on specimens recovered from intact cultural deposits, and those artifacts will be stored separately without processing for extraction of the residues. After that is accomplished, these specimens can be washed and treated like other artifacts.

Bone, both faunal and human, can be damaged by traditional processing techniques, and will therefore be treated differently than most other artifact categories. Sediment adhesions will be removed from faunal bone by dry brushing, and these materials will not be washed. Human bone identified during field studies will be packaged separately from faunal bone and stored in a secure laboratory location. While any trained technician will be permitted to clean faunal bone, human bone identified during field studies will only be cleaned and analyzed by a specialist, and will be treated in accordance with specifications listed in Appendix 2. Human bone that was not recognized during field investigations will be separated from faunal bone during analysis, repackaged separately, and stored in the same secure location used for other human remains.

Shell or horn artifacts will be treated in the same fashion as faunal bone. These specimens will be cleaned by dry brushing rather than washing. Should adhesions or pigment staining be noted on any specimens, cleaning will stop and the specimen will be stored separately for analysis of the residues/pigments.

Perishable materials like cloth and leather will probably not be recovered during these investigations. However, in the eventuality that specimens of these materials are found they will be treated in the same manner as bone. Processing will consist of careful dry brushing to remove adhering sediments, and specimens will be dried and, if necessary, stored in a freezer to prevent further deterioration.

Euroamerican artifacts including but not limited to metal, glass, and plastic will be cleaned to facilitate analysis, except under certain circumstances. Metal artifacts will be dry brushed rather than washed or, if too fragile, may undergo no cleaning at all before analysis. If residues are visible on glass artifacts recovered from intact cultural deposits, those specimens may be stored separately without processing for extraction of the residues. Once the residues have been extracted, these specimens can be washed and treated like other artifacts. Glass artifacts displaying an iridescent sheen will be dry brushed rather than wet washed. Non-iridescent glass and plastic artifacts will be washed to remove sediments adhering to them.

No samples collected for specialized analyses will be washed or processed except under the supervision of the specialists responsible for their analysis. An exception to this is radiocarbon samples, which will be sorted and identified by ethnobotanical specialists before being sent for dating. Processing for botanical specimens is discussed in the pertinent sections below, and is not repeated here.

Architectural Materials

Initial evaluation of the sites suggests that the frequency and variety in residential structures and other large, non-thermal features encountered by excavation may be limited. However, the collection of data relating to **construction methods**, **form**, and **use** will be maximized.

If any residential structures or substantial storage features are encountered, we will collect a series of standard samples and observations to permit analysis of construction methods and structure use. Architectural adobe and wood, if present, will be sampled and its contexts and use described. All visible formal and informal architectural elements of structures and features will be described. Documentation will include horizontal and vertical measurements, locations of any clay or adobe lining, evidence for roofs in structures, the relationship between structural features, descriptions of building materials and construction techniques, and post-abandonment processes including filling and erosion. Dimensions will be obtained for any wooden building elements that cannot be collected. If suitable specimens are available, they will be sampled or fully collected. Analysis of these specimens will be aimed at identifying the types of woods used for building, and collection of chronometric data. The latter will consist of cross-sections of tree rings and suitable radiocarbon samples, as discussed in the section on chronometrics.

Research Questions

Architectural materials analysis and construction style/technique, if any such data become available, can be used to address questions of chronology such as those posed in Research Questions 1 and 2. This can be done through analysis of materials capable of providing absolute dates, as well as by defining temporally-related construction styles and techniques derived from comparisons with other parts of the Jornada region where similar construction styles and techniques were used. These analyses will also be useful in defining site function and seasonality, which are addressed by Research Questions 3-6. While no structures have been identified, archaeological investigations of Archaic and Formative period sites, such as LA 111429, LA 111435, and LA 155963, have the potential to encounter pit structures. The types of features found inside structures can be indicative of the season of occupation, with the presence of interior thermal and storage features, formal floors, and substantial architecture usually evidence for a cold season occupation. A warm season occupation is usually indicated by such characteristics as a lack of interior thermal and storage features, informal floors, and insubstantial architecture.

Besides being an indicator of probable warm season occupation, the presence of insubstantial structures lacking interior features is also evidence for a fairly high degree of residential mobility during the warm season, a characteristic expected for all occupational periods through at least the Mesilla phase. More substantial structures tend to be indicative of a lower level of mobility, with residential sites being used for longer periods of time, perhaps through multiple seasons or even years. However, preliminary reconnaissance of the project sites suggests that this type of occupational pattern may not be found.

Besides structures, the types and condition of various features can also provide information on seasonality and site function, which are topics tied to Research Questions 3-6. Storage features, in particular, tend to be related to sites that were occupied for comparatively substantial periods of time or represent caches of foods stored for later transport to cold season villages. Thus, the occurrence of both storage features and substantial structures can be used to infer a cold season occupation, while storage features in conjunction with temporary, insubstantial structures may be evidence for food caching and later transport to winter villages. In both cases, important behavioral information can be derived.

Thermal features are found on numerous sites within the project area and can provide critical information for most of the research questions. If intact, or semi-intact, charcoal for radiocarbon dating can often be obtained from this type of feature. These data can be used to address Research Questions 1 and 2, and may provide information useful in addressing research questions 7 and 8, as well. Dated features may be the best way to demonstrate the presence of an Apache occupation, while the same data are critical to the examination of geomorphic processes through time. Archaeological testing of features at LA 111429 and 155963 suggests that charcoal is present in some contexts. By examining the physical characteristics of a sample of exposed thermal features, during archaeological testing, it was possible to develop a set of criteria for evaluating a feature's potential for yielding chronometric and subsistence data. Attributes recorded for each feature included feature size, the presence and density of fire-cracked rock, types of rock-used in the feature, the presence or absence of surface artifacts in association, and if soil discoloration was visible in and around the feature. Visible soil discoloration and a high density of fire-cracked rock appear to be indicators of in situ preservation and used to select features during later phases of the project. By focusing on features with the best chronometric or subsistence information, potential data recovery efforts can be optimized.

Botanical Materials

Botanical studies will include archaeobotanical analysis of plant remains recovered in soil samples processed by water flotation, pollen samples, wood charcoal, and larger botanical specimens collected during field excavation. Pollen samples will be sent to a specialized laboratory, and will not be studied at the OAS. Flotation is a widely-used technique for the separation of floral materials from soil. This type of analysis takes advantage of the simple principle that organic materials (especially those that are non-viable or carbonized) tend to be less dense than water, and will float or hang in suspension in a water solution. The processing of flotation samples entails immersion of the sample material in a bucket of water. After a short interval allowing heavier particles to settle out, the solution is poured through a screen lined with fabric (approximately 0.35 mm mesh). The floating and suspended materials are dried indoors, then separated by particle size using nested geological screens (4, 2, 1, and 0.5 mm mesh), before sorting and identifying specimens under a binocular microscope at 7-45x.

Macrobotanical Analysis

Archaeobotanical analysis of macro remains involves the **identification of floral material to genus or species**, **quantification of plant parts**, and **identification of wood specimens** from both flotation and macrobotanical samples. Flotation samples have the potential to yield wild plant parts (primarily seeds, but also leaf, caudex, and fruit fragments of leaf succulents such as yucca), and the remains of cultivars if agricultural components are encountered. Seed attributes such as **charring**, **color**, and aspects of **damage or deterioration** are recorded to help determine cultural use versus post-occupational contamination. Wood charcoal is very important as it is sometimes the only plant material that preserves and allows for documentation of wood resource procurement patterns over time and space. Recording of the **relative abundance of insect parts**, **bones, rodent and insect feces, and roots** observed in flotation samples helps isolate sources of biological disturbance in the ethnobotanical record. In some cases, fossil insects can serve as proxies for paleoclimate.

In addition to **counts** and **weights** of macrobotanical specimens, **condition** (carbonization, deflation, swelling, erosion, and damage) is also recorded along with any characteristics that might indicate **cultural alteration or modification** of original size dimensions. When less than half of an item is present it is counted as a fragment; **more intact specimens are measured** as well as counted. Corn remains (if present) are treated in greater detail. **Width, height, and thickness of kernels, cob length and mid-cob diameter, number of kernel rows, and several cupule dimensions are measured** following Toll and Huckell (1996). In addition, the following attributes are noted: **overall cob shape**, **configuration of rows**, **presence of irregular or undeveloped rows**, and **post-discard effects**.

Two aspects hallmark the most effective sampling protocols: awareness of which depositional contexts are most productive of floral remains, and recognition of site areas from which subsistence data will be most useful in addressing the research foci of the project. Previous experience with flotation analysis at sites on basin floors of central and southwestern New Mexico warns us that preservation of floral materials is likely to be poor. We will generally be dealing with shallow sites with few structures in windblown settings. Our best option is to maximize the size of individual soil samples from carefully considered proveniences. In practice, this will mean full collection of intact features (especially burn features) whenever possible. When this is not possible, at least a 1 liter sample should be collected, preferably 2 liters. Samples from any type of feature, but particularly from thermal features, structure floors, and from roof fall layers that may have preserved are some of the best contexts to sample to produce subsistence data.

Pollen Analysis

Pollen data should be considered complementary rather than parallel to that of flotation. Pollen is preserved in very different contexts from carbonized seeds and has different contributions to make to the biological data corpus that informs on subsistence and environmental parameters. Whereas primary and secondary deposits from thermal features make up much of the useful flotation record (along with far less frequent catastrophic burn events), pollen does not survive burning *or* deposition in alkaline, water-holding features (such as ash-filled, lined hearths). Pollen analysis is a useful tool when used with the goal of locating and identifying plant utilization activities that aren't likely to involve burning in places such as milling bins, storage features, and interior structure floors. Pollen washes can help identify plant material that was processed on ground stone artifacts. In addition, pollen analysis can be effective in not only verifying agricultural field locations, but in identifying crops that might have been grown. Pollen samples will be sent to a qualified consultant for analysis. At a minimum we will require pollen extraction from samples using methods that are standard to the field including the addition of marker grains to aid in the calculation of pollen concentration values and act as an indicator for accidental destruction of pollen during laboratory processing. Extracted pollen will be examined under a microscope to identify individual grains, including marker grains. Pollen grains will be identified to the lowest taxonomic level whenever possible. Sample counts of both pollen types and marker grains will be obtained, with a minimum of 200 grains being counted when possible.

Because pollen does not survive burning, collection of soil (about 1 cup) for pollen samples should be focused on interior floors, storage pits, or agricultural fields. The corners of room floors and around hearths are good interior contexts to sample. The base and sides of non-thermal pits or niches and from under a ceramic vessel or large sherd produce the best samples when encountered. The use surface of ground stone artifacts should be covered to minimize contamination, collected, and brought back to the laboratory to conduct pollen washes. Ceramic vessels should not be cleaned out prior to removal and should be treated in much the same way as ground stone (i.e. covered to avoid contamination) and brought to the lab for evaluation of the most effective analysis procedures.

Prehistoric Plant Use in South-Central New Mexico and Northern Texas

Available comparative flotation data include assemblages from Archaic and Formative period seasonal base camps and special activity sites from Chihuahuan Desert or semidesert grassland and desert scrub communities. Useful comparisons can be drawn from sites in the intermontane basins of south-central New Mexico and northern Texas. Ethnographic studies from the historic era point to a heavy focus on concentrated perennial resources such as the leaf succulents, cacti, and mesquite (Castetter and Opler 1936; Bell and Castetter 1937, 1941; Castetter et al. 1938; Baseheart 1974). Previous discussions of site function and subsistence strategies have centered on defining small sites consisting primarily of fire-cracked rock thermal features as special processing camps. Many studies have concluded that small rock hearths as well as considerably larger fire-cracked rock features from sites excavated in the foothills and basins of south-central New Mexico and northern Texas were predominately used to process leaf succulents (O'Laughlin 1980; Carmichael 1985; Seaman et al. 1987; Gasser 1983). Interpretations of feature use are based on feature distributions, presence and quantity of fire-cracked rock, associations of lithic tools such as agave knives, and distributions of leaf succulents today (O'Laughlin 1980; Seaman et al. 1987). More recent projects have produced ample evidence to reinforce these interpretations. In particular, the AT & T Nexgen/Core Project along US 62/180 and I-10 by Western Cultural Resource Management Inc., produced agave tissue, terminal leaf spines, and leaf fragments among other materials that substantiate the use of burned rock features dating to the Archaic and Formative periods for leaf succulent processing (Jones et al. 2010). Agave terminal and marginal leaf spines were also recovered from the Scorpion Site (LA 119530), with Archaic and Formative period occupations on an alluvial fan in Alamogordo (McBride 2008). Finally, agave fiber, leaf epidermis, and spines were found in burned rock features in use during the Archaic through the Formative in the Cornucopia Draw area, approximately 15 miles west of the Guadalupe Mountains (Phippen et al. 2000, Toll and McBride 1999).

Those sites where agave remains have been recovered are in the foothills or valley margins, where agave is easily accessible. Oxalic acid is a component of agave and causes contact dermatitis, providing motivation for processing the plant as close to the source as possible (Niethammer 1974:4; Buskirk 1986:170; Franceschi and Horner 1980; Kearney and Peebles 1951:193; Johns 1990). Buskirk notes that each agave crown can weigh as much as 20 pounds. Because it was common practice to roast 40 or more crowns at a time, their weight could also have been a compelling factor in the placement of roasting pits. With only one questionable yucca/agave carpel as evidence of the possible processing of leaf succulents during the Archaic period at Keystone Dam Site 33, O'Laughlin (1980:93) still states that the primary function of small fire cracked rock hearths at the site was to "bake leaf succulents such as soap-tree yucca, lechuguilla, and sotol." Evidence of exploitation of other economic plants at this site comes in the form of carbonized seeds of two species of cacti, sedge, and several edible weeds. While it is leaf succulents were probably processed at Site 33, it seems more accurate to assume that plant processing included a variety of plants at this and other Archaic sites of the Chihuahuan Desert.

Plant remains recovered from the Archaic period and early Mesilla phase reflect the geographical locations of the sites. The richest array of economic plant remains is found at the Keystone Dam Site and Fresnal Shelter (Bohrer 1981). Keystone Dam is on an alluvial terrace east of the Rio Grande and west of the Franklin Mountains, giving site occupants access to both riverine and montane plant resources. Fresnal Shelter is in a limestone cliff overhang of Fresnal Canyon in the Sacramento Mountains. More limited floral remains from these time periods may indicate true resource-specific processing of leaf succulents and cacti at Cornucopia Draw and sites excavated during the AT&T Nexgen/Core Project. Other floral studies come from sites situated in arid wind-swept basins, where resource availability is limited to grasses, weedy annuals, and yucca; here, grasses are the most widespread seed genera recovered. Evidence of domesticated plant use during the Archaic is restricted to Fresnal Shelter, in the Sacramento Mountains of southeastern New Mexico. Bohrer (1981:45) classifies maize as one of the "less commonly eaten foods" at the shelter based on constancy and presence ratios of all plant remains recovered. During the Archaic, it would appear that grasses, annuals, and perennials (including leaf succulents) were all used to a greater or lesser degree, depending on what environmental zone was under exploitation, while domesticates played a minor role in the diet.

Prickly pear seeds are the most common plant remains recovered from Mesilla phase contexts. Goosefoot, hedgehog cactus, mesquite, and purslane form a second tier of exploited taxa. Cultigens are present in a wider range of locations, in both basin and valley margin areas. Plant remains from Cornucopia Draw are more restricted in diversity, consisting of agave and prickly pear. The most diverse array of plant taxa was recovered from Turquoise Ridge, including maize and domesticated beans (Whalen 1994). Considering that Turquoise Ridge is on the edge of the Hueco Bolson, the best-watered spot between the desert basin zone and the mountain zone, this diversity is not surprising. Evidence of the exploitation of leaf succulents is present at several sites, but positive identification of agave is limited to Cornucopia Draw and Wind Canyon. Fewer grass taxa were recovered from Mesilla phase sites, suggesting that grasses could have been exploited more during the Archaic than during the early Formative.

Plant remains recovered from Doña Ana/El Paso phase sites indicate that the role of domesticated plants in the diet may have increased dramatically. Cultigens have been found at several Formative period sites (Ford 1977; Wetterstrom 1978). Corn caches in storage pits were discovered by Scarborough (1985) at Anapra Pueblo near Sunland Park, and Brook (1966:41) notes that 200 bushels of corn were excavated from a village about 64 km north of Hot Well Pueblo in El Paso. During the Doña Ana and El Paso phases, goosefoot is the most widely recovered plant taxon. Amongst perennials, agave and hedgehog cactus surpass the previously common prickly pear. In this period, a wide array of annuals and perennials were utilized, including taxa that did not occur in previous time periods (Mexican buckeye, tepary beans, *Pectis* type, and sedge).

Mesquite is the dominant wood taxon

identified at sites throughout the Mesilla Bolson, Hueco Bolson, and Tularosa Basin. A dense wood that provides "a bed of hot, slow burning coals," Mesquite's admirable fuel qualities are surely responsible for the clear prehistoric preference for this fuel, even in areas of the El Paso region, where it is not particularly abundant today, such as the high desert zone on Fort Bliss (Ford 1977:200). The predominance of mesquite charcoal is also significant at sites in the lower elevation zones, where the extent and density of mesquite has increased dramatically in Chihuahuan desert scrub communities during the last hundred years (York and Dick-Peddie 1969). The greater abundance of mesquite in the archeological record than in the contemporary environment (Minnis and Toll 1991:397) points to the particular usefulness and desirability of this fuel. If this prehistoric wood use pattern of preference for mesquite in areas where it may not have been as prevalent as it is today repeats itself in the Spaceport region, we might expect to see heavy use of mesquite, bolstered by smaller amounts of locally available but less useful shrubby taxa such as creosote bush, acacia, tarbush, and saltbush.

Research Questions

Archaeobotanical data are most likely to be retrieved from those sites with documented hearths or storage features, such as LA 111422, LA 111429, LA 111435, LA 155963, LA 155964, LA 155968 and LA 155969. In these instances, archaeobotanical data can best address Research Questions 1, 2, 4, and 5. In order to address site chronology (Research Questions 1 and 2), accurate identification of plant specimens is key to obtaining the most useful dates. As discussed in a later section, problems of age distortion can occur when tree wood is submitted for radiocarbon dating. To avoid these problems as much as possible, identifying shrub rather than tree wood or annuals such as yucca seeds would be the focus of analysis prior to submission of specimens to a radiocarbon dating laboratory.

Archaeobotanical data from flotation, pollen, and macrobotanical samples compiled from the Spaceport project can be compared to existing data from the Tularosa Basin and the Mesilla and Hueco Bolsons to examine plant use and seasonality that will be useful in addressing Research Questions 4 and 5 by providing information on the occurrence of plant foods that represent critical resources during different occupational periods, and that could be factors in the site location choice. Sites with Early Archaic components, such as LA 111420 and LA 111429, should yield a macrobotanical assemblage that indicates a possible focus on the seasonal exploitation of plants. Examples of resources available in the research area that fall into this category are dropseed grass grains, available in early to late Fall, mesquite pods that mature in late July and August and little leaf sumac berries (found in low-lying areas where water collects or along arroyos; Quaranta and Gibbs 2008:18-19) that are ready for harvest in late summer. An even more intense reliance on seasonal food sources is indicated for the Middle Archaic (Miller and Kenmotsu 2004:223). Archaeobotanical evidence from LA 155964, a Middle Archaic multi-use camp, might include more plant remains encompassing a wider range of taxa, such as agave, that could have been gathered in the foothills of the San Andres Mountains, approximately 10-15 miles to the east. The Late Archaic is marked by the first appearance of domesticates. However, since evidence of cultigens from this period has come largely from rock shelters, it is highly unlikely that flotation or macrobotanical samples from the Spaceport open-air sites, such as LA 111422, will produce cultigens. It is more likely to come from fortuitous pollen samples or from pollen wash or residue analyzes of ground stone. Since the subsistence regime of the Formative period is one of increasing dependence on agriculture with a concomitant decrease in mobility, corresponding archaeobotanical evidence for this might be an ever increasing number of samples with cultigens along with an ever increasing diversity of domesticated species which is certainly the case in the three comparative regions mentioned.

If sites were located in areas of the interior Jornada Basin because of plant resource availability, then we would expect to recover evidence of mesquite, yucca, dropseed grass, various cacti, and other resources commonly found in the Chihuahuan Desert Scrub biotic community. However, prior to overgrazing, mesquite was not the dominant shrub taxon as it is today (Dick-Peddie 1993). The coppice dunes found today in the area of interest were probably formed in the historic era (Steve Hall, personal communication). Therefore, recovery of mesquite pods or seeds will probably be minimal to none, but mesquite wood will most likely comprise a significant proportion of the wood charcoal assemblage as it does at sites throughout the lower Pecos Valley, Mesilla Bolson, Hueco Bolson, and Tularosa Basin. As mentioned in Chapter 4, however, site location is most likely not solely dependent on plant resource accessibility, but on that of animal and water resources as well.

Continuity in land use patterns, as discussed in Research Question 5, could be reflected in the consistent recovery of the same plant taxa through time, including both those identified by macrobotanical analysis and pollen analysis. Changes would come with increased dependence on agricultural pursuits and perhaps a decrease in the diversity of wild plant taxa would be apparent in the record. With an increase in farming on or near a site, a higher percentage of flotation samples yielding disturbance loving annual genera such as amaranth, goosefoot, and purslane might be an expected outcome. Wood procurement patterns can change when local resources are depleted and inhabitants must either go further afield for fuel and construction material or harvest driftwood from arroyos. If this type of change occurred wood assemblages would switch from being dominated by local tree and shrub taxa to those found in mountain foothills or higher elevations. If Protohistoric components are encountered, the archaeobotanical assemblage may reflect a reversion to an Archaic period subsistence regime, focusing on gathering wild plants and increased mobility, traveling to resource procurement locals such as the basin interior to gather grasses and other seasonally predictable plants.

Ceramic Artifact Analysis

The discussion of ceramic analysis presented here applies only to pottery produced by Native American groups, as that of American, Mexican, or European origin will be described and discussed in a separate section. All native pottery recovered will be analyzed in a manner that will provide information about the timing and nature of occupations at sites investigated during the Spaceport Project.

Analytic Procedures

In order to provide comparable data to address various questions in the project research design for the Spaceport Project, all native pottery will be described using procedures and categories similar to those in previous studies for this region (Wilson 1997; 2000; 2003; Wiseman 1996; 2002). These procedures will provide the basis for the examination of ceramic patterns that reflect cultural affiliation or tradition, area of origin, form, and use.

Types of information that will be recorded for all pottery analyzed include provenience of recovery, typological categories, descriptive attributes, and quantitative data. While this system is largely oriented toward the analysis of sherds rather than vessels, in some cases sherds belonging to the same vessel may be assigned to different combinations of typological or attribute categories. Any complete or partial vessel recovered, however, will be described in detail in a separate analysis.

Provenience data will include the associated site number, field specimen (FS) number and point provenience coordinates. Sherds from each provenience will be separated into types and sorting groups based on unique combinations of various attributes including paste, surface treatment, decoration and vessel form and portion. The attribute data for each sherd group will be recorded on a single data line. Each group will be bagged separately and included with a small slip of paper listing the site number, FS number, and a sequentially assigned catalogue number. Sorting, recording, and bagging by unique groups will allow for the matching of sherds recorded during ceramic analysis, which will, in turn, be necessary for locating items for data editing and for selecting samples for illustrative purposes or more detailed analyses.

Descriptive attributes can be used to monitor a wide range of ceramic traits, and will be examined by microscopic examination at 20-40X magnification. Categories that will be recorded for all sherds include **temper type**, **surface manipulation**, **paint type**, **vessel form**, **vessel radius**, and **modification**. Small nips will be broken out of sherds in order to determine temper and paste types. Temper type is considered to include particles occurring naturally in a clay as well as those that were intentionally added by potters. Attributes that may be recorded for sherds from selected samples include **wall thickness**, **paste profile**, **refired color**, and **design style**. Estimations of Minimum Number of Vessels (MNV) for ceramic assemblages per site will be calculated, based on the descriptive attributes recorded during analysis.

Other information is documented through the assignment and recording of ceramic types. Ceramic types refer here to groupings identified by various combinations of paste and surface characteristics with known temporal, spatial, and functional significance. Ceramic items are first assigned to specific **traditions** based on probable region of origin as indicated by paste and temper. They are then placed into a **ware group** based on general surface characteristics and form. Finally, they are assigned to temporally distinctive **types** previously defined for various tradition and ware groups.

The great majority of the pottery from this project is expected to exhibit pastes, tempers, manipulations, and decorations indicative of types produced in various regions of the Jornada Mogollon culture area (Jelinek 1967; Jennings 1940; Lehmer 1948; Whalen 1994b; Wiseman 1996). Southern Jornada Mogollon or El Paso area ceramic traditions may be represented by types including El Paso Brown, El Paso Smudged, El Paso Bichrome, and El Paso Polychrome (Miller 1995; Miller and Kenmotsu 2004; Whalen 1981a; 1994b; Wiseman 1996). Also likely to occur in significant frequencies in some project contexts is pottery of the Northern Jornada Mogollon tradition produced in Sierra Blanca region (Kelley 1984). Types associated with this tradition may include Jornada Brown, Corona Corrugated, Jornada Slipped Red, San Andres Red-on-terracotta, Three Rivers Red-on-terracotta, Lincoln Black-on-red (Mera 1943; McCluney 1962), and Chupadero Black-on-white (Hayes and others 1981; Kelley 1984). Other native pottery that may occur in site assemblages include Rio Grande glaze and white wares, Mogollon or Mimbres brown wares, Mimbres decorated or white wares, Cibola white wares, Salado Polychrome, Chihuahua decorated and utility wares, and Athabascan utility wares.

Ceramic attribute and type categories documented during this study will be used to examine various research issues, including the dating of various sites and contexts, the examination of patterns of exchange and interaction with surrounding areas, and trends in the production, decoration and use of ceramic vessels.

Research Questions

Several of the questions posed in the research design for this project can be addressed using ceramic data including Research Questions 1 and 2, 4 and 5, and 8. How this can be done for each of these groups of questions is examined below.

Questions related to ceramic dating. One of the most important contributions of this study will be to provide temporal assignments to the sites and components and aid in addressing Research Questions 1 and 2, which are concerned with examination of both local and regional chronologies. Ceramic distributions identified in assemblages assigned to various temporal periods should also provide an opportunity to address research questions relating to the cultural associations for an area about which extremely little is currently known. It is also hoped that chronometric dates from contexts that also yield ceramics will improve dating resolution not just for project sites but for ceramic assemblages from sites throughout the Jornada Mogollon region. Should sites in the project area that appear to contain few or no ceramics, such as LA 111422, LA 111429, and LA 111435, provide chronometric dates, they can be compared to contemporaneous occupations in adjacent areas where ceramics are relatively common. This comparison may provide important insights about the nature of the occupations in the project area.

One of the main contributions should be a better understanding of the nature of Mesilla, Doña Ana, and El Paso phase assemblages in the Jornada del Muerto. LA 111422, LA 111429, LA 111435 and LA 155963 are believed to have site components dating to the Formative period. Ceramic assemblages from these sites are expected to be small and dominated by extremely long-lived plain brown ware types, such as El Paso Brown or Jornada Brown. The project area is bounded by a number of regions with distinct ceramic traditions. Therefore site assemblages may contain low frequencies of dated decorated types that can be cross-dated providing more specific dating assignments.

Pottery from the Southern Jornada Mogollon region dating to the long-lived Mesilla phase (AD 200/500 to 1000) is almost exclusively represented by El Paso Brown, which appears to have changed very little over its 800-year manufacture span (Miller 1996; Miller and Kenmotsu 2004; Whalen 1993; 1994). This is clearly the case at LA 155963 where El Paso Brown represents well over 99 percent of the total ceramic assemblage. Similar brown ware pottery dominated the earliest assemblages over a fairly wide area of south-central New Mexico and far west Texas. Studies of El Paso Brown assemblages demonstrate gradual changes in paste and vessel attributes over time (Whalen 1981a; 1994b; Wilson 1997; 1998a). These changes may include a decrease in temper size and wall thickness, and increases in both the fineness of surface finish and surface hardness. (Whalen 1994b). Thus, a wide range of descriptive attributes will be recorded for at least some assemblages dominated by El Paso Brown. Such a detailed analysis can be quite time consuming since each sherd is recorded on a separate data line. This level of analysis will not be implemented for all assemblages collected at LA 155963 and, depending on the assemblage size, may be reserved for ceramics recovered from feature, activity area, and midden deposits that have high integrity. If assemblages consist of sherds only recovered from low integrity proveniences, then they will be subjected to the detailed analysis.

Assemblages that contain regionally distinct utility and decorated sherds of other ceramic traditions may permit the refinement of the chronology of the Mesilla phase. For example, sites dating to the early Mesilla phase should contain only plain utility ware types. Locally-made utility wares should be distinguishable from utility ware types produced in other areas and at later times, such as Jornada Brown (known to have been produced early in the Sierra Blanca region) and Alma Plain and San Francisco Red (produced in the Mogollon region). These distinctions are most pronounced for temper and paste characteristics. Throughout the Mesilla phase intrusive decorated types may occur in low frequencies after the seventh century AD. For example, the identification of Mogollon decorated or Mimbres white ware types, such as Mogollon Red-on-brown (AD 650 to 900), Three Circle Red-on-white (AD 800 to 900), Mangus Black-on-white (AD 850 to 1000), Mimbres Transitional Black-on-white (AD 800 to 1100), and Mimbres Classic Black-on-white (AD 1050 to 1250), may provide more specific temporal information (Haury 1936; Le Blanc 1982; Martin and Rinaldo 1950; Nesbitt 1939; Wilson 1999). The presence of other early decorated types, such as San Marcial Black-on-white (A.D. 750 to 950) and Red Mesa Black-on-white (AD 900 to 1050), occurring generally in sites in the Rio Abajo region to the north, may also contribute to refined dating of the earlier ceramic components (Marshall and Walt 1984; Mera 1935).

Doña Ana and El Paso phases can also be assigned ceramics dates indicative of occupations after AD 1l00 by the presence of painted or decorated types produced in the different regions within the Jornada Mogollon. For example, in the El Paso region, the local ceramic tradition, originally distinguished by El Paso Brown, underwent a series of changes from about AD 1100 to 1350 (Miller 1989; O'Laughlin 1985). Such changes are largely reflected in the appearance of, increase in, and changes to El Paso Bichrome and Polychrome types (Miller and Kenmotsu 2004; Whalen 1980b). Design trends noted during this time span include increasing elaboration, the addition of secondary design elements, and multiple band layouts. Early and late variants of El Paso Polychrome are differentiated by changes in rim thickness. The most common technique for establishing and dating these changes is the calculation of a rim-sherd index (West 1982; Seaman and Mills 1988). This technique requires fairly large sherds and entails taking two different thickness measurements on each sherd. Changes in rim thickness are used for differentiating between Doña Ana (AD 1000 to 1275) and El Paso (AD 1275 to 1450) phase assemblages.

Other clues to the dating of these later assemblages may be provided by the presence of distinctive Northern Jornada ceramic types. Chupadero Black-on-white was distributed over a wide area of the Jornada country from about AD 1100-1450 (Kelley 1984; Farwell et al. 1992; Hayes et al. 1981; Snow 1985; Wiseman 1986). Three Rivers Red-on-terracotta also commonly occurs in assemblages dating between AD 1100 and 1350 (Kelley 1984). Other types that were traded eastward over wide areas during the end of the twelfth and early thirteenth centuries from Anasazi regions to the northwest include late Cibola white wares, such as Reserve and Tularosa Black-on-white (Rinaldo and Bluhm 1956), and White Mountain red wares, such as Saint Johns Polychrome (Carlson 1970).

Another important shift in brown ware production that occurred over wide areas of southeast and south-central New Mexico is the change from earlier assemblages dominated by El Paso Brown to those dominated by Jornada Brown sometime around AD 1100 (Wilson 2000; 2003; Wiseman 1991). Thus, for the transition from the Doña Ana to El Paso phase the analysis will focus on attribute and typological categories that allow for the consistent identification of brown ware types made in different parts of the Jornada Mogollon region.

Decorated ceramics, associated with a variety of traditions, may occur with various forms of El Paso Polychrome at contexts dating from the mid-fourteenth to mid-fifteenth centuries. Types associated with later occupations include Lincoln Black-on-red (Mera and Stallings 1931; Wiseman 1991), late examples of Chupadero Black-on-white (Hayes et al. 1981), Rio Grande glaze ware (Franklin 1997; Hayes et al. 1981), Salado polychrome (Crown 1994; Lindsay and Jennings 1968; Wilson 1998; Wood 1987), and Chihuahua polychrome and utility ware types (DiPeso et al. 1974).

By AD 1450, most areas of the Jornada Mogollon appear to have been abandoned by agricultural groups. It is possible that resources in the project area could have still been utilized by either sedentary groups such as the Piro peoples along the Rio Abajo of the Rio Grande and Tompiro people in the Salinas District to the north as well as by Spanish settlements that may have developed along the Rio Grande Valley or Camino Real (Hayes et al. 1981: Marshall and Walt 1984). A more likely possibility for later use of this area is represented by mobile groups such as the Mescalero and Chiricahua Apache whose historic ranges appear to have been located within or very near the project area. It is possible that these highly mobile groups used this area as part of a much larger seasonal round which included both the utilization of widely scattered faunal and wild plant resources as well as interaction (including exchange and raiding) with widely scattered Pueblo and Spanish settlements (Baugh 1984; Spielmann 1983, 1996). While ceramics tend to be rare on sites occupied by the Apache and other mobile protohistoric groups in southern New Mexico, distinct thin utility wares of apparent Apachean origin have been identified in widely scattered areas of the Southwest known to have been occupied by these groups (Brugge 1982; Ferg 1988). While native pottery can be crucial to recognizing protohistoric components, it is quite rare on sites in this region. Since pottery associated with Apachean occupations are plain utility wares our analysis will employ criteria that will allow for the distinction of pottery produced by either protohistoric mobile groups, such as the Apache, from that known to have been made by more sedentary peoples, such as the historic Pueblo groups. A combination of Puebloan and Apachean pottery is particularly useful for the identification of historic components (see Wilson 1996 and 1998b for examples where this combination of pottery was used to recognize a probable Apachean occupation).

Questions related to trends in vessel use or function. Distributions of surface characteristics and vessel forms may provide insights into the importance and nature of activities in which pottery vessels were used which, in turn, may be used to address Research Questions 4 and 5, which are related to changing subsistence practices and strategies. Functional trends may be documented through the use of basic ware categories and ceramic groups, as well as categories that reflect the shape and portion of a vessel from which a sherd originated. Vessel form identification is based on rim shape, the presence and location of polish and painted decorations, and other traits. It is sometimes possible to identify the basic form (bowl or jar) of body sherds for many Southwestern ceramics by the presence and location of polishing. Examinations of rim sherds provide more specific information about vessel form. Rim diameters of vessels (as extrapolated from individual sherds) will provide information concerning the overall size of vessels, which in turn informs on group size, occupation duration, and reliance of stored foodstuffs.

The dominance of expediently made, undecorated brown wares and a range of generalized forms, such as seed jars, in most early

Jornada Mogollon assemblages, may represent ceramic tool kits amenable to a hunting and gathering adaptation. This interpretation is further supported by differences between the frequency of pottery and flaked stone artifacts recovered from residential sites and special activity sites in the Southwest. One way of understanding the role pottery played in mobile group tool kits is that pottery vessels used as storage containers served to even out spatial and temporal resource variation (Mills 1989). In this sense, the ability to store foodstuffs at residential sites reduced the risks imposed by resource heterogeneity providing an alternative to full-scale mobility (Mills 1989).

One model for understanding changes in the form and technology of pottery involves the distinction between maintainable and reliable technological systems (Mills 1989). Maintainable systems sacrifice durability for other attributes such as portability, while reliable systems provide for increased durability. The expected characteristics of ceramic vessels reflecting maintainable systems include simple and easily transferred manufacturing and repairing techniques, portability, and use in a limited range of tasks. Those associated with maintainable systems also require specialized manufacturing and firing techniques that are more time consuming. Containers associated with reliable production systems tend to be abundant and sturdy, and involve specialized forms that are more resistant to failure during specific tasks. We would expect that most of the pottery used by Jornada Mogollon groups practicing mobile patterns of subsistence in marginal areas (similar to that associated with earlier non-ceramic groups) would exhibit the overall characteristics of maintainable systems.

Initially, the slight changes in the range of technical characteristics and forms of El Paso Brown produced during the Mesilla phase may point to gradual changes in mobility and economic strategies. These slight changes, including decreases in vessel wall thickness and temper size, as well as an increase in hardness and degree of polish, may imply changes in manufacture and surface techniques intended to increase the durability of these vessels (Whalen 1994b:11). A possible increase in vessel size may also be associated with an increased need to store food which, in turn, may have been associated with an increased dependence on agriculture.

While the dominance of undecorated brown wares at sites dating to all periods seems to reflect maintainable containers, the appearance of, and then gradual increases in, decorated pottery from a variety of regional traditions may reflect some movement toward a reliable system. Unlike many other regional ceramic traditions, the great majority of the decorated pottery at Jornada Mogollon sites is represented by jars. Most common of these is El Paso Polychrome, which is mostly characterized by thin necked wide rimmed jars that may, in turn, reflect the increasing importance of storage or processing of corn (Miller 1997). Chupadero Black-on-white, on the other hand, is dominated by narrow jars or ollas that may have been mainly used for water storage. Thus, while later forms appear tend to be associated with fairly specific activities that tend to be dominated by various forms of jars, although bowls are present in low frequencies. This suggests a greater stress on storage rather than serving vessels, as compared to other contemporary regions of the Southwest. Finally, the rarity of pottery at Protohistoric sites in general, coupled with the presence of Athabaskan utility wares, indicates almost total reliance on a maintainable technology by the mobile groups who resettled this region after the Formative period.

