MUSEUM OF NEW MEXICO
OFFICE OF ARCHAEOLOGICAL STUDIES

# ARCHAEOLOGICAL TESTING AT THREE SITES WEST OF ABIQUIU, RIO ARRIBA COUNTY, NEW MEXICO

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Submitted by
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## ADMINISTRATIVE SUMMARY

Between March 14 and 28, 1990, the Office of Archaeological Studies of the Museum of New Mexico tested three sites along U.S. 84 west of Abiquiú, Río Arriba County, New Mexico. At the request of the New Mexico State Highway and Transportation Department, testing was conducted to determine whether subsurface cultural remains existed within proposed project limits. LA 75286 was a scatter of lithic artifacts that was completely within proposed project limits. LA 75287 and LA 75288 were multicomponent sites containing water and soil control systems and lithic artifact scatters; both were mostly outside proposed project limits. The lithic artifact component at LA 75287 is from an early Developmental period camp, while that at LA 75288 is from a middle Archaic camp. Cultural materials within proposed project limits at all three sites were either restricted to the surface or buried at shallow depths by natural processes. No further work is necessary within project limits at these sites.

MNM Project No. 41.484
NMSHTD Project No. F-052-1(28)
New Mexico Archaeological Excavation Permit No. SE-56
U.S. Forest Service Blanket Survey Permit, Carson National Forest

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# INTRODUCTION

At the request of the New Mexico State Highway and Transportation Department (NMSHTD), the Office of Archaeological Studies of the Museum of New Mexico tested three sites along U.S. 84 west of Abiquiú, Río Arriba County, New Mexico (Fig. 1). Proposed project limits coincide with the existing highway right-of-way boundary, and subsurface investigations were restricted to that area. Parts of two sites (LA 75287 and LA 75288) extended outside proposed project limits onto U.S. Forest Service land. To provide a complete record of those cultural properties, areas outside proposed project limits were mapped and recorded, but were not tested or collected. Testing inside proposed project boundaries was conducted under New Mexico State Archaeological Excavation Permit No. SE-56 (expires 1-23-91). Surface mapping and recording outside proposed project limits was carried out under U.S. Forest Service Blanket Survey Permit, Carson National Forest (expires 12-31-92).

Fieldwork began March 14, 1990, and continued until March 28, 1990. Three sites were tested to determine whether subsurface cultural remains were present within proposed project limits. The principal investigator for this project was David A. Phillips, Jr. Field work was supervised by James L. Moore. Field assistants included Timothy D. Maxwell, Daisy F. Levine, and Vernon Lujan. Sam Sweezy worked as a volunteer, and his help was invaluable. Field and laboratory analysis of lithic artifacts was completed by James L. Moore, and ceramic artifacts were identified by Daisy F. Levine and Timothy D. Maxwell.

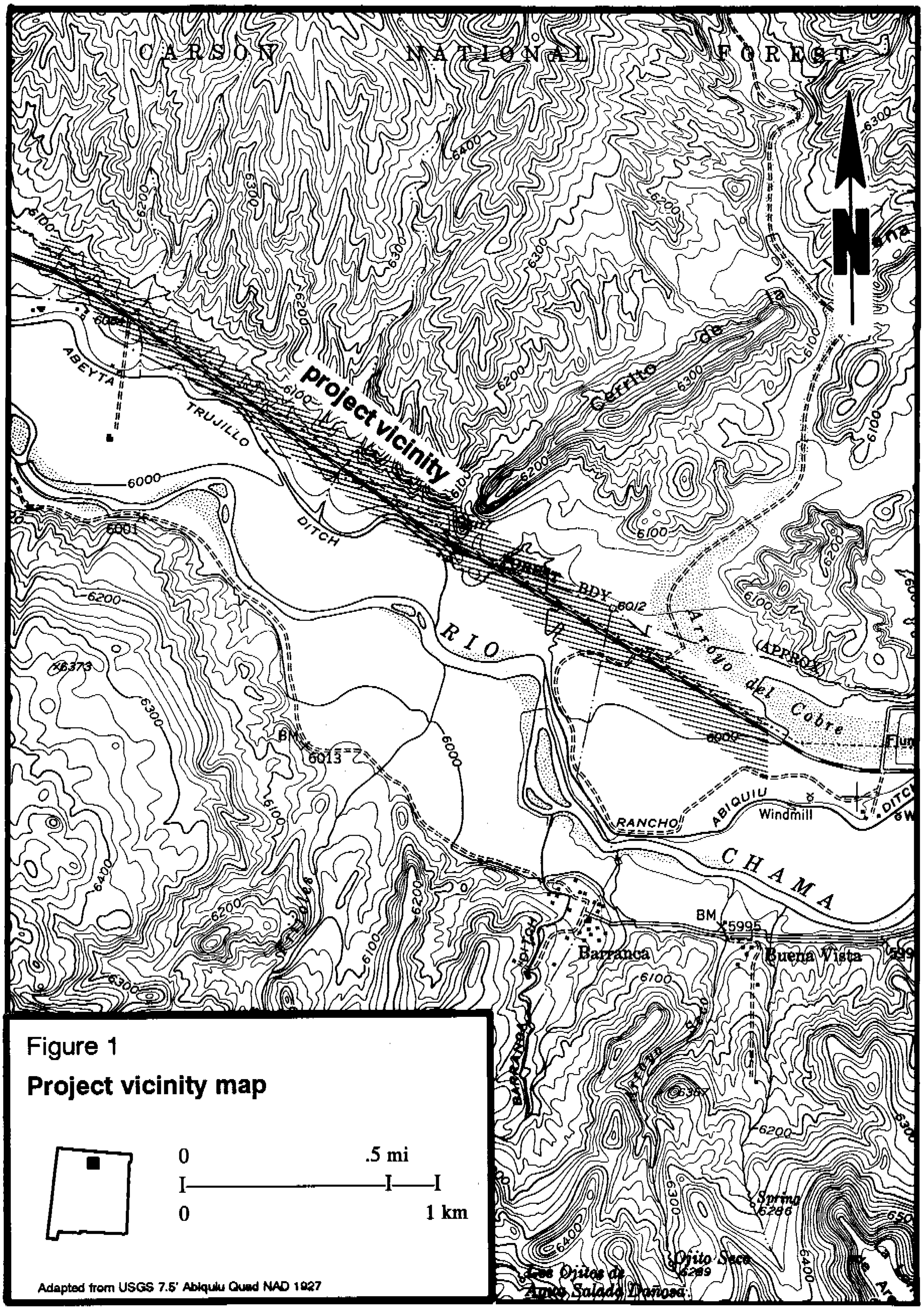


Figure 1
**Project vicinity map**

Adapted from USGS 7.5' Abiquiu Quad NAD 1927

# ENVIRONMENT

## Physiography and Geology

The study area is in the Río Chama Valley at the edge of the Sangre de Cristo Mountains, which Fenneman (1931:92-94) places in the Southern Rocky Mountain Province. More specifically, the study area is in the Española Basin, one of six or seven basins that comprise the Río Grande rift (V. Kelley 1979). It is bordered on the west by the Jemez Mountains, on the north by the Taos Plateau, on the east by the Sangre de Cristo Mountains, and on the south by La Bajada Hill and the Cerros del Río hills (V. Kelley 1979).

The Española Basin formed during the Tertiary period (V. Kelley 1979), and filled with alluvial and volcanic deposits. The Abiquiú Formation is the lowest of these deposits, and unconformably overlies Precambrian basement rocks. It includes light gray tuffaceous sandstones and conglomerates as well as the Pedernal chert member, an important source of material for stone tool production (Warren 1974). Above this is the Santa Fe group, which is characterized by shales, sandstones, and conglomerates containing numerous layers of volcanic ash (Kues and Lucas 1979). Sources for most of the Santa Fe sediments were the Nacimiento, Jemez, and Brazos uplifts on the west and the Sangre de Cristo uplift on the east (V. Kelley 1979). Thus, Precambrian quartzites from those areas were available for use in lithic reduction. The Puye Formation is above the Santa Fe group, and represents a separate episode of deposition (Dethier and Dempsey 1984). It is capped by local basalt flows and Bandelier tuff, which in turn are capped by Pleistocene sands and gravels (Dethier and Martin 1984).

## Soils

The Green River-El Rancho-Werlow and Pojoaque-Rough Broken Land associations dominate local soils (Maker et al. 1973). The Green River-El Rancho-Werlow association comprises soils on level to gently sloping floodplains of the Río Chama, Río Grande, and other large tributary streams (Maker et al. 1973:37, 46). While these soils were undoubtedly important to Anasazi farmers, the tested sites were all on Pojoaque-Rough Broken Land soils.

Soils of the Pojoaque-Rough Broken Land association occur on dissected and eroded rolling and hilly uplands, and form in medium- to coarse-textured and gravelly unconsolidated old alluvium (Maker et al. 1973:33, 36). Surface strata are sandy clay loam, sandy loam, or gravelly sandy loams that are often covered by a thin layer of gravels and cobbles. Pojoaque soils dominate the association, occurring on ridge tops and stable landforms between drainages. The surface layer is a light reddish brown calcareous sandy clay loam containing a few gravels. Under this is a weakly stratified layer of sandy loam, loam, or sandy clay loam containing numerous gravels and cobbles. Rough Broken Land soils include a complex of shallow soils and exposures of Santa Fe Formation deposits. Ridge tops and areas between Santa Fe Formation exposures are covered by a thin soil mantle, which is often capped by a layer of gravel. Landforms covered by these soils are usually highly dissected and eroded. Two characteristics of these soils appear to have made them attractive to prehistoric farmers. First, surface layers are sandy and well-drained, and are underlain by finer, less permeable strata. This allows moisture to penetrate into the soil rather than running off, and keeps it concentrated in the rooting zone (C. White, pers. comm.). Second, their high gravel and cobble content provided farmers with a convenient source for materials used to build and mulch grids.

## Climate

Climatic data for the Chama Valley are summarized from Gabin and Lesperance (1977) and Tuan and others (1973). Mean annual temperature at Española is 49.4 degrees F, measured over a 27-year period. At Abiquiú Dam, mean annual temperature is 50.2 degrees F. Average annual precipitation is 237 mm (9.35 in) at Española, 242 mm (9.54 in) at Abiquiú Dam, and 285 mm (11.25 in) at El Rito. The average number of frost-free days ranges from 140 near Abiquiú Dam to 160 near Española. The mean date of the last spring killing frost ranges from April 30 near Española to May 10 above Abiquiú, and the average date of the first fall killing frost ranges from October 10 near Española to September 30 above Abiquiú. Thus, the study area has a relatively short growing season, and when the last killing frost is later than usual or the first killing frost earlier than normal, the growing season is shortened even further.

In addition to these problems, cold air drainage at night is particularly hazardous. Bugé (1984:32-33) notes that modern farmers in the Ojo Caliente Valley lose one of three late maturing crops to early frosts caused by cold-air drainage. Cold air drainage occurs when warm up-valley daytime winds reverse to cool down-valley winds at night (Tuan et al. 1973). When winds remain stable through the night, drops in temperature before sunrise are gradual. However, on clear nights when winds are unstable, sudden temperature drops are common (Tuan et al. 1973:70). This phenomenon reduces valley bottom temperatures while nearby higher elevations often remain unaffected, as demonstrated by studies at Hopi (E. Adams 1979). Because of cold-air drainage, the growing season in the valley bottom may actually be shorter than in adjacent highlands.

## Flora and Fauna

The study area is in the piñon-juniper vegetative zone, with an overstory dominated by piñon pine *(Pinus edulis)* and juniper *(Juniperus monosperma)*. The understory is dominated by shrubs and grasses, and includes numerous succulents. The most common plants are snakeweed *(Gutierrezia sarothrae)*, rabbitbrush *(Chrysothamnus nauseosus)*, saltbush (*Artemesia* sp.), dropseed grass (*Sporobolus* sp.), several varieties of grama grass (*Bouteloua* sp.), cholla (*Opuntia* sp.), and prickly pear (*Opuntia* sp.).

Animals found in this area include mule deer *(Odocoileus hemionus)*, cottontail *(Sylvilagus audobonii)*, jackrabbits *(Lepus californius)*, and other small mammals (Findley et al. 1975). Birds include hawks (*Buteo* sp.), turkey vultures *(Cathártes áura)*, piñon jays *(Gymnorhínus cyanocéphalus)*, and ravens *(Córvus córax)*. Prairie rattlesnakes *(Crotalus viridis)* and various lizards are also common.

## Current Land Use

While there is evidence that the study area was used for farming in the past, it is now used for a variety of other purposes. Its main function is livestock grazing, though no cattle were seen on the sites during testing. Farming is now restricted to the Río Chama floodplain, and the main crops are hay and alfalfa. Residential use is also restricted to the floodplain, with most houses built near the edge of the valley adjacent to the second terrace above the river.

## CULTURAL RESOURCES OVERVIEW

### Introduction

Although the archaeology of the Chama Valley has been studied for nearly a century, many aspects of regional development are poorly understood. The consensus is that it was intermittently used for hunting or chert mining around Cerro Pedernal before A.D. 1200. After A.D. 1200, and particularly after A.D. 1300, rapid population growth resulted in the large multistoried pueblos of the Classic period. By the time the Spanish arrived in 1598, few permanent residents remained.

### Paleoindian

The earliest occupation of the Southwest was during the Paleoindian period (10,000-6500 B.C.). Although a few isolated projectile points have been found, no Paleoindian sites have been recorded in the in the Chama Valley (Anschuetz et al. 1985; Stuart and Gauthier 1981).

### Archaic

By the end of the Paleoindian period, a tradition based on the broad spectrum exploitation of floral and faunal resources developed--the Archaic. Renaud (1942a, 1942b, 1942c) provides the earliest discussion of Archaic sites in the upper Río Grande, assigning them to the Río Grande Culture. His projectile points resemble those of the Oshara sequence as defined by Irwin-Williams (1973) for north-central New Mexico, and probably represent the same tradition. Thus, more recent studies in the area assign Archaic projectile points to the Oshara sequence (Anschuetz et al. 1985; Lang 1980; Schaafsma 1976; Snow 1983).

The Oshara tradition is divided into five phases: Jay (5500 to 4800 B.C.), Bajada (4800 to 3200 B.C.), San Jose (3200 to 1800 B.C.), Armijo (1800 to 800 B.C.), and En Medio (800 B.C. to A.D. 400). Jay and Bajada sites are small base camps occupied by mobile nuclear or extended families (Moore 1980; Vierra 1980). San Jose sites are larger and more common than those of earlier periods; this is interpreted as evidence of population growth. Corn horticulture and a pattern of seasonal population aggregation and dispersion had been adopted by the beginning of the Armijo phase (Irwin-Williams 1973). The En Medio phase represented a transition from nomadic hunting-gathering to a semisedentary lifestyle based on hunting-gathering and limited horticulture.

Middle and late Archaic sites are common in the lower Chama Basin, but except for work at Abiquiú Reservoir (Bertram et al. 1989; Earls et al. 1989a; Schaafsma 1976, 1978), little detailed research has been completed. While examining available data, Anschuetz and others (1985) found interesting variations in the regional distribution of Archaic sites. Tools associated with intensive food processing are rare or absent on sites near Abiquiú, but are common on sites near the confluence of the Chama and Río Grande. They feel this demonstrates a differential pattern of seasonal use and exploitation from one end of the valley to the other.

## Anasazi

### *Developmental Period (A.D. 600 to 1200)*

There is little evidence of Anasazi occupation in the lower Chama Valley during the Developmental period; a records search by Maxwell and Anschuetz (1987) found only nine sites from that time period. Wendorf and Reed (1955) note a general scarcity of Developmental sites in the northern Río Grande, which contrasts with the San Juan region where such sites are common. During the second half of the period there was an influx of pueblo farmers into the Taos region. A similar movement into the Cimarron and Canadian drainages was posited (Wendorf and Reed 1955; Thoms 1973), but more recent investigations found a long developmental sequence in that area (Glassow 1980; Moore 1986). There was no corresponding movement into the Chama Valley.

Mera (1935) posits the descent of Kwahe'e and Taos Black-on-white--hallmarks of the late Developmental period--from Chacoan roots. Taos Black-on-white has not been found in the Chama Valley, and only one Kwahe'e sherd has been recovered (Peckham 1981). No other pottery predating the Coalition period has been found (Beal 1987:96). Early Anasazi projectile points occurring as isolates or on lithic artifact scatters are the only other evidence of Developmental use. Thus, occupation of the lower Chama Valley before A.D. 1200 was probably restricted to brief hunting episodes (Anschuetz et al. 1985:8) and quarrying. In this respect, early Anasazi use resembled that of the Archaic.

### *Coalition Period (A.D. 1200 to 1325)*

The beginning of the Coalition period is marked by a number of changes including a switch from mineral- to carbon-painted ceramics, construction of above-ground kivas, which were often incorporated into room blocks, the appearance of specialized rectangular rooms, and settlement of the Chama Valley (Wendorf and Reed 1955). Santa Fe Black-on-white was the most common early Coalition decorated pottery type, and was probably influenced by the Chaco and Mesa Verde ceramic traditions (Lang 1982; Mera 1935; Wendorf 1954). The late Coalition is demarcated by the appearance of Wiyo Black-on-white. The ancestry of this type is questionable, with connections to the San Juan, Chaco, and Pajarito areas being possible (Lang 1982; Mera 1935; Wendorf and Reed 1955).

Coalition pueblos in the Chama Valley are small (20 to 50 rooms) C-shaped room blocks closed on the fourth side by a palisade or line of stones (Cordell 1979). Kap, Riana, and Palisade pueblos were built near the end of this period, and all three evidence planned construction as well as accretional growth (Hibben 1937; Luebben 1953; Peckham 1958, 1981). Several of the large Classic villages may also have been founded during this period. Tsiping was built during the mid- to late Coalition and abandoned in the early Classic period (Beal 1987). Coalition period ceramics have been found at Te'ewi, Ponsipa'akeri, Hupobi, and Sapawe (Beal 1987; Bugé n.d.;

Wendorf 1953). Like the smaller villages, these sites probably began as small preplanned pueblos, growing accretionally through time.

Coalition period demographic patterns mirror trends elsewhere in the northern Río Grande. Substantial population growth was accompanied by residential expansion into areas of greater latitude and elevation than were previously settled (Anschuetz et al. 1985:8-9). Abandonment of earlier occupational zones may have been caused by environmental change, erosion, or conflict. Related factors probably included increased rainfall mitigating shorter growing seasons at higher elevations, new crops or agricultural techniques permitting farming in more marginal zones, and pressure from competing groups forcing population adjustments.

*Classic Period (A.D. 1325 to 1600)*

Like the Coalition period, the beginning of the Classic is marked by a number of changes. While a black-on-white ceramic tradition continued in the Chama, Santa Fe, Taos, Jemez, and Pajarito areas, the rest of the northern Río Grande produced glaze wares (Wendorf and Reed 1955). Wiyo Black-on-white evolved into carbon-painted Biscuit wares in the Chama Valley. An early variety (Biscuit A) was produced from A.D. 1375 to 1450, and a late variety (Biscuit B) was made between A.D. 1400 and 1500 to 1550 (Breternitz 1966:69-70). Sankawi Black-on-cream was produced between A.D. 1500 and 1600, and is ancestral to the modern Tewa wares (Breternitz 1966:94). The manufacture of Potsuwi'i Incised (A.D. 1425 to 1525) probably reflects a dramatic increase in exchange between the Eastern Pueblos and Plains groups (Breternitz 1966; Spielman 1983; Wendorf and Reed 1955).

Average village size increased during the Classic period, with some pueblos containing up to 2,000 rooms. At least 16 large villages were occupied in the Chama Valley; 15 have Tewa names and are considered ancestral to existing villages. While Kap and Tsiping were abandoned during the early Classic, most were occupied until nearly A.D. 1540. Five--Sapawe, Psere, Te'ewi, Ku, and Tsama--may have lasted until A.D. 1598-1620 (Schroeder 1979; Schroeder and Matson 1965).

The Chama Valley was abandoned by the Anasazi by A.D. 1620. They moved into the Río Grande Valley, either joining with or forming the existing Tewa villages. San Juan Pueblo considers Homayo, Howiri, and Pose'uingue to be ancestral villages (Bandelier 1892:50; Ortiz 1979). Sapawe is also claimed as ancestral by some Tewa (Bandelier 1892:53). Traditions at San Juan and Santa Clara mention migration from the Chama Valley (Jeançon 1923). By the early 1700s, the only Native Americans present were nomadic raiders.

# SITE DESCRIPTIONS AND TESTING RESULTS

Test excavations were conducted at three sites--a lithic artifact scatter (LA 75286), and two multicomponent sites containing water and soil control systems and lithic artifact scatters (LA 75287 and LA 75288). Following discussion of field methods, testing results for each site are presented. A detailed discussion of artifacts is presented in the following chapter.

## Testing Methods

The first step in testing was establishment of a datum to which all horizontal and vertical measurements were tied. Sites were then inspected to define their horizontal limits, define artifact clusters and features, and locate diagnostic materials. Surface artifacts were marked to assist recording and mapping, and site plans were produced using a transit and stadia rod or 30 m tape. Site plans include locations of all test pits, features, collected surface artifacts, artifact concentrations, and current topographic and cultural features. Topographic contours were mapped to provide an accurate depiction of site structure in relation to its immediate physical environment.