Questions related to trends in the production and exchange of pottery vessels. Pottery types associated with distinct regional traditions provide an opportunity to address Research Question 8, which relates to the dynamics of trade, interaction, and economy. Next to the assignment of dates, the examination of regional interaction during the Formative period, using materials recovered from sites such as LA 155963, will probably be the most important contribution of this ceramic study.

It is likely that few ceramic vessels were produced within the project area. Most of the pottery, including the brown utility wares, was probably produced in adjacent areas. These areas include the Southern (El Paso area) Jornada Mogollon, the Northern (Sierra Blanca) Jornada Mogollon, and the Mimbres Mogollon. Pottery from each area is defined by the use of distinct volcanic temper known to be widely distributed within, but specific to, each region. Therefore, an attempt will be made to identify local clay and temper resources and link them to pottery recovered from Spaceport sites.

The probable area of origin of pottery recovered from Spaceport sites may be determined using a variety of methods. Identification of temper with a binocular microscope will provide an initial determination of potential sources of pottery production. While the great majority of brown utility ware pottery is expected to be tempered with some form of igneous rock, differences noted within the igneous temper groups often correspond to production areas. Pottery from the Southern Jornada Mogollon, or El Paso, area usually contains granite temper characterized by relatively large temper particles dominated by quartz and feldspar grains that are white to clear gray (Whalen 1994b). This temper is linked to sources in the Franklin Mountains or associated gravels in the El Paso area. Brown wares produced in the Sierra Blanca, or Northern Jornada Mogollon, region can usually be identified by the presence of aplites, which are very small and profuse clear, gray, to white in color with a crystalline or sugary appearance. The aplites are indicative of production in the Capitan area of the Sierra Blanca region (Wiseman 1991). Brown ware pottery containing temper consisting of a combination of white to gray quartz, pumice particles, and quartz sand fragments may indicate the use of weathered volcanic clastic rock commonly used over wide areas of the Mimbres Region or Mogollon Highlands to the west (Wilson 1999).

The validity of distinct regional traditions may be further evaluated utilizing a number of methods. Among these are petrographic characterizations of the associated temper and more precise paste analysis, such as instrumental neutron activation analysis (Brewington and Schafer 1995). In addition, combinations of paste and surface characteristics noted for various regional types may provide support for making distinctions associated with specific traditions and regions.

Previously discussed changes for assemblages dominated by El Paso Brown or Jornada Brown may also have important implications concerning the extent and direction of interaction between groups spread across the Jornada Mogollon. For example, changes in the dominant brown ware and associated decorated ware traditions, noted in more sparsely occupied areas of the Jornada country where pottery appears not to have been commonly produced, seem to indicate a geographical shift in the direction from which most pottery vessels were obtained. Early groups obtained most of their pottery from farming groups in lowland settings along the Rio Grande and its tributaries to the south or southwest. Later in the occupation sequence, pottery was obtained from groups in more upland settings to the east. This shift may reflect a response to cultural or environmental changes that are not yet fully understood. In addition, the presence of pottery associated with increasing numbers of distinct and elaborate regional ceramic traditions outside the Jornada Mogollon country may reflect a gradual increase in the complexity of interaction with other regions. Early assemblages tend to indicate widespread east-west ties between smaller, more dispersed Southern Jornada groups and larger Mimbres Mogollon communities. Later in the sequence interactions are indicated with groups in regions in west-central New Mexico. The number of regional traditions increase and ceramic forms become increasingly elaborate and specialized during the late Formative period. These changes may reflect trends toward increasingly complex interactions between communities with emerging identities and competing interests within and across regions as diverse as El Paso, Casa Grandes, Eastern Salado, Rio Abajo, and Salinas. In contrast, the trace of simple ceramic assemblages found at protohistoric sites may reflect strategies associated with highly mobile groups after the abandonment of much of this area by agricultural groups.

Chipped Stone Artifacts

All chipped stone artifacts will be examined using a standardized analysis format. This format includes a series of standard attributes that describe material, artifact type and condition, cortex, striking platforms, and dimensions. Several additional attributes have also been developed that expand on the information available from the standard attributes, but are not suitable for every analysis. This analysis will include both standard and several of the additional attributes, the latter allowing a deeper exploration of some of the questions of material selection and reduction technology that are raised below.

The primary areas our analysis format explores are material selection, reduction technology, and tool use. These topics provide information about ties to other regions, mobility, and site function. While material selection studies cannot reveal *how* materials were obtained, they can usually suggest *where* they came from. By studying the reduction strategy employed at a site it is possible to compare how different cultural groups approached the problem of producing useable chipped stone tools from available raw materials. The types of tools in an assemblage can be used to help assign functions to sites or different site components, and to aid in assessing the range of activities that occurred during those occupations. By examining the distribution of chipped stone artifacts across a site, the locations where specific activities occurred can sometimes be defined. Certain types of chipped stone tools can provide temporal data, but are usually less time-sensitive than other materials like pottery and wood.

Chipped Stone Analytic Methods

Each fully analyzed chipped stone artifact will be examined using a binocular microscope to aid in defining morphology and material type, examine platforms, and determine whether it was used as a tool. The level of magnification will vary between 20x and 100x, with higher magnification used for wear pattern analysis and identification of platform modifications. Utilized and modified edge angles will be measured with a goniometer; other dimensions will be measured with a sliding caliper. Weights will be obtained using digital or balance beam scales. Analytic results will be entered into a computerized data base to permit more efficient manipulation of the data, and to allow rapid comparison with other data bases on file at the OAS. In regards to the last, the OAS has been using a standardized analytic framework for nearly two decades with some variation in the optional attributes used by various projects. Work has begun on compiling a comparative data base containing information from sites excavated across the state. Currently, the comparative data base contains information from over 165,000 individual artifacts, with plans to convert and add data from several more projects, ultimately bringing the count to over a quarter million cases. These data will be used in a comparative framework, searching for both similarities and differences between the contents of the sites examined during the current project as well as those from other regions within the state.

Attributes that will be recorded for all fully analyzed chipped stone artifacts include **material type**, **material quality**, **artifact morphology**, **artifact function**, amount of surface covered by **cortex** and **cortex type**, **portion**, evidence of **thermal alteration**, **edge damage**, **wear patterns**, **angles of formal and informal tool edges**, and **dimensions**. Other attributes are aimed specifically at examining the reduction process, and can only be obtained from flakes. They include **platform type**, evidence of **platform lipping**, presence or absence of **opposing dorsal scars**, **distal termination type**, **platform angle**, **bulb of percussion type**, evidence of **ventral curvature**, and the presence or absence of **waisting**. The last four attributes are aimed specifically at defining flakes removed during biface manufacture that were not identified by a polythetic set of variables used to distinguish between removals from cores and bifaces.

Should in-field analysis be used to examine uncollected artifacts at one or more of the sites investigated by this project, a minimum number of macroscopically-visible attributes will be recorded, using the same standardized codes used in the laboratory analysis. These attributes will include **material type**, **material texture**, **artifact morphology**, **artifact function**, amount of surface covered by **cortex**, **portion**, evidence of **thermal alteration**, **cortex type**, and **dimensions**.

Research Questions

Chipped stone is the dominant artifact type on all archaeological sites discussed in this report. In general, analysis of chipped stone assemblages is aimed at providing information on how and where raw materials were obtained, how those materials were reduced, and what types of activities can be inferred from the content and variability within an assemblage. The latter includes not only a consideration of the types of tools that might be recovered, but also their state. Fracture patterns on fragmentary tools can suggest whether a particular tool was broken during manufacture or use, and these data can be used to expand on the information available from tool form alone. Examination of the debitage assemblage can help examine the mobility pattern followed by site occupants, the condition of nodules when they arrived at that location, and whether or not the site has suffered significant damage from post-occupational impacts like trampling. Over and above these areas of interest, analysis of chipped stone assemblages can be used to address most of the research questions posed in Chapter 5.

Temporally diagnostic artifacts like projectile points, when available, may help place components into the chronological framework that will be developed as Research Questions 1 and 2 are addressed. Many sites, such as LA 111421 and LA 111432 at Spaceport America, are dated exclusively by the presence of specific projectile point styles and, in the absence of other temporal data, such general date assignments are useful. Projectile points with dates inconsistent with chronometric dating of components in which they are found may provide information on the salvaging of materials from earlier sites. Projectile point salvaging is a well-documented prehistoric activity and in these instances, other aspects of chipped stone assemblages may need to be examined These would include indicators that might suggest a Paleoindian, Archaic, or Formative period occupation consistent or at odds with the dates assigned to associated projectile points. Other types of chipped stone artifacts that have the potential to provide general temporal data include Clovis blades, channel flakes, certain types of scrapers, and characteristics of the reduction strategy. However, the latter is not always a reliable temporal indicator, and can only be used in association with other evidence of date.

Chipped stone analysis may provide data tangential to addressing Research Questions 3 and 4. In both cases, knowledge of whether evidence of hunting is represented in various components may help determine whether the distribution of game in relation to water sources had an impact on site location choice. Characteristics of break patterns on projectile points can indicate whether they were discarded during shaft refurbishing, or were transported to a residential camp in a meat package after a successful hunt (Moore 2003). Sites, like LA 111429 and LA 155963, that contain numerous projectile points from various occupational periods can be particularly useful in addressing these questions. Wear patterns on scrapers and some pieces of utilized debitage can be indicative of hide processing (Robinson and Attenbrow 2008; Vaughan 1985), an activity that is often directly associated with hunting. Likely candidates for blood residue analysis may be recovered. This technique could provide information on some of the types of animals that were exploited, in conjunction with data derived from analysis of any faunal bone that might be recovered.

Information derived from the analysis of chipped stone assemblages recovered from all investigated sites may be critical to our consideration of Research Question 5, especially for any determination of quarrying or early stage processing of lithic materials in areas that contain suitable sources. Whether or not a component served as a quarry location will be indicated by the state of the debitage recovered from that location, proportions of cortical debitage, and other indicators of early-stage reduction including the types of cores present. These analyses will also provide information that can be used to determine whether a location was specifically used for resource extraction, or was a residential camp where extraction of raw materials was one of several activities performed. This information can be derived by examining the structure of the chipped stone assemblage, and defining the range of activities visible in the types of debitage and tools that were left behind.

By examining the types of activities identified from the analysis of each site and temporal component, we can look for evidence of variation in occupational type, which should reflect landscape use and how it changed through time. Of course, data provided by chipped stone analysis only represents one of several sources of information germane to this type of examination. The structure of chipped stone assemblages can be used to identify mobility patterns and the types of tasks performed at various locations through time. Variation in these characteristics may reflect changes in landscape use, and can be used to corroborate or dispute conclusions made using other data sets. Through the examination of multiple data sources it should be possible to derive a more accurate picture of how people used the project area through time, and whether there were major changes in the settlement system similar to those seen elsewhere in the Jornada region.

Detailed analysis of chipped stone assemblages and the distributions of various artifact types may be important in addressing the question of site structure posed in Research Question 6. In this manner, we may be able to define locations containing evidence of discrete activities that illustrate how residential or resource extractive locations were used through time. This may provide estimates of both the intensity of use and how certain tasks were arranged in relation to one another as well as to potential sleeping areas or habitation structures. Since mobility and land use patterns are expected to change through time, these data may enable us to determine how the spatial structure of the associated sites changed. Of course, the possibility of repeated reoccupations of a specific location, such as LA 111429 and LA 155963, by Paleoindian, Archaic and Formative period peoples, can introduce noise that may hamper our ability to confidently define activity locations related to specific occupations.

Chipped stone analysis may also provide information that can be used to address Research Question 7. Any related data would essentially be the same as those used in considering Research Theme 1. Chronological information may be available from temporally diagnostic artifacts — projectile points as well as other tool types (Seymour 2002; Seymour and Church 2007) — that might indicate an Apache occupation. For example, several tear-drop shaped projectile points found during archaeological testing at LA 155963 might be associated with Historic or Protohistoric use of the area by indigenous groups. However, other data concerning site structure and the range of activities performed at a location will also be useful in addressing this question, particularly in determining whether Protohistoric Apaches used the study area in the same way as prehistoric occupants, or if their settlement and subsistence systems were different.

Material type analysis can provide information useful in addressing Research Question 8. Non-local or exotic material types can be found at many of archaeological sites that contain recognizable Paleoindian or Archaic components, including LA 111429 and LA 155963. The presence of exotic materials can mean various things, and it is usually up to the archaeologist to interpret that meaning. Exotic materials can occur in different forms, each of which might have a different meaning. For instance, the presence of debitage and cores of one or more exotic materials would tend to suggest that site occupants had good access to the sources of those materials, either directly or indirectly through down-the-line exchange. If exotic materials are only represented by broken or worn out formal tools and the structure of the assemblage suggests a high degree of mobility, those material sources may have been within the area exploited by site occupants. In both cases, interaction with the area in which exotic materials originated is indicated, but the type of interaction is completely different. The type of cortex that occurs on exotic materials can also be an important indicator of their source. Since Pedernal chert and certain types of Jemez obsidian are common in Rio Grande gravels far south of where they outcrop, the occurrence of waterworn cortex on artifacts made from these materials probably indicates they were obtained from Rio Grande gravels near the project area. Conversely, if nonwaterworn cortex is present, those same materials would have been obtained at their sources, either reaching the project area as trade goods or indicating a very large area of economic use.

Chronometric Samples

Accurate dates are needed in every archaeological study to place site components in the proper temporal context, both locally and regionally. This study is no exception, and chronometric data are very important to the research design. Inaccuracies are built into many chronometric techniques, or perhaps more properly phrased, some methods may not actually reflect the event they are being used to date. In order to increase confidence in assigned occupational dates, multiple chronometric data sources should be used to cross-check one another allowing the identification and elimination of faulty dates. Except for datable artifacts and archaeomagnetic samples, analysis of chronometric materials will be completed at specialized laboratories and will not be done in-house. This will include tree-ring, radiocarbon, thermoluminescence, and optically-stimulated luminescence samples.

Datable Artifacts

At least three artifact categories have the potential to provide relative dates: Euroamerican artifacts, projectile points, and local ceramics. Euroamerican artifacts can often provide fairly precise dates for a site. However, in this study, Euroamerican artifacts associated with specific site occupations rather than reflecting road-related trash disposal are expected to be rare. A possible exception consists of metal artifacts related to Historic period Apache occupations, which could occur at some sites. As noted earlier, chipped stone projectile points can be used to assign relative dates to sites, but can rarely provide date ranges narrower than several hundred years, and in some cases less than a thousand or more years. Native ceramics provide temporal information, but again, types often have very long duration of manufacture and use that only allow the derivation of relative dates. While specific types do not appear to have a great degree of temporal sensitivity, changing patterns of ware use and vessel forms and sizes through time may provide robust relative information that can be used to augment other types of temporal data.

Radiocarbon Dating

Since the 1950s, radiocarbon (or ^{14}C) analysis has been used to date archaeological sites. While this process was initially thought to provide accurate absolute dates, several problems have cropped up over the years that must now be taken into account. The three most pervasive problems have to do with the ways in which wood grows and is preserved. Both animals and plants absorb a radioactive isotope of carbon—^{14}C—while they are alive. Immediately following death, ^{14}C begins decaying into ^{13}C at a known rate. Ideally, by simply measuring the proportion of each isotope, it should be possible to determine how long ago that entity stopped absorbing radioactive carbon. Since plant materials are often available on sites, this technique is usually applied to those types of materials. However, research has tossed a few bugs into the system. For example, some plants use carbon in different ways. This variation can be taken into account by determining the type of plant being dated.

A more serious problem is encountered when wood or wood charcoal is submitted for dating (Smiley 1985). Only the outer parts of trees continue to grow through their lives, hence only the outer rings and bark absorb carbon. Samples of wood submitted for dating may contain numerous rings, each representing growth in a different year. Thus, rather than measuring a single event (when the tree died or was cut down), the dates of a series of growth years are averaged. This often tends to overestimate the age of the material. Smiley (1985:385) notes that a large error in age estimation can occur in arid or high altitude situations, where tree ring density may be high and dead wood can preserve for very long periods of time. This disparity was greater when fuel wood rather than construction wood was used for dating (Smiley 1985:372). This is because wood can be preserved for a long time in the Southwest, even when it is not in a protected location. Thus, wood used for fuel could have been lying on the surface for several hundred years before it was burned. Again, the event being measured is the death of the plant, not when it was used for fuel. This problem is referred to as "the old wood problem."

Another problem is caused by solar activity. Sunspots cause fluctuations in atmospheric ^{14}C levels, and thus in the amount of radioactive carbon absorbed by living entities. This introduces error into the calculations, which is currently corrected by using a calibration based on decadal fluctuations in atmospheric ^{14}C as measured from tree-ring sequences (Suess 1986). Since variation in atmospheric ^{14}C levels is not consistent, the curve is wavy. This means that there is a possibility that in some cases, the measured level of ^{14}C can intercept the curve in more than one place, with each intercept having the same probability of being the correct date. Thus, multiple dates are sometimes derived for a single sample, and they must be evaluated using other information to determine which is the more likely date.

Even considering these problems, radiocarbon analysis can provide relatively sensitive dates when properly applied. For example, annuals or twigs from perennials represent short periods of growth and can often be confidently used.

Construction wood can also be sampled in a way that measures the approximate cutting date rather than a series of growth years. This can be accomplished by obtaining only bark and outer rings from construction wood instead of submitting a large lump of charcoal. This is often difficult and time consuming, but can provide much more reliable dates.

Archaeomagnetic Dating

Archaeomagnetic dating analyzes the remnant magnetization in materials that have been fired. Those materials must contain particles with magnetic properties (ferromagnetic minerals), usually iron compounds like magnetite and hematite. Ferromagnetic minerals retain a remnant, or permanent, magnetization, which remains even after the magnetic field that caused it is removed (Sternberg 1990:13-14). When ferromagnetic materials are heated above a certain point (which varies by the type of compound), the remnant magnetization is erased and particles are remagnetized (Sternberg 1990:15). Samples of that material can be analyzed to determine the direction of magnetic north at the time of firing. Since magnetic north moves over time and its pattern of movement has been plotted for about the last 1,500 years in the Southwest, comparison of a sample with the archaeomagnetic plot can provide a reasonably accurate date. However, it should be remembered that only the last event in which the material was heated to the point of remagnetization is dated. Thus, a feature could have been used over a span of decades, but this method will only date the last time it was fired to the proper temperature.

Tree-Ring Dating

This method is based on the tendency of growth rings in certain types of trees to reflect the amount of moisture available during a growing season. In general, tree-rings are wide in years of abundant rainfall and narrow when precipitation levels are low. These tendencies have been plotted back in time from the present, in some cases extending over several thousand years. By matching sequences of tree-rings from archaeological samples to master plots, an absolute date can be obtained. This is the most accurate dating technique available because it can determine the exact year in which a tree was cut down. However, once again it is necessary to determine what event is being dated.

Because the reuse of wooden roof beams was common in the Southwest, it is not always possible to determine whether a date derived from a beam is related to construction of the structure within which it was found, or a previous use. Clusters of similar dates in roofing materials are usually, but not always, a good indication that the approximate date of construction is represented. Isolated dates may provide some information, but are often of questionable validity. Another problem associated with tree-ring dating concerns a sample's condition. In order to apply an accurate date to a specific event (in this case, the year in which a tree stopped growing), the outer surface of the tree is needed. An exact date can only be obtained when the outer part of a sample includes the bark covering of the tree or rings that were at or near the tree's surface. In addition, enough rings must be present to allow an accurate match with the master sequence. Samples can often be dated when they contain only inner rings, but this does not provide a cutting date.

Thermoluminescence and Optically Stimulated Luminescence Dating

Thermoluminescence (TL) dating has been successfully applied to pottery and, to some extent, burned rock. Conversations with Jim Feathers of the University of Washington Luminescence Dating Laboratory suggest the best results have come from TL dating of burned sandstone. However, most types of burned rock, including burned caliche, are potentially susceptible to TL dating (Personal Communication December 21, 2010). Electrons in crystalline materials are displaced when exposed to radiation, which can include both natural or cosmic radiation. Heating above 500 degrees C resets those electrons, which in the process give off light. Once cooled, the process of displacing electrons begins again. By again heating the pottery or burned rock in the laboratory and measuring the amount of light that is given off, the period of time that has passed since the last heating can be determined.

Optically stimulated luminescence (OSL) dating has only been used since the 1980s. In this case, light-sensitive minerals in sediments

— especially quartz and feldspar — are quickly reset when exposed to light, and the amount of time since those minerals were last exposed to light can be measured and a date for that event determined. This is done by exposing the sample to intense infrared (for feldspars) or green or blue (for quartz) light and measuring the ultraviolet light emitted in response. The advantage of this technique is that it can be used on sediments that were not exposed to extreme heat, since quartz and feldspars can be reset by just a few minutes of exposure to sunlight, as is common during transport and deposition. The drawback to this technique is that the sediments must be collected in such a way that they are not exposed to light, which would erase the previous setting.

Research Questions

Development of an accurate chronology is central to nearly all of the research questions presented in Chapter 5, but is especially important for Research Questions 1 and 2. Chronometric data are most likely to be retrieved from those sites with documented hearths or storage features, such as LA 111422, LA 111429, LA 111435, LA 155963, LA 155964, LA 155968 and LA 155969. When available, materials or samples amenable to dating will be collected from sites. Tree-ring samples are the most desirable type, and are also likely to be the least available. Radiocarbon samples will mainly be obtained from specific contexts, like thermal features, though scatter samples may also be obtained from within cultural strata. In particular, scatter samples of charcoal will be taken when thermal features are not available for examination. While individual sherds may be used for TL dating, this technique will mostly be applied to burned rock samples. Few opportunities to obtain archaeomagnetic samples are expected because thermal features may not have fired to a high enough temperature or insufficient iron may be present in the soil for the technique to be effective. Whenever possible, several methods of dating will be used to assess individual sites and components in order to provide the most reliable and confident temporal resolution possible. Temporally sensitive artifact types will be compared with chronometric dates derived for a site or component to see how well they match. Failure to match will result in a re-examination of the data to determine the source of any error, and what implications it might have for this study.

By obtaining a range of dates for these sites, we will be better able to determine the fit of the data with the chronology and culture history developed for this study. Since several of the research questions involve tracking changes in land and resource use through time, good temporal resolution is also important to addressing those questions, in particular Research Questions 3, and 5-8. OSL dating is critical to addressing Research Question 9, because this is the most accurate way in which periods of sediment deposition can be determined. Comparing OSL dates derived from non-cultural sediments with dates obtained through other means for cultural features and strata (radiocarbon, TL, tree-ring, or archaeomagnetic techniques) should allow determination of the relationship between sedimentation events and cultural occupations. This, in turn, should permit reconstruction of the prehistoric landscape at various times.

Euroamerican Artifacts: Research Issues and Analysis

Euroamerican artifacts represent objects that were not available in the American Southwest prior to the establishment of European settlements in sixteenth century. These types of assemblages typically include a variety of artifact classes such as bottle glass, can or metal fragments, and wheel-thrown ceramics.

While all sites currently slated for testing and data recovery at Spaceport America are primarily identified as being prehistoric, archaeological investigations sometimes have the potential to encounter substantial quantities of Euroamerican artifacts. For example, numerous nineteenth to early twentieth century artifacts were noted at LA 155963 and are related to the nearby ranch complex. Many, if not all, of the historic artifacts encountered at other sites will be associated with window-discard along roads, debris associated with fence installations and initial construction and maintenance within planned utility corridors. Expected artifacts associated with these activities include machine-manufactured bottle glass, sanitary-seam cans, plastic bags and fencing nails.

Most of these artifacts will clearly be less than 50 years in age and are of little or no value to the research themes.

However, it is possible that some of the sites reporting the project area were occupied or reoccupied during the proto-historic or historic periods by indigenous groups or by Hispanic and/or Anglo populations traveling along the Camino Real. If so, Euroamerican artifacts found on these sites may provide valuable information regarding chronology, activities performed at these sites, site function, trade contacts, and possibly social standing. This section deals specifically with the treatment of Euroamerican artifacts encountered during archaeological investigations at Spaceport America.

Euroamerican Artifact Collection and Curation Strategies

The majority of Euroamerican artifacts encountered are likely to be of little or no research value to the sites on which they are found and large collections of industrial age mass-produced artifacts may put an unnecessary burden on state run curational facilities. For these reasons, the OAS proposes a selective collection strategy in which all Euroamerican artifacts which appear to be less than 100 years in age (i.e. post-statehood, 1912+) are analyzed in the field but not collected. This will include all machine-manufactured bottle glass, sanitary-seam cans, wire-drawn nails, European ceramic pottery sherds with decorative styles dating after the Art Nouveau aesthetic movement (ca 1890-1910; Majewski 2008), and all artifacts manufactured from synthetic plastics. While some of these materials could be associated with historic ranching activities or nearby homesteads, these Euroamerican artifacts cannot be definitively linked to any specific historic context. Their placement on sites defined as being "prehistoric" limits their analytical value in informing us about past populations.

Those Euroamerican artifacts believed to be over 100 years in age will be collected and subjected to intensive laboratory analysis after field work is completed. However, only a judgmental sample of these materials will be saved for curation. Curated Euroamerican artifacts will include all unique or exemplary objects clearly associated with travelers along the Camino Real, the U.S. Army and historic indigenous groups. These artifacts could include Spanish and Mexican majolicas, military buttons and Apache-modified bullet cartridges, but will exclude large quantities of small indistinguishable broken bottle glass fragments, hordes of machine-cut square nails and minute metal can fragments.

Furthermore, exceptionally large artifacts exceeding 50 cm in length, width or height will be photographed and analyzed in the field, but not collected unless the artifact is unique or clearly representative of a specific culture known to utilize the area. For example, a spoke from a wagon wheel would simply be documented in field, but a mountain howitzer may be collected. It is important to note that since all of these sites are thought to date to the prehistoric period; it is unlikely that archaeologists will encounter any large Euroamerican artifacts.

Euroamerican Artifact Analysis Methods

The OAS Euroamerican artifact analysis format and procedures were developed over the last ten years and incorporate the range of variability found in sites dating from the sixteenth to twentieth centuries throughout New Mexico (Boyer et. al. 1994). These methods are loosely based on South's (1977) Carolina and Frontier artifact patterns and the function-based analytical framework described by Hull-Walski and Ayres (1989) for dam construction camps in central Arizona. This detailed recording format allows for the examination of particular temporal and spatial contexts and for direct comparisons with contemporaneous assemblages from other parts of New Mexico and the greater Southwest. Recorded attributes were entered into an electronic data base (in this case, the Statistical Package for the Social Sciences or SPSS) for analysis and comparison with similar data bases on file at the OAS.

Functional in nature, the Euroamerican artifact analysis focuses on quantifying the utility of various objects. One benefit to this type of analysis is that "various functional categories reflect a wide range of human activities, allowing insight into the behavioral context in which the artifacts were used, maintained, and discarded" (Hannaford and Oakes 1983:70). It also avoids some of the analytic pitfalls associated with frameworks focused on categorizing artifacts strictly by material type (e.g. glass, metal, ceramic, mineral, etc.).

One weakness of material type-based analyses is that only a limited number of functional categories are represented in a single material class. For instance, metal, while beneficial for examining construction and maintenance materials such as nails and wire, would not incorporate patent medicines or other bottled goods into the same analysis. In addition, variables, such as finish, while appropriate for the analysis of glass containers, is not appropriate for flat glass, decorative glass, or other glass items like light bulbs, since they can serve different roles within a single spatial and temporal context. As such the OAS analytic framework was designed to be flexible, documenting not only the qualities of each material type but the functional role of particular items. Like all analysis, there are inherent assumptions which require explicit explanation.

In functional analyses, each artifact is assigned a hierarchical series of attributes that classify an object by assumed **functional category**, **artifact type**, and its specific role within that matrix. These attributes are closely related and provide the foundation for additional variables that, with increasingly more detail, specify an artifact's particular function. In this analysis 12 functional categories will be used including economy/ production, food, indulgences, domestic, furnishings, construction / maintenance, personal effects, entertainment / leisure, transportation, communication, military / arms, and "unassignable." Each category encompasses a series of material types whose specific functions may be different but related. For example, a pickle jar and a meat tin are both assumed to have initially contained food. Therefore, both would be included in the functional category for food, but each container is made from a different material type and the contents had different functions.

In essence, this functional-based analysis represents an inventory of different artifact attributes where variables are recorded hierarchically to amplify the functional categories and to provide a detailed description of each artifact, when possible. Attributes that commonly provide detailed information about individual artifacts, and in turn functional categories, include **material type**, **date** and **location of manufacture**, and **artifact form** and **portion**.

Chronometric data will be derived from a variety of descriptive and manufacturing attributes, especially the latter. If an artifact retains enough information to derive a begin or an end date, those variables will be recorded under the Date attribute. **Manufacturer** records the name of the company that produced a particular object. Together these data can be used to assign specific date ranges to an artifact based on known manufacture periods or the dates of operation for manufacturing companies. A related attribute is **brand name**. Many brand names also have known production periods that can provide temporal information. The manufacturer or brand name is generally listed as labeling/lettering on an artifact and is used to advertise the product, describe its contents, or inform on its suggested use.

When evident, **manufacture technique**, such as wheel-thrown or forged, will also be recorded. Since some manufacturing techniques have changed over time, this attribute can often provide a general period of manufacture. A related attribute is **seams**, which records how parts of an artifact, particularly cans and bottles, were joined together during the manufacturing process. Through time these processes were altered and are reflected in the types of seams used to construct various containers. The type of **finish/seal** will be recorded to describe the opening of a container prior to adding the contents and the means of sealing it closed. Like seams, many finish/seal types have known manufacturing periods offering general temporal information. In addition, **opening/closure** records the mechanism used for extracting the contents of a container.

For some artifacts, attributes such as **color**, **ware**, and **dimensions** can also provide information on the period of manufacture. Thus, the current color of an artifact is recorded if determined to have diagnostic value. A good example is glass where the relative frequency of various colors in an assemblage can provide some temporal information since the manufacture and preservative processes have changed over time. Ware refers to china artifacts, and categorizes the specific type of ceramic represented, when known. Because temporal information exists for most major ware types, this attribute provides relatively more refined dating information compared to seams and color. Dimensions of complete artifacts can also provide chronometric data, especially artifacts like nails or window pane glass, where thickness or length of the object can be temporally sensitive.

In addition to temporal information, the **manufacturing process** of a particular object can be used to support functional inferences. **Material** records the type of material(s) from which an object was manufactured (e.g. glass, metal, paper, clay, etc.). **Paste** describes the texture of the clay used to manufacture ceramic objects, and is further defined by porosity, hardness, vitrification, and opacity. **Decoration and design** describes the type of technique used to apply distinctive decorative motifs to an object, such as china or glassware.

In addition to the attributes discussed above, several others will be used to quantify an object's condition and use-life. For each item the **fragment/part** variable describes what portion of a particular form was represented. However, fragments of objects which refit to complete or partial objects recovered from a single excavation context are recorded together as a minimum number of vessels (MNV) of one, and the number of specimens present represented by **count**.

Cultural alteration of an item to extend its use-life will be recorded as reuse. This variable describes any evidence of a secondary function, and the **condition/modification** variable monitors any physical modifications associated with that secondary use. If environmental conditions have altered the surface of an artifact through either glass patination or metal corrosion, it will be recorded as aging.

The appearance of an artifact will be monitored using the **shape** variable. This variable was generally used to describe the physical contours of complete objects. Finally, quantitative data including **volume**, **length/height**, **width/diameter**, **thickness**, and **weight** are recorded for most Euroamerican artifacts. Where appropriate, some measurements are recorded using industry standards (i.e. pennyweight, caliber, gauge, etc).

Research Questions: Euroamerican Artifact Research Potential

With the exception of LA 155963 which has a distinct Euroamerican component, all sites within the current project area are identified as prehistoric. However, most have a small quantity of Euroamerican artifacts lying on their surface. These cultural materials include ammunition casings, film reels, and the occasional soldered fruit or vegetable can.

The Euroamerican assemblage has the potential to provide information relevant to the four defined research themes listed within the mitigation plan (FAA and NMSA 2010a) and the research design proposed in this document. More specifically, the recovery of datable Euroamerican artifacts would aid in addressing Research Questions 1 and 2 by providing dates for Historic period uses for sites. The occurrence of Euroamerican artifacts associated with the use of these sites would also help in examining Research Questions 4 and 5 by providing evidence of where Historic period occupations occurred in comparison to those from other periods of prehistoric and protohistoric use, and whether or not those patterns were similar or different. Euroamerican artifacts are likely to be the only materials that would allow us to address Research Question 7 concerning the presence of Apache occupations in the project area that can potentially be tied to military operations.

Historic records and ethnographic interviews suggest Native American groups, like the Warm Springs Apache Band, utilized the project area during the proto-historic and historic periods (Ball 1970). The written record is often woefully short on details regarding subsistence strategies or on the precise geographic locations occupied by these groups. Simply the presence or absence of specific Euroamerican artifacts may aid in developing regional chronologies and the spatial distribution of indigenous populations during the proto-historic and historic periods.

Apache utilization and modification of Euroamerican artifacts have been well documented (Adams et al. 2000a, 2000b; Laumbach 2009; Johnson 2009; Seymour 2002; Seymour and Church 2006). These artifacts, which include metal projectile points, tinklers, wire bracelets and awls, are of additional use when determining the types of activities performed at a given site leading to better interpretations of over all site function. Furthermore, analysis of the Euroamerican assemblage should allow us to examine how imported goods were used by these indigenous groups to augment and replace traditional products. In the case of the Dark

Canyon Apachería, Adams et al. (2000a) were not only able to locate a Mescalero ranchería within Dark Canyon, but reconstruct a military battle between the Apache and the U.S. Military using only a metal detector survey and Euroamerican artifact analysis. While it seems unlikely that such a unique site will be encountered within the project area, the potential does exist for the identification of Apache encampments based on the analysis of Euroamerican artifacts.

While no previously identified portions of the trail, camps or stops along El Camino Real de Tierra Adentro occur within the area affected by the current undertaking, portions of LA 80070 have been impacted by prior Spaceport American construction and the potential remains for archaeologists to uncover Euroamerican artifacts associated with this bustling trade network. These artifacts could include materials such as Mexican lead-glazed earthenwares, majolica or assay equipment used during the Spanish Colonial Period, British white-bodied earthenware and American patent medicine bottles used during the Mexican and early American Territorial Periods. In addition to answering questions regarding chronology and activities occurring at the site, identifying the types and amounts of imported goods flowing along the Camino Real may also inform upon the scale of the mercantile system and how this system changed after the opening of the Santa Fe Trail in 1821.

Fauna

Context for Evaluating the Fauna Recovered from the Spaceport America Project

Miller and Kenmotsu (2004) provide an outline of the prehistory of the Jornada Mogollon and Eastern Trans-Pecos Regions of Texas that covers the pre-Clovis through the early historic periods and may be applicable to the Jornada del Muerto and Spaceport America project area. Assessment of the Spaceport America sites suggests that components could date from the Paleoindian through the early-Historic era. The faunal evidence for each period, as well as settlement and other factors that influence subsistence, are reviewed below. This review relies in part on Miller and Kenmotsu (2004) but supplements their descriptions with more recent or additional information.

Paleoindian period (10,000-6,000 BC). Area sites provide little information on subsistence during the Paleoindian period. Most evidence for the Early Paleoindian Clovis complex consists of isolated finds of projectile points, although possible living surfaces were reported at Mockingbird Gap in the northern Tularosa Basin. Little is known about how the Clovis-era groups used the area including what they hunted. It is possible that Clovis artifacts and components may be deeply buried (Miller and Kenmotsu 2004:214-215) and could be encountered in the project area.

Folsom components are better known through both occupation sites and distributions of projectile points. Unfortunately, many Paleoindian sites also have components dating to later periods, are heavily disturbed or are in deflated contexts. The lithic assemblages and the raw materials represented in those assemblages have led one researcher to conclude that the Folsom settlement in The Tularosa Basin involved residential settlements oriented toward hunting game animals other than bison. These sites could, in turn, be linked to an extensive regional land system that reached onto the Southern Plains of Texas (Miller and Kenmotsu 2004:215-217).

Late Paleoindian groups are well represented by surface finds but well-documented occupation sites remain rare. Sites are generally located near playas or along the margins of the Rio Grande Valley including the Tularosa Basin. This distribution suggests a pattern of hunting large game animals near permanent water sources (Miller and Kenmotsu 2004:217). It is not clear what this means for central basin sites such as those in the project area. If the diagnostic points found at these sites indicate components, this could suggest that animals were pursued in these areas or that hunters passed through on their way to more productive areas. Furthermore, if there was a playa to the south of LA 111429 (e.g. HSR 1997:189), the playa and Jornada Draw would have attracted game animals, the exploitation of which might have resulted in a range of site types.

Paleoindian projectile points and tools have been recovered from several of the Spaceport American project sites. These provide an opportunity to examine how these groups used the landforms and resources in the area and how these behaviors compare to other basin and river valley locales.

Archaic period (6,000 BC–AD 200). Environmental changes during the Pleistocene to Holocene transition changed the constraints of human adaptation. A drier climatic regime is thought by most to have caused the demise of large game animals, the reorganization and redistribution of plant communities, and the reduction in the size and number of perennial water sources. The Archaic adaptation was that of a seasonally mobile broad-spectrum hunter-gather. Populations were seasonally mobile with a long term trend towards increasing population and more diverse subsistence economies that included the intensification of land use patterns and an increase in the range of utilized environmental zones. More of the subsistence base was focused on plant life than in the Paleoindian period (Miller and Kenmotsu 2004:218).

Like the Paleoindian period, the Early Archaic phase (6,000-4,000/3,000 BC) is poorly known and found mainly as surface finds of projectile points, as a few thin deposits in rockshelters, and as radiocarbon dates of hearths in rockshelters. The small number of FCR rock or caliche features that are known for this time indicate that rock cooking appeared during this period which, along with the appearance of ground stone tools, could reflect an increased reliance on plant foods. A shift in prey selection and hunting practices may be indicated by the increased use of medium- or coarse-grained lithic material, mainly basalt, the adoption of stemmed projectile point forms, and a greater emphasis on reliable tools. Evidence suggests Early Archaic groups were seasonally mobile small bands (Miller and Kenmotsu 2004:220-223).