Artifacts were collected within project limits when they were found in test pits or were diagnostic. All visible lithic artifacts were analyzed in the field and left in place at LA 75286, and were sampled and left in place at the other sites. No attempt at obtaining statistically representative samples was made; samples were selected to provide an idea of the range of activities performed at a site.

Horizontal test units were 1-by-1-m grids. All excavation was done using hand tools. Grids were excavated in arbitrary 10-cm levels unless natural stratigraphic breaks were found. When natural strata were defined, they became the vertical units of excavation. Soil removed from test grids was screened through ¼-inch mesh hardware cloth. Artifacts recovered by screening were bagged, assigned a field specimen number, and transported to the laboratory for analysis. A form describing the matrix encountered (and listing ending depths and field specimen numbers) was completed for each excavation unit. Test pits ended when sterile strata or bedrock were encountered, and they were backfilled. Auger holes were bored into the bottoms of some test pits to verify that sterile strata had been reached, and they were also used to investigate areas between test pits. No datable or macrobotanical materials were found.

No cultural strata were encountered; therefore, profiles were not drawn. Soil colors were determined using a *Munsell Soil Color Chart*. Each site was photographed. Cultural materials recovered during these investigations are curated at the Archaeological Repository, Museum of New Mexico. Field and analysis records are on file at the Archaeological Records Management System of the Historic Preservation Division, State of New Mexico.

## LA 75286

### *Site Description*

During survey, LA 75286 was described as a scatter of eight chipped and ground stone artifacts in a 45-by-15-m area (Marshall 1989). Lacking diagnostic artifacts, no date was assigned. No features were noted, and recent trash associated with use of the nearby highway was present. As recorded, LA 75286 was completely within the existing highway right-of-way.

Closer examination during testing showed that the site was slightly larger than initially recorded (48 by 15 m), and contained more artifacts than were first noted (Fig. 2). Only chipped stone artifacts were found; no ground stone artifacts or cultural features were seen. None of the lithic artifacts were diagnostic; thus, no date was assigned. Most artifacts were in the existing highway right-of-way, which is sheetwashed by water draining from nearby slopes. It is doubtful that artifacts were still in situ.

Two test pits were excavated near artifact clusters in areas that did not seem badly eroded. Sixteen chipped stone artifacts were analyzed and left in place, and an oddly shaped piece of stone was collected for identification.

### *Test Pit Descriptions*

**Test Pit 1.** Test Pit 1 was placed near a cluster of surface artifacts to determine whether intact cultural deposits were present. Surface soil was a fine reddish brown sand containing a few quartzite gravels; vegetation was moderately heavy and included grama grass and small composites. No surface artifacts were found.

Excavation continued to a depth of 17 cm, and an auger was used to examine an additional 30 cm of soil. Three units were defined. Stratum 1 was an 11-cm-thick layer of fine reddish brown sand containing a few quartzite and chert gravels. Stratum 2 was a 27-cm-thick layer of fine to medium reddish brown sand containing numerous quartzite and chert gravels. Stratum 3 was a layer of gravel that could not be penetrated by the auger; excavation ended at the top of this unit. Fragments of glass were recovered from the upper 2 to 5 cm of Stratum 1; no other cultural materials were present.

**Test Pit 2.** Test Pit 2 was placed near a cluster of surface artifacts to determine whether intact cultural deposits were present. Surface soil was a fine reddish brown sand containing a few quartzite gravels; vegetation was moderate and included grama and dropseed grasses. No surface artifacts were found.

Excavation continued to a depth of 38 cm, encountering a fine reddish brown sand containing a few quartzite and chert gravels. Two lithic artifacts--quartzite flakes from the same core--were recovered from the upper 10 to 13 cm of fill, but probably reached those depths through natural rather than cultural processes. An auger hole penetrated an additional 32 cm, and Stratum 1 continued to the bottom. No other cultural materials were found.

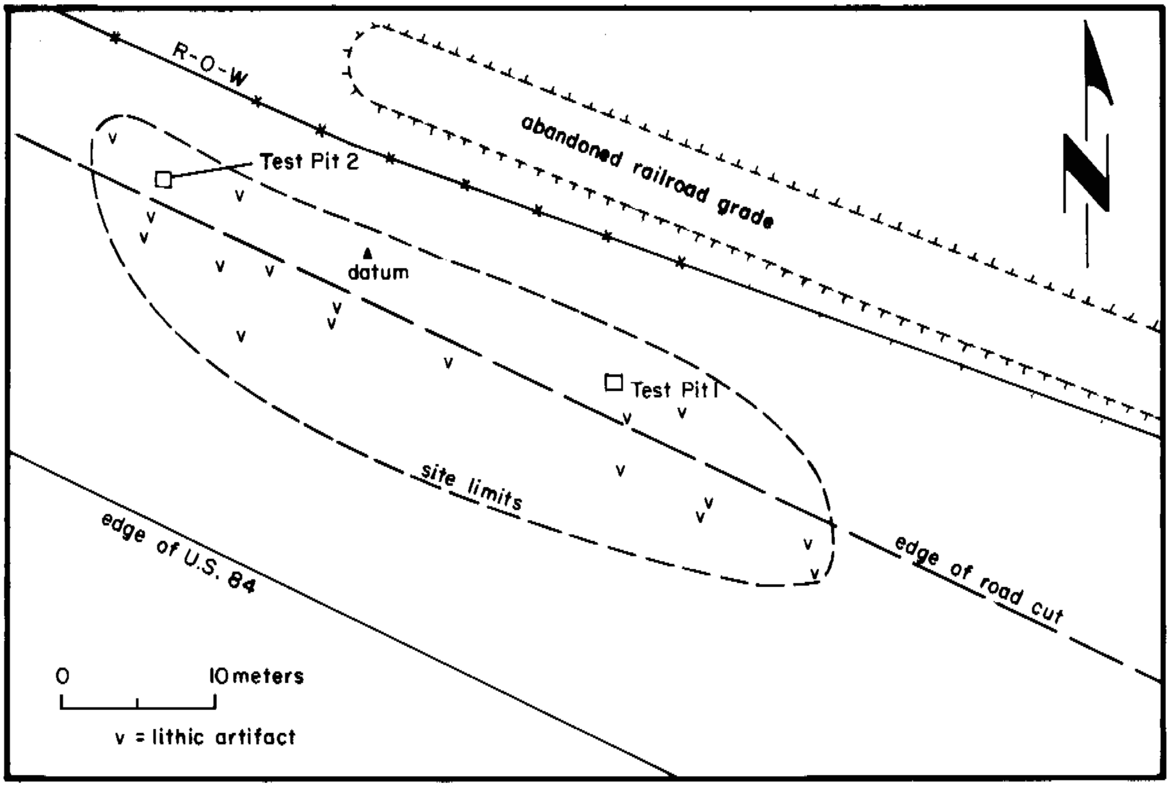


*Figure 2. Plan view of LA 75286.*

LA 75287

*Site Description*

During survey, LA 75287 was described as a water and soil control system containing three cobble alignments in a 50-by-30-m area (Marshall 1989). No artifacts were noted. A Classic period date was assigned because of the site's resemblance to others investigated in the area.

Closer examination during testing showed that LA 75287 is much larger than originally recorded, measuring 220 by 190 m. LA 75287 contains 37 Classic period Anasazi farming features and an early Developmental period lithic artifact scatter (Fig. 3). It sits on a series of eroded terraces flanking the north edge of the Río Chama floodplain, which rise out of the valley in a series of steps (Fig. 4). Vegetation is sparse to moderate, and includes mixed grasses, shrubs, and scrub juniper. The soil surface is quite rocky, with rock size ranging from pea gravels to cobbles. To simplify recording, LA 75287 was divided into four proveniences. Two test pits and three auger tests were excavated within proposed project limits to determine whether cultural deposits were present.

*Provenience 1*

Provenience 1 is on a low terrace, truncated by the existing highway right-of-way. The top of the terrace is flat and exposed to the south, and is the only part of the site that extends into proposed project limits. This provenience contains 12 features and a scatter of lithic artifacts in a 71-by-52-m area (Table 1). Two Biscuit ware sherds were found, implying a Classic period date for the features. Much of the area was disturbed by construction of utility lines, and a contour ditch crosses the terrace within the existing right-of-way. Locally available waterworn quartzite and igneous cobbles were used to build all structural features.

Several individual systems of farming features appear to be represented by these remains, but damage sustained during construction of a utility line makes it difficult to determine how several features are related. Features 1 to 3 form a single contour terrace system; Feature 4 may be associated, but this is unclear. These are the only features that extend into proposed project limits. Features 1 and 2 are relatively intact, but Feature 3 ends at the contour ditch and may have been cut by it. Feature 4 is divided by a cross-wall on its upslope side, which probably served to demarcate interior plots.

Features 5 and 6 may be parts of a single gravel mulched grid system, but damage caused by utility line construction makes this association tentative. Likewise, it is unclear whether Features 7 and 8 represent a contour terrace system or were part of the grid system represented by Features 5 and 6. Feature 10 may also be part of that system, but disturbance around a utility pole makes this impossible to determine.

The cluster of cobbles and small boulders at Feature 9 may be the remains of a temporary structure. Most of the lithic artifacts noted at this site are concentrated in a 7-m diameter area south of this feature, suggesting a domestic trash deposit associated with a fieldhouse. The lack

**Table 1. Features on Provenience 1, LA 75287**

| NO. | FEATURE TYPE | SIZE | COURSES | SOIL DEPTH | COBBLE DIAMETER |
|---|---|---|---|---|---|
| 1 | contour terrace wall | 4.7 m long | 1-2 | - | 15-20 cm |
| 2 | contour terrace wall | 6.8 m long | 1 | 2-5 cm | 15-20 cm |
| 3 | contour terrace wall | 8.2 m long | 1 | 2-4 cm | 12-20 cm |
| 4 | contour terrace wall | 11.9 x 2.4 m | 1 | 5-8 cm | 20-25 cm |
| 5 | L-shaped cobble alignment | 4.9 x 2.3 m | 1 | - | 19 cm |
| 6 | gravel mulched grid | 7.2 x 6.0 m | 1 | - | 15-25 cm |
| 7 | contour terrace wall | 10.3 m long | 1 | 10 cm | 12-20 cm |
| 8 | contour terrace wall | 4.8 m long | 1 | 5-8 cm | 25 cm |
| 9 | cobble and boulder cluster | 1.8 m diam. | - | - | 30 cm |
| 10 | gravel mulched grid system | 9.3 x 6.0 m | 1 | - | 20-24 cm |
| 11 | borrow pit | 8.1 x 7.5 m, 50-60 cm deep | - | - | - |
| 37 | charcoal stain | 60 cm diam. | - | - | - |

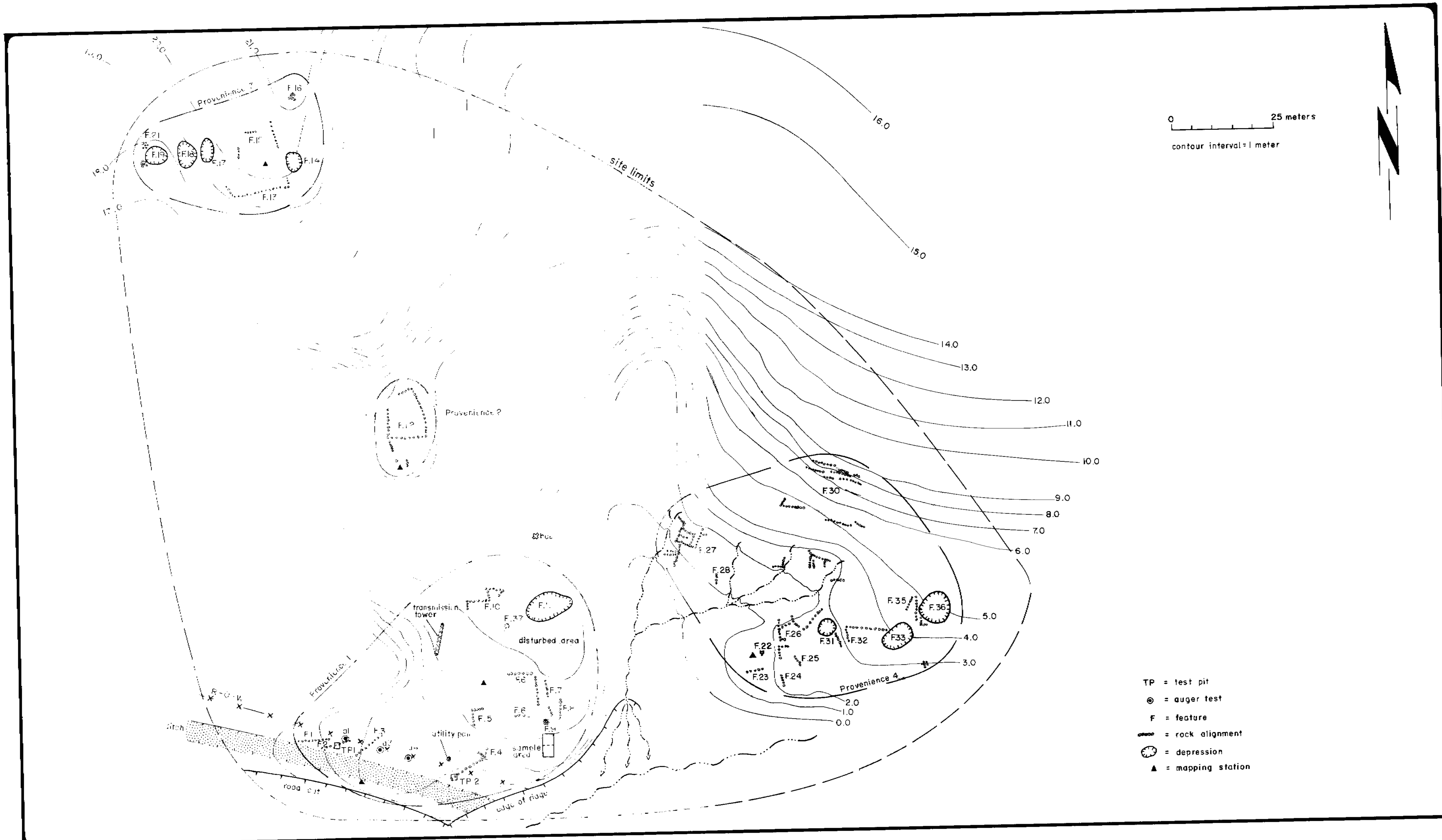

Figure 3. Plan view of LA 75287.

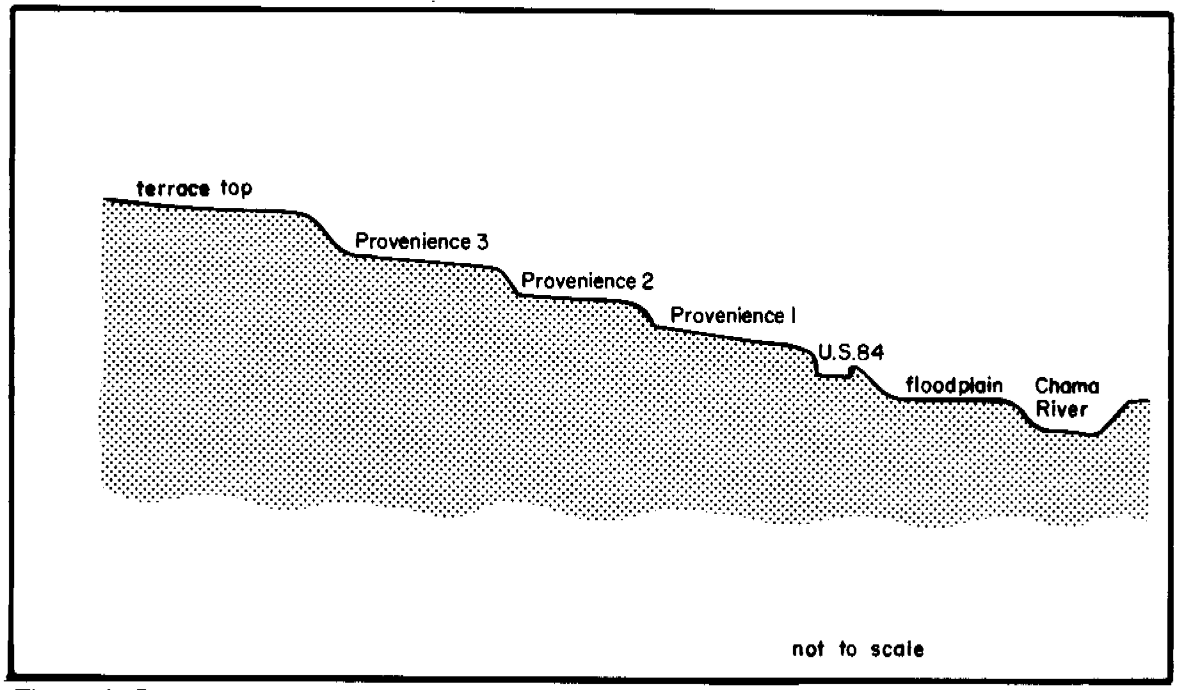


*Figure 4. Cross section of area containing LA 75287 (not to scale).*

of pottery and presence of an early Developmental period projectile point indicate that the artifact concentration may actually represent an earlier component.

*Provenience 2*

Provenience 2 is on a flat-topped hill, outside proposed project limits. It contains one feature (Feature 12) in a 21-by-10-m area, and is sheltered to the north by a higher terrace. No artifacts were noted on the surface. Locally available waterworn quartzite and igneous cobbles were used to build all walls.

Feature 12 is a grid system measuring 14.5 by 9.6 m. Two isolated cobble alignments measuring 1.3- and 3.4-m long may be part of the system, but are not currently connected to the grid. All grid walls are one course high and wide, and are constructed of cobbles averaging 16 to 33 cm in diameter. The surface of the grid is 2 to 5 cm higher than the surrounding hilltop, suggesting it is gravel mulched; however, as the gravel content of the grid is the same as that of the natural surface, the presence of a mulch could not be determined for certain. Erosion has displaced some walls at the edge of the hill. All cobbles appear to have been cleared from the hill top, and were incorporated into the grid walls.

*Provenience 3*

Provenience 3 is on a hill below the top of the highest terrace, and is outside proposed project limits. The hill top is flat, has a shallow southward slope, and is sheltered to the north by a higher terrace. This area contains nine features in a 45-by-28-m area (Table 2). Fewer than a dozen obsidian and Pedernal chert lithic artifacts were noted on the surface. Locally available waterworn quartzite and igneous cobbles were used to build all structural features.

The types of features recorded in this area include grids, rock piles, and borrow pits. Though Features 13 and 15 are now separated, they were probably once part of the same grid system. The center of the south wall of Feature 13 is eroded, and cobbles are scattered downslope. Cobbles in the east-west wall segment of Feature 15 are mostly buried, and several are set on end. This alignment may be the remains of an internal dividing wall, and the depth of soil within the feature suggests that it was gravel mulched. The presence of four nearby borrow pits (Features 14, 17, 18, and 19) supports this conclusion. Cobble piles (Features 20 and 21) west of Feature 19 are evidence of material sorting, with rejected materials being discarded at the source. Cobble discards were also noted between Features 17, 18, and 19, but were scattered rather than piled. Feature 16 is a collection of rocks stockpiled during field clearing or in preparation for construction.

*Provenience 4*

Provenience 4 is on a flat-topped terrace and adjacent hill slopes, which are sheltered to the north by a higher terrace. This area is outside proposed project limits and contains 15 features in a 76-by-62-m area (Table 3). Lithic artifacts are lightly scattered across the north and west parts of the provenience, and no concentrations were noted. Locally available waterworn quartzite and igneous cobbles were used to build all structural features.

This provenience contains several water and soil control complexes. Features 22 through 26, 32, and 35 seem to be part of an eroded gravel mulched grid system, with gravel for mulching supplied by two nearby borrow pits (Features 33 and 36). A few upright cobbles were noted in Features 24 and 25, and cobble alignments are mostly buried in Feature 25, supporting the conclusion that these grids were mulched. Erosion has displaced wall elements in Features 24 and 26. A rock pile (Feature 34) contains cobbles rejected during gravel quarrying in Feature 33.

Features 27 and 29 represent separate grid complexes, while Feature 28 is either part of one of those features or of another eroded system. As the gravel content of Feature 27 was the same as that of the natural terrace surface, it was uncertain whether that complex was mulched. Similarly, no definite evidence of a gravel mulch was noted in Feature 29. However, some of the cobbles used to build that feature are set upright and are nearly buried, suggesting that a mulch might be present.

Feature 30 is a contour terrace system containing six cobble alignments. Breaks in the upper two walls may have been left to allow excess water to pass into lower parts of the system; conversely, they could also be the result of erosion. Sheetwash has displaced cobbles in most of the walls, and the east side of the system may have been cut by a gully, so the latter conclusion is not unreasonable. While up to 5 cm of soil deposition is visible behind terrace walls, there is no evidence to suggest that it represents a gravel mulch. Rather, it is more likely the result of sheetwashed soil piling up behind cobble walls. Though these terraces are not directly connected to the nearby grid complexes, they may have been built to protect them from erosion.