The Middle Archaic phase (4,000/3,000-1,200 BC) is similar to the Early Archaic in subsistence, settlement, and technology. Some population growth is indicated and continued drying may have caused food resources to become more restricted and variable. Remains of shallow structures with brush or jacal superstructures make their appearance, implying a degree of semi-sedentism not seen before. Burned rock middens and extensive hearths suggest processing of cacti and desert succulents. Direct evidence of subsistence remains is nearly absent in open sites. At Keystone Dam, only 25 pieces of fauna (rabbit and small and medium-sized mammals) and 5 egg shell fragments were recovered. Technological changes include a diversification of projectile point suggesting increasing regional distinctions. The use of yet a wider range of environmental and topographic zones is indicated, but the majority of the sites occur as isolated hearths, FCR accumulations, or clusters of thermal features (Miller and Kenmotsu 2004:223-225).

Rockshelter deposits in the Tularosa Basin provide some of the best evidence for seasonal settlement and use of higher elevation locations during the Middle Archaic. At High Rolls Cave, Stratum 3 with a sample size of 269 pieces of bone, dates to the Middle Archaic period. Nearly all of the assemblage is artiodactyl (74.3 percent medium artiodactyl, 13.0 percent deer, 1.1 percent pronghorn, 1.5 percent bighorn) with little small mammal (small mammal 0.7 percent, woodrat 0.7 percent, medium to large rodent 0.7 percent, cottontail 3.0 percent) or bird (large bird 0.4 percent) suggesting an emphasis on hunting artiodactyls from these higher altitude sites. At High Rolls Cave, deer were probably taken when they gathered at a pool of water below the cave when moving between Fresnal Canyon and more open areas. Specimens from fetal and immature deer, pronghorn, and bighorn indicate use during most seasons of the year (Akins 2006:110, 123, 125). Nearby Fresnal Shelter produced a much larger assemblage of bone and exhibits evidence for occupation during a longer time span (about 6,000 to 900 BC). While the preliminary report does not break the faunal data down into components, the authors maintain there was little change in subsistence pursuits throughout the occupation. They interpret the site as a hunting camp used from July until November and that meat packages of deer were transported from the shelter to base camps located elsewhere (Wimberly and Eidenbach 1981:23, 26, 36).

The Late Archaic phase (1,200 BC-AD 200/900) was also a time of population growth and major changes in settlement and technology. These include substantial occupation of interior basins landforms as well as nearly all environmental and topographic zones. The first evidence of agriculture, brown ware ceramics and a more diverse array of feature types appear during this period. Much of the evidence for plant and animal use comes from rockshelter sites as the open air sites generally have poor preservation. Fauna from some shelter sites, such as Todsen Shelter, is mainly comprised of rabbit remains along with some aquatic species. In lowland settings, large and medium-sized mammals generally decrease from the Middle to the Late Archaic with a greater emphasis on rabbits. However, at least one exception, a small shelter north of El Paso, yielded substantial quantities of deer, pronghorn, and mountain goat. Projectile points from this period are smaller in size with side and corner notches and use of local raw materials increases, which along with other evidence suggest a reduction in territorial ranges (Miller and Kenmotsu 2004:226-229).

More recent studies at the Townsend Site near Roswell, a rockshelter in the Sacramento Mountains, and at High Rolls Cave add to our knowledge of subsistence during this period. The Late Archaic occupation of the Townsend Site, located on Salt Creek, a tributary of the Pecos River, consists of two camp sites with thermal features, sparse fire-cracked rock, and moderate amounts of lithic and ground stone artifacts. The fauna suggests a balanced use of large and small animal forms. A sample of 152 specimens from a non-feature grid location produced more bones from small mammals (59.2 percent) than artiodactyls (37.5 percent), and including some rodents (4.6 percent) but no mussel shell. The other area had a very small sample (n=5) (Akins 2003:276, 304). Fallen Pine Shelter is located in the Sierra Blanca Mountains on a convenient route between the Hondo Valley and the Tularosa Basin. Fauna recovered from the shelter itself (n=158) and the talus in front of the shelter (n=321) was highly fragmented artiodactyl (67.7 and 62.3 percent) and deer (9.5 and 9.3 percent) with virtually no rabbit (0.6 and 0.9 percent) and no small mammal bone. Most of the deer and medium artiodactyl bone was from mature animals (Akins 2004:108, 112).

The Late Archaic assemblage from High Rolls Cave (Stratum 2, n=1,653) is similar to Fallen Pine Shelter in that much of the bone is from artiodactyls (71.7 percent), especially deer (12.1 percent), but it also includes pronghorn (0.8 percent) and bighorn (1.0 percent) and a little more rabbit (3.4 percent). Aged immature artiodactyl specimens indicate the shelter was mainly used during the late spring and summer (Akins 2006:110, 117, 125). The latest of the Late Archaic deposits produced a fairly small and similar assemblage (n=142). Small mammals, including cottontail rabbit (5.8 percent) increase but remain rare as are woodrats (0.7 percent) and birds (very large bird 0.7 percent) compared to artiodactyl remains (66.9 percent medium artiodactyl, 17.6 percent deer, and 0.7 percent each for pronghorn and bighorn). The range of ages in deer specimens indicates summer and winter deposition (Akins 2006:110, 123, 125).

Fauna recovered during the recent work in the Pecos Valley and Tularosa Basin suggests a pattern similar to that observed by Miller and Kenmotsu (2004). Lowland sites contain significant amounts of rabbit bone, and these sites appear to represent groups with a more plant-based and a more diverse and small animal focus as compared to highland sites with an overwhelming emphasis on artiodactyls. If these do represent seasonal movements between the lowlands and highlands, finding animals indicative of just about every season in shelters such as at High Rolls suggests a great deal of mobility within, and possibly between, the basins and river valleys.

Formative period (AD 200-1450). The Formative period was a time of rapid changes in architecture, settlement, subsistence, and technology that accompanied decreasing mobility and a growing dependence on, and specialization in, agriculture. It is typically divided into three phases: Mesilla (AD 200/400-1000), Doña Ana (AD 1000-1250/1300), and El Paso (AD 1220/1300-1450), that also represent a continuum of increasing social integration with a corresponding decrease in settlement mobility. The early part of the Formative period is characterized by a dispersed settlement system, exploitation of several environmental zones, and ephemeral semi-circular house structures. Alluvial fan use increased gradually along with the construction of more substantial pit structures and a decrease in the use of central basin landforms. Between AD 1150 and 1275 alluvial fans appear to have been used as residential, and presumably, farming areas and the playa or central basin zones appear to have been used as logistic bases. Detailed studies of fauna, while rare, suggest rabbits are common in assemblages from lowland settings, with some medium artiodactyls and indications for the use of riverine resources. Projectile points are rare in Formative period habitations, an observation that is consistent with the reduced importance of large mammals in the diet (Miller and Kenmotsu 2004:236-238, 247, 250, 255).

Several projects in the Pecos Valley contribute to a better understanding of subsistence, in at least that area. The Townsend Site has Mesilla phase (radiocarbon dates of AD 570 ± 40 to 940 ±70) and later Late Mesilla/ Doña Ana phase (radiocarbon dates of AD 990 ± 40 and 1050 ± 80) components with structures. The earlier component faunal assemblage (n=1,316) is mainly small mammal (56.4 percent) and rabbit (14.2 percent) with very little bone from artiodactyls (1.7 percent) or large mammals (3.0 percent). Prairie dog is fairly common (2.5 percent) and the assemblage contains a range of other rodents, turtle, fresh-water mussel shell (8.3 percent), and a small amount of fish (0.5 percent). The smaller assemblage from the later component (n=363) has less small mammal (27.3 percent), a similar amount of rabbit (13.5 percent), little artiodactyl (1.7 percent) but more large mammal (10.5 percent), more fresh water mussel shell (22.0 percent), and a single fish specimen when samples from two structures are combined. Separately, the amount of small mammal bone is similar in the two structures (49.6 and 57.4 percent) but one has considerably more artiodactyl/large mammal (39.7 and 14.8 percent) while the other has all of the freshwater mussel shell (9.6 percent) (Akins 2003:270, 276).

South of Roswell on the edge of the Pecos River floodplain, the King Ranch Site dates between about AD 1150 to 1250 (Doña Ana phase). A small faunal assemblage from a shallow pit structure has a small (n=109) assemblage with more artiodactyl (deer, bison, pronghorn, large mammal, 21.0 percent), slightly less rabbit (10.0 percent) plus turtle, fish, mussel, and bird (Wiseman 1988:229, 242, 245). Earlier excavations at the same site in another pit structure produced an assemblage (n=67) that was mainly bison or large mammal the size of bison with a single piece from a medium-sized artiodactyl and two from rabbit sized animals (Wiseman 1981:191).

South and west of Townsend and located on the Hondo River, a major tributary of the Pecos River, the Fox Place is an unusual combination of 11 pit structures, numerous storage pits, and a more formal socio-religious structure dating to the El Paso phase (between AD 1250 to 1425; Wiseman 2002:183). An immense sample of fauna was recovered (about 60,000 specimens) and about 40 percent analyzed (25,615 pieces of fauna and 576 pieces of fresh water mussel shell). In this assemblage, artiodactyl and potential artiodactyl bone accounts for relatively little of the assemblage (8.8 percent, with deer at 0.4 percent, pronghorn at 4.2 percent, and bison at 0.9 percent) but considerably more of the large mammal is included (33.8 percent). Rabbits (15.1 percent) and small mammal (15.9 percent) contribute a significant amount. The remainder of the faunal assemblage is a wide range of rodents, carnivores, birds, fish, and turtles. When the pit structures (n=9), storage pits (n=11), and other proveniences (n=3) with sample sizes of over 100 (range n=119 to 3,000) are examined, two general patterns are suggested. Those with the most artiodactyl/ large mammal (40 to 66 percent) tend to have less bird, turtle, and fish but greater amounts of fresh water mussel while those with more rabbit/small mammal (35 to 54 percent) have larger amounts of bird, turtle, and fish suggesting what could be two distinct periods or seasons of use (Akins 2002:258-259, 282).

Also along the Hondo River and dating between AD 1275 and 1350, the Henderson Site is an E-shaped adobe pueblo with 50 or more rooms. The large sample of fauna (over 5,800 bones) has at least 55 taxa. Of the major taxa, rabbits are most abundant, bison the most abundant artiodactyl followed by pronghorn, with considerable amounts of prairie dog and fish, and at least 31 bird taxa (Speth 2000:90-91).

At Fallen Pine Shelter in the Sierra Blanca Mountains at the west edge of the Pecos Valley, fauna from earlier ceramic levels (n=274; equivalent to the Doña Ana Phase) are mainly artiodactyls (50.4 percent medium artiodactyl; 9.5 percent deer) with few rabbit (3.0 percent) or small mammal (1.1 percent), considerable turkey (10.6 percent) and large bird (6.9 percent). Slightly less of the assemblage from the later ceramic levels (n=107; equivalent to the El Paso phase) is from artiodactyls (40.2 percent medium artiodactyl, 15.0 percent deer), slightly more is from rabbits (5.6 percent, 0.9 percent small mammal), and very little is from turkey (0.9 percent, no large bird). Aspects of the earlier ceramic period assemblage are consistent with a short-term base camp occupied by small groups of foragers rather than a logistic camp produced by more settled groups who largely relied on agriculture. The later assemblage is more like what would be expected from these groups (Akins 2004:112, 131).

Other Pecos Valley sites have not been as productive for faunal remains. Two sites along Bob Crosby Draw, east of the river and probably dating to the El Paso phase, are camps or limited use sites and produced little fauna. What was found were almost all pieces of artiodactyl teeth, fragments of fresh water mussel shell, a few burned bones, and intrusive rodent remains (Akins 2000:81). Sites in the Southern Mesilla Bolson at the Santa Teresa Port-of-Entry also produced little or no fauna (Moore 1996).

These assemblages suggest a great deal of variability among sites depending on area. Sites along the Pecos River and its tributaries show a higher dependence on rabbits and small forms, on more diverse forms, and on increased use of riverine resources than in the Archaic. Highland sites show that artiodactyls were still an important resource and may document the shift from more mobile groups acquiring artiodactyls as part of their seasonal movements to more targeted logistic hunts by groups that were more sedentary. How the central basin sites fit into the overall picture is less clear. In some areas the trends in animal subsistence may resemble that in the Pecos Valley, that is, little artiodactyl, significant amounts of rabbit, and increased use of riverine resources. In other areas, and most likely the project area, the sites may be more like logistic bases from which plant resources are gathered and where the fauna could represent encountered species rather than targeted ones.

Post-Pueblo. After about AD 1450 to 1500, many of the Jornada Mogollon pueblos were abandoned and the few radiocarbon dates indicate a diminished population at this time (Miller and Kenmotsu 2004:258). If hunter-gatherers still occupied the region, faunal assemblages from these sites would probably resemble faunal assemblages from Late Archaic or early Mesilla phase camp sites. Post-Contact site assemblages could include modern domesticates.

Analytic Methods

Archaeological sites like those that will be investigated at Spaceport America typically do not produce large amounts of fauna, and the faunal remains that are found are often small burned or heavily eroded pieces identifiable only to the size of the animal. Every effort is made to extract a maximum amount of information from what is recovered and to distinguish between those that represent extracted resources and those that are incidental to the site deposits (e.g. burrowing rodents).

Bone from grid, feature, and flotation samples will be identified using the OAS comparative collection supplemented by the collections at the Southwest Museum of Biology at the University of New Mexico (if necessary. Recording will follow the established OAS computer coded format that identifies the animal and skeletal element, how and if the animal or part was processed for consumption or another use, and how taphonomic and environmental conditions have affected the specimen. The following describes and defines the variables.

Provenience-related variables. Provenience and stratigraphic information are linked to the data file through the Field Specimen (FS) number. At a minimum, each line contains the north and east coordinates of the grid, the level, the starting and ending depths, feature designation, and feature type. A lot number identifies a specimen or group of specimens that fit the description recorded in that line and the count indicates how many specimens are described by that line of data. A bone broken into a number of pieces during excavation or cleaning is counted as a single specimen.

Taxon. **Taxonomic identifications** are made to the most specific level possible. Identifications that are less than certain are flagged in the certainty variable. Specimens that cannot be identified to the species, family, or order are assigned to a range of indeterminate categories based on the size of the animal and whether it is a mammal, bird, other animal, or "cannot be determined." Unidentifiable fragments often constitute the bulk of a faunal assemblage. Identifying these as precisely as possible supplements the information gained from the identified taxa.

The taxa found at a site provide information on subsistence, other uses for animals, and seasonality. For example, some species may only be available, or have habits that limit their availability, during certain seasons of the year. Redundancy in the animals represented can suggest these were targeted resources, which provides information on site function.

Element characteristics. The **skeletal element** (e.g., cranium, mandible, humerus) is identified then described by **side**, **age**, and the **portion** recovered. Side is recorded for the element itself or for the portion recovered when it is axial, such as the left transverse process of a lumbar vertebra. Body part information is crucial for examining whether complete or partial animals are represented and can aid in determining site function.

Post-occupational burrowers tend to be represented by the larger parts that will not pass through screens, and parts that are complete. Small animals used for subsistence, such as rabbits, are generally returned to a site complete and the processing needed to render small animals into cooking or consumptive units is fairly minimal. It that case, all faunal parts are generally found. Artiodactyls, with their larger body sizes, can be treated differently depending on how far from the site the animal was killed, how much of the animal was returned to a site, and whether processing of complete animals took place at the site, whether only high-yield parts were returned and processed, and which parts may have been consumed.

Age is estimated at a general level as: fetal or neonate, immature (up to two-thirds mature size), young adult (near or full size with unfused epiphysis or young-textured bone), and apparently mature. The criteria used to assign the age are also recorded, including the size, epiphysis closure, or whether the texture of the bone is compact – as in mature animals – or porous – as in less than mature animals. Aging based on texture alone is not absolute since most growth in mammals takes place near the articular ends. Diaphyseal bone can be compact and dense while the bone near an end retains a roughened or trabecular structure (Reitz and Wing 1999:73). As a result, fragments from the same bone can be coded as different ages and juvenile bone is probably under represented. Age information can be useful for determining the seasons a site was occupied. While small animals have long breeding seasons and can sometimes be used to rule out some seasons of use, artiodactyls, such as deer, have a fairly restricted breeding and calving season, so aging by size, epiphyseal union, and tooth wear can provide information on the season an animal died.

The portion of the skeletal element represented by a specimen is recorded in detail for estimating the number of individuals represented in an assemblage and to aid in discerning patterns related to processing. Indeterminate fragments are generally recorded as either long bone shaft, as end fragments or as flat bone.

Completeness. **Completeness** refers to how much of the skeletal element is represented by the specimen (analytically complete, more than 75 percent complete but not analytically complete, between 50 and 75 percent complete, between 10 and 50 percent, or less than 10 percent complete). Completeness is used in conjunction with the portion represented to estimate the number of individuals present. It also provides information on whether a species was intrusive and on the degree of processing, environmental deterioration, animal activity, and thermal fragmentation.

Taphonomic variables. Taphonomy, or the study of preservation processes and how these effect the information obtained, has the goal of identifying and evaluating some of the non-human processes effecting the condition and frequencies found in a faunal assemblage (Lyman 1994:1). Taphonomic processes are monitored to include environmental, animal, and some types of burning. **Environmental alteration** includes pitting or corrosion from soil conditions, sun bleaching from extended exposure, checking or exfoliation from exposure or soil conditions, root etching from the acids excreted by roots, polish or rounding from sediment movement, a fresh or greasy look, and damage caused by the soil or minerals.

Animal alteration is recorded by source or probable source. Choices include carnivore (gnawing, punctures, and/or crushing), probable scat, rodent gnawing, carnivore and rodent, and altered but the agent is uncertain. Bones recorded as probable scat have rounding on edges and portions of the inner and outer tables can be partially dissolved.

Burning, when it occurs after burial, is also a taphonomic process. As such, burning influences the preservation and completeness of individual bones. Heavily burned bone is friable and tends to break more easily than unburned bone (Lyman 1994:389-391; Stiner et al. 1995:223). The effects of burning are described in more detail below.

Burning. Burning can occur as part of the cooking process, part of the disposal process when bone is used as fuel or discarded into a fire, or after it is buried. **Burn color** is a gauge of burn intensity. A light brown, reddish, or yellow color or scorch occurs when bones are lightly heated, while charred or blackened bone becomes black as the collagen is carbonized. When the carbon is oxidized, it becomes white or calcined (Lyman 1994:384-388). Burns can be graded, reflecting the thickness of the flesh protecting portions of the bone, or they can be categorized as dry, light on the surface and black at the core, or blackened on only the exterior or interior, indicating the burn occurred after disposal when the bone was dry. Graded or partial burns can indicate a particular cooking process, generally roasting, while complete charring or calcined bone can not. Uniform degrees of burning are possible only after the flesh has been removed (Lyman 1994:387) and generally indicate a disposal practice. While a wide range of colors and intensities can occur, this information is summarized in the burn type variable, which identifies the intent rather than a detailed visual description of the specimen. Complete and some graded burns represent discard processes and are recorded as discard. Patterns that suggest the part was roasted (e.g. graded burns that are scorched where the flesh is thick and burned black at the end where there is little or no flesh) are recorded as roasted. In other cases, the burn appears accidental or intentional (e.g. dry burns or a burned tip) and is recorded as such. Potential boiling is recorded as boiled (color change, waxy, rounded edges) or boiled(?) when it is less clear.

Butchering and processing. Evidence of **butchering** is recorded as a combination of morphology, tool type, and intent. Variables identify substantial cuts, chops, fine cuts (defleshing), impact breaks, spiral breaks, marrow breaks, snaps, and saw cuts. The **location** of these on the element is also recorded. A conservative approach is taken to the recording of marks and fractures that could be indicative of processing animals for food, tools, or hides since many natural processes result in similar marks and fractures. Spiral fractures are recorded on the basis of bone morphology, while recognizing there are other causes and that these can occur well after discard. Impacts require some physical indication, such as flake scars or evidence of percussion. These are not recorded when they are ambiguous or accompanied by carnivore gnawing. The condition of the bone in many faunal assemblages often obscures or destroys much of the evidence of processing.

Modification. Tools or ornaments, manufacturing debris, utilized bone, possible modification, and pigment stains are identified as **modification**. Categories are fairly broad, as a worked bone analysis will define the item type.

Comments. The **comment section** is used to flag specimens recovered from flotation and to make verbal comments. For example, when a more specific age can be assigned it would be recorded as a comment.

Data analysis. Once the data are entered and checked, the provenience, provenience groups, and chronological information are added. Data are tabulated and analyzed using SPSS (pc version 11).

Research Questions

Faunal data are better suited to address some research questions more than others. Given the central basin location and types of sites in the Spaceport America project area, we do not expect to find large samples of bone. Use of eighth inch mesh for screening feature fill and flotation samples will maximize recovery of small and burned bones. Each of the project research questions will be addressed in the following discussion, if only to indicate that fauna can provide little information concerning this question.

Research Question 1: What are the occupational chronologies of the various cultural components within the project area? This question deals with dating of sites and site components, an area where faunal data generally provide little information. Other types of data are better suited to establishing chronological frameworks within which faunal data can be evaluated. Most groups, from the Archaic on, pursued the same animals for food and other needs. While the overall proportions of small and large forms may have evolved or fluctuated with wet and dry periods, it is unlikely that we will find samples that do more than suggest or confirm regional trends.

On the other hand, deeply buried deposits, also relatively unlikely for this project, could contain Pleistocene fauna that would provide relative dates. In addition, the presence of modern domestic animals (cattle, sheep, goat, pig, horse, or chicken) would indicate either site occupations during the historic era or contamination by modern refuse.

For the most part, the faunal data will have to rely on chronological frameworks provided by the other analysts. Once the framework is established, the fauna can be evaluated within a chronology that could support our expectations that prey body size decreased from Paleoindian to the Archaic and again from the Archaic into at least the Middle Formative, where more faunal diversity also occurred.

Research Question 2: How does the chronology of site occupation in the project area fit the regional culture history framework? The previous section outlined our current understanding of faunal use in the greater Jornada region. That framework, and information from sites in the Pecos Valley, Tularosa Basin, and other regional data, will provide the basis for evaluating any faunal assemblages recovered by the project. The current information suggests that: 1) the sites in the central basin location of the Spaceport America project were part of a broader system that utilized mountain, riverine environs, and the central basin; 2) these sites functioned as part of seasonal or intermittent subsistence procurement strategies; and 3) these strategies changed with time and environmental factors. Any faunal data generated by this project will shed light on these expected patterns of behavior and assist us in evaluating how changes in these behaviors over time compare with those indicated by research in the Tularosa Basin, Pecos Valley, and other pertinent areas.

Research Question 3: How do site locations and the availability of water vary through time? Most of the Spaceport America project sites, such as LA 111429 and LA 155963, are located along the two major draws found in the area, suggesting water, or at least the vegetation associated with the draws, was a factor in site location. Animals attracted to water, or to the vegetation that grew in wetter environs, were undoubtedly targeted by prehistoric hunters who would find these to be a fairly predictable resource. Chapter 3, and the framework at the beginning of this section, outline what we expect for each period. Changes in the balance of plant and animal resources, and between large and small animal forms, can inform on how these resources were used by different groups, while the species present could provide information on how potential wet and dry cycles affected the primary water sources.

Research Question 4: How do site locations and the access to other critical resources vary through time? This question is hard to separate from the preceding one, although other critical resources for animals include salt licks, travel corridors, and wallows. Most of the animals targeted by prehistoric hunters would be more concentrated and more predictable in areas of water or denser vegetation, at least during certain seasons and more so during wetter periods. If animals were the critical resource, we would expect that camps would be located in areas where animal movements towards water could be monitored from a distance. If the animals were incidental and plants and the water were the critical resource, we might expect camps to be located closer to water. Both settlement patterns may be visible at LA 155963. Paleoindian and Archaic occupations appear to be focused along a ridge overlooking the draw, whereas, later Formative period habitation occurs within an intermittent drainage basin.

Regardless, the location, type, duration, and season of occupation will affect not only the types of animals targeted, but the preservation of animal bone. Mobile groups generally spend a limited amount of time in any one area and many of the bones left by such groups do not survive the open conditions found in the central basin. Those that do survive are often small burned pieces of bone that defy identification beyond the size of the animal. Even if animal bone has not been preserved in most sites, stone tools used to kill and process animals can provide indirect evidence of some aspects of animal use, as can the behavior of the species inhabiting the area.

Research Question 5: What evidence is there for either continuity or changes in land use patterns through time and between regions?

Again, this question is implicit in those above. The fact that some of the Spaceport America project sites were reoccupied from the earliest to the latest periods indicates continuity. However, the ways in which their uses persisted or changed over time is of concern in this research. For fauna, this could mean a change from preying on artiodactyls drawn to the area by water sources, and demonstrated by stone tools rather than actual faunal remains, to an emphasis on the plants growing in the slightly wetter environments of the draws where encounters with small body forms is the only evidence of hunting represented in the archaeological assemblage. Any fauna collected, along with stone tools used in the hunting and processing of animals, can be used to compare sites in the Jornada del Muerto with those in neighboring regions.

Research Question 6: What can site structure analyses tell us about occupational patterns through time? As mentioned above, the distance from the water source could provide information on hunting methods and whether animals were a critical resource for determining site location. Longer occupations of an area within a given site could result in different uses of space than those at a short-term camp. The need to manage trash, by placing it in pits or by burning to discourage scavengers, implies a longer occupation. Similarly, if sufficient fauna are recovered, their differential spatial locations could aid in assessing the different functional uses of space at a site.

Research Question 7: Is there evidence of an Apache presence in the project area that can be tied to concurrent military activities? Finding bones from modern domestic animals, especially horse, could indicate the presence of Apache groups. Other types of evidence would be necessary to infer that the horses had been related to military activities.

Research Question 8: With what areas did the residents of the study area interact during various periods of occupation? It is unlikely that fauna can contribute to answering this question. Most of the animals targeted for food occurred throughout the region. If more exotic species like bison or elk are found, these could indicate interaction with distant groups. However, it could also indicate that the areas utilized by these groups included the distant habitats of these species.

Geomorphology and Geological Archaeology

Each of the 14 archaeological sites will be evaluated geologically. The geomorphic framework of each site will be determined through the stratigraphy, sedimentology, soil geomorphology, and OSL chronology of the deposits in which the sites occur. The deposits associated with the archaeological sites will be placed within a broader context of landscape evolution in the Jornada del Muerto, blending the geological and archaeological records. This section describes where and when samples will be taken, how deposits will be recorded, and the laboratory analyses that will used to examine them.

The following list of specific studies will be carried out at each site. A recent geologic map of the project area provides a useful background for the proposed detailed investigation at Spaceport America (Seager 2005, Preliminary geologic map of the Prisor Hill quadrangle, Sierra County, New Mexico: NMBGMR Open-file Geologic Map 114).

Stratigraphy

Documentation of the stratigraphic units and their properties (thickness, color, texture, bedding, structure) at each site will be facilitated by one or more soil pits or trenches excavated to bedrock or caliche. The origin of the stratigraphic units (eolian, fluvial, colluvial) will be determined.

Sedimentology

The texture and chemistry of the sediments at each site will be determined. Sediment samples will be collected from each 10-cm interval from the sediment column exposed in the site trench. Where the local stratigraphy is complex, more than one trench will be cut and additional samples collected. The samples will be analyzed for sand (1-Φ), silt, clay, organic carbon, and carbonate.

Soils and Paleosols

The presence of soils and buried paleosols within the stratigraphic sequence will be documented. The soils will be characterized by textural and chemical analyses (sand, silt, clay, organic carbon, carbonate, and iron content, where a strong B horizon is present).

OSL Geochronology

Age is everything in the realm of correlating archaeological and geological records. In this investigation, optically stimulated luminescence (OSL) dating of the deposits at most of the archaeological sites will provide a valuable chronology of sediment deposition, especially related to site occupation. The age of each stratigraphic unit encountered at the sites will be determined. Where OSL dating is carried out, a minimum of three samples from a single stratigraphic column will provide the age as well as facilitate the determination of sedimentation rates of the deposits.

Evaluation of Archaeological Sites

The geomorphic-stratigraphic condition of each site will be assessed. The stratigraphic horizon of the site's occupation will be placed within the context of the associated deposits and soils. The chronology of the site's occupation will also be evaluated in relation to the age of the deposits.

Overview of the Archaeological Record and Jornada del Muerto Landscape

The distribution and chronology of the archaeological record will be evaluated within the context of the geomorphology and surface geology. Patterns of archaeological site occupation and geomorphological deposition, erosion, and soil formation will be compared. A comprehensive picture of Jornada del Muerto landscape development and the prehistoric record will be established.

Research Questions

This study is aimed at addressing Research Question 9, which concerns the geomorphic history of the project area and how it relates to the archaeological record. Initial archaeological testing suggests somewhat different sedimentation histories across sites located in the Horizontal and Vertical Launch Areas. At LA 155963 (located in the HLA), much of the site is actively eroding whereas sites in the VLA, such as LA 111420 and LA 111432, are covered with an eolian sediment stabilized by natural grasses.

If a relationship between specific layers of sediments or soils and the occurrence of archaeological materials from various periods of occupation can be established, it might be possible to develop a model that would allow archaeologists to predict where remains from those periods will occur in the project area. This analysis will also make it possible to determine whether archaeological materials in a certain stratum are potentially in place or were deflated onto the surface of a much earlier stratum, which would indicate that materials were no longer in situ, and the original spatial relationship between artifacts no longer exists.

Geographical Information System

A geographical information system (GIS) can be most simply defined as "a computer based system to aid in the collection, maintenance, storage, analysis, output and distribution of spatial data and information" (Blosetad 1:2002). Use of GIS as a management tool to assist in data collection and analysis during archaeological projects has been ongoing since the mid 1990's (Tennant 2007) and has become increasingly common during both survey and excavation phases. It is widely used in archaeology for both site and regional data analysis and management (Tennant 2007, Levy et al. 2001).

At its most basic level a GIS is used as a mapping program employing a series of points, lines and polygons (vector data) to represent geo-referenced points on the globe and providing the user with a spatially referenced and scaled map that is projectable at almost any scale. The obvious advantage is that all recorded features are easily located with a Global Positioning System (GPS) unit. The real strength of a GIS though, in addition to its ability to organize data and produce maps, is its ability to analyze spatially referenced data (Moyes and Awe 2000). More integrated approaches employ the use of a series of data layers or a geodatabase. Layers may represent data collected during survey and excavation, in the form of artifact and cultural feature locations, type and frequency, overlayed with relevant environmental data layers (for instance elevation models, soil and botanical surveys, aerial imagery, historic maps and photographs) as a basis for query building. Basic site scale queries can involve the creation of artifact frequency plots for different artifact classes to aid in site structure analysis. Other examples can include buffering around selected features or artifact classes to search for spatial correlation. During excavations of Actun Tunichil Muknal cave, a buffer function in ArcView was employed to search for correlation between bowls and other artifact classes in an attempt to understand ritual site use (Moyes and Awe 2000). On project wide or regional scales, environmental data can be employed to model the proximity of potential water sources or geomorphologic features to site location. In a study of the northern San Diego region, Brewster et al. (2003) used drainage catchment analysis to determine proximity of different water sources to ranked sites in order to model costal hunter gather settlement patterns. Their results indicated that residential base sites were exclusively located in two major catchment systems but that specialized activity sites within a 5 km foraging range were absent from the same basins. Although this example is not necessarily well-suited to the resolution provided by current excavation and survey data in the current project area (the regional data set considered in the San Diego study was extremely dense and robust) the example does illustrate the potential analytic power of a GIS when considering regional data.

Field Methods

A discussion of GIS at Spaceport America requires a detailed appraisal of field methods with regard to mapping, as this forms the basis for geospatial reference. OAS standard data collection methods outlined in Chapter 4 are well-suited to spatial analysis. Data collection will be preformed at 1 meter (m), or finer, resolution and sequential field specimen numbers linked to grid and feature locations within a site can potentially be used to link preliminary data collection with later analysis through a relational database.

To streamline the data collection process, OAS will employ a professional surveyor to locate a series of monuments on each site and reference these monuments to UTM zone 13 NAD 83 (Universal Transverse Mercator Zone 13, North American Datum 83). Although past data was collected by previous archaeological contractors in UTM NAD 27 (the Archaeological Records Management System standard at that time), the 2011 standard has been changed to NAD 83.

These monuments, consisting minimally of two points per site (depending on the size of the site area), will provide a main datum and back sight for a Nikon total station which will, in turn, be employed for the vast majority of site level mapping. Where possible, datum points will be integrated to create a web of datum and back-site points on large sites. The last four numbers of the North and East UTM coordinates, will be adopted for all grid locations and point provenience data. This numbering convention will allow all provenience data to be integrated into a single continuous geo-referenced grid that will cover the entire project area. This will also allow digital data collection files created during site mapping to be minimally modified in order for incorporation as point data into the coverage.

As noted above, mapping of all small sites, and all activity loci within large sites, will be conducted with a Nikon total station. Depending on site size, the total station may be used in conjunction with a Trimble Geo XH 2005 using Terasync software. Because all total station data are spatially interrelated in terms of the way the instrument collects data (i.e. an angle azimuth relationship) the data collected are potentially more precise in terms of spatial relationships than that collected by a GPS unit. On very large sites (LA 111429 and LA 155963), total station mapping of an entire site may be impractical Under these circumstances, the Geo XH using Terrasync/Pathfinder system will be employed to map isolated thermal features, artifacts, geological features, roads and site boundaries. In terms of research impact, the potential precision loss of this approach will be negligible. Though data collected with a Trimble Geo XH are potentially accurate to approximately 15 cm they are also less precise because the errors of all point readings are averaged. Accuracy, on the other hand, depends on the satellite array at any one time. These problems can be mitigated by mapping at times of the day with optimal satellite geometry. All spatial data collected from the field will be incorporated into a coverage using ArcGIS Version 9.3 or newer.

Research Questions

The most obvious and immediate use of GIS at Spaceport America is to address Research Questions 3-6 about the interactions of settlement, land use, access to resources, and subsistence practices. All sites are expected to yield data relevant to these questions. However, such research requires an evaluation of site structure in relation to the locations of different temporal components and to physical setting at both a site and project level. To this end artifact data from testing and surface collection was initially incorporated into the existing site map as point data derived from the Field Specimen (FS) logs. This was used to facilitate initial data checks and give project directors initial indications about artifact densities from both surface collections and preliminary excavations in relationship to features and the natural landscape.

When appropriate, (as in the case of previously collected artifacts) past survey data can potentially be incorporated into this initial site evaluation layer. Excavation data may also be converted to a raster set and interpolated using nearest neighbor or similar analyses to show relative artifact concentrations, or to identify activity loci and potential temporal components. Later, the same method will likely be used to layer data sets from more detailed artifact analysis in order to better define spatial and temporal associations at the site level and ultimately at the project level.

On the project and regional levels, environmental layers, including aerial photography, 7.5 USGS topographic quads, digital elevation models and contour data, will be overlaid with excavation (and potentially survey) data to help address research questions about the interplay between settlement, land use and access to resources throughout time. Because access to both water and stone materials figured prominently in the research design, hydrology and geology layers may be added to the analysis as well.

Hypothetically, the same coverage may be used to examine the relationship between the overall geologic stratigraphy of the project area and the locations within them of archaeological remains from various periods of occupation. Exposed paleosols identified by the project geomorphologist may be distinguishable by soil color from the air. If so, areal imagery could be used to examine Research Question 9 by more readily identifying the interplay between environmental processes and site formation.

Ground Stone Artifacts

Ground stone analysis has evolved considerably due to the innovative work of several researchers. Adams (1999, 2002, 2010), Hard (1986, 1996), and Lancaster (1986) provide analytical tools which greatly assist in functional understanding. Adams (1999) and Wright (1994) have stressed that subsistence strategies and artifact function cannot be derived from ground stone tool morphology alone, but must rely on tool wear and ethnographic sources. Both Adams and Wright argue against assigning single functions to ground stone tools, emphasizing their multifunctional nature in hunter-gatherer economies. Adams' use wear experiments underscore the need for detailed analysis of the use wear surface so that function, processing strategies, and desired end-product can be determined (1999). The relationship between tool size and degree of agricultural dependence has been delineated by Hard (1986, 1990, 1996). Lancaster sought to assign mano size categories with gathered or cultivated foods. Many of the attributes and interpretations from these studies will be applied to the Spaceport ground stone analysis, with the goal of understanding the relationship between tool morphology and wear to define function and processing strategies to the furthest extent possible.

Ground Stone Analytic Methods

All artifacts will be analyzed for a series of attributes used to record information on the type of material used for manufacture as well as the function(s) of a tool. **Material type** records the basic stone from which a tool was made, using a series of codes consistent with those applied to the chipped stone analysis. **Texture** and **induration** supplement material descriptions, providing more detailed information on material type choice and, sometimes, source. By examining **function(s)** it is possible to define the range of activities in which ground stone tools were used. Because these tools are usually large and durable, they may undergo a number of different uses during their lifetime, even after being broken. Several attributes are designed to provide information on the manufacture and life history of ground stone tools, including **dimensions** (including weight), **cross section shape, evidence of heating**, **portion**, **ground surface sharpening**, **wear patterns**, **alterations**, **number of uses**, **number of wear surfaces or edges**, and the presence of **adhesions**. These measures can help identify post-manufacturing changes in artifact shape and function, and describe the value of an assemblage by identifying the amount of wear or use. Such attributes as material type, material texture, **production input**, **shaping methods**, **preform morphology**, and **plan view outline form** provide information on raw material choice and the cost of producing various tools. **Mano cross-section form** and **ground surface cross-section** are specialized measures aimed at describing aspects of form for manos and metates, since as these tools wear they undergo regular changes in morphology that can be used as relative measures of age.

It should be noted here that function consists of very broad terminology, such as handstone or netherstone (Adams 2002: 98). Subgroups of these broad categories will be defined only when analysis is complete. The goal of this approach is to avoid assigning function based on tool morphology alone, enabling incorporation of use-surface attributes. Use-surface attributes have great information potential, informing on the stroke(s) used to manipulate tools (both horizontal and vertical movement), the degree of desired control, multiple uses, the type of netherstone or handstone companion tool, and degree of use. Various combinations of these factors may denote a specific processing strategy. This approach differs from defining relative dependence on gathered versus planted foods. Rather, tool configuration may indicate the extent to which foods are being processed into flour (Adams 1999: 479). This applies to wild and cultivated food, as processing strategies may overlap for both. Tool design may also be related to grinding of wet or oily foods versus dry, which affects storage life (Adams 1999:485-486).

So that these processing strategies may be better understood, the use-surface of ground stone tools will be analyzed for a number of attributes. Utilized surfaces and edges will be analyzed individually for dimensions, texture, sharpening, transverse and longitudinal contour shape and **microscopic wear patterns. Macroscopic wear type** and **location** can provide a great deal of information about artifact function, and can often differentiate artifacts which appear to have identical functions (Adams 2010). **Edge angle** will be measured for modified or worn edges. Wear and contour attributes together will inform on the **type of stroke used to manipulate the mano** and **the type of base companion stone used** (Adams 2002: 100-114). These will aid in the definition not only of processing strategies, but will greatly enhance the identification of multifunctional tools. Adams' terminology for mano surface and edges are employed (2002: 45), so that the location of all cultural modification is clear.

Research Questions

Ground stone has been found on the majority of sites potentially impacted by the construction at Spaceport America. Ground stone analysis will be particularly useful in addressing Research Questions 5 and 6 by providing information on some of the subsistence-related tasks that occurred at the project area sites, how those tasks may have varied through time and where they occurred on sites. At LA 111429 and LA 155963, concentrations of ground stone artifacts suggest discrete plant processing activity areas. Variety in the types and shapes of ground stone tools should reflect a similar range in the types of tasks for which they were used. Should any ground stone specimens recovered from subsurface contexts provide us with the ability to obtain pollen wash samples, those data will aid in addressing these questions by providing important supplementary information on plant use.

Tool stone source identification will rely initially and most heavily on accurate material type identification, and may be useful in looking at Research Question 4 concerning site location in relation to critical resources other than water, especially if evidence for the manufacture of ground stone tools is found at one or more sites. These data may also be useful in examining Research Question 8 by identifying some of the areas to which site occupants were tied through the identification of nonlocal materials.

Material identification can be done by examining color, grain size, degree of cementation, and identification of as many mineral inclusions as possible. Tool stone may be obtained from mountain, riverine and arroyo gravel sources. If possible, all source options in the vicinity of the project area will be visited to obtain material samples. Within the immediate project vicinity is Jornada Draw, a possible source of gravels, and Prisor Hill, comprised of volcanic rock. More distant material sources may be found in the Doña Ana Hills to the south, and the San Andres Mountains to the east. Possible sources to the west include the Rio Grande, the Fra Cristobal Range and the Caballo Mountains. Gravel sources offer the opportunity to view both favored and rejected material, informing on material preference other than assemblage constituents. Exotic material sources will also be identified, if possible, to ascertain regional interaction.

Procurement costs will also be reflected in the assemblage. If quarry sources are distant or tool stone is scarce, the assemblage will manifest a high percentage of multifunctional tools, bifacial use, thin cross sections, reshaping and reuse of fragments, and an abundance of surface rejuvenation. Sites near water will have, theoretically, had access to a greater variety of plant and animal resources, requiring a broader tool kit with which to process them. These data may be useful in examining Research Question 3 concerning how site location and water variability were related through time.

In the Jornada Mogollon region, where farming did not make a significant impact on the economy until AD 1000 (Hard and Roney 2005: 141), many temporal constants existed among ground stone tools. As a result, ground stone tools are not considered more than very general temporal indicators. However, potential exists for these tools to more accurately inform on chronology. Expanded descriptive data are fundamental to this, permitting subgroups of larger functional categories to be formed. General groupings are useful, but can obscure task-specific information or ancillary functions unless the use-surface is considered. Chronometric data obtained from the project excavations may allow these detailed subgroups to be temporally defined. Where this is possible, the picture of ground stone tool development may emerge in greater detail within the Jornada Mogollon region, and these data can be applied to examination of Research Questions 4 and 5.

The Spaceport America project offers a unique opportunity for comparisons with two ground stone assemblages recovered from sites in south-central and southeastern New Mexico. Because the culture history of different parts of the Jornada Mogollon area may vary, these comparisons with the other projects may be of particular interest. An analysis similar to that proposed for the Spaceport has been recently completed for ground stone assemblages from the U.S. 54 excavations near Carrizozo in the Tularosa Basin and from the N.M. 128 (Loving Lakes) project near Carlsbad (analyses in progress at OAS). The Carrizozo area is also located in the Jornada Mogollon region, while the Loving Lakes area is located in a possibly related region. Subsistence strategies vary between sites in the different project areas, providing a valuable comparative opportunity. The use-surface analysis of the N.M. 128 assemblage identified a high percentage of multifunctional tools and artifacts with both typical and atypical uses. This resulted in the recognition of a functionally specialized mano subgroup. Thus, expanded use-surface analysis will greatly assist in defining ground stone tool roles at sites in the Spaceport America project area.

Site function can also be defined through the presence of ground stone site furniture, trash accumulations, tool use-life stages, including reshaped and reused items, and multifunctional tools. The spatial distribution of tool groups and assemblage characteristics is fundamental to an understanding of site function, as well as spatial associations of ground stone with features and other artifact types. These factors will also be used to identify various ground stone activity areas. These data will be used in addressing Research Question 6, by providing information on differences or similarities in how areas were used on sites.

Several assemblage characteristics will inform on site settlement patterns and seasonality (Research Questions 5 and 6). For example, the longer term cold season settlements of the Early Archaic, if present, should reflect a variety of processing strategies. Because a wide range of foods gathered during warm season foraging trips will be stored and consumed at these sites, tools may have a variety of tool and use-surface morphologies, site furniture, various stages of tool use-life, a high percentage of fragmentary tools, and possibly, smaller dimensioned use-surfaces. Repeatedly occupied sites, as in the case of LA 111429, may reflect a similar pattern, though with greater accumulations of trash. In contrast, short-term foraging camps and single-use sites, such as LA 112370, LA 112371, and LA 112374, should have comparatively lower frequencies of the same characteristics, with a more restricted range of activity. While tools may be specialized at these sites, multifunctional tools and reworked tool fragments should be fewer in number, reflecting a more limited range of resources.

LA 111422, LA 111429, and LA 155963, with Doña Ana and later Formative phase components, pose an interesting challenge. Opinion ranges considerably regarding changes in ground stone tool morphology and their implications regarding the inclusion of cultigens into the diet. Hard has argued that mano size increases with the importance of cultigens in the diet (1986, 1990, 1996). Adams (1999) and Wright (1994) link tool morphology to processing strategy, suggesting that a variety of methods can be used for both gathered and planted foods. Differentiating tools used for cultigens from those used for gathered foods may be particularly problematic in the project area, as cultivated foods supplemented, rather than dominated, gathered foods until the El Paso phase. There may be considerable overlap in processing methods for both types of food resources. Size alone may not be sufficient to delineate the two, as Adams suggests that the larger tools associated with cultigen processing may reflect a heavier reliance on flour rather than more efficient function (1999: 479). Ground stone surface adhesions such as pollen and corn starch grains may assist with this issue, as will results of the ethnobotanical analysis and paleoenvironmental study.

Human Remains

Appendix 2 contains the legal framework and general procedures that will be followed should human remains be encountered during OAS excavations, including tribal consultations. NMSA officials will be contacted as outlined in Appendix 2. Once the official consultations are complete, the human remains on NM SLO property will be excavated under the 2010 and 2011 annual burial permits issued to the Office of Archaeological Studies. Following the permit provisions, the intent to use the annual permit will be submitted in writing by OAS to the State Historic Preservation Officer (SHPO) before excavation of the burials begins. This document will include a legal description of the location of the burial, the written authorization from the landowner to remove the burial, a description of the procedures to be implemented to identify and notify living relatives of the burials, certification that the law enforcement agency with jurisdiction in the area has been notified, a list of personnel supervising and conducting excavations of the human burial, and the NMCRIS LA Project/Activity Number for the permitted excavation. The Sierra County Sheriff's Department and the state medical investigator (who will determine if the burial is of mediolegal significance) will be notified by either NMSA or OAS. Procedures for human remains found on BLM land are similar and are outlined in Appendix 2.

Excavation Procedures

Human burials will always be treated with the utmost dignity and respect. Excavation will not proceed until after the appropriate officials have been notified and the procedures outlined in Appendix 2 have been completed. Excavation will be consistent with current professional archaeological standards. This generally includes the identification of a burial pit and careful removal of fill within the pit. When possible, half the fill will be removed to provide a profile of the fill in relation to the pit and the burial. The pit, pit fill, burial goods, and burial will be examined and recorded in detail on an OAS burial form with special attention paid to any disturbance that may have taken place. Plans, profiles and photographs will further document the burial and associated objects. Flotation and pollen samples will be taken from all burials. Disarticulated or scattered remains will be located horizontally and vertically and photo documented. The potential cause of disturbance or evidence of deliberate placement will be recorded in detail, along with any physically associated materials.

Analysis Methods

The analysis of human remains will follow the procedures set out in *Standards for Data Collection From Human Skeletal Remains* (Buikstra and Ubelaker 1994). This comprehensive system collects the maximum amount of comparable information by recording the same attributes and by using the same standards. Documentation on how a series of 29 attachments should be recorded includes the following information.

(1) An inventory sheet records codes for each element that makes up a skeleton. Diagrams of infant, child, and adult skeletons and anatomical parts allow for the location of observations concerning these parts. Another form records codes assigned to commingled or incomplete remains.

(2) Adult sex is determined by examining aspects of the pelvis and cranium. Age changes are documented on the pubic symphysis using two sets of standards, one for changes observed on the auricular surface of the ilium, and one for documenting cranial suture closure.

(3) For immature remains, the age-at-death is determined by scoring epiphyseal union, union of primary ossification centers, and measurements of elements.

(4) Recording of dental information includes an inventory, pathologies, and cultural modifications. Each tooth is coded and visually indicated as "present" and whether it is in place, unobservable, damaged, congenitally absent, or lost pre-mortem or post-mortem. Tooth development is assessed; occlusal surface wear is scored; caries are located and described; abscesses are located; and dental hypolasias and opacities are described and located with respect to the cemento-enamel junction. Any pre-mortem modifications are described and located.

(5) The secondary dentition is measured and dental morphology is scored for a number of traits.

(6) Measurements are recorded for the cranium (n=35), clavicle, scapula, humerus, radius, ulna, sacrum, innominate, femur, tibia, , fibula, and calcaneus (n=46 postcranial measurements).

(7) Non-metric traits are recorded for the cranium (n=21), atlas vertebra, seventh cervical vertebra, and humerus.

(8) Post-mortem or taphonomic changes are recorded when appropriate. These include color, surface changes, rodent and carnivore damage, and cultural modification.

(9) The paleopathology section groups observations into nine categories: abnormalities of shape, abnormalities of size, bone loss, abnormal bone formation, fractures and dislocations, porotic hyperostosis/cribra orbitalia, vertebral pathology, arthritis, and miscellaneous conditions. The element, location, and other pertinent information are recorded under each category.

(10) Cultural modifications, such as trepanation and artificial cranial deformation, are recorded in another set of forms.

Standards (1994:174) recommends that, for burials that will be repatriated, the following samples should be curated for future analysis. These include: The middle portion of a femur midshaft (at least 100 g) that can be used for radiocarbon dating, trace element analysis (diet), stable isotope ratios (climate and diet), strontium (population movement), bone geometry (activity patterns), histomorphometry (age and health), and aspartic acid (age and health); several teeth (the upper central incisor, lower canines and premolars, and lower second molar) for histomorphometric analysis, cementum annulation (root), aspartic acid (dentin), isotope studies (enamel), and future studies of linear hypoplasias and enamel microwear patterning; 5 grams of trabecular bone for DNA extraction; the middle third of a clavicle and rib six for age-at-death, health studies, and morphological age assessments; and finally, two sections of the right femur and one section each of the humerus or, alternately, CT scans of both to assess the level and type of behavior. No such samples will be collected, however, without the express permission of the SHPO and landowner.

Native American tribes will also be consulted regarding a decision to collect samples.

Research Design Questions

The central basin sites that will be investigated at the Spaceport America project area are not the types of sites that typically have human burials. Cultural groups, like those who inhabited the project area, generally depended on widely dispersed, seasonal, or mobile resources and rarely stayed in the same location long enough for deaths to occur. When they did, interment would not necessarily have been in the space used for camping or processing resources. Although pit structures may be present at LA 155963 and these structures could represent a possible location for interment after abandonment.

Preservation is likely to be poor in these shallow sites with little deposition and considerable deflation. Thus, rather than complete burials, human remains found will likely consist of scattered fragments of bone or partial inhumations.

The primary aim of the human skeletal analysis and reporting will be to completely describe the conditions of burial and the individual and to put these into a regional context. Even a single individual can provide some information on mortuary practices and the general health and habits of a group.

Researchers have long debated whether mobile hunter gatherers or more sedentary agriculturalists worked harder and which group was healthier. Results vary by location, the time period represented, and other factors. With humans from small populations, which would most likely be typical of any recovered during this project, it is expected that any human remains found would have derived from either mobile groups, or from groups based elsewhere. Thus, one focus for the Spaceport America project sites is likely to be determining where the burial falls in the temporal and cultural sequences (Research Questions 1 and 2). That is, does the burial represent a group of mobile hunters and gatherers or are they part of a more sedentary group that spent portions of the year extracting resources from the central basin area? At least two types of data – dental characteristics and postcranial metrics – can address this particular issue.

Tooth wear, caries, and tooth loss are closely related to diet, so their presence and frequencies have the potential to inform on the relative contribution of carbohydrates, especially corn, to the diet. Researchers have noted an increase in caries through time, especially in recent complex societies. In Eastern North America, studies demonstrate an increase in caries with the introduction and intensification of maize agriculture (Larsen et. al. 1991:179-180, 198). As a result, we would expect that hunter gatherers would have less wear, fewer caries, and less tooth loss than groups relying largely on agriculture. While it would be ill advised to characterize mobility and subsistence strategy based on a small sample of individuals, this type of data would provide another piece of evidence to be considered in conjunction with subsistence remains, ground stone, chipped stone, and other artifact classes.

The size, shape, and robusticity of long bones reflect the type and level of activity in both modern and prehistoric populations. Bone tissue responds in the direction of functional demand. To counteract the effect of mechanical loading, the size and shape change as new bone is added to the region of the bone where the strain is greatest. More remodeling occurs with low or moderate intensity and repeated use than sporadic high intensity use (Bridges 1989:387). One such measurement is the femoral index, calculated by dividing the mid-shaft anterior-posterior diameter by the medio-lateral mid-shaft diameter of the femur. An index of 1.00 is round while a more ovoid shape (higher index) indicates mechanical loading or pull on the back of the femur, which is arguably an indicator of mobility. Another measurement is the maximum diameter of the humerus at mid-shaft. Males using their arms for throwing or drawing back a bow string should have this reflected in the development of the deltoid process and this development can, in turn, be monitored by this measurement. Similarly, females would display increased development of the deltoid process from habitual corn grinding. Again, information from a single individual or small group would hardly be definitive but could add additional evidence and could be compared to larger populations with better defined subsistence practices.

A second goal would be to evaluate the general health of any individual recovered as a human burial. Such an evaluation could be used to address Research Design questions 2 and possibly questions 3, 4, and 5 (this volume). Most researchers look at a variety of skeletal and dental indicators of stress to assess general health. Poor diet, infectious disease, parasitic infestations, and heavy workloads contribute to physiological stress. When the diet is deficient in essential nutrients or is insufficient to resist opportunistic infectious disease, a number of biological stress markers can occur. Among these are reduced tooth and body size in adults, dental and skeletal asymmetry, dental crowding, caries, abscesses, enamel defects, evidence for increased risk of spina bifida, and indications of specific deficiencies such as rickets and scurvy (Cook and Powell 2006:310; Martin 1994:94-95). In both hunters and gatherers and sedentary agriculturalists, infectious disease was the major cause of death, killing up to one third of infants and many adults. Yet, these rarely leave any evidence on the skeleton. When abnormal bone is found, this skeletal evidence is usually the result of chronic conditions that did not necessarily lead to death (Ortner 2003:180-181).

Evaluating any human burials will require the almost exclusive examination of gray literature reports on human burials recovered from southern New Mexico (Research Design question 8). Dental data, measurements, and general health data from the Pecos Valley (e.g. the Townsend site, Akins 2003, and the Henderson site, Rocek and Speth 1986), the Mimbres area west of the Rio Grande, and Jornada Mogollon sites to the south will provide a basis for evaluating and comparing this population with those in the surrounding region.

X-Ray Fluorescence Spectrometry and Obsidian Sourcing Studies

Previous archaeological surveys (Duran 1986; Gibbs 2008; Human Systems Research 1997; Lawrence 2010; Quaranta and Gibbs 2008) within the current project area have identified only a handful of obsidian artifacts. However, these artifacts have the potential to address research questions regarding interactions between inhabitants of the Jornada del Muerto with other areas within the greater Southwest. This section briefly examines x-ray fluorescence spectrometry as an analytical method for sourcing obsidian artifacts and how this technique can be applied to addressing questions proposed in the current data recovery plan.

As discussed in Glascock et al. (2008:18-19), the chemical composition of most volcanic obsidian ranges between 70-75% SiO_2, 10-15% Al_2O_3, 3-5% Na_2O, 2-5% K_2O and 1-5% total Fe_2O_3 + FeO. Perlkaline obsidians are typically higher in Fe composition than rhyolitic obsidians. In addition, the intrinsic water content of obsidian ranges from 0.1-0.5% and water content increases to about 3.5% by weight as rhyolitic obsidian gradually transforms into a less useful form of the glass known as perlite. Most of the remaining elements in obsidian are present in concentrations much less than 1% and are therefore referred to as trace elements.

The success of chemical sourcing is due to the fact that these trace element compositions may differ by one or two orders magnitude between sources, while within-source variation is usually much smaller (Glascock et al. 1998:19). In a few cases, within-source variation in elemental composition can be considerable (e.g. Bowman et al. 1973). Nevertheless, the correlation in variation between certain elements is so extraordinary that the ability to assign artifacts to the source is just as certain as if the obsidian flow were homogenous. Other sources have been discovered where a collection of individually homogenous and discrete flows have been reported (e.g. Hughes 1988). Obsidian artifacts from these sources can be assigned to specific sub-sources.

One analytical method developed to characterize these sources is x-ray fluorescence spectrometry (XRF). In XRF, a beam of x-rays irradiates the specimen causing displacement of atomic electrons from the inner energy levels. As electrons from outer levels repopulate these vacant inner levels, energy is emitted in the form of fluorescent x-rays. Because the energy levels are unique for each element, these x-rays have characteristic energies that permit identification of the element. By measuring the intensities of emitted x-rays, one can determine the quantities of elements present in a specimen (Glascock et al. 1998:19).

The OAS purposes to use an XRF laboratory listed with the International Association of Obsidian Studies (IAOS), such as the Berkley Archaeological XRF Lab directed by M. Steven Shackley or the Geochemical Research Lab directed by Richard E. Hughes. Such labs have the potential to perform both wavelength-dispersive (WD-XRF) and energy-dispersive (ED-XRF) x-ray fluorescence analyses and most have long track records of interpreting results from the Southwestern United States and Northern Mexico (Shackley 1988, 1995, 2005, 2009). For this study, ED-XRF will be utilized to characterize samples sent from the Spaceport America. ED-XRF is particularly adapted to non-destructive analyses of archaeological obsidian, and unlike WD-XRF can analyze larger samples, and can acquire elements Ti, Mn, and Fe with greater precision (http://www.swxrflab.net). Trace elements slated to be measured include: Ti, Mn, Fe, Co, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Pb, and Th.

To select samples for XRF analysis, the OAS will first perform its standard chipped stone analysis (discussed in Chapter 8 of this report). A judgmental sample of each obsidian material type identified will then be sent for XRF analysis to confirm, deny or clarify the assertions by the analyst using only cosmetic qualities to source the material. This sample will include all obsidian tools as ED-XRF analysis is nondestructive. If fewer than 50 obsidian artifacts are collected, all will be sent for ED-XRF.

Potential sources of obsidian utilized by populations in the Jornada del Muerto include: the Jemez Mountains, Mount Taylor, Gwynn Canyon, Mule Creek, Red Hill, Antelope Wells, Sierra Fresnal, Sierra la Brena, Agua Fria, Ojo Fredrico, Lago Barreal and Los Jagueyes. According to Baugh and Nelson (1989), there are at least seven distinct Jemez obsidian sources, each associated with different geographically areas: Banco Bonito, Valle Grande, Cerro Toledo/Rabbit Mountain, El Rechuelos (Polvadera Peak), Bearhead, Paliza Canyon, and Canovas Canyon (aka Bear Springs Peak). Of the seven, Valle Grande and is often considered to be of the highest quality because of its exceptional fracture properties and tendency to outcrop in cobble size and larger fragments (Steffen and Letourneau 2008). Cerro Toledo/ Rabbit Mountain and El Rechuelos are also of adequate quality and are found in adequate sizes to allow for human utilization on a large-scale. However, these materials are often found as small water worn nodules within the Rio Grande gravels throughout northern, central and southern New Mexico. Canovas Canyon may be found in small marekanites, or apache tears, around Walatowa (present day Jemez Pueblo). It is unclear if these marekanites have ever been found in substantial quantities within the Rio Grande gravels. Gwynn Canyon, Mule Creek and Red Hill are found far to the west of the Jornada del Muerto in or north of the Gila Mountains and cannot occur within the current project area unless carried over the continental divide by humans. Antelope Wells is located in New Mexico's boot heel region (Shackley 1988) and also cannot occur naturally in or near the Jornada del Muerto. Sierra Fresnal, Sierra la Brena, Agua Fria, Ojo Fredrico, Lago Barreal, and Los Jagueyes are all found in northern Mexico.

Research Questions

Obsidian artifacts are a rarity on the central basin sites that will be investigated at Spaceport America. However, small quantities of chipped stone obsidian artifacts were identified at LA 111420 and an obsidian projectile point was recovered from LA 155963 during archaeological testing.

If obsidian source information can be tied to chronometric data, artifacts recovered from Spaceport America could be used to examine Research Question 8 concerning how interactions between inhabitants of the Jornada del Muerto and other regions of New Mexico have changed over time. As discussed in Chapter 4 of the current data recovery plan, it has been suggested that exchange ties in the southern Jornada region were aligned along a north-south axis during the Archaic, shifting to an east-west alignment during the Mesilla phase, and back to a north-south alignment during the Doña Ana and El Paso phases (Miller and Kenmotsu 2004). It is possible that these interactions may be visible within the obsidian assemblage. If so, sites dating to the Archaic Period and Doña Ana and El Paso phases would be expected to yield obsidian materials from locations such as the Valle Grande, Mount Taylor and Sierra Fresnal. Whereas Mesilla phase sites should contain obsidian from sources in or near the Gila Mountains, such as Gwynn Canyon, Mule Creek, or even Red Hill. If the Antelope Wells source was to be found in the current project area, it could indicate clear economic ties to the New Mexico boot heel region. Ojo Fredrico may point to ties with Casas Grandes in northern Chihuahua.

Research Results

A final report on the testing and data recovery program at Spaceport America will be published by the Office of Archaeological Studies in the *Archaeology Notes* series. This report will comply with final technical report standards presented in 4.10.16.15 NMAC and with guidelines discussed in BLM handbook H-8100-1. The report will describe the site excavations, report the analytical results, and present interpretive summaries. It will include photographs, site and feature maps, and data summaries. In accordance with 4.10.16.16 NMAC, upon project completion, a popular article will also be prepared.

Field maps and notes, analytical data sheets, and photographs will be deposited with the Archeological Records Management Section of the New Mexico Historic Preservation Division. Artifacts will be curated at the Museum of New Mexico Archaeological Research Collection facility under the OAS curation agreement with the Museum of Indian Arts and Culture. Fire cracked rock and unprocessed bulk sediment, thermoluminescence, optically stimulated luminescence, pollen, and flotation samples will not be curated. If massive quantities of Historic Euroamerican artifacts are encountered, they will be curated under the sampling strategies discussed in the Euroamerican artifact analysis section.

References Cited

Adams, Christopher D., Diane E. White and David M. Johnson

2000a *Dark Canyon Rancheria Apache/Military Battle Site*. Lincoln National Forest Heritage Program. Southwestern Region, USDA. Alamogordo, New Mexico.

2000b *Last Chance Canyon 1869 Apache/Cavalry Battle Site*. Lincoln National Forest Heritage Program. Southwestern Region, USDA. Alamogordo, New Mexico.

Adams, Jenny L.

1999 Refocusing the role of Food Grinding Tools as Correlates for Subsistence Strategies in the U.S. Southwest. *American Antiquity* 64(3):475–498.

2002 *Groundstone Analysis, a Technological Approach.* University of Utah Press, Salt Lake City.

2010 Understanding Grinding Technology through Experimentation. In *Designing Experimental Research in Archaeology: Examining Technology Through Production and Use* edited by Jeffrey R. Ferguson. University Press of Colorado.

Agogino, George A.

1968 A Brief History of Early Man in the Western High-Plains. In *Early Man in North America*, edited by C. Irwin-Williams, pp. 1-5. Eastern New Mexico University Contributions in Anthropology 1(4):1-5. Portales.

Akins, Nancy J.

2000 Fauna. In *Bob Crosby Draw and River Camp: Contemplating Prehistoric Social Boundaries in Southeastern New Mexico* by Regge N. Wiseman, pp. 81-85. Museum of New Mexico, Office of Archaeological Studies, Archaeology Note 235, Santa Fe.

2002 Fox Place Fauna. In *The Fox Place: A Late Prehistoric Hunter-Gatherer Pithouse Village near Roswell, New Mexico* by Regge N. Wiseman, pp. 133-156. Museum of New Mexico, Office of Archaeological Studies, Archaeology Note 234, Santa Fe.

2003 *Salt Creek; Data Recovery at Seven Prehistoric Sites along US 285 in Chaves and De Baca Counties, New Mexico*. Museum of New Mexico, Office of Archaeological Studies, Archaeology Note 298, Santa Fe.

2004 Changing Patterns of Animal Use at Fallen Pine Shelter. In *Fallen Pine Shelter: 3,000 years of Prehistoric Occupation on the Mescalero Apache Reservation* by Yvonne R. Oakes, pp. 99-136. New Mexico Department of Transportation Cultural Resource Technical Series 2004-2 and Museum of New Mexico, Office of Archaeological Studies, Archaeology Note 325, Santa Fe.

2005 Archaic Animal Subsistence in Fresnel Canyon. In *High Rolls Cave: Insectos, Burrito, Y Frajos: Archaic Subsistence in Southern New Mexico*, by Stephen C. Lentz, 85-144. Office of Archaeological Studies, Archaeology Note 345, Santa Fe.

Allen, B. D.

1994 *Ancient Lakes: A Tool for Understanding Climatic Change*. Lite Geology, Summer 1994. New Mexico Bureau of Mines and Mineral Resources.

2005 *Ice Age Lakes in New Mexico*. New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech, Socorro.

Allen, B. D., and R. Y. Anderson

2000 A Continuous, High-Resolution Record of Late Pleistocene Climate Variability from the Estancia Basin, New Mexico. *Geological Society of America Bulletin* 112:1444–1458.

Allen, B. D., D. W. Love, and R.G. Myers

2005 *Hydrologic and Wetland-Habitat Response to Late Quaternary Climatic Change, Northern Tularosa Basin, New Mexico, Determined* *by Sedimentology and Geomorphology.* New Mexico Water Research Symposium, Socorro, 16 August, 2005.

2009 Evidence for Late Pleistocene Hydrologic and Climatic Change from Lake Otero, Tularosa Basin, South-Central New Mexico. *New Mexico Geology* 31:9-14.

Amick, Daniel S.
1994 *Folsom Diet Breadth and Land Use in the American Southwest*. Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

1996 Regional Patterns of Folsom Mobility and Land Use in the American Southwest. *World Archaeology* 27:411-426.

Anschuetz, Kurt F.
1990 Archeological Background. In *Landscape Archeology in the Southern Tularosa Basin,* vol. 1, *Small Site Distributions and Geomorphology*, edited by K. Anschuetz, W. Doleman, and R. Chapman, pp. 17-37. Office of Contract Archeology, University of New Mexico, Albuquerque.

Anschuetz, Kurt F., and Timothy J. Seaman
1987 Fear and Loathing in the Tularosa Basin: An Evaluation of the Current Debate over the Doña Ana Phase. Paper presented in the General Session of the Fifth Jornada Mogollon Conference, Tularosa, New Mexico.

Anschuetz, Kurt F., Peter N. Eschman, and William H. Doleman
1990 Survey Results. In *Landscape Archeology in the Southern Tularosa Basin,* vol. 1, *Small Site Distributions and Geomorphology*, edited by K. Anschuetz, W. Doleman, and R. Chapman, pp. 67-130. Office of Contract Archeology, University of New Mexico, Albuquerque.

Antevs, E.
1948 *The Great Basin with emphasis on glacial and postglacial times*. University of Utah Bulletin 38, 168-191.

Asmerom, Yemane, Victor Polyak, Stephen Burns and Jessica Rassmussen
2007 Solar forcing of Holocene Climate: New insights from a Speleothem Record, Southwestern United States. *Geology*. 35(1):1-4.

Athearn, Frederic J.
1974 *Life and Society in Eighteenth-Century New Mexico, 1692-1776*. Ph.D. Dissertation, Department of History, The University of Texas at Austin. University Microfilms International (no. 74-24,825), Ann Arbor, Michigan.

Baillie, M. G. L.
1994 Dendrochronology Raises Questions about the Nature of the AD 536 Dust-Veil Event. *The Holocene* 4(2):212-217.

Ball, Eve
1970 *In the Days of Victorio: Recollections of a Warm Springs Apache*. University of Arizona Press, Tucson.

Bannon, John Francis
1963 *The Spanish Borderlands Frontier, 1513-1821*. Holt, Rinehart, and Winston, Inc., New York (1974 edition by University of New Mexico Press, Albuquerque).

Baseheart, Harry W.
1974 Mescalero Apache Subsistence Patterns and Socio-Politico Organization. In *Apache Indians* XII. Garland Publishing, New York.

Batcho, David G., David L. Carmichael, Meliha Duran, and Margaret Johnson
1985 *Archaeological Investigations of Sites Located at the Southern Dona Ana County Airport, Santa Teresa, New Mexico.* Part 1. Cultural Resources Management Division Report No. 533. New Mexico State University, Las Cruces.

Battelle Pacific Northwest Laboratories
1981 *Computer-Enhanced Geophysical Survey Techniques for the Location of Underground Objects and Structures*. Report by Battelle Pacific Northwest Laboratories, Richland, Washington.

Baugh, Timothy G.

1984 Southern Plains Societies and Eastern Frontier Pueblo Exchange during the Protohistoric Period. In *Collected Papers in Honor of Harry L. Hadlock*. edited by Nancy L. Fox, pp. 157-167. Papers of the Archaeological Society New Mexico. 9. Albuquerque.

Baugh, Timothy G. and Fred W. Nelson
1987 New Mexico Obsidian Sources and Exchange on the Southern Plains. *Journal of Field Archaeology* 14(3):313-329.

Baugh, Timothy, and Mark T. Sechrist
2001 *Protohistoric Apachean Adaptations within the Basin and Range Province of South-Central New Mexico and West Texas: A Perspective from the Fort Bliss Reservation*. TRC Mariah Associates, Inc., El Paso.

Beckes, M. R., and J. M. Adovasio
1982 Perspectives on the Origins and Affinities of Mogollon on the Eastern Periphery. In *Mogollon Archaeology: Proceedings of the 1980 Mogollon Conference*, edited by P. Beckett, pp. 201-209. Acoma Books, Ramona California.

Beckett, Patrick H.
1984 The Manso Problem. In *Views of the Jornada Mogollon: Proceedings of the Second Jornada Mogollon Archaeology Conference*, edited by C. Beck, pp. 148-150. Eastern New Mexico University Contributions in Anthropology, vol. 12. Portales.

1994 Historic Relationships to Prehistoric Populations. In *Mogollon VII: The Collected Papers of the 1992 Mogollon Conference*, edited by P. Beckett, pp. 163-171. COAS Publishing and Research, Las Cruces.

Beckett, Patrick H., and Terry L. Corbett
1992 *The Manso Indians*. Coas Publishing and Research, Las Cruces, New Mexico.

Bell, Willis H., and Edward F. Castetter
1937 The Utilization of Mesquite and Screwbean by the Aborigines in the American Southwest. *University of New Mexico Bulletin, Biological Series* 5(2).

1941 The Utilization of Yucca, Sotol, and Beargrass by the Aborigines in the American Southwest. *University of New Mexico Bulletin, Biological Series* 5(5).

Bender, Barbara
1978 Gather-Hunter to Farmer: A Social Perspective. *World Archaeology* 10:204-222.

Berry, Claudia F. and Michael S. Berry
1986 Chronological and Conceptual Models of the Southwestern Archaic. In *Anthropology of the Desert West – Essays in Honor of Jesse D. Jennings*, edited by Carol J. Condie and Don D. Fowler, pp. 253-327. University of Utah Anthropological Papers No. 110, University of Utah Press, Salt Lake City.

Bentley, Mark T.
1993 Hot Well Village and Reservoir: A Preliminary Overview. *The Artifact* 31(2):1-32.

Betancourt, J. L., K. A. Rylander, C. Penalba, and J. L. McVickar
2001 Late Quaternary vegetation history of Rough Canyon, south-central New Mexico, USA. *Palaeogeorgaphy, Palaeoclimatology, Palaeoecology* 165:71-95.

Betancourt, J. L., T. R. Van Devender, and P. S. Martin,
1990 *Packrat Middens: The Last 40,000 Years of Biotic Change*. The University of Arizona Press, Tucson.

Bilbo, Michael J.
1972 The Castner Annex Range Dam Site EPAS-10: Preliminary Report. *The Artifact* 10(2):59-81.

Binford, Lewis R.
1990 Mobility, Housing, and Environment: A Comparative Study. *Journal of Anthropological Research* 46:119-152.
1991 When the Going Gets Tough the Tough Get Going: Nunamiut Local Groups, Camping Patterns and Economic Organization. In *Ethnoarchaeological Approaches to Mobile Campsites – Hunter-Gather and Pastoralist Case Studies*, edited by C. S. Gamble and W. A. Boismier. International Monographs in

Prehistory – Ethnoarchaeological Series 1.

2001 *Constructing Frames of Reference: An Analytical Method for Archaeological Theory Building Using Ethnographic and Environmental Data Sets*. University of California Press, Berkeley.

Blair, T. C., J. S. Clark, and S. G. Wells
1990 *Quaternary continental stratigraphy, landscape evolution, and application to archeology: Jarilla piedmont and Tularosa graben floor, White Sands Missile Range, New Mexico*. Geological Society of America Special Paper 291.

Bohrer, Vorsila L.
1981 Former Dietary Patterns of People as Determined from Archaic-Age Plant Remains from Fresnal Shelter, South-Central New Mexico. In Archaeological Essays in Honor of Mark Wimberley, edited by Michael S. Foster. *The Artifact* 19(3-4):41-50. El Paso Archaeological Society.

2005 Flotation Analysis from High Rolls Cave. In *High Rolls Cave: Insectos, Burritos, y Frajos, Archaic Subsistence in Southern New Mexico*, by S. Lentz, pp. 183-222. Archaeology Notes No. 345. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Bolstad, Paul
2002 *GIS Fundamentals; A First Text on Geographic Information Systems.* College of Natural Resources, University of Minnesota, St. Paul.

Bowman, H. R., E. Asaro and I. Perlman
1973 On the Uniformity and Composition in Obsidians and Evidence for Magmatic Mixing. *Journal of Geology* 81:312-327.

Boyer, Jeffrey, Charles Hannaford, Guadalupe Martinez and Adisa Willmer
1994 *Historic Artifact Analysis Standardized Variable and Attribute Codes.* Archaeology Notes 24d. Museum of New Mexico Office of Archaeological Studies, Santa Fe.

Brackenridge, G. R.
1978 Evidence for a Cold, Dry, Full Glacial Climate in the American Southwest. *Quaternary Research* 9:22-40.

Bradley, Ronna J.
1983 La Cabrana: A Study of Fourteenth Century Resource Utilization in Southern New Mexico. M.A. thesis, University of Texas at El Paso.

Brethauer, Douglas P.
1979 The Possible Role of Mesquite as a Food Resource in the Jornada Mogollon Region. In *Jornada Mogollon Archaeology: Proceedings of the First Jornada Conference*, edited by P. Beckett and R. Wiseman, pp. 67-80. New Mexico State University, Las Cruces.

Brewster, Alice, Bryan F. Byrd and Seetha N. Reddy
2003 C*ultural Landscapes of Coastal Foragers: An Example of GIS and Drainage Catchment Analysis from Southern California*, in Journal of GIS in Archaeology Volume 1. ESRI, Redlands CA.

Bridges, Patricia S.
1989 Changes in Activities with the Shift to Agriculture in the Southeastern United States. *Current Anthropology* 30(3):385-394.

Brook, George A.
1999 Arid Zone Palaeoenvironmental Records from Cave Speleothems. In *Paleoenvironmental Reconstruction in Arid Lands* edited by A. K. Singhvi, and E. Derbyshire. A. A. Balkema, Rotterdam/Brookfield.