Table 2. Features on Provenience 3, LA 75287

| NO. | FEATURE TYPE | SIZE | COURSES | SOIL DEPTH | COBBLE DIAMETER |
|---|---|---|---|---|---|
| 13 | gravel mulched grid | 15.3 x 3.3 m | 1-2 | 2-4 cm | 15 cm |
| 14 | possible borrow pit | 5.7 x 5.2 m, 30 cm deep | - | - | - |
| 15 | gravel mulched grid | 8.4 x 10.5 m | 1 | - | 12-22 cm |
| 16 | rock pile | 60 cm diam. | - | - | 20 cm |
| 17 | borrow pit | 7.0 x 3.4 m, 10-15 cm deep | - | - | - |
| 18 | borrow pit | 6.0 x 4.0 m, 20 cm deep | - | - | - |
| 19 | borrow pit | 4.5 x 4.0 m, 20-25 cm deep | - | - | - |
| 20 | rock pile | 1.0 m diam. | - | - | 10-15 cm |
| 21 | rock pile | 70 cm diam | - | - | 10-15 cm |

Table 3. Features on Provenience 4, LA 75287

| NO. | FEATURE TYPE | SIZE | COURSES | SOIL DEPTH | COBBLE DIAMETER |
|---|---|---|---|---|---|
| 22 | rock pile | 1.4 x .7 m | - | - | 20-25 cm |
| 23 | cobble wall | 2.0 m long | 1 | - | 18 cm |
| 24 | cobble wall | 3.6 m long | 1 | - | 18 cm |
| 25 | cobble wall | 2.8 m long | 1-2 | 10-12 cm | 20 cm |
| 26 | grid system | 14.0 x 12.0 m | 1 | - | 18-30 |
| 27 | grid system | 13.5 x 13.0 m | 1 | - | 25-30 cm |
| 28 | cobble wall | 1.8 m long | 1 | - | 20-25 cm |
| 29 | grid system | 19.0 x 8.5 m | 1 | - | 20-25 cm |
| 30 | contour terrace system | 23.0 x 18.0 m | 1 | 5 cm | 20 cm |
| 31 | borrow pit | 4.3 x 4.1 m, 30 cm deep | - | - | - |
| 32 | gravel mulched grid system | 14.5 x 6.0 m | 1 | 3-4 cm | 25 cm |
| 33 | borrow pit | 2.5 m diam., 50 cm deep | - | - | - |
| 34 | rock pile | 2.5 m diam. | - | - | 20-25 cm |
| 35 | grid system | 8.0 x 5.0 m | 1 | - | 15-20 cm |
| 36 | borrow pit | 8.7 x 8.0 m | 1 | - | 15-20 cm |

*Test Pit Descriptions*

**Test Pit 1.** Test Pit 1 was excavated across Feature 2 in Provenience 1 to determine whether cultural deposits were present. Surface soil was a dark yellowish brown loam containing numerous gravels; vegetation was moderate and included grama grass and sagebrush. No artifacts were found on the surface.

Excavation continued to a depth of 10 cm, encountering a gravelly dark yellowish brown sandy loam; no cultural materials or deposits were found. The terrace wall was one course high and wide, and the soil behind it had built up naturally.

**Test Pit 2.** Test Pit 2 was excavated across Feature 4 in Provenience 1 to determine whether cultural deposits were present. The grid was extended by 50 cm on its west and south sides to define the extent of a perpendicular alignment (Fig. 5). Surface soil was a dark yellowish brown sandy loam containing numerous gravels; vegetation was moderate and included grama grass. A Pedernal chert flake and piece of angular debris were found on the surface.

Excavation continued to a depth of 10 cm, encountering a gravelly dark yellowish brown sandy loam. A Pedernal chert core was found in the upper 10 cm of fill, but no cultural deposits were encountered. The terrace wall was one course high and wide, and the soil behind it had built up naturally.

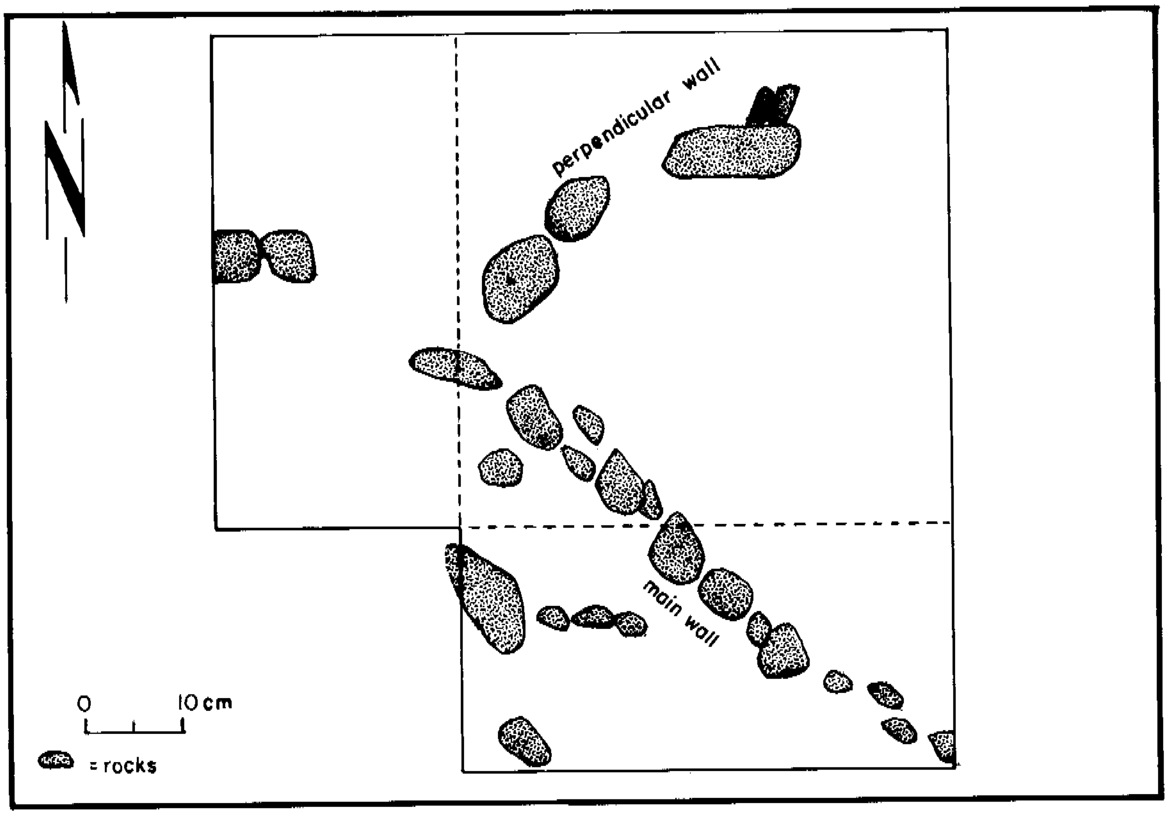


***Figure 5. Plan view of Test Pit 2 on LA 75287.***

**Auger Tests.** Three auger tests were bored to determine whether cultural deposits existed in untested areas, and to recover pollen samples. Auger Test 1 encountered a fine sand that contained a moderate amount of gravel in its upper 20 cm. The test ended at a depth of 94 cm when it hit a layer of gravel that could not be penetrated by the auger. Auger Test 2 encountered a fine sand; surface gravels did not continue downward. At 55 cm below the surface a 1 to 5-cm-thick layer of fine to coarse sand containing a few gravels was found. Below this, fine sand continued to a depth of 95 cm when a layer of gravel that could not be penetrated by the auger was hit. Auger Test 3 encountered 5 to 10 cm of coarse sand and gravel, which was underlain by an 85-cm thick layer of sand containing a few gravels. The test ended at 90 cm below surface when a layer of gravel that could not be penetrated by the auger was encountered. No cultural materials or deposits were found in any of the auger tests.

## LA 75288

### *Site Description*

During survey, LA 75288 was described as a water and soil control system containing two cobble alignments in a 30-by-25-m area (Marshall 1989). Three lithic artifacts were noted, but no diagnostic materials were found. A Classic period date was assigned because of the site's resemblance to others investigated in the area.

Closer examination showed that the site is much larger than recorded during survey, containing 34 Classic period Anasazi farming features and an Archaic lithic artifact scatter in a 210-by-155 m area (Fig. 6). Diagnostic artifacts include Biscuit A, Biscuit B, and Potsuwi'i Incised sherds, and a large side-notched Archaic projectile point base. The site is on a series of eroded terraces flanking the north edge of the floodplain. Vegetation is sparse to moderate and includes mixed grasses, shrubs, and scrub juniper. The soil surface is quite rocky, with rock size ranging from pea gravels to cobbles. To simplify recording, LA 75288 was divided into six proveniences. Five test pits and eight auger tests were excavated into Proveniences 1 through 3 to determine whether cultural deposits were present.

### *Provenience 1*

Provenience 1 is on a low terrace that ends at the existing highway road cut. The terrace top is relatively flat, is exposed to the south, and extends into proposed project limits. This area contains three features in an 18-by-17-m area (Table 4). Four lithic artifacts were found on the surface; all were outside proposed project limits and none were diagnostic. A contour ditch runs through the south end of this provenience. Locally available waterworn quartzite and igneous cobbles were used to build all structural features.

Though three features were defined at this provenience, they appear to be closely related. Feature 2 is an eroded grid; it is likely that the four cobble alignments comprising this feature were connected at one time, with intervening wall segments removed by erosion. Soil buildup (10 cm) behind the west wall suggests that it was gravel mulched, as does the presence of a nearby borrow pit (Feature 1). Unfortunately, Feature 1 was cut by the contour ditch, making

**Table 4. Features on Provenience 1, LA 75288**

| NO. | FEATURE TYPE | SIZE | COURSES | SOIL DEPTH | COBBLE DIAMETER |
|---|---|---|---|---|---|
| 1 | possible borrow pit | 4.0 x 2.0 m, 20-30 cm deep | - | - | - |
| 2 | gravel mulched grid | 17.5 x 11.0 m | 1 | 10-15 cm | 20-25 cm |
| 3 | contour terrace system | 17.5 x 5.0 m | 1 | 2-4 cm | 20-25 cm |

its dimensions and cultural origin questionable. Feature 3 is a contour terrace system containing two cobble alignments. Erosion has displaced cobbles in both walls, but a slight soil buildup (2 to 4 cm) is visible behind intact segments. While it is likely that crops were grown in Feature 3, these terraces probably also helped protect Feature 2 from erosion.

*Provenience 2*

Provenience 2 is on a low terrace that ends at the existing highway road cut. The terrace top is relatively flat, is exposed to the south, and extends into proposed project limits. This provenience contains one feature in a 39-by-32-m area. Surface artifacts include 10 to 20 pieces of Pedernal chert and quartzite debitage, an obsidian biface fragment, a quartzite core, and five Biscuit ware sherds. A contour ditch crosses the south end of the terrace, but did not affect any features. Locally available waterworn quartzite and igneous cobbles were used to build all walls.

Feature 25 is a grid system measuring 39.0 by 32.0 m. Walls are one course high and wide, except at the west edge of the feature where two to three courses are visible. The cobbles used to construct walls average 20 to 25 cm in diameter, and some were set upright. Most walls trend from east to west, and erosion has broken long alignments into shorter segments. There is no evidence of north-south walls dividing the system into cells; rather, only long narrow east-west trending cells were visible. The interior grid surface is 5 to 10 cm higher than the exterior terrace surface, suggesting that the feature is gravel mulched. However, as the gravel content of the grid is the same as that of the natural surface, this is uncertain. A cluster of four large (25- to 35-cm diameter) cobbles at the east end of the feature may be a stockpile.

*Provenience 3*

Provenience 3 is on a low terrace that ends at the existing road cut. The terrace top is flat, is exposed to the south, and extends into proposed project limits. This provenience contains five features in a 44-by-27-m area (Table 5). No artifacts were noted on the surface. Locally available waterworn quartzite and igneous cobbles were used to build all structural features.

Several grid systems and individual grids were defined in this area, none of which appear to have been connected to the others. Features 27 and 28 are small grid complexes; Feature 27 extends into proposed project limits. Grid surfaces are higher than the surrounding terrace surface in both cases, tentatively suggesting that they were gravel mulched. The presence of a borrow pit (Feature 26) inside project boundaries near these features supports this conclusion. Erosion has disturbed both grid systems, resulting in the discontinuous wall segments now visible. Features 29 and 30 are individual grids, and both are outside proposed project boundaries. No soil buildup was noted in either feature, and gravel content is the same inside and outside both grids. This suggests that neither is mulched. Erosion has disturbed Feature 29, resulting in the discontinuous wall segments now visible. Feature 30 was disturbed by utility line construction, again resulting in discontinuous wall segments.

**Table 5. Features on Provenience 3, LA 75288.**

| NO. | FEATURE TYPE | SIZE | COURSES | SOIL DEPTH | COBBLE DIAMETER |
|---|---|---|---|---|---|
| 26 | borrow pit | 4.3 x 4.1 m, 15-20 cm deep | - | - | - |
| 27 | gravel mulched grid system | 16.0 x 9.0 m | 1 | 10 cm | 18 cm |
| 28 | gravel mulched grid system | 8.0 x 6.0 m | 1 | 3-10 cm | 18-20 cm |
| 29 | grid | 14.0 x 11.0 m | 1 | - | 16 cm |
| 30 | grid | 8.0 x 5.0 | 1 | - | 16 cm |

*Provenience 4*

Provenience 4 is outside proposed project limits on a low terrace top that has a shallow slope to the south. Much of this area has been disturbed by utility line construction. The provenience contains 19 features and a lithic artifact scatter in a 75-by-64-m area (Table 6). Locally available waterworn quartzite and igneous cobbles were used to build all structural features.

A variety of agricultural features were recorded in this area including rock piles, cobble walls, borrow pits, grids, and probable grids. Three rock piles (Features 4, 5, and 10) are discard zones related to field clearing and cultivation. A fourth (Feature 15) is unstructured and contains numerous gravels. This feature may be an eroded grid, but it is more likely a discard zone. Defining the two remaining rock piles (Features 23 and 24) as agricultural features is more tenuous. Feature 23 forms a low hill 30 to 40 cm higher than the surrounding terrace surface, and contains gravels as well as cobbles. Cobbles are common on this feature, but not in the area around it. While it may have been a discard zone, it is more likely an eroded grid; a natural origin is also quite possible. Feature 24 was disturbed by utility line construction, so it was unclear whether it is a farming device or the result of construction.

The cobble walls represent a variety of agricultural devices. Features 6 and 21 are segments of eroded contour terraces or grids built on shallow slopes. Features 11, 12, 13, and 16 may be short contour terrace walls, though it is equally likely that Feature 16 is part of an eroded grid. Feature 7 contains two perpendicular cobble alignments, and most likely represents a section of an eroded grid system.

Table 6. Features on Provenience 4, LA 75288

| NO. | FEATURE TYPE | SIZE | COURSES | SOIL DEPTH | COBBLE DIAMETE R |
|---|---|---|---|---|---|
| 4 | rock pile | 1.3 m diameter | - | - | 25 cm |
| 5 | rock pile | 1.2 m diameter | - | - | 20 cm |
| 6 | cobble wall | 2.0 m long | 1 | - | 20 cm |
| 7 | L-shaped cobble wall | 2.2 x 1.1 m | 1 | - | 25 cm |
| 8 | borrow pit | 9.8 x 9.2 m, 40-50 cm deep | - | - | - |
| 9 | grid | 8.0 x 5.0 m | 1 | 2-3 cm | 20-25 cm |
| 10 | rock pile | 2.2 x 1.8 m | - | - | 15 cm |
| 11 | cobble wall | 1.3 m long | 1+ | 5 cm | 20 cm |
| 12 | cobble wall | 1.3 m long | 1 | 3-4 cm | 22 cm |
| 13 | cobble wall | 1.6 m long | 1 | - | 20-25 cm |
| 14 | gravel mulched grid | 8.4 x 2.8 m | 1 | 5-15 cm | 25 cm |
| 15 | rock pile | 4.1 x 2.1 m | - | - | 20-25 cm |
| 16 | cobble wall | 5.4 m long | 1 | 2-3 cm | 25 cm |
| 17 | gravel mulched grid | 6.2 x 5.9 m | 1 | 5-10 cm | 25 cm |
| 18 | eroded gravel mulched grid | 8.0 x 7.0 m | 1 | 5-8 cm | 20 cm |
| 19 | borrow pit | 6.3 x 5.7 m, 20-40 cm deep | - | - | - |
| 20 | eroded gravel mulched grid | 7.0 x 3.0 m | 1 | 2-5 cm | 20 cm |
| 21 | cobble wall | 1.4 m long. | 1 | - | 20 cm |
| 22 | lithic artifact scatter | 46.0 x 23.0 m | - | - | - |
| 23 | cobble and gravel pile | 4.0 x 3.3 m | - | - | 20 cm |
| 24 | cobble pile | 4.1 x .6 m | - | - | 25-30 cm |

Three definite and two probable grids were also defined. Features 9, 14, and 17 are sections of eroded grids. In each case there is a slight buildup of soil within the features, suggesting the presence of a gravel mulch. While the surface gravel content of Features 9 and 17 is similar to that of the natural terrace surface, there is a higher concentration of gravel in Feature 14, confirming the presence of a gravel mulch in that grid. Features 18 and 20 are sections of probable grids. Upright cobbles were noted in both, and their interior surfaces are higher than the natural terrace surface. This suggests that both are gravel mulched. A higher gravel density in Feature 20 than on the adjacent terrace surface is partial confirmation of this.

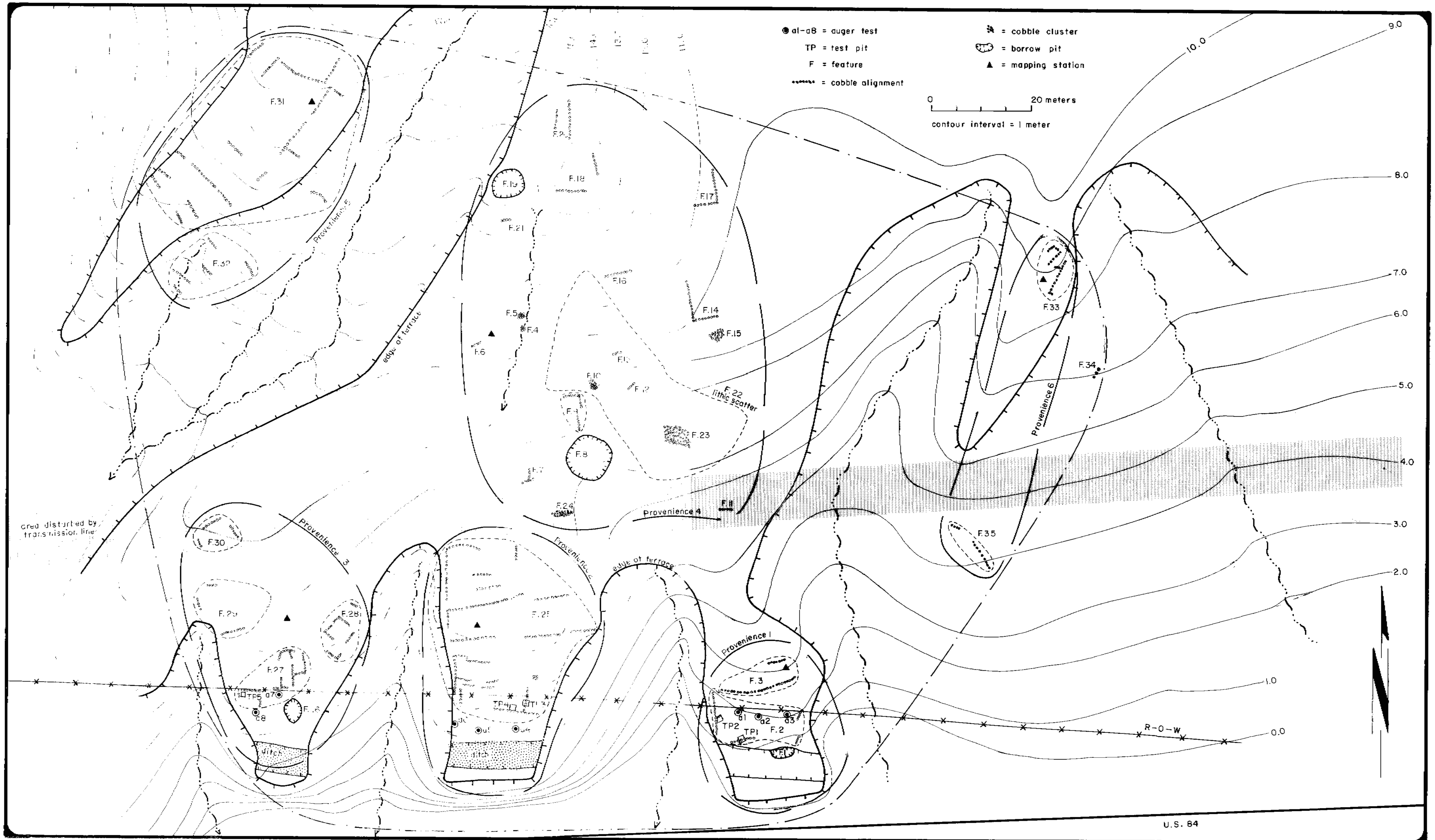


Figure 6. Plan view of LA 75288.

The presence of borrow pits (Features 8 and 19) near Feature 9 and Features 18 and 20 also suggests that those features are gravel mulched.