Brook, Vernon R.
1966a The McGregor Site (32:106:16:4; E.P.A.S. 4). *The Artifact* 4(4):1-22.

1966b They Didn't Have to Fill the Larder. *The Artifact* 4(3):1-11.

1967 The Sarge Site: An El Paso Phase Ruin. *The Artifact* 5(2):45-48.

1968a A Folsom and Other Related Points Found near El Paso, Texas. *The Artifact* 6(3):11-15.

1968b A Scottsbluff Point from the Vicinity of El

Paso, Texas. *The Artifact* 6(1):17-20.

1975 Development of Prehistoric House Types in the Jornada Branch. *Awanyu* 3(4):16-31.

1979 An El Paso Astronomical Observatory. In *Jornada Mogollon Archaeology: Proceedings of the First Jornada Conference*, edited by P. Beckett and R. Wiseman, pp. 25-39. New Mexico State University, Las Cruces.

Browman, David L.
1981 Isotopic Discrimination and Correction Factors in Radiocarbon Dating. *Advances in Archaeological Method and Theory*, Vol. 4, pp. 241-295, edited by M. Schiffer. Academic Press, Inc., New York and London.

Brown, David E. (editor)
1982 Biotic Communities of the American Southwest – United States and Mexico. *Desert Plants* 4(1-4).

Brown, Marie E.
1994 Vertebrate Faunal Analysis. In *Excavations at the Cox Ranch Exchange Lands, Doña Ana and Otero Counties, New Mexico*, by P. Gerow, pp. 239-252. Office of Contract Archeology, University of New Mexico, Albuquerque.

Browning, Cody Bill
1991 El Paso Phase Structural Sites in the Southern San Andres Mountains, New Mexico. In *Jornada Mogollon Archaeology: Collected Papers from the Fifth and Sixth Jornada Mogollon Conferences*, edited by M. Duran and P. Beckett, pp. 17-33. Coas Publishing and Research and Human Systems Research, Las Cruces.

Brugge, David M.
1982 Apache and Navajo Ceramics, In *Southwestern Ceramics: A Comparative Review*, Arizona Archaeologist No, 15, edited by A. H. Shroeder, pp 279-298, Phoenix.

Buck, Brenda J., and H. Curtis Monger
1999 Stable isotopes and soil-geomorphology as indicators of Holocene climate change, northern Chihuahuan Desert. *Journal of Arid Environments* 43:357-373.

Buck, Brenda J., and J. G. Van Hoesen
2005 Assessing the applicability of isotopic analysis of pedogenic gypsum as a paleoclimate indicator, Southern New Mexico. *Journal of Arid Environments* 60:99–114.

Buikstra, Jane E., and Douglas H. Ubelaker (editors)
1994 *Standards for Data Collection from Human Skeletal Remains*. Arkansas Archeological Survey Research Series No. 44, Fayetteville.

Buskirk, Winfred
1986 *The Western Apache*. University of Oklahoma Press, Norman.

Cameron, Cathy
1972 An Analysis of "Low Muscle Mass" Bone Fragments in Relation to Hearth Areas at Fresnal Shelter. In *Training Bulletin, Tularosa Valley Project, 1972 Excavations at Fresnal Shelter*, pp. 398-401. Technical Manual, Human Systems Research, Tularosa, New Mexico.

Camilli, Eileen L., LuAnn Wandsnider, and James I. Ebert
1988 *Distributional Survey and Excavation of Archaeological Landscapes in the Vicinity of El Paso, Texas*. USDI Bureau of Land Management, Las Cruces, New Mexico.

Carlson, Roy L.
1970 *White Mountain Redware; A Pottery Tradition of East-Central New Mexico*. Anthropological Papers of the University of Arizona No. 19. University of Arizona Press, Tucson.

Carmichael, David L.
1983 *Archeological Settlement Patterns in the Southern Tularosa Basin, New Mexico: Alternative Models of Prehistoric Adaptations*. Ph.D. dissertation, University of Illinois, Urbana-Champaign.

1984 Possible Archaeological Evidence for Non-Linear Culture Change in the Southern Tularosa Basin. In *Recent Research in Mogollon*

Archaeology, edited by S. Upham, F. Plog, D. G. Batcho, and B. Kauffman, pp. 13-27. New Mexico State University Occasional Papers, No. 10. Las Cruces.

1985a Transitional Pueblo Occupation on Dona Ana Range, Fort Bliss, New Mexico. In *Views of the Jornada Mogollon: Proceedings of the Second Jornada Mogollon Archaeology Conference*, edited by C. Beck, pp. 45-53. Eastern New Mexico University Contributions in Anthropology, vol. 12. Portales.

1985b The Pithouse to Pueblo Transition in the Jornada Mogollon: A Reappraisal. In *Proceedings of the Third Jornada Mogollon Conference*, edited by M. Foster and T. O'Laughlin, pp. 109-118. *The Artifact* 23(1, 2).

1985c *Archaeological Excavations at Two Prehistoric Campsites near Keystone Dam, El Paso, Texas*. University Museum Occasional Papers No. 14. New Mexico State University, Las Cruces.

1986a *Archaeological Survey in the Southern Tularosa Basin of New Mexico*. El Paso Centennial Museum Publications in Anthropology No. 10. University of Texas at El Paso.

1986b Ephemeral Residential Structures at Keystone Site 37: Implications for Interpreting Prehistoric Adaptive Strategies in the El Paso Area. In *Mogollon Variability*, edited by C. Benson and S. Upham, pp. 239-253. University Museum Occasional Papers, No. 15. New Mexico State University, Las Cruces.

Carrillo, Charles M.
2004 A History of Santa Rosa De Lima De Abiquiú. In *Adaptations on the Anasazi and Spanish Frontiers: Excavations at Five Sites Near Abiquiú, Rio Arriba County, New Mexico*, by J. Moore, J. Boyer, and D. Levine, pp. 51-56. Archaeology Notes No. 187. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Castetter, Edward F., and M.E. Opler
1936 *The Ethnobiology of the Chiricahua and Mescalero Apache*. University of New Mexico Bulletin, Biological Series 4(5).

Castetter, Edward F., Willis H. Bell, and Alvin Grove
1938 *The Early Utilization and Distribution of Agave in the American Southwest*. University of New Mexico Bulletin, Biological Series 5(4).

Castiglia, Peter J., and Peter J. Fawcett
2006 Large Holocene Lakes and climate change in the Chihuahuan Desert. *Geology* 34(2):113-116.

Chapin, Charles E., and William R. Seager
1975 Evolution of the Rio Grande Rift in the Socorro and Las Cruces Areas. In *Guidebook of the Las Cruces Area*, edited by W. Seager, R. Clemons, and J. Callender, pp. 297-321. Twenty-Sixth Field Conference, New Mexico Geological Society, Socorro.

Chapman, Richard C.
1980 *The Archaic Period in the American Southwest*. Unpublished Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Charnov, Eric L. and Gordon H. Orians
1973 *Optimal Foraging: Some Theoretical Explorations*. Department of Biology, University of Utah, Salt Lake City.

Cleaveland, Malcolm K.
2006 *Extended Chronology of Drought in the San Antonio Area*. Tree-Ring Laboratory, Geosciences Department, University of Arkansas, Fayetteville.

Cleaveland, M. K., D. W. Stahle, M. D. Therrell, J. Villanueva-Diaz, and B. T. Burns
2003 Tree-Ring Reconstructed Winter Precipitation and Tropical Teleconnections in Durango, Mexico. *Climatic Change* 59(3): 369-388.

Collier, Michael, and Robert H. Webb
2002 *Floods, Droughts, and Climate Change.* The University of Arizona Press, Tucson.

Connor, Seymour V., and Jimmy M. Skaggs
1977 *Broadcloth and Britches: The Santa Fe Trade*. Texas A & M University Press, College Station.

Cook, Della Collins, and Mary Lucas Powell
2006 The Evolution of American Paleopathology. In *Bioarchaeology: The Contextual Analysis of Human Remains*, edited by Jane E. Buikstra and Lane A. Beck, pp. 281-322. Academic Press, New York.

Cordell, Linda S.
1978 *A Cultural Resources Overview of the Middle Rio Grande Valley, New Mexico*. Prepared for the USDA Forest Service, Southwestern Region, Albuquerque, NM and the USDI Bureau of Land Management, New Mexico State Office, Santa Fe.

1984 *Prehistory of the Southwest*. Academic Press, Inc. Orlando.

Cordell, Linda S., and Amy C. Earls
1984 The Rio Grande Glaze "Sequence" and the Mogollon. In *Recent Research in Mogollon Archaeology*, edited by S. Upham, F. Plog, D. Batcho, and B. Kauffman, pp. 90-97. New Mexico State University Occasional Papers No. 10. Las Cruces.

Covey, Cyclone (editor)
1990 *Adventures in the Unknown Interior of America*. University of New Mexico Press, Albuquerque. Originally published 1961.

Crown, Patricia L.
1994 *Ceramics and Ideology: Salado Polychrome Pottery*. University of New Mexico Press, Albuquerque.

Cully, Anne C., and Mollies S. Toll
1983 Plant Communities in the NMAP Study Area, San Juan County, New Mexico: An Assessment of Resources Available for Human Populations. In *Economy and Interaction along the Lower Chaco River*, edited by Patrick Hogan and Joseph C. Winter, pp. 37-48. Prepared for Utah International, Inc. by the Office of Contract Archaeology and Maxwell Museum of Anthropology, University of New Mexico, Albuquerque.

Damp, Jonathan E. and Chris Adams
2008 For Want of a Nail: Archaeological Evidence of Coronado's Stay at Zuni. Paper prepared for the *Between Entrada and Salida: New Mexico Perspectives on the Coronado Expedition* symposium organized by Charles Haecker and Clay Mathers. Annual meeting of the Society for Historical Archaeology, Albuquerque, New Mexico, January 9-12, 2008.

Davenport, Harbert, and Joseph K. Wells
1918 The First Europeans in Texas, 1528–1536. *Southwestern Historical Quarterly* 22 (October 1918).

Davis, John V.
1975 A Paleo-Indian Projectile Point from Hueco Firing Range. *The Artifact* 13(1):26-29.

Dean, Glenna
1994 Analysis of Flotation Samples. In *Excavations at the Cox Ranch Exchange Lands, Doña Ana and Otero Counties, New Mexico*, by P. Gerow, pp. 253-264. Office of Contract Archeology, University of New Mexico, Albuquerque.

Dean, Jeffrey S., and William J. Robinson
1977 *Dendroclimatic Variability in the American Southwest A.D. 680 to 1970. Final Report to the National Park Service Department of Interior.* Laboratory of Tree-Ring Research, University of Arizona, Tucson.

Dean, J. S., W. H. Doelle, and J. D. Orcutt
1994 Adaptive Stress, Environment, and Demography. In *Themes in Southwest Prehistory*, edited G. J. Gumerman, pp. 53-86. School of American Research Press, Santa Fe.

Dello-Russo, Robert
2008 Got Water? Modeling the Early Use of Maize in Regions of the Southwest – Gila Mountains and Beyond. In Natural History of the Gila, A Symposium, edited by K. Kindscher and W. Norris, pp. 17-33. *The New Mexico Botanist*, Special Issue 1, Silver City, NM.

DeLorme
1988 *New Mexico Atlas and Gazeteer.* First Edition, DeLorme, Yarmouth, Maine.

DeMenocal, Peter B.
2001 *Cultural Responses to Climate Change During the Late Holocene*. Science 292.5517 (2001): 667 General OneFile. Web. 26 Aug. 2010. Document URL http//find.galegroup.com/gps/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=IPS&docId=A75161670&source=gale&srcprod=ITOF&userGroupName=nm_p_newmex&version=1.0

Dick-Peddie, William A.
1965 Changing Vegetation Patterns in Southern New Mexico. In *Guidebook of Southwestern New Mexico II*, edited by J. Fitzsimmons and C. Lochman-Balk, pp. 234-235. Sixteenth Field Conference, New Mexico Geological Society.

1975 Vegetation of Southern New Mexico. In *Guidebook of the Las Cruces Area*, edited by W. Seager, R. Clemons, and J. Callender, pp. 81-84. Twenty-sixth Field Conference, New Mexico Geological Society.

1993 *New Mexico Vegetation: Past, Present, and Future*. University of New Mexico Press, Albuquerque.

DiPeso, Charles C.
1974 *Casas Grandes: A Fallen Trading Center of the Gran Chichimeca.* Vol. 1, *Preceramic-Viejo Periods*. Amerind Foundation, Dragoon, Arizona.

DiPeso, Charles C., John B, Rinaldo, and Gloria S. Fenner
1974 *Casa Grandes: A Fallen Trading Center of the Gran Chichimeca* (Vol. 6). Amerind Foundation, Dragoon, and Northland Press, Flagstaff

Duran, Meliha S.
1982 *Patterns of Prehistoric Land Use in Doña Ana County, New Mexico.* Cultural Resources Management Division Report No. 471. New Mexico State University, Las Cruces.

1985 *An Archeological Survey of 47 Miles of Telephone Right-of-Way in the Jornada del Muerto, Sierra and Doña Ana Counties, New Mexico.* Human Systems Research, Report No. 8512.

1986 *Monitoring for Two Mountain Bell Fiber Optics Cable Right-of-Way, Southern New Mexico.* Human System Research, Report 8512 and 8538.

Elias, Scott A.
1987 Paleoenvironmental Significance of Late Quaternary Insect Fossils from Packrat Middens in South-Central New Mexico. *The Southwestern Naturalist* 32(3):383-390.

Ellis, Florence H.
1987 The Long Lost "City" of San Gabriel del Yunque, Second Oldest European Settlement in the United States. In *When Cultures Meet: Remembering San Gabriel del Yunque Oweenge*, pp. 10-38. Sunstone Press, Santa Fe, New Mexico.

Ellis, Richard N. (editor)
1971 *New Mexico Past and Present*. University of New Mexico Press, Albuquerque.

Ellwood, Brooks B., and Wulf A. Gose
2006 Heinrich H1 and 8200 yr. B.P. Climate Events Recorded in Hall's Cave, Texas. *Geology* 34(9):753-756. Geological Society of America.

Elyea, Janette
1988 Analysis of Paleoindian Tools from LA 63880. In *The Border Star 85 Survey: Toward an Archeology of Landscapes*, edited by T. Seaman, W. Doleman, and R. Chapman, pp. 231-237. Office of Contract Archeology Report No. 185-227. Albuquerque.

1989 *An Archeological Survey of the Santa Teresa Patent Restriction Lands*. Office of Contract Archeology, University of New Mexico, Albuquerque.

2004 *A Sample Survey of the Mockingbird Gap Special Management Area*. Report No. 185-804 submitted to the USDI Bureau of Land

Management, Socorro Field Office by the Office of Contract Archeology, University of New Mexico, Albuquerque.

Espinosa, J. Manuel
1988 *The Pueblo Indian Revolt of 1696*. University of Oklahoma Press, Norman.

FAA (Federal Aviation Administration)
2008 *Final Environmental Impact Statement for the Spaceport America Commercial Launch Site, Sierra County, New Mexico* (volume 1). Office of Commercial Space Transportation, FAA, Washington, D.C.

FAA (Federal Aviation Administration) and NMSA (New Mexico Spaceport Authority)
2010a *Cultural Resources Protection, Preservation, and Mitigation Plan for Spaceport America.* Developed for compliance with Section 106 of the National Historic Preservation Act, and consulted on and concurred with by the Section 106 Consulting Parties for the Spaceport undertaking. New Mexico Spaceport Authority, Las Cruces.

2010b *Mitigation Plan for Archaeology, Spaceport America 2010.* Developed for compliance with Section 106 of the National Historic Preservation Act, and consulted on and concurred with by the Section 106 Consulting Parties for the Spaceport undertaking. New Mexico Spaceport Authority, Las Cruces.

Farwell, Robin E., Yvonne R. Oakes, and Regge N. Wiseman
1992 *Investigations into the Prehistory and History of the Upper Rio Bonito, Lincoln County, Southeastern New Mexico*, Laboratory of Anthropology Notes 297, Museum of New Mexico, Santa Fe.

Favata, Martin A., and José B. Fernández
1993 *The Account: Núñez Cabeza de Vaca's Relación.* Arte Público Press, Houston.

Ferg, Allan
1988 *Western Apache Material Culture: The Goodwin and Guenther Collections*. The University of Arizona Press, Tucson.

Firestone, R. B., A. West, J. P. Kennett, L. Becker, T. E. Bunch, Z. S. Revay, P. H. Schultz, T. Belgya, D. J. Kennett, J. M. Erlandson, O. J. Dickenson, A. C. Goodyear, R. S. Harris, G. A. Howard, J. B. Kloosterman, P. Lechler, P. A. Mayewski, J. Montogmery, R. Poreda, T. Darrah, S. S. Que Hee, A. R. Smith, A. Stich, and W. Topping
2007 Evidence for an Extraterrestrial Impact 12,900 Years Ago that Contributed to the Megafaunal Extinctions and the Younger Dryas Cooling. *Proceedings of the National Academy of Sciences*, October 9, 2007, v. 104, no. 41.

Fitzsimmons, J. Paul
1955 Some Notes on the Natural history of South-Central New Mexico. In *Guidebook of South-Central New Mexico*, edited by J. Fitzsimmons and H. Krusekopf, Jr., pp. 175-175. Sixth Field Conference, New Mexico Geological Society.

Flowers, Mike and Victor Gibbs
2008 *Cultural Resource Survey of 181 Acres of Water Well Field and Pipeline and Transmission Line Corridors for Proposed Spaceport America, Sierra County, New Mexico.* Zia Project No. LCS-06-086.1 Addendum. Zia Engineering & Environmental Consultants, LLC. Las Cruces.

Forbes, Jack D.
1960 *Apache, Navajo, and Spaniard*. University of Oklahoma Press, Norman.

Ford, Richard I.
1977 Archaeobotany of the Fort Bliss Maneuver Area II, Texas. In *Settlement Patterns of the Eastern Hueco Bolson*, by M. Whalen, pp. 199-205. El Paso Centennial Museum Publications in Anthropology No. 4. University of Texas at El Paso.

Foster, Michael S.
1988 An Isolated Structure from Keystone Dam. In *Fourth Jornada Mogollon Conference (Oct. 1985): Collected Papers*, edited by M. Duran and K. Laumbach, pp. 107-117. Human Systems Research, Tularosa, New Mexico.

1993 *Archaeological Investigations at Pueblo Sin Casas (FB6273), a Multicomponent Site in the*

Hueco Bolson, Fort Bliss, Texas. Historic and Natural Resources Report No. 7. Cultural Resource Management Program, Directorate of the Environment, United States Army Air Defense Artillery Center, Fort Bliss, Texas.

Foster, Michael S., and Ronna J. Bradley
1984 La Cabrana: A Preliminary Discussion of a Jornada Mogollon Pueblo. In *Recent Research in Mogollon Archaeology*, edited by S. Upham, F. Plog, D. Batcho, and B. Kauffman, pp. 193-213. New Mexico State University Occasional Papers No. 10. Las Cruces.

Foster, Michael S., Ronna J. Bradley, and Charlotte Williams
1981 Prehistoric Diet and Subsistence Patterns at La Cabraña Pueblo. *The Artifact* 19(3, 4):151-168.

Franceschi, Vincent R., and Harry T. Horner Jr.
1980 Calcium Oxalate Crystals in Plants. *Botanical Review* 46(4):361–427.

Frank, Ross H.
1992 *From Settler to Citizen: Economic Development and Cultural Change in Late Colonial New Mexico, 1750-1820*. Ph. D. Dissertation, Department of History, University of California at Berkeley. University Microfilms International, Ann Arbor.

Franklin, Hayward
1997 Valencia Pueblo Ceramics. In *Excavations at Valencia Pueblo (LA 953) and a Nearby Hispanic Settlement (LA 67321), Valencia County, New Mexico*. edited by K. L. Brown and B. J. Vierra, pp 125-257. Office of Contract Archaeology Report No. 185-400F, Albuquerque.

Frechette, Jedediah D., and Grant A. Meyer
2009 Holocene Fire-Related Alluvial Fan Deposition and Climate in Ponderosa Pine and Mixed Conifer Forests, Sacramento Mountains, New Mexico, USA. *The Holocene* 19(4):639-651.

Frederickson, E. L., R. E. Estell, A. Laliberte, and D. M. Anderson
2006 Mesquite Recruitment in the Chihuahuan Desert: Historic and Prehistoric Patterns with Long-Term Impacts. *Journal of Arid Environments* 65:285-295.

Gaffney, Chris and John Gater
2004 *Revealing the Buried Past: Geophysics for Archaeologists*. Tempus Publishing, Limited. Stroud, United Kingdom.

Gasser, Robert E
1983 Negative Evidence for Roasting Pits: The Flotation Data. In *Excavations in the Castner Range Archeological District in El Paso, Texas*, by Robert Jarratt Hard, Appendix A. Publications in Anthropology 11. El Paso Centennial Museum, University of Texas, El Paso.

Gerald, Rex G.
1988 Pickup Pueblo: A Late Prehistoric House Ruin in Northeast El Paso. *The Artifact* 26(2):1-86.

Gerow, Peggy A.
1994 *Excavations at the Cox Ranch Exchange Lands, Doña Ana and Otero Counties, New Mexico*. Office of Contract Archeology, University of New Mexico, Albuquerque.

Gibbs, Victor
2008 *Cultural Resources Survey of 463 Acres of Off-site Fiber Optics and Transmission Lines for Proposed Spaceport America Sierra County, New Mexico*. Zia Project No. LCS-06-086.1. Zia Engineering & Environmental Consultants, LLC. Las Cruces.

Gibbs, Victor, Christina Chavez, and David H. Reynolds
2009 *Archaeological Date Recovery Plan for Four Sites Along the Spaceport America Entrance Road Sierra County, New Mexico.* Zia Report No. LCS-08-044. Zia Engineering & Environmental Consultants, LLC, Las Cruces, New Mexico.

Gile, Leland H.
1987 *Late Holocene Displacement along the Organ Mountains Fault in Southern New Mexico*. New Mexico Bureau of Geology and Min-

eral Resources Circular 196. Socorro.

2002 Lake Jornada, an Early-Middle Pleistocene Lake in the Jornada del Muerto Basin, Southern New Mexico. *New Mexico Geology* 24(1):3-14.

Glascock, Michael D., Geoffrey E. Braswell, and Robert H. Cobean
1998 A Systematic Approach to Obsidian Source Characterization. In *Archaeological Obsidian Studies*, edited by M. Steven Shackley, pp. 15-65. Plenum Press, New York.

Glover, Vernon J., and John McCall
1988 The Santa Fe Railway. In *Pecos: Gateway to Pueblos and Plains*, edited by J. Bezy and J. Sanchez, pp. 112-117. Southwest Parks and Monuments Association, Tucson.

Goodfriend, Glenn A., and G. Lain Ellis
2000 Stable carbon isotope record of middle to late Holocene climate changes from land snail shells at Hinds Cave, Texas. *Quaternary International* 67(1):47-60.

Graybill, Donald A.
1983 Mount Goliath, Colorado, 39°N, 105°W. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

1984 Almagre Mountain, Colorado, 39°N, 105°W. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

Green, John W.
1969 Preliminary Report on Site EPAS-60: An El Paso Phase House Ruin. *Transactions of the Fifth Regional Archeological Symposium for Southeastern New Mexico and Western Texas*, pp. 1-12. El Llano Archaeological Society, Portales, New Mexico.

Green, Richard
2009 Metal Detection Reconnaissance. http://har-indy.com/Methods.html. Website accessed March 15, 2009.

Grissino-Mayer, Henri D.
1996a A 2129 Year Annual Reconstruction of Precipitation for Northwestern New Mexico, USA. In *Tree Rings, Environment, and Humanity* edited by J. S. Dean, D. M. Meko and T. W. Swetnam, pg 191-204. Radiocarbon 1996, Department of Geosciences, University of Arizona, Tucson.

1996b *El Malpais Precipitation Reconstruction*. International Tree-Ring Data Bank. IGBP PAGES/World Data Center-A for Paleoclimatology Data Contribution Series # 96-002. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

Grissino-Mayer, H. D., D. Stahle and M. Therrell
2004 El Malpais, New Mexico update, 34°N, 108°W. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

Grissino-Mayer, H. D., and T. W. Swetnam
1981 Oscura Peak, White Sands Missile Range, Socorro Co. Pied 33°N, 106°W. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

Grissino-Mayer, H. D., T. W. Swetnam and A. C. Caprio
1990 Salinas Peak, San Andres Mountains, New Mexico, 33°N, 106°W. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

Gunnerson, James H.
1978 Southern Athapaskan Archaeology. In *Handbook of North American Indians, Vol. 10, Southwest*, edited by A. Ortiz pp 162-169. Smithsonian Institution Washington D.C.

Habicht-Mauche, Judith A.

1993 *The Pottery from Arroyo Hondo Pueblo, New Mexico: Tribalization and Trade in the Northern Rio Grande*. Arroyo Hondo Archaeological Series, vol. 8. School of American Research Press, Santa Fe, New Mexico.

Hackett, Charles W. (editor)
1937 *Historical Documents Relating to New Mexico, Nueva Vizcaya, and Approaches Thereto, to 1773* (vol. 3), translated by A. Bandelier and F. Bandelier. Carnegie Institution, Washington D.C.

Hackett, Charles W., and Charmion C. Shelby
1942 *Revolt of the Pueblo Indians of New Mexico and Otermin's Attempted Reconquest, 1680-1682, Vol. 2.* The University of New Mexico Press, Albuquerque.

Haecker, Charles M.
1998 *Archaeological Remote Sensing Survey of the Civil War Site of Camp Lewis, Pecos National Historic Park, San Miguel, New Mexico*. Cultural Anthropology Projects, PECO-01, Intermountain Support Office-Santa Fe National Park Service, Santa Fe, New Mexico.

2008 Tracing Coronado's Route through Trace Element Analysis. Paper prepared for the *Between Entrada and Salida: New Mexico Perspectives on the Coronado Expedition* symposium organized by Charles Haecker and Clay Mathers. Annual meeting of the Society for Historical Archaeology, Albuquerque, New Mexico, January 9-12, 2008.

Haecker, Charles and Jeffery G. Mauck
1997 *On the Prairie of Palo Alto*. Texas A & M University Press, College Station.

Hall, Stephen A.
2001 Geochronology and Paleoenvironments of the Glacial-Age Tahoka Formation, Texas and New Mexico High Plains. *New Mexico Geology* 23:71-77.

2005 *Ice Age Vegetation and Flora of New Mexico*. In *New Mexico's Ice Ages*, S. G. Lucas, G. S. Morgan and K. E. Zeigler, eds. New Mexico Museum of Natural History and Science Bulletin No. 28.

Hammack, Laurens C.
1961 *Missile Range Archeology*. Laboratory of Anthropology Notes 2. Museum of New Mexico, Santa Fe.

1962 *LA 5599: A Pithouse Village near Rincon, New Mexico*. Laboratory of Anthropology Notes 8. Museum of New Mexico. Santa Fe.

Hammond, George R., and Agapito Rey
1966 *The Rediscovery of New Mexico, 1580-1594: The Explorations of Chamuscado, Espejo, Castaña de Sosa, Morlete, and Leyva de Bonilla and Humaña*. University of New Mexico Press, Albuquerque.

Hannaford, Charles A., and Yvonne R. Oakes
1983 Historic Artifacts. In *The Ontiberos Site: A Hispanic Homestead near Roswell, New Mexico*. Laboratory of Anthropology Notes No. 311. Museum of New Mexico Laboratory of Anthropology Research Section, Santa Fe.

Hard, Robert J.
1983a *Excavations in the Castner Range Archaeological District in El Paso, Texas*. El Paso Centennial Museum Publications in Anthropology No. 11. University of Texas at El Paso.

1983b A Model for Prehistoric Land Use, Ft. Bliss, Texas. *American Society for Conservation Archaeology Proceedings,* pp. 41-51

1986 *Ecological Relationships Affecting the Rise of Farming Economies: A Test from the American Southwest*. Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

1990 Agriculture Dependence in the Mountain Mogollon. In *Perspectives in Southwestern Prehistory*. Paul E. Minnis and Charles L. Redman, editors. Westview Pres, Boulder.

Hard, Robert J., Raymond P. Mauldin, and Gerry R. Raymond
1996 Mano Size, Stable Carbon Isotope Ratios, and Macrobotanical Remains as Multiple Lines of Evidence of Maize Dependence in the American Southwest. *Journal of Archaeological Method and Theory* 3:253-318.

Hard, Robert J., and John R. Roney
2005 The Transition to Farming on the Rio Casas Grandes and in the Southern Jornada Mogollon Region. In *The Late Archaic Across the Borderlands: From Foraging to Farming*, edited by B. Vierra, pp. 141-186. The University of Texas Press, Austin.

Harris, Arthur H.
2003 The Pleistocene Vertebrate Fauna from Pendejo Cave. In *Pendejo Cave*, edited by Richard S. MacNeish and Jane G. Libby. University of New Mexico Press, Albuquerque.

Hart, Jeanie
1994 *Archaeological Survey for U.S. Border Patrol Drag Roads near Orogrande and Alamogordo, Otero County, New Mexico*. WSMR Archaeological Report No. 94-13. Human Systems Research, Tularosa, New Mexico.

Haury, Emil W.
1936 *Some Southwestern Pottery Types*. Medallion Papers No. 19, Gila Pueblo, Globe, Arizona.

Havstad, Kris, and Reldon Beck
1996 Research in the Jornada Basin of Southern New Mexico: A Field Tour. In *Proceedings: Shrubland Ecosystem Dynamics of a Changing Environment* compiled by Jerry R. Barrow, E. Durant McArthur, Ronald E. Sosebee, and Robin J. Tausch. May 23-25, 1995; Las Cruces, NM. Gen. Tech. Rep. INT-GTR-338. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Hawley, John W.
1993 *Geomorphic Setting and Late Quaternary History of Pluvial-Lake Basins in the Southern New Mexico Region*. New Mexico Bureau of Mines and Mineral Resources Open-File Report 28 p.

Hawley, John W., and Frank E. Kottlowski
1969 Quaternary Geology of the South-Central New Mexico Border Region. In *Border Stratigraphy Symposium*, edited by F. Kottlowski and D. LeMone, pp. 89-104. Circular 104. State Bureau of Mines and Mineral Resources and New Mexico Institute of Mining and Technology, Socorro.

Hawley, J. W., G. O. Bachman, and K. Manley
1976 Quaternary Stratigraphy in the Basin and Range and Great Plains Provinces, New Mexico and Western Texas. In *Quaternary Stratigraphy of North America* edited by W. C. Mahaney, pp. 235–274. Dowen, Hutchinson and Ross, Inc., Stroudsburg, Pennsylvania,.

Hayes, Alden C., Jon N. Young, and A.H. Warren
1981 *Contributions to Gran Quivira Archaeology, Gran Quivira National Monument, New Mexico.* Publications in Archaeology No. 17, National Park Service Washington D.C.

Haynes, Jr., C. Vance
2008 *Younger Dryas "Black Mats" and the Rancholabrean Termination in North America.* Proceedings of the National Academy of Sciences, Vol. 60, No. 18, May 2008.

Hendricks, Rick, and Gerald J. Mandell
2002 Francisco de Lima, Portuguese Merchants of Parral, and the New Mexico Trade, 1638-1675. *New Mexico Historical Review* 77:261-293.

Hester, Thomas R. (editor)
1977 *An Archeological Survey of the Radium Springs Area, Southern New Mexico.* Archaeology Survey Report No. 26. Center for Archaeological Research, the University of Texas at San Antonio, San Antonio.

Hilley, G. F.
1983 *Seismic Testing Transects for Petty-Ray Geophysical*, New Mexico State University Cultural Resources Management, Report No. 542.

Hilley, J.
1981 *The ARMA Project: 407 Miles of Archaeological Transect Sampling in the Basins of Southern New Mexico.* Cultural Resources Management Division Report No 475. New Mexico State University, Las Cruces.

Hogan, Patrick
1986 *Overview, Research Design, and Data Recovery Program for Cultural Resources Within the Bolack Exchange Lands*. Prepared for the USDI Burea of Land Management by the Office of Contract Archaeology, University of New Mexico, Albuquerque.

Holden, W. C.
1928 West Texas Drouths. *Southwestern Historical Quarterly Online*, v. 32, no. 2, p. 103-123, October, 1928. URL: http://www.tshaonline.org/shqonline/apager.php?vol=032&pag=103 (accessed Sept. 17, 2010).

Holliday, Vance T.
1987 Re-examination of Late-Pleistocene Boreal Forest Reconstructions for the Southern High Plains. *Quaternary Research* 28:238-244, 1987. University of Washington.

1989 Middle Holocene Drought on the Southern High Plains. *Quaternary Research* 31:74-82, 1989. University of Washington.

2000 Folsom Drought and Episodic Drying on the Southern High Plains from 10,900 to 10,200 ^{14}C yr. B.P. *Quaternary Research* 53:1-12. University of Washington.

Holliday, Vance T., James H. Meyer and Glen G. Fredlund
2008 Late Quaternary Sedimentology and Geochronology of Small Playas on the Southern High Plains, Texas and New Mexico, USA. *Quaternary Research* 70(1):11-25.

Holmgren, Camille A., M. Cristina Penalba, Kate Aasen Rylander and Julio Betancourt
2003 A 16,000 ^{14}C yr B.P. Packrat Midden Series from the USA-Mexico Borderlands. *Quaternary Research* 60:319-329.

Hubbard, Richard A.
1987 Prehistoric Agricultural Fields and Water Control Systems of South-Central New Mexico. M.A. thesis, University of Texas at Austin.

1992 *An Archeological Reconnaissance of the Hudspeth County Conservation and Reclamation District #1, Proposed Regulating Reservoir #3, Hudspeth Co., Texas*. Texas Water Development Board, Austin.

Hughes, Richard E.
1988 The Coso Volcanic Field Reexamined: Implications for Obsidian Sourcing and Hydration Dating Research. *Geoarchaeology* 3:253-265.

Hull-Walski, Deborah A. and James E. Ayres
1989 *The Historical Archaeology of Dam Construction Camps in Central Arizona, Volume 3: Laboratory Methods and Data Computerization*. Dames & Moore, Phoenix.

HSR (Human Systems Research, Inc.) Staff
1997 *Southwest Regional Spaceport: Archeological Survey of the Proposed Upham Area Site*, (2 volumes). Human Systems Research, Report No. 9510 and 9517.

Hunter, Rosemarie
1988 The Tony Colon Site I. In *Fourth Jornada Mogollon Conference (Oct. 1985), Collected Papers*, edited by M. Duran and K. Laumbach, pp. 137-161. Human Systems Research, Tularosa, New Mexico.

Hunter-Anderson, Rosalind L.
1986 *Prehistoric Adaptation in the American Southwest*. Cambridge University Press, Cambridge.

Irwin-Williams, Cynthia
1965 Configurations of Preceramic Development in the Southwestern United States. In *Contributions to Southwestern Prehistory,* vol. 4, *Proceedings, VII Congress, International Association for Quaternary Research*, edited by C. Irwin-Williams, pp. 1-9. Eastern New Mexico University Contributions in Anthropology 1(4). Portales.

1973 *The Oshara Tradition: Origins of Anasazi Culture*. Eastern New Mexico University Contributions in Anthropology 5(1). Portales.

Irwin-Williams, Cynthia, and C. Vance Haynes
1970 Climatic Change and Early Population Dy-

namics in the Southwestern United States. *Quaternary Research* 1(1):59-71.

Ivey, James E.
1993 Seventeen Century Mission Trade on the Camino Real. In *El Camino Real de Tierra Adentro*, compiled by G. Palmer, pp. 41-67. Cultural Resources Series No. 11. USDI Bureau of Land Management, New Mexico State Office, Santa Fe.

Jelinek, Arthur J.
1967 *A Prehistoric Sequence in the Middle Pecos Valley., New Mexico*. Anthropological Papers No. 31. Ann Arbor: Museum of Anthropology, University of Michigan.

Jennings, Jesse D.
1940 *A Variation of Southwestern Pueblo Culture*. Technical Series Bulletin No. 19. Santa Fe: Laboratory of Anthropology, Museum of New Mexico.

1978 *Prehistory of Utah and the Eastern Great Basin*. University of Utah Anthropological Papers No. 98, University of Utah Press, Salt Lake City.

Jochim, Michael A.
1976 *Hunter-Gatherer Subsistence Systems and Settlement – A Predictive Model.* Academic Press, New York.

Johns, Timothy
1990 *With Bitter Herbs They Shall Eat It*. The University of Arizona Press, Tucson.

Johnson, David M.
2009 Apache Victory Against the U.S. Dragoons, the Battle of Cieneguilla, New Mexico. In *Fields of Conflict: Battlefield Archaeology from the Roman Empire to the Korean War* edited by Douglas Scott, Lawrence Babits and Charles Haecker. Potomac Books, Inc. Washington, D.C.

Jones, Joshua G., Timothy M. Kearns, and Janet L. McVickar (compilers)
2010 *Archaeological Investigations for the AT&T Nexgen/Core Project for AT&T Corporation, Atlanta, Georgia.* Western Cultural Research, Inc., Farmington.

Kearney, Thomas H., and Robert H. Peebles
1951 *Arizona Flora*. University of California Press, Berkeley.

Kegley, George
1982 *Archaeological Investigations at Hueco Tanks State Historical Park, El Paso County, Texas.* Revised edition (originally published 1980). Texas Parks and Wildlife Department, Austin.

Kelley, Jane Holden
1984 *The Archaeology of the Sierra Blanca Region of Southeastern New Mexico*. Anthropological Papers No. 74. University of Michigan, Ann Arbor.

Kelly, Robert L.
1983 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research* 39:277-306.

1988 Three Sides of a Biface. *American Antiquity* 53(4):717-734.

1995 *The Foraging Spectrum – Diversity in Hunter-Gatherer Lifeways*. Smithsonian Institution Press, Washington, D.C.

King, W. E., J. W. Hawley, A. M. Taylor, and R. P. Wilson
1971 *Geology and Ground-Water Resources of Central and Western Dona Ana County, New Mexico*. State Bureau of Mines and Mineral Resources and New Mexico Institute of Mining and Technology, Socorro.

Kinnaird, Lawrence
1958 *The Frontiers of New Spain, Nicolas de Lafora's Description 1766-1768*. Quivira Society Publications Vol. 13, Berkeley.

Kirkpatrick, David T., and Jeanie Hart
1995 *An Archaeological Survey of the Proposed Southwest Regional Spaceport, Doña Ana and Sierra Counties, New Mexico*. Human Systems Research Report No. 9431. Tularosa, New Mexico.

Kirkpatrick, David T., Sergio Mendez, and Mark

Sechrist
1994 *Archaeological Testing on 12 Sites for the Joint Task Force-Six Project, Southern New Mexico.* Report No. HSR 9114B. Human Systems Research, Tularosa, New Mexico.

Kirkpatrick, David T., Peter Eidenbach, Karl W. Laumbach, and Meliha S. Duran
2000 *Basin and Range Archaeology; An Overview of Prehistory in South-Central New Mexico.* Human Systems Research, Inc. manuscript on file, New Mexico Historic Preservation Division, Santa Fe, New Mexico.

Krone, Milton F.
1975 A Report on Folsom Points Found in the El Paso Area. *The Artifact* 13(4):1-19.

1976 A Clovis Point from the El Paso Area. *The Artifact* 14(2):44-48.

Lamarche, V. C., and T. P. Harlan.
1969 Almagre Mountain (1 + 2), Colorado, 39ºN, 105ºW. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology. NOAA/ NCDC Paleoclimatology Program, Boulder, Colorado.

Lancaster, James
1986 Groundstone. In *Short Term Sedentism in the American Southwest, the Mimbres Valley Salado*. Maxwell Museum of Anthropology, University of New Mexico Press, Albuquerque.

Langford, Richard P.
2002 Eolian Deflation of Holocene Playas and Formation of the White Sands Dune Field. In *Proceedings of ICAR5/GCTE-SEN Joint Conference, International Center for Arid and Semiarid Lands Studies, Texas Tech University, Lubbock, Texas* edited by Jeffrey A. Lee and Ted M. Zobeck, p 400. USDA Publication 02-2.

Larsen, Clark Spenser, Rebecca Shavit, and Mark C. Griffin
1991 Dental Caries Evidence for Dietary Change: An Archaeological Context. In *Advances in Dental Anthropology*, edited by Marc A. Kelley and Clark Spencer Larsen, pp. 179-202. Wiley-Liss, New York.

Larsen, L. B., B. M. Vinther, K. R. Briffa, T. M. Melvin, H. B. Clausen, P. D. Jones, M. L. Siggaard-Anderson, C. U. Hammer, M. Eronen, H. Grudd, B. E. Gunnarson, R. M. Hantemirov, M. M. Naurzbaev, and K. Nicolussi
2008 New Ice Core Evidence for a Volcanic Cause of the A.D. 536 Dust Veil. *Geophysical Research Letters* 35.

Laumbach, Karl W.
2009 Buffalo Soldiers versus the Apache: The Battle in Hembrillo Basin, New Mexico. In *Fields of Conflict: Battlefield Archaeology from the Roman Empire to the Korean War* edited by Douglas Scott, Lawrence Babits and Charles Haecker. Potomac Books, Inc. Washington, D.C.

Lawrence, Hollis P., Elyse Sewell and Darryl Del Frate
2010 *A Cultural Resource Survey for a Proposed Monitoring Well and Access Road, Spaceport America Facility, Sierra County, New Mexico.* Cienega Environmental Report No. CE-2010-2. Cienega Environmental, Albuquerque.

Leach, Jeff D., Federico A. Almarez, Brenda Buck, and Galen R. Burgett
1993 The Hueco Mountain Reservoir: A Preliminary Assessment of an El Paso Phase Water Catchment Basin. *The Artifact* 31(2):33-45.

LeBlanc, Steven A.
1982 Temporal Change in Mogollon Ceramics. *Southwestern Ceramics: A Comparative Review*, edited by A.H. Shroeder, pp. 107-127. Arizona Archaeologists 15. Arizona Archeological Society Phoenix.

Lehmer, Donald J.
1948 *The Jornada Branch of the Mogollon*. University of Arizona Social Sciences Bulletin No. 17. University of Arizona Press, Tucson.

Lentz, Stephen C.
2005 *High Rolls Cave: Insectos, Burritos, Y Frajos, Archaic Subsistence in Southern New Mexi-*

co. Archaeology Notes No. 345. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Levy, Thomas, James D. Anderson, Mark Waggoner, Neil Smith, Adolfo Muniz, and Russell B. Adams
2001 Digital Archaeology 2001: GIS-Based Excavation Recording in Jordan. *The SAA Archaeological Record* 1(3):23-29.

Lindsay, Alexander J., Jr., and Calvin H. Jennings
1968 *Salado Red Ware Conference, Ninth Ceramic Seminar*. Museum of Northern Arizona Ceramic Series 4, Flagstaff.

Lovelace, Arlon D.
1972 *Geology and Aggregate Resources District II*. Geology Section, New Mexico State Highway Department Materials and Testing Laboratory, Design Division; U.S. Department of Transportation, Federal Highway Administration. Santa Fe.

Lucas, S. G., G. S. Morgan, J. W. Hawley, D. W. Love, and R. G. Myers
2002 Mammal Footprints from the Upper Pleistocene of the Tularosa Basin, Doña Ana County, New Mexico. In *Geology of White Sands*, edited by V. Lueth, K. A. Giles, S. G. Lucas, B. S. Kues, R. G. Myers, and D. Ulmer-Scholle, D., pp. 285-288. New Mexico Geological Society Guidebook 53.

Lucas, S. G., B. D. Allen, G. S. Morgan, R. G. Myers, D. W. Love, and D. Bustos
2007 Mammoth Footprints from the Upper Pleistocene of the Tularosa Basin, Doña Ana County, New Mexico. In *Cenozoic Vertebrate Tracks and Traces* edited by S. G. Lucas, J. A. Spielmann, and M. G. Lockley, pp. 149-154. New Mexico Museum of Natural History and Science Bulletin 42.

Lyman, R. Lee
1994 *Vertebrate Taponomy*. Cambridge Manuals in Archaeology. Cambridge University Press, Cambridge.

MacArthur, Robert and Eric Pianka
1966 On the Optimal Use of a Patchy Environment. *American Naturalist* 100:603-609.

MacKay, William P., and Scott A. Elias
1992 Late Quaternary Ant Fossils from Packrat Middens (Hymenoptera: Formicidae): Implications for Climatic Change in the Chihuahuan Desert. *Psyche* 99:169-184.

MacNeish, Richard S.
1993 *Preliminary Investigations of the Archaic in the Region of Las Cruces, New Mexico*. Historic and Natural Resources Report No. 9. Cultural Resource Management Branch, Directorate of Environment, United States Army Air Defense Artillery Center, Fort Bliss, Texas.

MacNeish, Richard S., and Patrick H. Beckett
1987 *The Archaic Chihuahua Tradition*. Coas Monograph No. 7. Las Cruces, New Mexico.

MacNeish, Richard S., and Jane G. Libby
2003 *Pendejo Cave*. University of New Mexico Press, Albuquerque.

MacNeish, Richard S., and B. Marino
1993 C13/12 and N15/14 Isotope Ratios in Skeletons from the Jornada Region. In *Preliminary Investigations of the Archaic in the Region of Las Cruces, New Mexico*, edited by R. MacNeish, pp. 117-122. Historic and Natural Resources Report No. 9. Cultural Resources Management Program, Directorate of Environment, U.S. Army Air Defense Artillery Center. Fort Bliss, Texas.

MacNeish, Richard S., Geoffrey Cunnar, Gary Jessop, and Peggy Wilner
1993 *A Summary of the Paleo-Indian Discoveries in Pendejo Cave near Orogrande, NM*. Annual Report of the Andover Foundation for Archaeological Research. Andover, Maine.

Majewski, Teresita
2008 Notes on Historic Ceramics. Presented at the 2008 New Mexico Archaeological Council Historic Artifact Workshop: Euroamerican, Hispanic, and Asian Ceramics and other Artifacts. Albuquerque, New Mexico.

Maker, H. J., H. E. Dregne, V. G. Link, and J. U. Anderson
1978 *Soils of New Mexico*. New Mexico State University Agricultural Experiment Station Research Report No. 285. Las Cruces.

Mann, Michael E., Raymond S. Bradley and Malcom K. Hughes
1999 Northern Hemisphere Temperatures during the Past Millennium: Inferences, Uncertainties, and Limitations. *Geophysical Research Letters* 25(6):759-762.

Marshall, Michael P.
1973 Background Information on the Jornada Culture Area. In *Human Systems Research Technical Manual, Tularosa Basin Survey*, pp. 49-119. Human Systems Research, Tularosa, New Mexico.

1991 *El Camino Real de Tierra Adentro: An Archaeological Investigation: Volume 1, The 1990 New Mexico Historic Preservation Division Survey*. Submitted to New Mexico Historic Preservation Division, Santa Fe, New Mexico.

Marshall, Michael P. and Henry J. Walt
1984 *Rio Abajo: Prehistory and History of a Rio Grande Province*. Historic Preservation Division, New Mexico Office of Cultural Affairs, Santa Fe.

Martin, Debra L.
1994 Patterns of Diet and Disease: Health Profiles for the Prehistoric Southwest. In *Themes in Southwest Prehistory*, edited by George J. Gummerman, pp. 87-108. School of American Research Press, Santa Fe.

Martin, Paul S., and John B. Rinaldo
1950 *Turkey Foot Ridge Site: A Mogollon Village, Pine Lawn Valley Western New Mexico*. Fieldiana Anthropology 38 (2), Chicago.

Maslin, Mark, Dan Seidov, and John Lowe
2001 *Synthesis of the Nature and Causes of Rapid Climate Transitions During the Quaternary*. In *The Oceans and Rapid Climate Change: Past, Present, and Future*. Geophysical Monograph 126. American Geophysical Union.

Mathers, Clay, Phillip Leckman and Nahide Aydin
2008 "Non-ground Breaking" Research at the Edge of Empire: Geophysical and Geospatial approaches to 16th Century Interaction in Tiguex Province. Paper prepared for the *Between Entrada and Salida: New Mexico Perspectives on the Coronado Expedition* symposium organized by Charles Haecker and Clay Mathers. Annual meeting of the Society for Historical Archaeology, Albuquerque, New Mexico, January 9-12, 2008.

Mauldin, Raymond
1993 The Divad Archaeological Project. Historical and Cultural Resources Report No. 8. Cultural Resources Management Program, Directorate of Environment, United States Army Air Defense Artillery Center, Fort Bliss, Texas.

McBride, Pamela J.
2008 Macrobotanical Analysis. In *The Scorpion Site (LA 119530): Changing Land Use Patterns on an Alluvial Fan in Alamogordo, New Mexico*, by Cristopher A. Turnbow and Alexander Kurota, pp. 253-275. Office of Contract Archaeology, University of New Mexico, Albuquerque.

Mehringer, P. J., Jr., C. V. Haynes Jr., and S. Larralde
1989 The Pollen Evidence for the Environment of Early Man and Extinct Mammals at the Lehner Mammoth Site, Southeastern Arizona. *American Antiquity* 31:17-23.

Meltzer, David J.
1991 Altithermal Archaeology and Paleoecology at Mustang Springs on the Southern High Plains of Texas. *American Antiquity* 56(2):236-267.

Meltzer, David J., and Michael B. Collins
1987 Prehistoric Water Wells on the Southern High Plains: Clues to Altithermal Climate. *Journal of Field Archaeology* 14(1):9-28.

Mera, H. P.
1935 *Ceramic Clues to the Prehistory of North Central New Mexico*. Technical Series Bulletin

No. 8, Laboratory of Anthropology, Santa Fe.

1943 *An Outline of Ceramic Development in Southern and Southeastern New Mexico*. Technical Series

Mera, Harry P., and William Stallings
1931 *Lincoln Black-on-Red*. New Mexico Archaeological Survey, Laboratory of Anthropology, Technical Series Bulletin 2, Santa Fe.

McCluney, Eugene
1962 A New Name and Revised Description for a Mogollon Pottery Type from Southern New Mexico. *Southwestern Lore* 27(4):49-55.

Miller, Myles R.
1990 *The Transitional Period in the Southern Jornada Mogollon: Archaeological Investigations in the North Hills Subdivision*. Research Report No. 1. Batcho & Kauffman Associates, El Paso.

1995 Ceramics of the Jornada Mogollon and Trans-Pecos Regions of West Texas. In *Prehistoric and Historic Aboriginal Ceramics in Texas*, by T. K. Perttula, M. R. Miller, R. A. Rickliss, D. J. Prikryl, and C. Lintz. Bulletin of the Texas Archeological Society 66:210–220.

1996 *The Chronometric and Relative Chronology Project*. Archaeological Technical Report No. 5. Anthropology Research Center and Department of Sociology and Anthropology, University of Texas at El Paso, El Paso.

1997 Late Formative Period Settlement and Subsistence: Evidence from Chronometrically Dated Features and Architectural Forms, Ceramics, and Flotation. Paper presented at the Tenth Jornada Mogollon Conference, Mesilla, New Mexico.

2001 Post-Pueblo, Protohistoric, and Early Mission Period Archaeology in Western Trans-Pecos and South Central New Mexico; A.D. 1450-1680. *Bulletin of the Texas Archaeological Society* 72:105-163.

Miller, Myles R., and Nancy A. Kenmotsu
2004 Prehistory of the Jornada Mogollon and Eastern Trans-Pecos Regions of West Texas. In *The Prehistory of Texas*, edited by T. Perttula, pp. 205-265. Texas A & M University Press, College Station.

Miller, Myles, David Carmichael, and Mary Sullivan
1985 Feature Descriptions and Analysis: Pit Structures. In *Archeological Excavations at Two Prehistoric Campsites near Keystone Dam, El Paso, Texas*, by D. Carmichael, pp. 142-182. University Museum Occasional Papers No. 14. New Mexico State University, Las Cruces.

Miller, Robert Ryan (translator)
1975 New Mexico in Mid-Eighteenth Century: A Report Based on Governor Vélez Cachupín's Inspection. *Southwestern Historical Quarterly* 79:166-181.

Mills, Barbara J.
1989 The Organization of Ceramic Production in Household Economies. Paper presented at a Symposium in Honor of Lewis R. Binford, University of New Mexico, Albuquerque

Minnis, Paul D., and Mollie S. Toll
1991 Macrobotanical Analysis. In *Landscape Archeology in the Southern Tularosa Basin,* vol. 2, *Testing, Excavation, and Analysis*, edited by W. Doleman, R. Chapman, J. Schutt, M. Swift, and K. Morrison, pp. 387-398. Office of Contract Archeology Report No. 185-324E. Albuquerque.

Monger, H. Curtis, editor
1993 *Soil-Geomorphic and Paleoclimatic Characteristics of the Fort Bliss Maneuver Areas, Southern New Mexico and Western Texas.* Historic and Natural Resources Report No. 10, Cultural Resources Management Program, Directorate of Environment, United States Army Air Defense Artillery Center. Fort Bliss, Texas.

Moore, Mrs. Glen E.
1947 Twelve Room House Ruin. *Bulletin of the Texas Archaeological and Paleontological Soci-*

ety 18:94-114.

Moore, James L.
1996 *Archaeological Investigations in the Southern Mesilla Bolson: Data Recovery at the Santa Teresa Port-of-Entry Facility*. Archaeology Notes No. 188. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

2001 Analysis of the Chipped Stone Assemblages. In *Prehistoric and Historic Occupation of Los Alamos and Guaje Canyons: Data Recovery at Three Sites Near the Pueblo of San Ildefonso*, by J. Moore, pp. 77-128. Archaeology Notes No. 244. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

2003 *Occupation of the Glorieta Valley in the Seventeenth and Nineteenth Centuries: Excavations at LA 76138, LA 76140, and LA 99029*. Archaeology Notes No. 262. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

2004 Spanish Chipped Stone Artifacts. In *Adaptations on the Anasazi and Spanish Frontiers: Excavations at Five Sites Near Abiquiú, Rio Arriba County, New Mexico*, by J. Moore, J. Boyer, and D. Levine, pp. 179-200. Archaeology Notes No. 187. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

n.d. Chapter 10: Patterns of Historic Spanish Chipped Stone Use and Manufacture. In *Land, Settlement, and Community in the Southern Tewa Basin, Volume 2*, edited by J. Moore. MS. On file at Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Moore, James L., Nancy J. Akins, and Stephen S. Post
2010 *Test Excavation Plan for Eight Sites Located at the Spaceport America Facility, Sierra County, New Mexico.* Preliminary Report No. 41. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Moorhead, Max L.
1958 *New Mexico's Royal Road: Trade and Travel on the Chihuahua Trail*. University of Oklahoma Press, Norman.

Morgan, G. S., and S. G. Lucas
2002 Pleistocene Vertebrates from the White Sands Missile Range, Southern New Mexico. In *Geology of White Sands* edited by V. Lueth, K. A. Giles, S. G. Lucas, B. S. Kues, R.G. Myers, and D. Ulmer-Scholle, pp. 267-276. New Mexico Geological Society Guidebook 53.

2005 Pleistocene Vertebrate Faunas in New Mexico from Alluvial, Fluvial, and Lacustrine Deposits. In *New Mexico's Ice Ages* edited by S. G. Lucas, G. S. Morgan, and K. E. Zeigler, pp. 185-248. New Mexico Museum of Natural History and Science Bulletin 28.

Moyes, Holly and Dr. Jamie J. Awe
Spatial Analysis of an Ancient Cave Site. ArcUser. www. Esri. Com / news/arcrser/1000/cave.html accessed 9/16/1010.

Myrick, David F.
1990 *New Mexico's Railroads: A Historical Survey* (revised edition). Colorado Railroad Museum, Golden.

Naylor, Thomas H.
1971 Sierra del Nido Site B, Chihuahua, Mexico, 19°N, 106°W. In *Contributors of the International Tree-Ring Data Bank*. IGBP PAGES/ World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

Nelson, Margaret C.
1991 *The Study of Technological Organization. In Archaeological Method and Theory, Volume 3*, edited by M. B. Schiffer, pp. 57-100. University of Arziona Press, Tucson.

Nelson, Margaret C. and Heidi Lippmeier
1993 Grinding Tool Design as Conditioned by Land-Use Patterns. *American Antiquity* 58(2):286-305.

Nesbitt, Paul H.
1939 *Starkweather Ruin: a Mogollon-Pueblo Site in the Upper Gila Area of New Mexico, and Affili-*

ative Aspects of the Mogollon Culture. Logan Museum Publications in Anthropology Bulletin 6. Beloit College, Beloit, Wisconsin.

Neuman, Robert W.
1967 Radiocarbon-Dated Archaeological Remains on the Northern and Central High Plains. *American Antiquity* 32:471-486.

Niethammer, Carolyn
1974 *American Indian Food and Lore*. Macmillan Publishing, New York.

NMSA (New Mexico Space Authority)
2010 *Cultural Resources Protection, Preservation, and Mitigation Plan*. New Mexico Space Authority, Las Cruces.

NPS (National Park Service)
1996 *Draft National Historic Trail Feasibility Study and Environmental Assessment, El Camino Real de Tierra Adentro, New Mexico*. U.S. Department of the Interior, National Park Service.

Noyes, Stanley
1993 *Los Comanches: The Horse People, 1751-1845*. University of New Mexico Press, Albuquerque.

OAS (Office of Archaeological Studies)
1995 *Safety Manual for Field Archaeology in New Mexico*. Archaeology Notes No. 24e. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

O'Laughlin, Thomas C.
1977 Excavations at the Sandy Bone Site, Dona Ana County, New Mexico. *Awanyu* 5(2):11-42.

1979 *Excavations at the Transmountain Campus, El Paso Community College, El Paso, Texas*. El Paso Centennial Museum Publication in Anthropology No. 7. University of Texas at El Paso.

1980 *The Keystone Dam Site and Other Archaic and Formative Sites in Northwest El Paso, Texas*. El Paso Centennial Museum Publications in Anthropology No. 8. University of Texas at El Paso.

1981 The Roth Site. *The Artifact* 19(3, 4):133-149.

1985 Early Formative Ceramic Assemblages in the Mesilla Valley of Southern New Mexico. In *Views of the Jornada Mogollon*, edited by C. Beck, pp. 54-67. Eastern New Mexico University Contributions in Anthropology 12. Portales.

O'Laughlin, Thomas C., and T. Weber Greiser
1973 *Preliminary Field Report on the Findings and Results of the Evaluation of the Cultural and Historical Resources of the Spillway Area of the Range Dam Lying within the Northgate National Registry Site (EPCM 31:106:3:10) in El Paso, Texas*. El Paso Centennial Museum, University of Texas at El Paso.

O'Leary, Beth
1987 *Prehistoric Land Use in the Southern Mesilla Bolson: Excavations on the Navajo-Hopi Land Exchange near Santa Teresa, New Mexico*. Office of Contract Archeology, University of New Mexico, Albuquerque.

Orians, G. H. and N. E. Pearson
1979 On the Theory of Central Place Foraging. In *Analysis of Ecological Systems*, edited by D. J. Horn, G. R. Stairs, and R. D. Mitchell, pp. 155-177. Ohio State University, Columbia.

Ortner, Donald J.
2003 *Identification of Pathological Conditions in Human Skeletal Remains*. Second Edition, Academic Press, New York.

Parks, James A., Jeffrey S. Dean and Julio L. Betancourt
2006 Tree Rings, Drought, and the Pueblo Abandonment of South-Central New Mexico in the 1670's. In *Environmental Change and Human Adaptation in the Ancient American Southwest*; edited by David E. Doyel and Jeffrey S. Dean. University of Utah Press, Salt Lake City.

Parry, William J. and Robert L. Kelly
1987 Expedient Core Technology and Seden-

tism. In *The Organization of Core Technology*, edited by J. Johnson and C. Morrow, pp. 285-304. Westview Press, Boulder.

Phillips, Fred M., Leslie A. Peeters, Michael K. Tansey, and Stanley N. Davis
1986 Paleoclimatic Inferences from an Isotopic Investigation of Groundwater in the Central San Juan Basin, New Mexico. *Quaternary Research* 26(2):179-193.

Phippen, G. R. Jr., A. B. Silberberg, C. J. Zier, K. B. Menke, C. L. Wase, G. D. Smith, M. McFaul, G. W. Crawford, T. J. Kludt, D. V. Hill, and P. J. McBride
2000 *Excavation of Thirteen Archaeological Sites along the D.S.E. El Paso Pipeline, Otero and Chaves Counties, Southeastern New Mexico*. Centennial Archaeology, Inc., Fort Collins, Colorado.

Pielou, E. C.
1991 *After the Ice Age: The Return of Life to Glaciated North America*. University of Chicago Press, Chicago, Illinois.

Plog, F., G. J. Gumerman, R. C. Euler, J. S. Dean, R. H. Hevly, and T. N. V. Karlstrom
1988 Anasazi Adaptive Strategies: The Model, Predictions, and Results. In *The Anasazi in a Changing Environment*, edited by G. J. Gumerman, pp. 230-276. Cambridge University Press, New York.

Polyak, Victor J., and Yemane Asmerom
2001 Late Holocene Climate and Cultural Changes in the Southwestern United States. *Science* 294:148-151.

2005 Orbital Control of Long-Term Moisture in the Southwestern USA. *Geophysical Research Letters* 32.

Polyak, Victor J., James C. Cokendolpher, Roy A. Norton, and Yemane Asmerom
2001 Wetter and Cooler Late Holocene Climate in the Southwestern United States from Mites Preserved in Stalagmites. *Geology* 29(7):643-646. Geological Society of America.

Polyak, Victor J., Jessica B. T. Rasmussen and Yemane Asmerom
2004 Prolonged Wet Period in the Southwestern United States through the Younger Dryas. *Geology* 33(3):209-212. Geological Society of America.

Poore, R. Z.; M. J. Pavich, and H. D. Grissino-Mayer
2005 Record of the North American Southwest Monsoon from Gulf of Mexico Sediment Cores. *Geology* 32(1):209-212. Geological Society of America.

Pratt, Boyd C., and David H. Snow
1988 *The North Central Regional Overview: Strategies for the Comprehensive Survey of the Architectural and Historic Archaeological Resources of North Central New Mexico* (Vol. 1). New Mexico Historic Preservation Division, Santa Fe.

Pratt, G. Michael
2009 How Do You Know It's a Battlefield? In *Fields of Conflict: Battlefield Archaeology from the Roman Empire to the Korean War* edited by Douglas Scott, Lawrence Babits and Charles Haecker. Potomac Books, Inc., Washington, D.C.

Quaranta, James, and Victor Gibbs
2008 *Cultural Resources Survey of 2,720 Acres for the Proposed Spaceport America, Sierra County, New Mexico*. Zia Project LCS-06-086. Zia Engineering & Environmental Consultants, Inc., Las Cruces.

Quimby, Byron, and Vernon R. Brook
1967 A Folsom Site near El Paso, Texas. *The Artifact* 5(4):31-47.

Railey, Jim A.
2010 Reduced Mobility or the Bow and Arrow? Another Look at "Expedient" Technologies and Sedentism. *American Antiquity* 75(2):259-286.

Rasmussen, Jessica B. T., Victor J. Polyak and Yemane Asmerom
2006 Evidence for Pacific-Modulated Precipitation Variability during the Late Holocene

from the Southwestern USA. *Geophysical Research Letters*, Vol. 33, 2006.

Raven, Christopher
1990 *Prehistoric Human Geography in the Carson Desert – Part II: Archaeological Field Tests of Model Predictions*. Cultural Resource Series Number 4, U.S. Department of the Interior Fish and Wildlife Service, Region 1, Portland.

Raven, Christopher and Robert G. Elston
1989 *Prehistoric Human Geography in the Carson Desert – Part I: A Predictive Model of Land-Use in the Stillwater Wildlife Management Area*. U.S. Department of the Interior Fish and Wildlife Service, Region 1. No. 3. Intermountain Research, Silver City, Nevada.

Ravesloot, John C. (editor)
1988a *Archaeological Resources of the Santa Teresa Study Area, South-Central New Mexico*. Arizona State Museum Cultural Resources Management Division, University of Arizona, Tucson.

1988b The Santa Teresa Project: Temporary Use Sites of the Mesilla Bolson, Southern New Mexico. In *Fourth Jornada Mogollon Conference (Oct. 1985), Collected Papers*, edited by M. Duran and K. Laumbach, pp. 39-64. Human Systems Research, Tularosa, New Mexico.

Read, Dwight
2008 An Interaction Model for Resource Implement Complexity Based on Risk and Number of Annual Moves. *American Antiquity* 73(4):599-625.

Reeve, Frank D.
1960 Navajo-Spanish Diplomacy, 1770-1790. *New Mexico Historical Review* 35:200-235.

Reher, Charles A., and D.C. Witter
1977 Archaic Settlement and the Vegetation Diversity. In *Settlement and Subsistence Along the Lower Chaco River: The CGP Survey*, edited by Charles A. Reher, pp. 113-126. University of New Mexico Press.

Reinhart, Theodore R.
1968 *Late Archaic Cultures of the Middle Rio Grande Valley, New Mexico: A Study of the Process of Culture Change*. Unpublished doctoral dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

Reitz, Elizabeth J., and Elizabeth S. Wing
1999 *Zooarchaeology*. Cambridge University Press, Cambridge.

Riley, Carroll L.
1995 *Rio del Norte: People of the Upper Rio Grande from Earliest Times to the Pueblo Revolt*. University of Utah Press, Salt Lake City.

Rinaldo, John B., and Elaine Bluhm
1956 *Late Mogollon Pottery Types of the Reserve Area*. Fieldiana: Anthropology 36 (7):149-187.

Robertson, Gail, and Val Attenbrow
2008 Skin-Working at Emu Tracks 2, New South Wales, Australia: An Integrated Residue and Use-Wear Analysis of Backed Artefacts. *Lithic Technology* 33:31-49.

Rocek, Thomas R., and John D. Speth
1986 *The Henderson Site Burials: Glimpses of a Late Prehistoric Population in the Pecos Valley*. Museum of Anthropology, University of Michigan Technical Reports No. 18; Research Reports in Archaeology, Contribution 13. Ann Arbor.

Roney, John R., and David C. Simons
1988 Excavated Feature Descriptions. In *Distributional Survey and Excavation of Archaeological Landscapes in the Vicinity of El Paso, Texas*, by E. Camilli, L. Wandsnider, and J. Ebert, pp. 9-1 to 9-49. USDI Bureau of Land Management, Las Cruces, New Mexico.

Russell, Paul
1968 Folsom Complex near Orogrande, New Mexico. *The Artifact* 6(2):11-16.

Schaafsma, Polly
1972 *Rock Art in New Mexico*. New Mexico State Planning Office, Santa Fe.

1992 *Rock Art in New Mexico.* Second edition. Museum of New Mexico Press, Santa Fe.

Schaefer, Harry J. and Robbie Brewington
1995 Microstylistic Changes in Mimbres Black-on-white Pottery: Examples from the Nan Ruin, Grant County, New Mexico. *Kiva* 66(1)5-29.

Scarborough, Vernon L.
1985 Anapra Pueblo Site. In *Proceedings of the Third Jornada Mogollon Conference*, edited by M. Foster and T. O'Laughlin, pp. 129-135. *The Artifact* 23 (1, 2).

1986 Meyers Pithouse Village: A Preliminary Assessment. In *Mogollon Variability*, edited by C. Benson and S. Upham, pp. 271-284. University Museum Occasional Papers No. 15. New Mexico State University, Las Cruces.

Scholes, Frances V.
1930 The Supply Service of the New Mexico Mission in the Seventeenth Century. *New Mexico Historical Review* 5:93-115, 186-210, 386-404.

Scott, Douglas, Lawrence Babits and Charles Haecker (editors)
2009 *Fields of Conflict: Battlefield Archaeology from the Roman Empire to the Korean War*. Potomac Books, Inc., Washington, D.C.

Scott, Douglas D., Richard A. Fox, Jr., Melissa A. Connor, and Dick Harmon
1989 *Archaeological Perspectives on the Battle of Little Bighorn*. University of Oklahoma, Norman, Oklahoma and Lincoln, Nebraska.

Scott, Linda J.
1985 Pollen and Macrofloral Analysis. In *Archaeological Excavations at Two Prehistoric Campsites near Keystone Dam, El Paso, Texas*, by D. Carmichael, pp. 339-350. University Museum Occasional Papers No. 14. New Mexico State University, Las Cruces.

Scurlock, Dan
1998 *From the Rio to the Sierra: An Environmental History of the Middle Rio Grande Basin*. USDA Forest Service General Technical Report RMRS-GTR-5, Rocky Mountain Research Station, U.S. Department of Agriculture, Fort Collins Colorado.

Seager, W.R.
2005 Preliminary geologic map of the Prisor Hill quadrangle, Sierra County, New Mexico: NMBGMR Open-file Geologic Map 114.

Seaman, Timothy J., and William H. Doleman
1988 *The 1986 GBFEL-TIE Sample Survey on White Sands Missile Range, New Mexico: The NASA, Stallion, and Orogrande Alternatives*. Office of Contract Archeology, University of New Mexico, Albuquerque.

Seaman, Timothy J., and Barbara J. Mills
1988a El Paso Brownware Rim Analysis. In *The Border Star 85 Survey: Toward an Archaeology of Landscapes*, edited by T. Seaman, W. Doleman, and R. Chapman, pp. 169-183. Office of Contract Archeology Report No. 185-227. Albuquerque.

1988b What Are We Measuring? Rim Thickness Indices and Their Implications for Change in Vessel Use. In *Fourth Jornada Mogollon Conference (Oct. 1985), Collected Papers*, edited by M. Duran and K. Laumbach, pp. 163-194. Human Systems Research, Tularosa, New Mexico.

Seaman, Timothy J., Peggy Gerow, and Glenna Dean
1987 *Archeological Investigations at Sites 030-3895 and 030-3900, Doña Ana Fairgrounds, New Mexico*. Office of Contract Archeology, University of New Mexico, Albuquerque.

Sebastian, Lynne, and Signa Larralde
1989 *Living on the Land: 11,000 Years of Human Adaptation in Southeastern New Mexico*. U.S. Bureau of Land Management Cultural Resources Series No. 6, 1989. Santa Fe.

Sechrist, Mark
1994 *The Joint Task Force-Six Border Survey: Archaeological Survey along the U.S./Mexican Border Road from Anapra to Antelope Wells, New Mexico*. Project no. HSR 9114A. Human Systems Research, Tularosa, New Mexico.

Seymour, Deni J.
2002 *Conquest and Concealment: After the El Paso Phase on Fort Bliss: An Archaeological Study of the Manso, Suma, and Early Apache.* Lone Mountain Report No. 525/528. Lone Mountain Archaeological Services, Inc, El Paso.

Seymour, Deni J., and Tim Church
2007 *Apache, Spanish, and Protohistoric Archaeology on Fort Bliss*. Lone Mountain Report No. 560-005. Lone Mountain Archaeological Services, Inc, El Paso.

Shackley, M. Steven
1988 Sources of Archaeological Obsidian in the Southwest: An Archaeological, Petrological, and Geochemical Study. *American Antiquity* 53:752-772.

1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. *American Antiquity* 60:531-551.

2005 *Obsidian: Geology and Archaeology in the American Southwest*. University of Arizona Press, Tucson.

2009 Two Newly Discovered Sources of Archaeological Obsidian in the Southwest: Archaeological and Social Implications. *Kiva* 74(3):269-280.

Simmons, Marc
1977 *Father Juan Augustín de Morfi's Account of Disorders in New Mexico, 1778* (translator and editor). The Historical Society of New Mexico, Isleta.

1979 History of Pueblo-Spanish Relations to 1821. In *Handbook of North American Indians* (Vol. 9), edited by A. Ortiz, pp. 178-193. Smithsonian Institution Press, Washington, D.C.

Simmons, Marc, and Frank Turley
1980 *Southwestern Colonial Ironworking*. Museum of New Mexico Press, Santa Fe.

Simms, Steven R.
1984 *Aboriginal Great Basin Foraging Strategies: An Evolutionary Approach*. Unpublished Ph.D. dissertation. University of Utah, Salt Lake City.

1985 Acquisition Costs and Nutritional Data on Great Basin Resources. *Journal of California and Great Basin Anthropology* 7:117-125.

1987 *Behavioral Ecology and Hunter-Gather Foraging – An Example from the Great Basin*. BAR International Series 381. Oxford.

Smiley, Francis E.
1985 The Chronometrics of Early Agricultural Sites in Northeastern Arizona: Approaches to the Interpretation of Radiocarbon Dates. Unpublished Ph.D. dissertation, University of Michigan. University Microfilms, International, Ann Arbor, Michigan.

Smith, G. I., and F. A. Street-Perrott
1983 Pluvial Lakes of the Western United States. In *Late Quaternary Environments of the United States, Volume 1, The Late Pleistocene* edited by S.C. Porter, pp. 190-212. University of Minnesota Press, Minneapolis.

Snow, David H.
1985 A Preliminary Ceramic Analysis, LA 120, Gran Quivira, 1985: The Glazes and Black-on- White Wares. Draft report submitted to Arizona State University, Tempe.

South, Stanley
1977 *Method and Theory in Historical Archaeology*. Academic Press, Orlando.

Southward, Judith A.
1979 A Summary of Ceramic Technology, Plant Remains and Shell Identification Analyses from LA 4921, Three Rivers, New Mexico. In *Jornada Mogollon Archaeology: Proceedings of the First Jornada Conference*, edited by P. Beckett and R. Wiseman, pp. 91-102. New Mexico State University, Las Cruces.

Speth, John D.
2000 Boiling vs. Baking and Roasting: A Taphonomic Approach to the Recognition of Cooking Techniques in Small Animals. In *Animal Bones, Human Societies*, edited by

Peter Rowley-Conway, pp. 89-105. Oxbow Books, Oxford.

Spielmann, Katherine A.
1983 Late Prehistoric Exchange between the Southwest and Southern Plains. *Plains Anthropologist* 28–102(1):257–272.

1996 Exchange and Evolution: Themes in the Study of Plains-Pueblo Relations. In *Interpreting Southwestern Diversity: Underlying Principles and Overarching Patterns*, edited by Paul R. Fish and J. Jefferson Reid, pp. 35–40. Anthropological Research Papers 48. Arizona State University, Tempe.

Stahle, D. W., M. K. Cleaveland, H. D. Grissino-Mayer, R. D. Griffin, F. K. Fye, M. D. Therrell, D. J. Burnette, D. M. Meko and Diaz J. Villanueva
2008 *Cool- and Warm-Season Precipitation Reconstructions over Western New Mexico*. American Meteorological Society.

Steffen, Anastasia and Philippe D. Le Tourneau
2008 The Jemez Mountains Obsidian Database Project: Compiling Obsidian Artifact Provenance Data to Inform on Prehistoric Movement, Trade, and Interaction. Presented at the Southwest Symposium January 2008. Tempe, Arizona.

Sternberg, Robert S.
1990 The Geophysical Basis of Archaeomagnetic Dating. In *Archaeomagnetic Dating*, edited by Jeffrey L. Eighmy and Robert S. Sternberg, pp. 5-28. The University of Arizona Press, Tucson.

Stiner, Mary C., Steven L. Kuhn, Stephen Weiner, and Ofer Bar-Yosef
1995 Differential Burning, Recrystallization, and Fragmentation of Archaeological Bone. *Journal of Archaeological Science* 22:223-237.

Stockton, C. W.
1981 Gallinas Mountains, New Mexico, 34°N, 105°W. In *Contributors of the International Tree-Ring Data Bank*. IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

1982 Gallinas Mountains, New Mexico, 34°N, 105°W. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

Stokes, M. A., T. H. Naylorand, and T. P. Harlan
1971 Organ Mountains, New Mexico, 32°N, 106°W. In *Contributors of the International Tree-Ring Data Bank.* IGBP PAGES/World Data Center for Paleoclimatology, NOAA/NCDC Paleoclimatology Program, Boulder, Colorado.