Feature 22 is a lithic artifact concentration. While lithic artifacts are scattered across the site, this is the densest concentration, containing 100 to 200 obsidian and Pedernal chert artifacts. A large side-notched Archaic dart point base was the only diagnostic artifact found. At least one sherd was noted, but was at the edge of the scatter. Based on the predominance of obsidian and the presence of a large dart point, this feature probably represents an Archaic occupation.

*Provenience 5*

Provenience 5 is outside proposed project limits on a narrow terrace. It contains two features in a 52-by-42-m area (Table 7), and is sheltered to the north by a higher terrace. About 20 Pedernal chert and quartzite artifacts were noted, but no sherds were found. Locally available waterworn quartzite and igneous cobbles were used to build all structural features.

**Table 7. Features on Provenience 5, LA 75288**

| NO. | FEATURE TYPE | SIZE | COURSES | SOIL DEPTH | COBBLE DIAMETER |
|---|---|---|---|---|---|
| 31 | grid system | 48.0 x 33.0 m | 1 | 2-10 cm | 18 cm |
| 32 | check dam system | 16.0 x 11.5 m | 1 | 4-10 cm | 20-24 cm |

Two systems of farming features were defined in this area. Feature 31 contains a grid system and a possible contour terrace system. The grid system occupies the eastern part of the feature. Though its surface is a few centimeters higher than the natural terrace surface, gravel concentrations are the same in both areas. Thus, it was not possible to determine whether a gravel mulch was present. Most feature walls are discontinuous because of erosion, making it hard to tell whether the three western series of walls were part of the grid system, or a separate contour terrace system.

Feature 32 contains the only check dams found at the site, and shows that erosion was active at the time the system was in use. Five dams were identified; all appeared to be only one course high and wide. However, the longest dam was badly eroded and the arrangement of displaced stones suggests that this feature could be more than one course wide.

*Test Pit Descriptions*

**Test Pit 1.** Test Pit 1 was placed across the south wall of Feature 2 to examine building techniques and determine whether cultural deposits were present. Surface soil was a gravelly reddish brown sandy loam; vegetation was moderate and included grama grass and prickly pear. No surface artifacts were found.

Excavation continued to a depth of 18 cm, encountering a gravelly reddish brown sandy loam. No cultural materials or deposits were found. The grid wall was one course high and wide; testing did not reveal whether it was gravel mulched or filled naturally.

**Test Pit 2.** Test Pit 2 was placed across the west wall of Feature 2 to examine building techniques and determine whether cultural deposits were present. Surface soil was a gravelly reddish brown sandy loam; vegetation was moderate and included grama grass and prickly pear. No surface artifacts were found.

Excavation continued to a depth of 10 cm, encountering a reddish brown sandy loam containing numerous gravels in the upper 5 cm, with gravel density increasing in the lower 5 cm. A second 10-cm level was excavated in the north half of the grid to see whether this density of gravel continued deeper. While there was no change in soil texture or color in this level, gravel density decreased slightly. No cultural materials or deposits were found. The grid wall was one course high and wide; testing suggested but did not confirm that it was gravel mulched.

**Test Pit 3.** Test Pit 3 was placed across an alignment that abuts the south wall of Feature 25 to examine building techniques and to determine whether cultural deposits were present. Surface soil was a gravelly fine reddish brown sandy loam; vegetation was moderate and included grama grass. No surface artifacts were found.

Excavation continued to a depth of 16 cm, encountering a reddish brown sandy loam containing numerous gravels (60 to 70 percent). Gravel density dropped substantially below the bottom of the wall, and was about half that of the soil directly behind the alignment. This indicates that the grid was gravel mulched. No cultural materials or deposits were found, and the wall was one course high and wide.

**Test Pit 4.** Test Pit 4 was placed across the south wall of Feature 25 to examine construction techniques and to determine whether cultural deposits were present. Surface soil was a reddish brown sandy loam containing numerous gravels; vegetation was moderate and included grama grass. A Pedernal chert flake was found on the surface.

Excavation continued to a depth of 7 cm, encountering a very gravelly reddish brown sandy loam containing a moderate number of small cobbles. No cultural materials or deposits were found, and the wall was one course high and wide. Testing did not determine whether it was gravel mulched or filled naturally.

**Test Pit 5.** Test Pit 5 was placed across the west wall of the southwest grid in Feature 27 to examine construction techniques and to determine whether cultural deposits were present. Surface soil was a gravelly reddish brown sandy loam; vegetation was moderate and included grama grass. No surface artifacts were found.

Excavation continued to a depth of 8 cm, encountering a gravelly reddish brown sandy loam. No cultural materials or deposits were encountered, and the wall was one course high and wide. Testing did not determine whether it was gravel mulched or filled naturally.

**Auger Tests.** Eight auger tests were excavated to examine soil stratigraphy outside features or deposits within features. Three were dug into Feature 2 on Provenience 1. Auger Test 1 hit 10 cm of very gravelly fine sand, underlain by 40 cm of fine sandy loam containing only a few gravels. Below that was a unit of compact fine sand that continued to a depth of 1.15 m, ending at a layer of gravel. Auger Test 2 encountered a very gravelly fine sandy loam in its upper 15 to 20 cm, underlain by fine sand containing only a few gravels. This unit continued to a depth of 1.23 m, where the auger hit a layer of gravel. Auger Test 3 was almost identical to the others. A 10- to 15-cm-thick very gravelly fine sandy loam was encountered at the surface, underlain by a fine sand containing only a few gravels. This unit continued to a depth of 1.0 m where the auger hit a gravel layer. No cultural materials were found in these tests.

Three auger tests were dug into the slope below Feature 25 on Provenience 2. Auger Test 4 penetrated to a depth of 50 cm, encountering a gravelly fine to coarse sand, and ending at a layer of gravel. A similar matrix was noted in Auger Test 5, which ended at a depth of 23 cm when the auger hit a large cobble. The matrix in Auger Test 6 was similar to that of the others, but more and larger gravels were encountered. This test penetrated to a depth of 23 cm, and ended at a layer of gravel. No cultural materials were found in these tests.

Two auger holes were dug into the slope below Feature 27 on Provenience 3. Auger Test 7 penetrated to a depth of 35 cm, encountering a fine- to medium-grained sand containing numerous gravels and small cobbles. It ended when a large cobble was hit. Auger Test 8 contained a similar matrix, and also ended at a depth of 35 cm when the auger hit a large cobble. No cultural materials were recovered from either of these tests.

# DESCRIPTION OF ARTIFACTS

## Introduction

Diagnostic artifacts found within proposed project limits and artifacts recovered from test pits were collected for analysis; other artifacts were examined in the field and left in place. Pottery analysis was aimed at providing an estimate of the period during which these sites were used. Thus, only ceramic type and vessal form were recorded. Lithic analysis was designed to provide detailed information on reduction technology. This more intensive approach was necessary because both LA 75287 and LA 75288 contained lithic artifact concentrations that appeared to represent components predating use of those areas for farming. Detailed in-field analysis provided information that allowed us to compare and contrast lithic artifacts from the concentrations with those found elsewhere on the sites, and determine whether more than one component was present.

## Ceramic Artifacts

With the exception of two sherds found within project limits on LA 75287, no pottery was collected. In-field analysis was aimed at providing dates for features, and no detailed examinations were performed. No sherds were found at LA 75286.

Only three sherds were found at LA 75287. One Biscuit B jar sherd and an unidentified white ware bowl sherd were collected. In addition, a Biscuit B jar rim was found outside project limits on Provenience 1. These limited data suggest that the farming features at this site were built and used during the late Classic period, ca. A.D. 1400 to 1550.

No sherds were found within project limits on LA 75288, but several were noted on three proveniences outside project limits. Provenience 2 contained four sherds from the same Biscuit B bowl and one sherd from a Biscuit A bowl. Two Potsuwi'i Incised jar sherds and three Biscuit B jar sherds were noted on Provenience 4, and two Biscuit B jar sherds were found on Provenience 5. The predominance of late Classic period wares suggest that this site was used about the same time as LA 75287, ca. A.D. 1400 to 1550.

## Lithic Artifacts

### *Methods of Analysis*

Attributes examined included artifact type, material type and quality, percentage of dorsal cortex, portion, alterations, wear patterns, utilized edge angles, and dimensions (length, width, and thickness). Formal tools were artifacts that were intentionally altered to produce specific shapes or edge angles. Alterations took the form of unifacial or bifacial retouch, and artifacts were considered intentionally shaped when retouch scars extended across two-thirds or more of a surface. Lithic debris that was not altered into formal tools was classified as debitage. Both formal tools and debitage were analyzed.

Debitage was divided into flakes and angular debris by the presence or absence of striking platforms, bulbs of percussion, and recognizable ventral surfaces--flakes possess these attributes and angular debris lack them. Attributes recorded for flakes included platform type and presence of platform lipping. Artifact definitions were consistent with those presented by Chapman (1977:374-378), Chapman and Schutt (1977:85-86), and Schutt and Vierra (1980:50-55).

To facilitate discussion of reduction stages, a set of physical attributes was used to assign flakes to the primary, secondary, and tertiary stages of reduction. Primary and secondary flakes are produced during core reduction--primary reduction is the removal of the weathered and useless outer rind of a nodule, and secondary reduction is the removal of interior flakes for use or further modification. The modification of by-products of core reduction into formal tools constitutes the tertiary reduction stage.

Primary and secondary core reduction were distinguished by the percentage of dorsal cortex present on individual flakes. Primary flakes had 50 to 100 percent of their dorsal surfaces covered by cortex, while cortex covered 0 to 49 percent of the dorsal surfaces of secondary flakes. This was an arbitrary distinction, but it allowed the analyst to determine whether lithic raw materials were brought to a site as unworked nodules or as cores that were partially reduced elsewhere. These data provided useful insights into material procurement strategy and group mobility.

Flakes produced during the tertiary reduction stage were biface flakes. They were distinguished from primary and secondary flakes by a polythetic set of variables (as defined by Acklen et al. 1983, table 1.4-1), which took flake size, shape, and platform characteristics into account (Table 8). Further evidence of tool manufacture included the presence of formal tools that were broken and discarded during manufacture.

*LA 75286*

All visible surface artifacts were analyzed at LA 75286 (Table 9). Core reduction debris dominated the 19 artifacts found here; the only tool was a fragment of sandstone with a groove ground around it. The function of this tool could not be determined. No flake platforms were modified--57 percent (n=8) were single facet, 7 percent (n=1) were cortical, 21 percent (n=3) were collapsed, and 14 percent (n=2) were missing. Of the latter, one flake was broken in manufacture and the other after removal. Twenty-eight percent of the flakes were removed during primary core reduction, while 72 percent were produced during secondary core reduction (Table 10). Evidence for use of debitage as informal tools was lacking. From these limited data, it is concluded that core reduction was the main activity pursued at this site. As a one-hand mano was noted during survey (Marshall 1989), it is likely that plant food processing also occurred. The lack of features, small number of artifacts, and limited number of activities represented in the data set suggest that LA 75286 was a small campsite occupied for a short period of time.