Stuart, David, and Rory P. Gauthier
1981 *Prehistoric New Mexico: Background for Survey*. New Mexico Historic Preservation Division, Santa Fe.

Stuart, Trace
1990 *A Cultural Resources Inventory of the Proposed Santa Teresa International Port of Entry Phase 1 Industrial Park/Business Loop and Beltway Road on Private Land in Southern Doña Ana County, New Mexico*. Batcho and Kauffman Associates Cultural Resources Report No. 123. Las Cruces, New Mexico.

1997 *Evaluation of Prehistoric Archaeological Sites in Maneuver Areas 4D and 5E, Fort Bliss, Texas*. Technical report No. 9. Anthropological Research Center, University of Texas at El Paso, El Paso.

Stuiver, M., P. M. Grootes and T. F. Braziunas
1995 The GISP2 18O Climate Record of the Past 16,500 Years and the Role of the Sun, Ocean, and Volcanoes. *Quaternary Research* 44:341-354.

Suess, Hans E.
1986 Secular Variation of Cosmogenic C^{14} on Earth: Their Discovery and Interpretation. *Radiocarbon* 28:259-265.

Swift, Marilyn K., and Randy A. Harper
1991 LA 64097. In *Landscape Archeology in the Southern Tularosa Basin,* vol. 2, *Testing, Excavation, and Analysis*, edited by W. Doleman, R. Chapman, J. Schutt, M. Swift, and

K. Morrison, pg. 107-128. Office of Contract Archeology Report No. 185-324E. Albuquerque.

Taylor, K. C., P. A. Mayewski, R. B. Alley, E. J. Brook, A. J. Gow, P. M. Grootes, D. A. Meese, E. S. Saltzman, J. P. Severinghaus, M. S. Twickler, J. W. C. White, S. Whitlow and G. A. Zielinski
1997 The Holocene-Younger Dryas Transition Recorded at Summit, Greenland. *Science* 278:825-827.

Taylor, R. E.
1987 *Radiocarbon Dating; an Archaeological Perspective*. Academic Press, Inc., New York and London.

Telford, R. J., E. Heegaard, and H. J. B. Birks
2004 The Intercept is a Poor Estimate of a Calibrated Radiocarbon Age. *The Holocene* 14(2):296-298.

Tennant, Edward W.
2007 A Sample Geodatabase Structure for Managing Archaeological Data and Recourses with ArcGIS. *Technical Briefs in Historical Archaeology 2:12-13. Society for Historical Archaeology.* http://www.sha.org/publications/technical_briefs/volume02/article02.cfm.

Thomas, Alfred B.
1932 *Forgotten Frontiers: A Study of the Spanish Indian Policy of Don Juan Bautista de Anza, Governor of New Mexico, 1777-1787* (second printing, 1969). University of Oklahoma Press, Norman.

1940 *The Plains Indians and New Mexico, 1751-1778*. University of New Mexico Press, Albuquerque.

Thompson, Marc
1988 The Cultural System of the El Paso Phase Pueblos. In "Pickup Pueblo: A Late Prehistoric House Ruin in Northeast El Paso," edited by R. Gerald, pp. 61-63. *The Artifact* 26(2).

Toll, Mollie S., and Lisa Huckell.
1996 A Guide for Standardizing Collection of *Zea Mays* Morphometric Data. Prepared for 6th Southwest Paleoethnobotanical Workshop, Albuquerque.

Toll, Mollie S. and Pamela J. McBride
1999 *Results of Flotation and Radiocarbon Sample Analysis at Archaic through Protohistoric Sites (Piñon Project), Cornucopia Draw, Otero County, New Mexico*. Ms. on file, Geo-Marine, El Paso. Technical Series 74, Ethnobotany Lab, Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

United States Department of the Interior Geological Survey
1959 Loma De Las Cañas Quadrangle, 1:24,000 scale. Photorevised 1979.

1981 San Antonio Quadrangle, 1:24,000 scale.

Upham, Steadman
1984 Adaptive Diversity and Southwestern Abandonment. *Journal of Anthropological Research* 40:235-256.

1988 Archaeological Visibility and the Underclass of Southwestern Prehistory. *American Antiquity* 53:245-261.

Van Devender, Thomas R.
1990 Late Quaternary Vegetation and Climate of the Chihuahuan Desert, United States and Mexico. I*n Packrat Middens: The Last 40,000 Years of Biotic Change edited by* J. L. Betancourt, T. R. Van Devender and P. S. Martin. University of Arizona Press, Tucson.

Van Devender, Thomas R., and W. Geoffrey Spaulding
1978 Development of Vegetation and Climate in the Southwestern United States. *Science* 204:701-710.

Van Devender, Thomas R., Julio L. Betancourt and Mark Wimberley
1984 Biogeographic Implications of a Packrat Midden Sequence from the Sacramento Mountains, South-Central New Mexico. *Quaternary Research* 22(3): 344-360.

Vaughan, Patrick C.

1985 *Use-Wear Analysis of Flaked Stone Tools*. The University of Arizona Press, Tucson.

Vierra, Bradley J.
1994 Archaic Hunter-Gatherer Archaeology in the American Southwest. *Eastern New Mexico Contributions in Anthropology* 13(1). Eastern New Mexico University, Portales.

Villanueva, Josè D., Julian P. Ceraño, Dave W. Stahle, Brian H. Luckman, and Matthew D. Therrell
2006 *Historical Droughts in North-Central Mexico*. North American Drought Monitor Workshop. Mexico City, Mexico, October 18-19, 2006.

Weaver, Andrew J., Oleg A. Saenko, Peter U. Clark, and Jerry X. Mitrovica
2003 Meltwater Pulse 1A from Antarctiva as a Trigger of the Bolling-Allerod Warm Interval. *Science* 299:1709-1713.

Weber, Robert H., and George Agogino
1997 Mockingbird Gap Paleoindian Site: Excavations in 1997. In *Layers of Time: Papers in Honor of Robert H. Weber*, edited by M. Duran and D. Kirkpatrick, pp. 123-127. Papers of the Archaeological Society of New Mexico 23, Albuquerque.

Wendorf, Fred, and James J. Hester (editors)
1975 *Late Pleistocene Environments of the Southern High Plains*. Fort Burgwin Research Publication 9. Ranchos de Taos, New Mexico.

Wendorf, Fred, and Alex D. Krieger
1959 New Light on the Midland Discovery. *American Antiquity* 25:66-78.

West, K.
1982 Analysis of Rim Sherds from North McGregor Range. On file, Directorate of Facilities Engineering, Environmental Office, Fort Bliss, Texas.

Wetterstrom, Wilma E.
1978 Appendix F: Plant Remains from Mesilla and El Paso Phase Sites of the Hueco Bolson: A Preliminary Report on Food Plants. In *Settlement Patterns of the Western Hueco Bolson*, by M. Whalen, pp. 230-242. El Paso Centennial Museum Publications in Anthropology No. 8. University of Texas at El Paso.

Weymouth, John W.
1986 Geophysical Methods of Archaeological Site Surveying. *Advances in Archaeological Method and Theory* 9:311-395.

Whalen, Michael E.
1977 *Settlement Patterns of the Eastern Hueco Bolson*. El Paso Centennial Museum Publications in Anthropology No. 4. University of Texas at El Paso.

1978 *Settlement Patterns of the Western Hueco Bolson*. El Paso Centennial Museum Publications in Anthropology No. 8. University of Texas at El Paso.

1980a The Pithouse Period of South-Central New Mexico. In *An Archeological Synthesis of South-Central and Southwestern New Mexico*, edited by S. LeBlanc and M. Whalen, pp. 318-386. Prepared for the USDI Bureau of Land Management. On file at the Laboratory of Anthropology, Santa Fe, New Mexico.

1980b *Special Studies in the Archaeology of the Hueco Bolson*. El Paso Centennial Museum Publications in Anthropology No. 9. University of Texas at El Paso.

1981a Cultural-Ecological Aspects of the Pithouse-to-Pueblo Transition in a Portion of the Southwest. *American Antiquity* 46:75-92.

1981b The Origin and Evolution of Ceramics in Western Texas. *Bulletin of the Texas Archaeological Society* 52:215-229.

1989 The Pithouse Period of South-Central New Mexico. In *An Archeological Synthesis of South-Central and Southwestern New Mexico*, edited by S. LeBlanc and M. Whalen, pp. 318-386. Prepared for the USDI Bureau of Land Management. On file at the Laboratory of Anthropology, Santa Fe, New Mexico.

1993 El Paso Brown Rims as Chronological Markers? New Data on an Old Question. *The Kiva* 58:475-486.

1994a *Turquoise Ridge and Late Prehistoric Residential Mobility in the Desert Mogollon Region*. University of Utah Anthropological Papers No. 118. University of Utah Press, Salt Lake City.

1994b Moving out of the Archaic on the Edge of the Southwest. *American Antiquity* 59:622-638.

Wilson, C. Dean
1996 Ceramic Analysis. In *Archaeological Investigations in the Southern Bolson: Data Recovery at the Santa Teresa Port-of-Entry Facility*, by J. L. Moore, pp. 293-306, Office of Archaeology Studies Archaeology Notes 188, Museum of New Mexico, Santa Fe.

1997 Ceramic Artifacts. In *Archaeological Test Excavations Along U.S. 70 and a Recovery Plain for LA 110338, Mescalero Apache Tribal Lands, Otero County, New Mexico*, by N.J. Akins, pp 29-34. Office of Archaeological Studies Archeology Notes 221, Museum of New Mexico, Santa Fe.

1998a Ormand Ceramic Analysis Part I: Methodology and Categories. In *The Ormand Village: Final Report on the 1965-1966 Excavation*, by L. T. Wallace, pp. 195-252, Office of Archaeological Studies Archaeology Notes 229, Museum of New Mexico, Santa Fe.

1998b Ceramic Assemblages. In *The Datil Mountain Project: Archaic, Puebloan, and Athabascan Campsites along U.S. 60, near Datil, Catron County, New Mexico*, by D. J. Hayden, L. A. Miola, and Y. R. Oakes, pp. 87-100. Office of Archaeology Studies Archaeology Notes 177, Museum of New Mexico, Santa Fe.

1999 Ceramic Types and Attributes. In *Archaeology of the Mogollon Highlands Settlement Systems and Adaptations; Volume 4. Ceramics, Miscellaneous Artifacts, Bioarchaeology. Bone Tools and Faunal Analysis*, edited by Y. R. Oakes and D. A. Zamora, pp 5-86. Office of Archaeological Studies Archaeology Notes 232, Museum of New Mexico, Santa Fe.

2000 Angus Ceramic Analysis. In *The Angus Site: A Prehistoric Settlement Along the Rio Bonito Lincoln County, New Mexico*, by D. A. Zamora and Y. E. Oakes, Office of Archaeological Studies Archaeology Notes 276, pp. 101-134. Museum of New

2003 Chapter 13, Ceramics. In *Salt Creek; Data Recovery at Seven Prehistoric Sites along US 285 Chaves and De Baca Counties, New Mexico*, by Nancy J Akins, pp 157-172, Office of Archaeological Studies Archaeology Notes 298, Museum of New Mexico, Santa Fe.

Wimberly, Mark L. and Peter L. Eidenbach
1981 Preliminary Analysis of Faunal Remains from Fresnal Shelter, New Mexico: Evidence of Differential Butchering Practices during the Archaic Period. In *The Artifact: Archaeological Essays in Honor of Mark Wimberly*, edited by Michael S. Foster, pp. 20-39. El Paso Archaeological Society Vo. 19, Nos. 3-4. El Paso.

Winterhalder, Bruce and Carol Goland
1997 An Evolutionary Ecology Perspective on Diet Choice, Risk and Plant Domestication. In *Anthropological Perspectives on Plant Domestication*, edited by K. Gremillion and P. Gardner. University of Alabama Press, Tuscaloosa.

Winterhalder, Bruce and Eric A. Smith
1992 Evolutionary Ecology and the Social Sciences. In *Evolutionary Ecology and Human Behavior*, edited by E. A. Smith and B. Winterhalder, pp. 3-24. Aldine de Gruyter, New York.

Wiseman, Regge N.
1981a Playas Incised, Sierra Blanca Variety: A New Pottery Type in the Jornada Mogollon. In *Transactions of the 16th Regional Archaeological Symposium for Southeastern New Mexico and Western Texas*, pp. 21-27.

Portales, New Mexico.

1981b Further Investigations at the King Ranch Site, Chaves County, New Mexico. In *Archaeological Essays in Honor of Mark Wimberly*, edited by Michael S. Foster. *The Artifact* Vol. 19(3-4):169-198.

1986 *An Initial Study of the Origin of Chupadero Black-on-white*. Albuquerque Archaeological Society Study No. 3. Albuquerque.

1991 *The Bent Project; Archaeological Excavation at the Bent Site, (LA 10835) Otero County, Southern New Mexico*. COAS Monograph No. 5, Las Cruces.

1996 *The Land in Between: Archaic and Formative Occupations along the Upper Rio Hondo of Southeastern, New Mexico*. Archaeology Notes 125. Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

2002 *The Fox Place: A Late Prehistoric Hunter-Gatherer Pithouse Village near Roswell, New Mexico*. Office of Archaeological Studies Archaeology Notes 234, Museum of New Mexico, Santa Fe.

Wondzell, Steven M., Gary L. Cunningham, and Dominique Bachelet

1996 Relationships between Landforms, Geomorphic Processes, and Plant Communities on a Watershed in the Northern Chihuahuan Desert. *Landscape Ecology* 11:351-362.

Wood, Chris, and Dan Smith

2004 Dendroglaciological Evidence for a Neoglacial Advance of the Saskatchewan Glacier, Banff National Park, Canadian Rocky Mountain. *Tree Ring Research* 60(1): 59-65.

Wood, J. Scott

1987 *Checklist of Pottery Types for the Tonto National Forest: An Introduction to the Archaeological Ceramics of Central Arizona*. The Arizona Archaeologist No. 21. Arizona Archaeological Society, Phoenix.

Wright, Jr., H. E., J. E. Kutzbach, T. Webb III, W. F. Ruddiman, F. A. Street-Perrott, and P. J. Bartlein

1993 *Global Climates since the Last Glacial Maximum*. University of Minnesota Press. Minneapolis – London.

Wright, Katharine I.

1994 Ground-Stone Tools and Hunter-Gatherer Subsistence in Southwest Asia: Implications for the Transition to Farming. *American Antiquity* 52(2): 238-263.

York, John C., and William A. Dick-Peddie

1969 Vegetation Changes in Southern New Mexico during the Past Hundred Years. In *Arid Lands in Perspective*, edited by W. McGinnies and B. Goldman, pp. 157-166. University of Arizona Press, Tucson.

Appendix 1: Archaeological sites documented by registered activities listed in Table 3.1.

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
39797	7	Structural/Prehistoric	Residential complex/community	87,100	Anasazi (AD 1100 to 1600)
7023	5599	Structural/Prehistoric	Artifact scatter with pit structures	197,800	Mogollon (AD 200 to 1400)
39797	6346	Structural/Prehistoric & Historic	Artifact scatter with hearth features, Transportation/communication	30,000	Mogollon (AD 1175 to 1400), Hispanic (AD 1539 to 1692)
104538	8871	Structural/Historic	Artifact scatter with simple features	?	Anglo (AD 1846 to 1912)
46610	22267	Structural/Prehistoric	Artifact scatter with hearth features	750	Archaic (3000 to 1800 BC), Mogollon (AD 200 to 1400)
26132	30643	Structural/Prehistoric	Petroglyphs	?	Mogollon (AD 200 to 1400)
26132	30644	Structural/Prehistoric	Artifact scatter with pit structures	30,000	1175 to 1400)
26132	30645	Structural/Prehistoric	Residential complex/community	30,000	Mogollon (AD 600 to 1400)
26132	30646	Structural/Prehistoric	Artifact scatter with pit structures	30,000	Mogollon (AD 750 to 1100)
26132	30647	Structural/Prehistoric	Artifact scatter with pit structures	30,000	Mogollon (AD 1100 to 1175)
26132	30648	Structural/Prehistoric	Artifact scatter with pit structures	7,500	Mogollon (AD 1100 to 1175)
26132	30649	Nonstructural/Unknown	Artifact scatter	750	Unknown (9500 BC to AD 1993)
26132	30650	Nonstructural/Unknown	Artifact scatter	62	Unknown (9500 BC to AD 1993)
26132	30651	Nonstructural/Unknown	Artifact scatter	300	Unknown (9500 BC to AD 1993)
26132	30652	Nonstructural/Prehistoric	Artifact scatter	300	Archaic (5500 BC to AD 900)
26132	30653	Nonstructural/Prehistoric	Artifact scatter	30,000	Mogollon (AD 200 to 1400)
26132 & 49589	30654	Structural/Prehistoric	Artifact scatter with hearth features	19,625	Archaic (3000 BC to AD 200), Mogollon (AD 1200 to 1400)
26132	30655	Nonstructural/Prehistoric	Artifact scatter	7,500	Mogollon (AD 200 to 1400)
26132	30656	Nonstructural/Prehistoric	Artifact scatter	300	Mogollon (AD 200 to 1400)
26132	30657	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30658	Structural/Prehistoric	Artifact scatter with hearth features	750	Mogollon (AD 200 to 1400)
26132	30659	Structural/Prehistoric & Historic	Artifact scatter with hearth features	30,000	Archaic (5500 BC to AD 900), Mogollon (AD 200 to 1400), Apache (AD 1539 to 1993)
26132	30660	Structural/Prehistoric & Historic	Artifact scatter with pit structures	30,000	Mogollon (AD 200 to 1400), Apache (AD 1539 to 1993)
26132	30661	Nonstructural/Prehistoric	Artifact scatter	750	Mogollon (AD 200 to 1400)
26132	30662	Nonstructural/Prehistoric	Artifact scatter	30,000	Archaic (5500 BC to AD 900)
26132	30663	Nonstructural/Prehistoric	Artifact scatter	300	Archaic (5500 BC to AD 900)
26132	30664	Nonstructural/Unknown	Artifact scatter	750	Unknown (9500 BC to AD 1993)
26132	30665	Structural/Prehistoric	Artifact scatter with hearth features	7,500	Mogollon (AD 200 to 1400)
26132 & 49589	30666	Structural/Prehistoric	Residential complex/community	7,850	Mogollon (AD 400 to 1000)
26132	30667	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30668	Structural/Prehistoric	Artifact scatter with hearth features	3,000	Mogollon (AD 1100 to 1400)
26132	30669	Nonstructural/Prehistoric	Artifact scatter	750	Mogollon (AD 1100 to 1400)
26132	30670	Nonstructural/Unknown	Artifact scatter	30,000	Unknown (9500 BC to AD 1993)
26132	30671	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Mogollon (AD 200 to 1400)
26132	30672	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Mogollon (AD 200 to 1400)
26132	30673	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Mogollon (AD 200 to 1400)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
26132	30675	Structural/Prehistoric	Artifact scatter with hearth features	7,500	Mogollon (AD 200 to 1400)
26132	30676	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30677	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30678	Structural/Prehistoric	Artifact scatter with hearth features	300	Mogollon (AD 200 to 1400)
26132	30679	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Mogollon (AD 200 to 1400)
26132	30680	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Mogollon (AD 200 to 1400)
26132	30681	Nonstructural/Prehistoric	Artifact scatter	750	Mogollon (AD 200 to 1400)
26132	30682	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30683	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30684	Nonstructural/Prehistoric	Artifact scatter	12	Mogollon (AD 200 to 1400)
26132	30685	Nonstructural/Prehistoric	Artifact scatter	62	Mogollon (AD 200 to 1400)
26132	30686	Nonstructural/Prehistoric	Artifact scatter	750	Mogollon (AD 200 to 1400)
26132	30687	Nonstructural/Prehistoric	Artifact scatter	62	Mogollon (AD 200 to 1400)
26132	30688	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30689	Nonstructural/Prehistoric	Artifact scatter	62	Mogollon (AD 200 to 1400)
26132	30690	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
26132	30691	Structural/Prehistoric	Artifact scatter with hearth features	62	Mogollon (AD 200 to 1400)
26132	30692	Nonstructural/Prehistoric	Artifact scatter	750	Mogollon (AD 200 to 1400)
26132	30693	Nonstructural/Prehistoric	Artifact scatter	300	Mogollon (AD 200 to 1400)
26132	30694	Nonstructural/Unknown	Artifact scatter	3,000	Unknown (9500 BC to AD 1993)
26132	30695	Nonstructural/Unknown	Artifact scatter	3,000	Unknown (9500 BC to AD 1993)
26132	30696	Nonstructural/Unknown	Artifact scatter	3,000	Unknown (9500 BC to AD 1993)
26132	30697	Nonstructural/Unknown	Artifact scatter	750	Unknown (9500 BC to AD 1993)
26132 & 49589	30698	Structural/Unknown	Artifact scatter with hearth features	18,840	Unknown (9500 BC to AD 1993)
26132	30699	Structural/Unknown	Artifact scatter with hearth features	30,000	Unknown (9500 BC to AD 1993)
26132	30700	Structural/Unknown	Artifact scatter with hearth features	3,000	Unknown (9500 BC to AD 1993)
26132	30701	Nonstructural/Unknown	Artifact scatter	750	Unknown (9500 BC to AD 1993)
26132	30702	Structural/Unknown	Artifact scatter with hearth features	300	Unknown (9500 BC to AD 1993)
26132	30703	Nonstructural/Prehistoric	Artifact scatter	3,000	Archaic (5500 BC to AD 900)
26132	30704	Structural/Unknown	Artifact scatter with hearth features	30,000	Unknown (9500 BC to AD 1993)
26132	30705	Structural/Prehistoric	Artifact scatter with hearth features	750	Archaic (5500 BC to AD 900)
26132	30706	Structural/Unknown	Artifact scatter with hearth features	300	Unknown (9500 BC to AD 1993)
26132	30707	Structural/Unknown	Artifact scatter with hearth features	30,000	Unknown (9500 BC to AD 1993)
26132	30708	Structural/Unknown	Artifact scatter with hearth features	30,000	Unknown (9500 BC to AD 1993)
26132	30709	Structural/Unknown	Artifact scatter with hearth features	300	Unknown (9500 BC to AD 1993)
26132	30710	Structural/Unknown	Artifact scatter with hearth features	750	Unknown (9500 BC to AD 1993)
26132	30711	Structural/Unknown	Artifact scatter with hearth features	30,000	Unknown (9500 BC to AD 1993)
26132	30712	Structural/Unknown	Artifact scatter with hearth features	7,500	Unknown (9500 BC to AD 1993)
26132	30713	Nonstructural/Unknown	Artifact scatter	300	Unknown (9500 BC to AD 1993)
26132	30714	Structural/Unknown	Artifact scatter with hearth features	7,500	Unknown (9500 BC to AD 1993)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
26132 & 49589	30716	Structural/Prehistoric	Artifact scatter with hearth features	13,188	Archaic (3000 BC to 1800 BC), Mogollon (AD 200 to 1400)
26132	30717	Nonstructural/Unknown	Artifact scatter	3,000	Unknown (9500 BC to AD 1993)
26132	30718	Structural/Prehistoric	Artifact scatter with hearth features	?	Archaic (5500 BC to AD 900)
26132	30719	Structural/Prehistoric	Artifact scatter with hearth features	3,000	Mogollon (AD 200 to 1400)
26132	30720	Nonstructural/Unknown	Artifact scatter	3,000	Unknown (9500 BC to AD 1993)
26132	30721	Nonstructural/Prehistoric	Artifact scatter	3,000	Archaic (5500 BC to AD 900)
26132	30722	Nonstructural/Prehistoric	Artifact scatter	750	Archaic (5500 BC to AD 900)
26132	30723	Structural/Unknown	Artifact scatter with hearth features	7,500	Unknown (9500 BC to AD 1993)
26132	30724	Structural/Prehistoric	Artifact scatter with hearth features	12	Archaic (5500 BC to AD 900)
26132	30725	Structural/Unknown	Artifact scatter with hearth features	30,000	Unknown (9500 BC to AD 1993)
26132	30726	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Archaic (5500 BC to AD 900)
26132	30727	Structural/Unknown	Artifact scatter with hearth features	300	Unknown (9500 BC to AD 1993)
26132	30728	Nonstructural/Unknown	Artifact scatter	300	Unknown (9500 BC to AD 1993)
26132	30729	Structural/Prehistoric	Artifact scatter with hearth features	300	Archaic (5500 BC to AD 900)
26132	30730	Structural/Unknown	Artifact scatter with hearth features	3,000	Unknown (9500 BC to AD 1993)
26132	30731	Structural/Unknown	Artifact scatter with hearth features	750	Unknown (9500 BC to AD 1993)
26132	30732	Nonstructural/Prehistoric	Artifact scatter	62	Mogollon (AD 1175 to 1400)
26132 & 49589	30733	Structural/Unknown	Artifact scatter with hearth features	3,925	Unknown (9500 BC to AD 1993)
26132	30734	Structural/Historic	Cemetery	3,000	Unknown (AD 1539 to 1993)
26132	30735	Structural/Prehistoric	Artifact scatter with simple features	314	Mogollon (AD 775 to 1175)
26132	30736	Structural/Prehistoric	Artifact scatter with simple features	300	Mogollon (AD 200 to 1400)
46610	30757	Structural/Prehistoric & Historic	Artifact scatter with simple features	30,000	Archaic (5500 BC to AD 900), Anglo (AD 1945 to 1993)
46610	30758	Nonstructural/Prehistoric	Artifact scatter	1,250	Archaic (1800 BC to AD 900), Mogollon (AD 400 to 1450)
26132	35269	Structural/Prehistoric	Residential complex/community	225,000	Mogollon (AD 750 to 1200)
636	37512	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Archaic (3000 BC to 1800 BC), Mogollon (AD 1175 to 1400)
636	37513	Structural/Unknown	Artifact scatter with hearth features	3,000	Unknown (9500 BC to AD 1993)
636	37514	Structural/Prehistoric & Historic	Artifact scatter with hearth features	30,000	Archaic (5500 BC to 900 AD), Anglo (AD 1912 to 1945)
636	37515	Structural/Unknown	Artifact scatter with hearth features	3,000	Unknown (9500 BC to AD 1993)
636	37516	Nonstructural/Unknown	Artifact scatter	3,000	Unknown (9500 BC to AD 1993)
636	37517	Structural/Prehistoric	Artifact scatter with hearth features	30,000	Mogollon (AD 200 to 1400)
636	37518	Nonstructural/Historic	Artifact scatter	3,000	Anglo (AD 1912 to 1945)
636	37519	Nonstructural/Prehistoric	Artifact scatter	300	Mogollon (AD 750 to 1100)
636	37520	Structural/Prehistoric	Artifact scatter with hearth features	3,000	Archaic (1800 BC to AD 900)
636	37521	Nonstructural/Unknown	Artifact scatter	300	Unknown (9500 BC to AD 1993)
636	37522	Nonstructural/Unknown	Artifact scatter	300	Unknown (9500 BC to AD 1993)
636	37523	Nonstructural/Unknown	Artifact scatter	7,500	Unknown (9500 BC to AD 1993)
636	37524	Structural/Prehistoric	Lithic quarry	1,260,000	Archaic (5500 BC to 900 AD)
49589	47166	Nonstructural/Prehistoric	Artifact scatter	12,720	Mogollon (AD 1175 to 1400)
7023	51203	Structural/Prehistoric	Artifact scatter with hearth features	350,000	Archaic (5500 BC to 900 AD), Anglo (AD 1912 to 1945)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
7023 & 106719	51204	Structural/Unknown	Artifact scatter with hearth features	610,000	Unknown (9500 BC to AD 1850)
106719	51205	Nonstructural/Historic	Artifact scatter	30,000	Anglo (AD 1846 to 1912)
46610	51205	Nonstructural/Historic	Artifact scatter	30,000	Anglo (AD 1846 to 1912)
7023	51206	Structural/Prehistoric	Artifact scatter with hearth features	187,500	Archaic (5500 BC to AD 900), Mogollon (AD 200 to 1400)
46610	51206	Structural/Prehistoric	Artifact scatter with hearth features	187,500	Archaic (5500 BC to AD 900), Mogollon (AD 200 to 1400)
46610	53640	Structural/Unknown	Lithic quarry	400,000	Unknown (9500 BC to AD 1993)
46610	53641	Nonstructural/Prehistoric	Artifact scatter	3,000	Mogollon (AD 200 to 1400)
46610	53642	Structural/Prehistoric	Artifact scatter with hearth features	3,000	Archaic (5500 BC to AD 900)
39797	71818	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1912)
39797	80001	Structural/Historic	Artifact scatter with residential structure	30,000	Hispanic (AD 1846 to 1912)
39797	80002	Structural/Historic	Transportation/communication	45,000	Hispanic (AD 1846 to 1912)
39797	80003	Structural/Historic	Transportation/communication	450	Anglo (AD 1846 to 1912)
39797	80004	Structural/Historic	Artifact scatter with hearth features	750	Pueblo (AD 1539 to 1680), Pueblo (AD 1692 to 1821)
39797	80005	Structural/Prehistoric & Historic	Artifact scatter with simple features, Transportation/communication	7,500	Archaic (5500 BC to AD 200), Hispanic (AD 1539 to 1912), Hispanic (AD 1821 to 1912)
39797	80006	Structural/Historic	Artifact scatter with simple features	3,000	Hispanic (AD 1846 to 1912)
39797	80007	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1912)
39797	80008	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1912)
39797	80009	Structural/Historic	Transportation/communication	62	Hispanic (AD 1539 to 1993)
39797	80010	Structural/Historic	Transportation/communication	15,000	Hispanic (AD 1846 to 1912)
39797	80011	Structural/Historic	Transportation/communication	5,301	Hispanic (AD 1821 to 1912)
39797	80012	Structural/Historic & Unknown	Artifact scatter, Transportation/communication	28,050	Unknown (9500 BC to AD 1850), Hispanic (AD 1821 to 1912)
39797	80013	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1912)
39797	80014	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1912)
39797	80016	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1912)
39797	80050	Structural/Historic	Transportation/communication	3,000	Hispanic (AD 1539 to 1680)
39797	80051	Structural/Historic	Ranching/agricultural	3,000	Anglo (AD 1846 to 1912)
39797 & 49589	80052	Structural/Historic	Transportation/communication	5,998	Hispanic (AD 1539 to 1912)
39797 & 49589	80053	Nonstructural/Historic	Transportation/communication	200	Hispanic (AD 1598 to 1880)
39797 & 49589	80054	Structural/Historic	Transportation/communication	1,000	Hispanic (AD 1598 to 1880)
39797	80055	Structural/Historic	Transportation/communication	?	Anglo (AD 1821 to 1912)
39797	80056	Structural/Historic	Simple features	12	Unknown (AD 1539 to 9999)
39797	80057	Structural/Historic	Transportation/communication	30,000	Anglo (AD 1539 to 1993)
39797	80058	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1993)
39797	80059	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1846)
39797	80060	Structural/Historic	Artifact scatter with simple features	300	Unknown (AD 1550 to 9999)
39797	80061	Structural/Historic	Artifact scatter with simple features	3,000	Anglo (AD 1846 to 1912)
39797	80062	Structural/Historic	Artifact scatter with simple features	3,000	Anglo (AD 1846 to 1912)
39797	80063	Structural/Historic	Artifact scatter with hearth features	300	Apache (AD 1539 to 1993)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
39797	80064	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1846)
39797	80065	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1846)
39797	80066	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1846)
39797	80067	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1912)
39797	80068	Structural/Historic	Transportation/communication	?	Hispanic (AD 1539 to 1846)
39797	80069	Structural/Historic	Transportation/communication	?	Hispanic (AD 1821 to 1912)
39797 & 49589	80070	Structural/Historic	Transportation/communication	?	Hispanic (AD 1598 to 1880)
49589	80071	Structural/Historic	Artifact scatter	4,200	Anglo (AD 1846 to 1912)
49589	80072	Structural/Historic	Transportation/communication	30,000	Hispanic (AD 1598 to 1880), Anglo (AD 1846 to 1912)
26132	87895	Structural/Unknown	Lithic quarry	15,000	Unknown (9500 BC to AD 1993)
49589	107269	Structural/Prehistoric	Artifact scatter with hearth features	4,300	Archaic (1800 BC to AD 200)
49589	110391	Structural/Prehistoric & Historic	Artifact scatter with simple features	24,840	Archaic (5500 to 1800 BC), Mogollon (AD 200 to 1400), Anglo (AD 1880 to 1996)
49589	110392	Structural/Unknown & Historic	Artifact scatter with hearth features	3,730	Unknown (9500 BC to AD 1880), Anglo (AD 1904 to 1995)
49589	110393	Structural/Prehistoric	Artifact scatter with hearth features	120,170	Mogollon (AD 1175 to 1525)
49589	110394	Nonstructural/Prehistoric	Artifact scatter	3,770	Archaic (5500 to 1800 BC)
49589	110395	Structural/Historic & Unknown	Artifact scatter with simple features, Industrial	157,080	Unknown (9500 BC to AD 1880), Anglo (AD 1912 to 1945)
49589	110396	Nonstructural/Prehistoric & Historic	Artifact scatter	23,562	Archaic (5500 to 1800 BC), Pueblo (AD 1710 to 1750)
49589	110397	Nonstructural/Prehistoric	Artifact scatter	26,533	Archaic (3000 to 1800 BC)
49589	110398	Nonstructural/Unknown	Artifact scatter	42,312	Unknown (**** to AD 1900)
49589	110399	Structural/Historic	Single residence	115,450	Anglo (AD 1880 to 1945)
49589	110400	Structural/Historic & Unknown	Artifact scatter, Transportation/ communication	5,424	Unknown (9500 BC to AD 1880), Hispanic (AD 1598 to 1945)
49589	110401	Structural/Historic & Unknown	Artifact scatter, Transportation/ communication	5,514	Unknown (9500 BC to AD 1880), Hispanic (AD 1598 to 1880)
49589	110402	Structural/Historic & Unknown	Artifact scatter, Transportation/ communication	5,652	Unknown (9500 BC to AD 1880), Hispanic (AD 1598 to 1880)
49589	110403	Structural/Prehistoric & Historic	Artifact scatter with simple features	4,712	Mogollon (AD 1175 to 1300), Hispanic (AD 1598 to 1939)
49589	110404	Structural/Historic & Unknown	Artifact scatter, transportation/communication	1,884	Unknown (9500 BC to AD 1880), Hispanic (AD 1598 to 1880)
49589	110405	Structural/Prehistoric & Historic	Artifact scatter with simple features, Transportation/communication	2,199	Archaic (5500 BC to AD 200), Hispanic (AD 1598 to 1880)
49589	110406	Structural/Prehistoric & Historic	Artifact scatter with hearth features, Transportation/communication	6,428	Archaic (3000 BC to AD 200), Mogollon (AD 900 to 1150), Hispanic (AD 1598 to 1880)
49589	110902	Nonstructural/Unknown	Artifact scatter	12,400	Unknown (9500 BC to AD 1880)
49589	110903	Structural/Historic	Artifact scatter with hearth features	485	Anglo (AD 1918 to 1950)
49589	110904	Nonstructural/Historic	Artifact scatter	2,474	Anglo (AD 1912 to 1945)
49589	111000	Structural/Historic	Transportation/communication	1,520,700	Hispanic (AD 1598 to 1881), Anglo (AD 1881 to 1945)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
49589 & 104538	111420	Nonstructural/Unknown	Artifact scatter	11,775	Unknown (9500 BC to AD 1880)
49589 & 104538	111421	Nonstructural/Unknown	Artifact scatter	3,888	Unknown (9500 BC to AD 1880)
49589 & 104538	111422	Nonstructural/Prehistoric	Artifact scatter	7,850	Mogollon (AD 800 to 1000)
49589	111423	Nonstructural/Unknown	Artifact scatter	1,100	Unknown (9500 BC to AD 1880)
49589	111424	Nonstructural/Unknown	Artifact scatter	707	Unknown (9500 BC to AD 1880)
49589	111425	Structural/Prehistoric	Artifact scatter with hearth features	2,551	Mogollon (AD 400 to 1400)
49589	111426	Structural/Unknown	Artifact scatter with hearth features	1,766	Unknown (9500 BC to AD 1880)
49589	111427	Nonstructural/Unknown	Artifact scatter	3,770	Unknown (9500 BC to AD 1880)
49589	111428	Structural/Prehistoric & Unknown	Artifact scatter with hearth features	13,738	Paleoindian (9000 to 8000 BC), Unknown (9500 BC to AD 1880)
49589 & 104538	111429	Structural/Prehistoric	Artifact scatter with hearth features	151,190	Paleoindian (9000 to 8000 BC), Archaic (3000 BC to AD 750), Mogollon (AD 950 to 1000)
49589	111430	Structural/Unknown	Artifact scatter with hearth features	12,168	Unknown (9500 BC to AD 1880)
49589	111431	Nonstructural/Prehistoric	Artifact scatter	15,072	Archaic (6000 to 4000 BC)
49589 & 104538	111432	Nonstructural/Prehistoric	Artifact scatter	4,320	Paleoindian (6700 to 6000 BC)
49589	111433	Structural/Unknown	Artifact scatter with hearth features	12,370	Unknown (9500 BC to AD 1880)
49589	111434	Nonstructural/Unknown	Artifact scatter	4,416	Unknown (9500 BC to AD 1880)
49589 & 104538	111435	Structural/Prehistoric	Artifact scatter with hearth features	30,223	Mogollon (AD 750 to 1250)
49589	111436	Structural/Prehistoric	Artifact scatter with hearth features	8,792	Mogollon (AD 800 to 1000)
49589	111437	Nonstructural/Unknown	Artifact scatter	1,414	Unknown (9500 BC to AD 1880)
49589	111438	Structural/Prehistoric	Artifact scatter with hearth features	10,000	Mogollon (AD 200 to 1400)
49589	112367	Nonstructural/Prehistoric	Artifact scatter	4,396	Mogollon (AD 200 to 1400)
49589	112368	Nonstructural/Prehistoric	Artifact scatter	4,710	Paleoindian (9500 to 5500 BC), Archaic (3000 to 1800 BC)
49589	112369	Nonstructural/Prehistoric & Unknown	Artifact scatter	2,748	Paleoindian (9500 to 5500 BC), Unknown (9500 BC to AD 1880)
49589, 98713 & 104538	112370	Nonstructural/Unknown	Artifact scatter	4,241	Unknown (9500 BC to AD 1880)
49589, 98713 & 104538	112371	Nonstructural/Unknown	Artifact scatter	3,181	Unknown (9500 BC to AD 1880)
49589 & 104538	112372	Nonstructural/Unknown	Artifact scatter	1,374	Unknown (9500 BC to AD 1880)
49589	112373	Nonstructural/Unknown	Artifact scatter	16,493	Unknown (9500 BC to AD 1880)
49589, 98713 & 104538	112374	Nonstructural/Unknown	Artifact scatter	1,885	Unknown (9500 BC to AD 1880)
49589	112375	Nonstructural/Unknown	Artifact scatter	1,178	Unknown (9500 BC to AD 1880)
49589 & 104538	112376	Nonstructural/Unknown	Artifact scatter	393	Unknown (9500 BC to AD 1880)
49589 & 104538	112377	Structural/Prehistoric & Unknown	Artifact scatter with hearth features	4,712	Paleoindian (9500 to 5500 BC), Unknown (9500 BC to AD 1880)
49589 & 104538	112378	Structural/Prehistoric & Unknown	Artifact scatter with hearth features	100,138	Paleoindian (9500 to 5500 BC), Archaic (3000 to AD 1800 BC)
49589 & 104538	112379	Structural/Prehistoric	Artifact scatter with hearth features	2,651	Archaic (1500 BC to AD 200)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
49589	112381	Structural/Prehistoric & Unknown	Artifact scatter with hearth features	13,823	Paleoindian (9500 to 5500 BC), Unknown (9500 BC to AD 1880)
49589 & 104538	112382	Structural/Unknown	Artifact scatter with simple features	118	Unknown (9500 BC to AD 1880)
49589 & 104538	112383	Structural/Unknown	Artifact scatter with hearth features	1,728	Unknown (9500 BC to AD 1880)
49589 & 104538	112384	Structural/Prehistoric	Artifact scatter with hearth features	1,728	Mogollon (AD 200 to 1400)
49589 & 104538	112385	Nonstructural/Unknown	Artifact scatter	226	Unknown (9500 BC to AD 1880)
49589	112386	Nonstructural/Unknown	Artifact scatter	785	Unknown (9500 BC to AD 1880)
49589	112387	Nonstructural/Unknown	Artifact scatter	785	Unknown (9500 BC to AD 1880)
49589	112388	Structural/Prehistoric	Artifact scatter with hearth features	10,053	Mogollon (AD 200 to 1400)
49589	112389	Structural/Prehistoric	Artifact scatter with hearth features	16,965	Archaic (1000 BC to AD 100)
49589	112390	Structural/Unknown	Artifact scatter with hearth features	6,597	Unknown (9500 BC to AD 1880)
49589	112391	Structural/Prehistoric	Artifact scatter with hearth features	3,829	Mogollon (AD 800 to 1000)
49589	112392	Nonstructural/Prehistoric	Artifact scatter	1,414	Mogollon (AD 200 to 1400)
49589	112393	Nonstructural/Prehistoric	Artifact scatter	2,121	Paleoindian (6700 to 6000 BC)
49589	112394	Nonstructural/Prehistoric	Artifact scatter	42,412	Paleoindian (9500 to 5000 BC), Unknown (9500 BC to AD 1880)
49589 & 104538	112395	Nonstructural/Prehistoric	Artifact scatter	4,712	Paleoindian (9000 to 5500 BC)
49589	112396	Structural/Historic & Unknown	Artifact scatter with simple features	884	Unknown (9500 BC to AD 1880), Anglo (AD 1951 to 1997)
49589	112397	Nonstructural/Prehistoric	Artifact scatter	2,160	Archaic (1800 BC to AD 750)
49589	113564	Structural/Unknown	Artifact scatter with hearth features	38,132	Unknown (9500 BC to AD 1880)
49589	113565	Nonstructural/Prehistoric	Artifact scatter	19,780	Mogollon (AD 750 to 1200)
49589	113566	Nonstructural/Prehistoric	Artifact scatter	4,710	Mogollon (AD 1200 to 1400)
49589	113567	Structural/Prehistoric	Artifact scatter with hearth features	13,994	Archaic (BC 3000 to AD 200), Mogollon (AD 1200 to 1400)
49589	113568	Structural/Unknown	Artifact scatter with hearth features	1,099	Unknown (9500 BC to AD 1880)
49589	113569	Nonstructural/Unknown	Artifact scatter	1,570	Unknown (9500 BC to AD 1880)
49589	113570	Nonstructural/Unknown	Artifact scatter	1,570	Unknown (9500 BC to AD 1880)
49589	113571	Structural/Prehistoric	Artifact scatter with hearth features	28,260	Mogollon (AD 200 to 1400)
49589	113572	Structural/Prehistoric	Artifact scatter with hearth features	29,437	Archaic (BC 1800 to AD 200), Mogollon (AD 200 to 1100)
49589	113573	Nonstructural/Unknown	Artifact scatter	1,649	Unknown (9500 BC to AD 1880)
49589	113574	Structural/Unknown	Artifact scatter with hearth features	2,826	Unknown (9500 BC to AD 1880)
49589	113575	Nonstructural/Prehistoric	Artifact scatter	10,048	Archaic (BC 1800 to AD 200), Mogollon (AD 200 to 1100)
49589	113576	Structural/Prehistoric	Single residence	22,451	Mogollon (AD 750 to 1200)
49589	113577	Structural/Prehistoric	Artifact scatter with hearth features	4,945	Mogollon (AD 200 to 1400)
49589	113578	Structural/Prehistoric	Artifact scatter with hearth features	4,710	Archaic (3000 to 1800 BC)
49589	113579	Nonstructural/Unknown	Artifact scatter	3,140	Unknown (9500 BC to AD 1880)
49589	113580	Structural/Unknown	Artifact scatter with hearth features	10,048	Unknown (9500 BC to AD 1880)
49589	113581	Nonstructural/Unknown	Artifact scatter	895	Unknown (9500 BC to AD 1880)
49589	113582	Structural/Prehistoric	Artifact scatter with hearth features	16,500	Mogollon (AD 400 to 1000)
49589	113583	Structural/Prehistoric	Artifact scatter with hearth features	15,700	Mogollon (AD 200 to 1400)
49589	113584	Structural/Prehistoric	Artifact scatter with hearth features	12,953	Mogollon (AD 200 to 1400)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
49589	113586	Structural/Prehistoric	Artifact scatter with hearth features	43,960	Mogollon (AD 400 to 1000)
49589	113587	Structural/Prehistoric & Unknown	Artifact scatter with hearth features	13,188	Paleoindian (9000 to 8000 BC), Unknown (9500 BC to AD 1550)
49589	113588	Structural/Unknown	Artifact scatter with hearth features	1,731	Unknown (9500 BC to AD 1880)
49589	113589	Structural/Prehistoric	Artifact scatter with hearth features	21,980	Archaic (3000 to 1800 BC), Archaic (BC 1800 to AD 200), Mogollon (AD 200 to 1400)
49589	113590	?	?	?	?
49589	113591	Structural/Unknown	Artifact scatter with hearth features	2,355	Unknown (9500 BC to AD 1880)
49589	113592	Structural/Unknown	Artifact scatter with hearth features	1,275	Unknown (9500 BC to AD 1550)
49589	113593	Structural/Unknown	Artifact scatter with hearth features	3,454	Unknown (9500 BC to AD 1550)
49589	113594	Structural/Prehistoric	Artifact scatter with hearth features	11,343	Paleoindian (6600 to 5500 BC), Archaic (3000 BC to AD 200)
49589	113595	Structural/Prehistoric	Artifact scatter with hearth features	66,234	Paleoindian (9000 to 5500 BC), Archaic (5500 BC to AD 200)
49589	113596	Nonstructural/Prehistoric & Historic	Artifact scatter	13,816	Archaic (4000 to 2500 BC), Mogollon (AD 1250 to 1400), Unknown (AD 1540 to 1675)
49589	113597	Structural/Prehistoric	Artifact scatter with hearth features	14,130	Mogollon (AD 900 to 1350)
49589	113598	Structural/Prehistoric	Artifact scatter with hearth features	6,771	Archaic (1800 BC to AD 200), Mogollon (AD 400 to 1000)
49589	113599	Structural/Prehistoric	Artifact scatter with hearth features	65,940	Archaic (1800 BC to AD 400), Mogollon (AD 1000 to 1400)
49589	113600	Structural/Prehistoric	Artifact scatter with hearth features	8,160	Paleoindian (6700 to 6600 BC), Archaic (3000 to 1800 BC)
49589	113601	Structural/Prehistoric	Artifact scatter with hearth features	15,543	Mogollon (AD 400 to 1000)
49589	113602	Structural/Prehistoric	Artifact scatter with hearth features	39,211	Archaic (1800 BC to AD 400)
49589	113760	Structural/Unknown	Artifact scatter with hearth features	2,198	Unknown (9500 BC to AD 1880)
49589	113804	Structural/Prehistoric	Artifact scatter with hearth features	8,478	Mogollon (AD 200 to 1400)
49589	113805	Structural/Prehistoric	Artifact scatter with hearth features	3,461	Mogollon (AD 1000 to 1150)
49589	113806	Structural/Prehistoric	Artifact scatter with hearth features	12,151	Archaic (1800 BC to AD 200)
46610	152701	Nonstructural/Unknown	Artifact scatter	345	Unknown (9500 BC to AD 9999)
104538	155962	Structural/Prehistoric & Historic	Artifact scatter with hearth features	60,027	Late Archaic, Tornado Mogollon, Anglo (no date range)
104538	155963	Structural/Prehistoric	Artifact scatter with hearth features	501,810	Late Archaic, Tornado Mogollon, Mesilla Phase (no date range)
104538	155964	Structural/Prehistoric	Artifact scatter with hearth features	3,300	Middle Archaic (no date range)
104538	155965	Structural/Unknown	Artifact scatter with hearth features	10,486	Unknown (no date range)
104538	155966	Structural/Historic	Simple features	7,100	Anglo (AD 1880 to 1945)
104538	155967	Structural/Prehistoric	Artifact scatter with hearth features	1,715	Unknown Prehistoric (no date range)
104538	155968	Structural/Unknown	Artifact scatter with hearth features	8,866	Unknown (no date range)
104538	155969	Structural/Prehistoric	Artifact scatter with hearth features	1,065	Unknown Prehistoric (no date range)
104538	155970	Nonstructural/Prehistoric	Artifact scatter	2,792	Unknown Prehistoric (no date range)
104538	155971	Structural/Unknown	Artifact scatter with hearth features	187	Unknown (no date range)
104538	155972	Structural/Prehistoric	Artifact scatter with hearth features	774	Unknown Prehistoric (no date range)
104538	155973	Structural/Prehistoric	Artifact scatter with hearth features	1,521	Unknown Prehistoric (no date range)
104538	155974	Structural/Prehistoric	Artifact scatter with hearth features	4,540	Unknown Prehistoric (no date range)
104538	155975	Structural/Prehistoric	Artifact scatter with hearth features	698	Unknown Prehistoric (no date range)
104538	155977	Nonstructural/Unknown	Artifact scatter	688	Unknown (no date range)

NMCRIS	LA	Site Type	Site Description	Size (sq m)	Components
104538	155978	Structural/Prehistoric	Artifact scatter with hearth features	2,549	Unknown Prehistoric (no date range)
104538	155979	Structural/Prehistoric	Artifact scatter with hearth features	2,549	Tornado Mogollon (no date range)
104538	155980	Structural/Prehistoric	Artifact scatter with hearth features	1,214	Unknown Prehistoric (no date range)
106719	156860	Nonstructural/Prehistoric	Artifact scatter	4,476	Unknown Prehistoric (no date range)
106719	156861	Nonstructural/Prehistoric & Historic	Artifact scatter	90,805	Unknown Prehistoric (no date range), Anglo (AD 1880 to 1920)
106719	156862	Structural/Prehistoric	Artifact scatter with hearth features	3,029	Late Archaic (no date range)
106719	156863	Structural/Prehistoric & Historic	Artifact scatter with hearth features	10,665	Mogollon (no date range), Anglo (AD 1880 to 1920)
106719	156864	Structural/Prehistoric	Artifact scatter with hearth features	22,512	Late Archaic (no date range)
106719	156865	Structural/Prehistoric	Artifact scatter with hearth features	20,924	Middle Archaic (no date range), Anglo (AD 1880 to 1940)
106719	156866	Structural/Prehistoric	Artifact scatter with hearth features	2,322	Unknown Prehistoric (no date range)
106719	156867	Structural/Prehistoric & Historic	Artifact scatter with simple features	2,858	Archaic (no date range), Anglo (AD 1900 to 2000)
106719	156868	Nonstructural/Historic	Artifact scatter	5,272	Anglo (AD 1880 to 1940
106719	156869	Nonstructural/Prehistoric	Artifact scatter	7,992	Paleoindian (9500 to 5500 BC)
106719	156870	Nonstructural/Prehistoric	Artifact scatter	2,632	Early Archaic (no date range)
106719	156871	Structural/Prehistoric	Artifact scatter with hearth features	15,630	Unknown Prehistoric (no date range)
106719	156872	Structural/Prehistoric	Artifact scatter with hearth features	15,130	Mogollon (no date range)
106719	156873	Nonstructural/Prehistoric	Artifact scatter	65,056	Late Archaic (no date range)
106719	156874	Nonstructural/Prehistoric	Artifact scatter	9,221	Unknown Prehistoric (no date range)
106719	156875	Nonstructural/Prehistoric	Artifact scatter	6,236	Unknown Prehistoric (no date range)
106719	156876	Nonstructural/Prehistoric	Artifact scatter	7,391	Unknown Prehistoric (no date range)
106719	159142	Structural/Prehistoric	Artifact scatter with hearth features	15,664	Unknown Prehistoric (no date range)
106719	159143	Nonstructural/Prehistoric	Artifact scatter	13,536	Unknown Prehistoric (no date range)
106719	159144	Nonstructural/Prehistoric	Artifact scatter	9,262	Unknown Prehistoric (no date range)

=site impacted by current undertaking.

Appendix 2: Specific Procedures to Follow for Discoveries of Human Remains and/or Funerary Objects, Sacred Objects, and Objects of Cultural Patrimony during Intentional Archaeological Excavations, Spaceport America Project

The Federal Aviation Authority (FAA) issued a Launch Site Operator License in December 2008 to the New Mexico Spaceport Authority (NMSA) for the operation of Spaceport America. The issuance of a Launch Site Operator License is a federal undertaking subject to review as required by the National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act (NHPA). A Project-specific Programmatic Agreement (PA) was developed and signed in December 2008 to ensure compliance with Section 106 of the NHPA. The PA includes stipulations for identification of cultural resources, evaluation for National Register eligibility, and determination of effects on eligible cultural resources. The PA also includes stipulations requiring the development of mitigation and treatment measures and the development of protocols for unanticipated or inadvertent discoveries of cultural resources, including human remains and associated items. Land statuses within the Project area include a mix of federally managed, state-owned, and private lands, as well as rights-of-way pertaining to the New Mexico Department of Transportation (NMDOT) and the Burlington Northern Santa Fe Railroad (BNSF).

Archaeological studies have been conducted during the project design phase to determine the presence of historic and prehistoric cultural resources within the Project Areas of Potential Effect (APEs), evaluate their eligibility, and plan for their treatment (including data recovery). These archaeological studies have been and will continue to be conducted pursuant to Section 106 of the National Historic Preservation Act of 1966 (16 USC 470f), as amended and implementing regulations of the Advisory Council on Historic Preservation (36 CFR 800). All work has been and will be undertaken pursuant to the *Secretary of the Interior Standards for Archeology and Historic Preservation* as defined in 48 FR 44716-44742 (1983), as well as New Mexico State Standards as outlined in Title 4 ("Cultural Resources") of the state regulations, as specified in Stipulation I of the PA.

NMSA is committed to the protection and preservation of cultural resources, in accordance with federal and state laws. In particular, NMSA acknowledges the requirement for strict compliance with federal and state regulations and guidelines regarding the treatment of human remains, funerary objects, sacred objects, and objects of cultural patrimony, if any are discovered. This plan describes the protocols that will be followed in the event that human remains and/or the above-listed objects are exposed during intentional excavations performed by archaeologists during data recovery and/or testing at sites in the APEs identified for the Spaceport undertaking. It is intended to do the following:

- Comply with applicable federal and state laws and regulations, particularly 36 CFR Part 800 (2004) of the regulations that implement Sections 106 and 110 of the National Historic Preservation Act of 1966, as amended; 36 CFR Part 63; 36 CFR Part 61; the Native American Graves Protection and Repatriation Act or "NAGPRA" (25 U.S.C. §§ 3001 et seq.) and its implementing regulations (43 CFR 10); the Archeological Resources Protection Act of 1979 or "ARPA" (16 U.S.C. 470 aa-mm) and its implementing regulations (43 CFR 7); the New Mexico "Cultural Properties Act" (18-6-1 through 18-6-17 NMSA 1978) and the "New Mexico Prehistoric and Historic Sites Preservation Act" (18-8-1 through 18-8-8 NMSA 1978); and Title 4 ("Cultural Resources") of the State of New Mexico regulations.

- Comply with the provisions of the December 2008 *Programmatic Agreement among the Federal Aviation Administration, Bureau of Land Management, New Mexico State Land Office, New Mexico Spaceport Authority, New Mexico State Historic Preservation Officer, and Advisory*

Council on Historic Preservation Regarding the Spaceport America Project, Sierra County, New Mexico (Programmatic Agreement).

Because the Project is a federal undertaking, the procedures of 36 CFR 800 inform the procedures to be followed. Land status of a specific discovery location also plays a role: discoveries of human remains and funerary objects on state lands must comply with the State of New Mexico's "Cultural Properties Act", while compliance with NAGPRA and ARPA is required for discoveries made on federal lands. At all times human remains will be treated with the utmost dignity and respect. Human remains, funerary objects, sacred objects, and objects of cultural patrimony will be left in place and not disturbed, collected, or removed—and protected and secured—until appropriate consultation has taken place and a plan of action has been developed and approved by the appropriate authorities (FAA and Section 106 signatories and consulting parties; agency with land managing status in the locus of discovery).

(1) If skeletal material or other human remains are discovered, the following officials must be notified immediately: NMSA; the Office of the Medical Investigator (OMI); the New Mexico State Archaeologist; and the FAA. The OMI will make the official ruling on the nature of the remains, as either forensic (medicolegal) or archeological. The Field Director for the archaeological excavations will make the required immediate notifications, and will notify NMSA and the FAA of the medical examiner's official ruling. The Field Director and their staff will assist law enforcement personnel, but will also ensure that the archaeological context of the remains stays intact. If it is determined that the remains are forensic (i.e., they represent a modern crime scene), the archaeologists will cooperate with the law enforcement investigation, and assist law enforcement personnel in obtaining necessary evidence without destruction of the site. The NMSA will coordinate appropriate follow-up as described below.

(2) If the human remains are archaeological (i.e., they do not represent a modern crime scene) and determined to be Native American, the remains will be left in place and protected until a specific plan for their protection or removal can be generated. The FAA, and the Bureau of Land Management (BLM) if the discovery is made on BLM land, will consult with the nine tribes recognized as having cultural affiliation to the Project area and a custodial relationship to human remains: the Comanche Indian Tribe; the Fort Sill Apache Tribe of Oklahoma; the Hopi Tribe; the Pueblo of Isleta; the Kiowa Tribe of Oklahoma; the Mescalero Apache Tribe; the Navajo Nation; the White Mountain Apache Tribe, and Ysleta del Sur Pueblo. Implementing regulations for the Native American Graves Protection and Repatriation Act (25 U.S.C. §§ 3001-3013) and the Archeological Resources Protection Act of 1979 (16 U.S.C. 470 aa-mm) will be followed if the discovery is made on BLM land. If the remains are discovered on state or private land, the FAA shall provide the New Mexico State Historic Preservation Officer (NM SHPO) with information on the FAA's tribal consultation efforts and results to assist the NM SHPO in coordinating tribal consultation pursuant to Section 18-6-11.2 of the Cultural Properties Act (18-6-1 through 18-6-17 NMSA 1978). If ethnicity of the remains cannot be determined, the remains should be assumed to be Native American and the procedures outlined above should be followed.

(3) If the human remains are archaeological and determined to be non-Native American, the remains will be left in place and protected until a plan for their protection or removal can be generated. NMSA will consult with the FAA and the BLM if the discovery is on BLM land, to determine an appropriate plan of action. Implementing regulations for the Archeological Resources Protection Act of 1979 (16 U.S.C. 470 aa-mm) will be followed if the discovery is made on BLM land. If the remains are discovered on state or private land, the FAA shall provide the NM SHPO with information on the FAA's consultation efforts and results to assist the NM SHPO in determining an appropriate plan of action pursuant to Section 18-6-11.2 of the Cultural Properties Act (NMSA 1978).

(4) If the discovery consists of funerary objects, sacred objects, and/or objects of cultural property that are not associated with human remains, the objects will be protected and the NMSA, the FAA, and the NM SHPO will be notified immediately. NMSA will consult with the FAA, and the BLM

if the discovery is on BLM land, to determine an appropriate plan of action; implementing regulations for the Native American Graves Protection and Repatriation Act (25 U.S.C. §§ 3001-3013)and the Archeological Resources Protection Act of 1979 (16 U.S.C. 470 aa-mm) will be followed if the discovery is made on BLM land. If the remains are discovered on state or private land, the FAA shall provide the NM SHPO with information on the FAA's consultation efforts and results to assist the NM SHPO in determining an appropriate plan of action, including tribal consultation.

In the event that human remains are to be exhumed following the appropriate consultation (as described above), they will be excavated in accordance with the guidelines and regulations appropriate for the land status of the discovery location. On state or private lands, Guidelines for Excavation of Human Burials (4.10.11.10 NMAC) and the Museum of New Mexico policy on sensitive materials will be adhered to. For BLM land, implementing regulations for the Archeological Resources Protection Act of 1979 (43 CFR 7) and BLM Manual Supplement H-8100-1, *Procedures for Performing Cultural Resource Fieldwork on Public Lands in the Area of New Mexico BLM Responsibilities* will guide excavations. The *ACHP Policy Statement Regarding Treatment of Burial Sites, Human Remains and Funerary Objects (*February 23, 2007) also provides guidance. There will be no public exposure of the remains or objects. No images will be taken other than those necessary as part of archaeological documentation. No actions will be taken to conserve or stabilize bone that might prevent effective reburial. No destructive analyses of human remains or objects will be undertaken without prior consultation with and approval by tribes that have expressed a relationship with or custodial interest in the remains. Documentary reporting will conform to standards required by regulation**.** In situ images will not be included in documentary reporting; reporting of field burial observations will be limited to drawings. Laboratory images of human remains may be used in reporting, but only to document specific osteological conditions. Funerary objects, sacred objects, and/or objects of cultural patrimony will be illustrated by laboratory photographs or drawings, but illustrations will not be made public. All human remains and/or objects will be retained by NMSA (or their cultural resources contractor) pending the final outcome of disposition consultations and the required direction from FAA and the agency with land status in the locus of discovery, and in consultation with the nine Native American tribes recognized as having cultural affiliations to the Project area if the remains and/or objects are determined to be Native American. All required notifications of disposition will be made (per state or federal law) prior to disposition.

List of Contacts

Bureau of Land Management (BLM)
David V. Legare, Archeologist
(575-525-4398)
<<David_Legare@blm.gov >>

Tom Holcomb, Archeologist
(575-525-4364)
<<tom_holcomb@nm.blm.gov>>

Bureau of Land Management, Las Cruces District Office
1800 Marquess St.
Las Cruces, NM 88005

Federal Aviation Administration, Office of Commercial Space Transportation (FAA)
Michael McElligott, Manager of Space Systems Development Division
(202-267-7859)

Ken Gidlow, Deputy Manager of Space Systems Development Division
(202-267-9860)

Daniel Czelusniak, Environmental Protection Specialist
(202-267-5924)
<<Daniel.Czelusniak@faa.gov>>

Jaclyn M. Johnson, Environmental Protection Specialist
(202-267-5352)
<< Jaclyn.Johnson@faa.gov >>

Office of Commercial Space Transportation

Federal Aviation Administration
800 Independence Ave SW, Suite 331
Washington, DC 20591

New Mexico Spaceport Authority (NMSA)
Rick Homans, Executive Director
901 E. University
Building 3, Suite C
Las Cruces, NM 88001
(575-373-6110)
<<Rick.Homans@state.nm.us>>

Randy Gilbert, Project Manager
8501 Jefferson NE
Albuquerque, NM 87113
(505-934-4497)
<<rgilbert@geraldmartin.com>>

Elizabeth A. Oster, Cultural Resources Specialist for NMSA
P.O. Box 4759
Santa Fe, NM 87502
(505-603-8527)
<<suchil@comcast.net>>

New Mexico State Historic Preservation Office (NM SHPO)
Jan Biella, Deputy SHPO and State Archaeologist
(505-827-4045)
<<jbiella@state.nm.us>>

Michelle Ensey, Staff Archaeologist
(505-827-4064)
<<michelle.ensey@state.nm.us>>

Historic Preservation Division
Bataan Memorial Building
407 Galisteo Street, Suite 236
Santa Fe, NM 87501

Office of the Medical Investigator (OMI)
Amy Wyman
Office of Medical Investigator
University of New Mexico, School of Medicine
Albuquerque, NM 87131-5091.
(505-272-3053)
<<awyman@salud.unm.edu.>>

Sierra County Sheriff's Department
24-hour Dispatch
(575-894-7111)

State Land Office (SLO)
David C. Eck, State Trust Lands Archaeologist
P.O. Box 1148
Santa Fe, NM 87504-1148
(505-827-5857)
<< deck@slo.state.nm.us >>

Appendix 3: Features Reported by the 2007 Zia Survey

LA No.	Feature No.	Feature ID Notes
111422	1	FCR; 2.1 m x 1.6 m FCR scatter igneous fragments; large pieces; not highly fragmented; approximately 16 pieces; located in dune; good potential subsurface. Silicified siltstone and limestone flakes (approximately 4); within 3 m of feature.
	2	FCR; 0.8 m x 0.6 m FCR scatter; 12 pieces; medium/high fragmentation, metal; igneous FCR. In dune, excellent potential for subsurface deposits.
	3	FCR; 0.6 m x 0.3 m FCR scatter; low fragmentation; average size of cobble is 8 - 10 cm in diameter; limestone and shale igneous; 8 pieces. Grey chert flake, within 40 cm of feature.
111429	1	FCR; 2.5 m diameter; (plus more dispersed); caliche fragments; variable fragmentation; some as large as 25 cm; many pebble-size fragments.
	2	FCR; 2.5 m diameter; moderate/high fragmentation.
	3	FCR; 3 m diameter plus dispersed; caliche; high fragmentation
	4	FCR; 3 m diameter, most discrete, extends to 15 m scattered; variable fragmenation; mostly caliche; possible ring midden with extent/discrete larger fragments. Heat treated purpble chert flake in association.
	5	FCR; 4 m diameter (most discrete); caliche; some igneous; possible ring midden; disarticulated; conjoining. Cherts, high quality (heat treated)
	6	3 m diameter; caliche; igneous; possible ring midden; disarticulated; conjoining. Metate fragment 5 m to southwest.
	7	7.5 m x 5 m ring midden (exposed); 1,000s FCR; caliche; igneous; mounded to 60 cm above ground surface; stained; chunks of charcoal. Chert flakes in association.
	8	FCR; 10 igneous cobbles; 1.25 m area metate fragment in association.
	9	FCR (ring); 7 m diamter; FCR mostly on ringed periphery. Flakes in association.
	10	5 m x 2.5 m; 100s of FCR; caliche; igneous; moderately fragmented; central portion of feature obscured by dunal forming; FCR scatted more widely but mostly discrete. Chert flakes in association.
	11	2 m diameter; mostly caliche, some igneous; fragmentation low-moderate; extends down slope to west as disarticulated wash off original feature material.
	12	FCR feature (75 FCR); distinct from others on site; for size of rock; mostly igneous; low fragmentation; (cobble size roughly 20 cm). Basin metate fragment at north edge of feature, flakes in association.
	13	FCR Feature (3 m diameter); mostly caliche; 50+ FCR; moderate-high fragmentation; apparently mostly buried. Chert core on south edge, chert flakes.
	14	FCR (3 m diameter); caliche mostly; some igneous; high fragmentation; mostly buried. Quartzite flake; distal end; possible early stage biface; retouched; utilized along lateral margin at west end, 4 fragments of shale, apparently shaped on margins; grinding slabs; chert flakes: white, maroon; siltstone flake; possible use wear.
	15	FCR (3 m diameter); 50+ FCR; dispersed within feature area; mostly caliche; some igneous; high fragmentation; buried.
	16	FCR mostly igneous; low fragmenation; 30 FCR (2 m diameter).

LA No.	Feature No.	Feature ID Notes
	17	FCR caliche (3 m diameter); mostly pebble-size fragment; therefore high fragmentation; low density; buried. Subtle. Flakes in association.
	18	FCR (igneous, caliche) 4 m diameter, low-moderate fragmentation; eroding down slope into FCR concentration.
	19	FCR caliche; 3 m diameter; moderate fragmenation; (75 FCR). Flake in association.
	20	FCR igneous; large, fire-split igneous cobble (15 cm) and other smaller igneous; 2 caliche FCR; mostly buried.
	21	FCR (4 m diameter); 80 FCR mostly caliche; low fragmentation, large caliche cobbles; mounded 30 cm above surrounding ground surface; deposits forming small dune.
111435	1	4 m diameter; moderate fragmentation; igneous, limestone, rhyolite.
	2	12 m and 8 m; washing down slope. Multi core, chert.
	3	7 m diameter ring midden; central depression; large cobbles; dense, mounded; 30 cm above ground surface. Cores, flakes, angular debris, ground stone fragments.
	4	1 m diameter; sparse, smaller cobbles; light stain. Basin metate fragment in association.
	5	8 m diameter ring midden; mounded about 30 cm; fairly dense; moderate-sized fragments of igneous and limestone materials. Anvil/rock 3 m north with pestle/cobble; sandstone slab metate fragments.
	6	1 m diameter; charcoal-stained soil; staining. Multiple platform core, rhyolite in association.
	7	1 m diameter; charcoal-stained soil; staining in abandoned two-track along east side of fence. Jornada sherds, limstone flake probably utilized; chert flake in association.
	8	3.5 m diameter; sparse density; low-moderate fragmentation; stain on west end. 2 ground stone fragments (rhyolite) anvils, pestle/hammer.
	9	4 m diameter; igneous, limestone; low-moderate fragmentation.
	1	2 m diameter discrete; 3cm - 15cm sized cobbles. Quartzite, limestone, rhyolite and burned caliche. Hamerstone, flakes.
	2	50 pieces in 2 m diameter discrete; 2 cm - 5 cm partially broken rocks; burned caliche, quartzite, limestone, rhyolite partially buried. Mano in association.
	3	75 m x 120 m area; burned caliche, quartzite, limestone, rhyolite; eroded. On edge of wash.
	4	100 BC in 2 m x 2 m; partially burned; 3 cm - 5 cm Mostly burned; scattered 3 cm - 8 cm pieces. In area north of wash scatters out to the east; groundstone, flake.
	5	100 pieces; 5 m x 5 m, quartzite, BC; 100 pieces in 10m diameter area north of east trending drainage eroding down drainage. Flakes, groundstone, core, scraper.
	6	5 cm - 10 cm; mostly burned; mostly eroded and burned; slight erosion down slope too.
	7	Quartzite, rhyolite; 5 cm - 10 cm; 3 m x 3 m Eroded; 3 m x 2 m; small broken rock. Flakes.
	8	Quartzite, red; slightly burned.
	9	Quartzite; 1 m x 1 m, slightly burned.
	10	Quartzite; 1 m x 1 m; 5 cm - 10 cm cobbles, slightly burned.
	11	Quartzite; 1 m x 1 m, partially burned.
	12	Quartzite; 2 m x 2 m, discrete. Flakes.

LA No.	Feature No.	Feature ID Notes
155963	14	Huge, scattered.
	15	Quartzite; 50 pieces in 2 m x 2 m; partially burned.
	16	Quartzite; 50 pieces in 3 m x 3 m; mounded; possible stain.
	17	Scattered, mounded, eroded. Groundstone, flakes.
	18	Quartzite, limestone 2 cm - 10 cm 5m E/W x 3m N/S; mostly burned caliche, limestone; small amount igneous; moderate density FCR; washing to west; most dense at east; low fragmentation. Heat treated chert flakes around feature.
	19	Discrete; 50 cm diameter of FCR (About 15 FCR); burned caliche and limestone at east edge of dune; many exposed portion of approximately 4 m diameter feature that is mostly buried. Chalcedony biface thinning plate, others heat treated chert, red, tan flakes.
	20	about 4 m diameter feature that is mostly buried. White chalcedony/chert biface thinning plate; Smokey chalcedony flake (pressure flaked lithics, heat treated).
	21	2 m diameter; approximately 20 thermally affected caliche and limestone; low fragmentation; low density; subtle, no highly thermally affected. A number of thin (probably biface thinning flake); heat treated cherts.
	22	0.5 m diameter; small pebble size FCR (about 20 pieces); limestone; moderate fragmentation; moderate density. Chert: yellow, red, white (heat treated).
	23	2 m diameter; limestone; a few igneous; moderate fragmentation; of a few igneous most obvious part of feature (subtle); drainage passes through feature area to southwest.
	24	4 m SW/NE x 2m NW-SE; following/exposed in drainage; low fragmentation; moderate thermally discolor; moderate density. Sandstone; mano part/artifact nearby; 2 m to north.
	25	Limestone/ burned caliche; 5 m x 2 m; exposed along/within drainage; moderate fragmentation; moderate density.
	26	Approximately 9 m diameter area of sparsely distributed pebble size FCR (limestone/burn caliche). Tool 4 - 1.45 m north; Tool 3 - 3.5 m south; Tool 1- approximately 11m southwest; Tool 2- approximately 8 m south; southwest portion of this FCR concentration area has a 4 m diameter, mesquite stabilized, pack rat midden dune; small FCR brought out of burrows (bioturbation).
	27	2 m diameter concentration (discrete, dense); large burned caliche cobbles (hand-sized); low fragmentation; thermally discolor. Various cherts; heat treated cherts, limestone flake.
	28	Scattered in line possible 3 features. Flakes.
	29	100s+ pieces in 2 m x 20 m, discrete; burned. Flakes.
	30	100 pieces in 2 m x 2 m, discrete; burned.
	31	50 pieces in 2 m x 2 m. discrete; buried in 1 m x 1 m; flakes in association. Just outside west boundary of PA.
	32	50 pieces in 1 m x 1 m; 3 cm - 8 cm Partially buried; partially scattered; limestone; rhyolite; quartzite; possible stain. Flakes, groundstone, recycled as FCR northwest edge of site.
	33	30 pieces in 2 m x 2 m; 5 cm - 10 cm, intact, buried with stain; 3cm - 5cm pieces.
	34	50 cm x 50 cm; stain, partially buried on edge of drainage.
	35	Quartzite in 1 m x 1 m, scattered; quartzite, burned caliche; 2cm-8cm diameter; light staining. Groundstone.

LA No.	Feature No.	Feature ID Notes
	36	5 m x 5 m; 30 pieces; scattered; partially buried; light staining.
	37	40 pieces BC in 2 m x 2 m Partially unburied; partially burned.
	38	50 pieces BC in 2 m x 2 m; 3 cm - 8 cm Southeast edge of site 3. Partially buried; partially burned.
	39	30 pieces BC in 50 cm x 50 cm; 5 cm - 10 cm cobbles Partially buried; no stain; 2 cm - 8 cm cobbles. Metate fragment, flakes.
	40	50 pieces BC, quartzite in 2 m x 2 m Mostly buried. Flakes.
	41	30 pieces in 1 m x 1 m; BC only Mostly buried. Flakes.
	Core Area 1	Possibly 20+ features mostly eroded and scattered by sheet wash erosion; 2cm - 20cm cobbles (most around 5 cm); generally broken up; features south of main drainage that cuts through site; south of hill. Quartzite, limestone, rhyolite Flakes, groundstone, some areas retain feature shape with sizes ranging from 2m - 10m diameter; 1000+ pieces in area; several east trending drainages (small) run through the area; most groundstone found as FCR as well.
	Core Area 2	Large 100 m diameter area with dense concentrations of FCR, stains, etc. limestone; quartzite; 2 m x 2 m feature within it (Feature 13). 100s El Paso brownware (mostly small); 1 San Andres; 2 grayware; 1 collected; 1 San Pedro (collected); 1,000s FCR. Possible habitation area in stain locations in center and southern area.
155964	1	FCR; 5 m diameter; 5 cm - 8 cm heavily burned; quartzite, limestone, burn caliche; stain, dark; possible ring midden; 1000+ pieces. Flakes.
	2	FCR; 1 m diameter; 5cm - 8cm heavily burned; quartzite, limestone, burn caliche; light staining.
	3	FCR; 10 rocks around edge of depression; possible small structure; 8 cm - 10 cm cobbles.
155968	1	Stain not heavy on surface, 3m diameter area stain with FCR; mano part on west edge and other FCR on sides of stain; may represent habilitation; 1 structure. Limestone and siltstone expedient and formal unifacial tools, flakes.
155969	1	1.25 m diameter; 30 FCR mostly igneous and limestone with 10 additional FCR washing to the northeast.