**Table 8. Polythetic Set for Defining Biface Flakes**

Whole Flakes

1. Platform:
    a. has more than one facet
    b. is modified (retouched and/or abraded)
2. Platform is lipped.
3. Platform angle is less than 45 degrees.
4. Dorsal scar orientation is:
    a. parallel
    b. multidirectional
    c. opposing
5. Dorsal topography is regular.
6. Edge outline is even.
7. Flake is less than 5 mm thick.
8. Flake has a relatively even thickness from proximal to distal end.
9. Bulb of percussion is weak (diffuse).
10. There is a pronounced ventral curvature.

Broken Flakes or Flakes with Collapsed Platforms

1. Dorsal scar orientation is:
    a. parallel
    b. multidirectional
    c. opposing
2. Dorsal topography is regular.
3. Edge outline is even.
4. Flake is less than 5 mm thick.
5. Flake has a relatively even thickness from proximal to distal end.
6. Bulb of percussion is weak.
7. There is a pronounced ventral curvature.

Artifact is a Biface Flake When:
-If whole it fulfills 7 of 10 attributes.
-If broken or platform is collapsed it fulfills 5 of 7 attributes.

**Table 9. Chipped Stone Artifact Type by Material Type for LA 75286 (including test pits)**

| Material | Core Flakes | Angular Debris | Cores |
|---|---|---|---|
| Pedernal chert | 10 | 1 | 1 |
| chert | 1 | 0 | 1 |
| quartzite | 3 | 0 | 1 |
| Totals | 14 | 1 | 3 |

**Table 10. Material Type by Reduction Stage--Flakes from LA 75286**

| Material | Primary | Secondary | Tertiary |
|---|---|---|---|
| Pedernal chert | 2 | 8 | 0 |
| chert | 1 | 0 | 0 |
| quartzite | 1 | 2 | 0 |
| Totals | 4 | 10 | 0 |

*LA 75287*

Two strategies were used to examine lithic artifacts on LA 75287. All visible lithic artifacts within project limits on Provenience 1 were analyzed (Sample Area 1). All artifacts within two adjacent 3-by-3-m grids in Provenience 1 south of Feature 4 were also examined (Sample Area 2). Artifacts in the first sample were related to the agricultural features, while those in the second represent an earlier use of the area.

Twelve lithic artifacts were analyzed in Sample Area 1 (Table 11). Four additional artifacts were collected, including two pieces of debitage and a core from test pits, and a uniface. Only core reduction debris was represented among the debitage; there was no evidence of informal tool use or tool manufacture. No flake platforms were modified--46 percent (n=5) were cortical, 36 percent (n=4) were single facet, 9 percent (n=1) were collapsed, and 9 percent (n=1) were absent. Eighteen percent of the flakes were removed during primary core reduction, while the remaining 82 percent were produced during secondary core reduction (Table 12). A uniface was the only tool found in this area.

Twenty artifacts were analyzed in Sample Area 2 (Table 11). Both core and biface reduction debris were represented. No evidence of informal tool use was noted. The size of the biface flake (distal fragment, 39 by 23 mm) suggests that it was removed from a large biface. Large unspecialized bifaces often served as sources for debitage that were then used as informal tools (Kelly 1988), and it is possible that this artifact represents such a usage.

**Table 11. Artifact Type by Material Type for LA 75287**

*Sample Area 1 (including collected artifacts)*

| Material | Core Flakes | Angular Debris | Cores | Unifaces |
|---|---|---|---|---|
| Pedernal chert | 4 | 3 | 1 | 1 |
| quartzite | 7 | 0 | 0 | 0 |
| Totals | 11 | 3 | 1 | 1 |

*Sample Area 2*

| Material | Core Flakes | Biface Flakes | Angular Debris | Projectile Points | Cores |
|---|---|---|---|---|---|
| Pedernal chert | 6 | 0 | 1 | 0 | 0 |
| obsidian | 2 | 1 | 1 | 1 | 0 |
| quartzite | 5 | 0 | 2 | 0 | 1 |
| Totals | 13 | 1 | 4 | 1 | 1 |

**Table 12. Material Type by Reduction Stage--Flakes from LA 75287**

*Sample Area 1*

| Material | Primary | Secondary | Tertiary |
|---|---|---|---|
| Pedernal chert | 0 | 4 | 0 |
| quartzite | 2 | 5 | 0 |
| Totals | 2 | 9 | 0 |

*Sample Area 2*

| Material | Primary | Secondary | Tertiary |
|---|---|---|---|
| Pedernal chert | 1 | 5 | 0 |
| obsidian | 0 | 2 | 1 |
| quartzite | 2 | 3 | 0 |
| Totals | 3 | 10 | 1 |

No flake platforms in this sample were modified--35 percent (n=5) were cortical, 28 percent (n=4) were single facet, 14 percent (n=2) were collapsed, and 21 percent (n=3) were absent. None of the latter were broken during manufacture. Twenty percent of the flakes were removed during primary core reduction, 73 percent were produced during secondary core reduction, and 7 percent during the tertiary stage (Table 12). An early Developmental period projectile point fragment was the only formal tool found.

As far as reduction is concerned, the only difference between these areas is the presence of a biface flake in Sample Area 2. Otherwise, both exhibited similar percentages of primary and secondary flakes, and both lacked evidence of platform modification. The main difference between samples was the types of lithic materials used. Sample Area 1 contained Pedernal and other cherts and quartzite, all of which are available in local gravels. In addition to local chert and quartzite, Sample Area 2 also contained a high percentage of obsidian, which is not locally available.

*LA 75288*

Two strategies were used to examine artifacts on LA 75288. All visible lithic artifacts within project limits were analyzed. Only a few artifacts were in this area, and sampling was extended to include all of Provenience 2. Lithic artifacts in the north half of Feature 22 were also examined. No lithic artifacts were found on Proveniences 3, 5, or 6.

Lithic artifacts were rare on Proveniences 1 and 2--only four were found within project limits on Provenience 1, and five on all of Provenience 2 (Table 13). No evidence of tool manufacture or use was found on Provenience 1; only core reduction debris was present. Provenience 2 contained a biface tip in addition to core reduction debris. No flake platforms were modified on either provenience--both platforms on Provenience 1 were single facet; one platform on Provenience 2 was multifacet, and the other was absent. All debitage on these proveniences were removed during secondary core reduction (Table 14).

Twenty-five artifacts were analyzed on Feature 22 (Table 13). This represents about half the visible artifacts, though it is estimated that between 100 and 200 are present. The assemblage is dominated by obsidian, contrasting with Proveniences 1 and 2, which are dominated by Pedernal chert. In fact, except for one artifact on Provenience 2, obsidian was absent from other parts of the site. In addition to core reduction debris, four biface flakes were found in Feature 22, indicating that tool manufacture occurred there. No evidence of informal tool use was noted. Of the core flakes, most (86 percent) were produced during the secondary stage, suggesting that cores were partially reduced elsewhere before being brought here. The primary flakes were removed from only quartzite nodules.

Most of the platforms on Feature 22 were unmodified. Single-facet platforms comprised 28 percent of the total, 16 percent were collapsed, and multifacet, abraded, collapsed, and crushed platforms comprised 4 percent each. Forty percent (n=10) of the flakes were distal or medial fragments; six of these were broken during manufacture. One of two proximal fragments was also broken during manufacture. Large percentages of flakes broken during manufacture suggests tool production. As tool manufacture proceeds, flakes grow progressively smaller and thinner. As this occurs, they are more prone to breakage through secondary compression, as defined by

**Table 13. Artifact Type by Material Type for LA 75288**

*Provenience 1 -- Area Within Right-of-Way*

| Material | Core Flakes | Angular Debris |
|---|---|---|
| Pedernal chert | 2 | 2 |
| Totals | 2 | 2 |

*Provenience 2 -- Entire Provenience and Test Pits*

| Material | Core Flakes | Cores | Bifaces |
|---|---|---|---|
| Pedernal chert | 2 | 1 | 0 |
| obsidian | 0 | 0 | 1 |
| quartzite | 0 | 1 | 0 |
| Totals | 2 | 2 | 1 |

*Provenience 4 -- Feature 22 Sample*

| Material | Core Flakes | Biface Flakes | Angular Debris | Projectile Points |
|---|---|---|---|---|
| Pedernal chert | 4 | 0 | 4 | 0 |
| chert | 1 | 0 | 0 | 1 |
| obsidian | 13 | 4 | 2 | 0 |
| quartzite | 3 | 0 | 0 | 0 |
| totals | 21 | 4 | 6 | 1 |

**Table 14. Material Type by Reduction Stage--Flakes from LA 75288**

*Proveniences 1 and 2*

| Material | Primary | Secondary | Tertiary |
|---|---|---|---|
| Pedernal chert | 0 | 4 | 0 |
| Totals | 0 | 4 | 0 |

*Provenience 4*

| Material | Primary | Secondary | Tertiary |
|---|---|---|---|
| Pedernal chert | 0 | 4 | 0 |
| chert | 0 | 1 | 0 |
| obsidian | 0 | 13 | 4 |
| quartzite | 3 | 0 | 0 |
| Totals | 3 | 18 | 4 |

Sollberger (1986). This, in addition to the presence of a modified platform and several biface flakes, suggests that tool manufacture occurred in this area. The only tool found was a middle Archaic projectile point base.

### *Discussion*

The limited information provided by this analysis suggests that two reduction strategies are represented--a curated strategy based on the production of bifaces, and an expedient strategy based on the removal of flakes from cores. The former is usually associated with groups that are residentially mobile, while the latter is characteristic of sedentary peoples. In general, Archaic hunter-gatherers relied on curated bifaces that could be transported from camp to camp and used as tools or cores, while Anasazi farmers relied on expediently produced informal tools. There are, of course, exceptions to these patterns. Large unspecialized bifaces were sometimes made by the Anasazi, while Archaic hunter-gatherers also used expedient tools. In general, however, evidence of large unspecialized biface production and use suggests occupation by mobile Archaic hunter-gatherers.

Three areas produced evidence of large unspecialized biface manufacture or use. Sample Area 2 on LA 75287 contained the distal end of a flake removed from a large biface. Feature 22 on LA 75288 contained four biface flakes (averaging 26 cm long) that seem to have been removed from large bifaces. Other evidence (as discussed above) also suggests that biface manufacture was an important activity in that area. Finally, a large biface tip was noted on Provenience 2 of LA 75288. As the latter contains only a few artifacts of questionable association with the farming features, it will not be discussed in detail.

Two areas on LA 75287 and LA 75288 contain limited evidence of occupation by mobile populations. Corroborating information is found in material selection data. Materials available in local gravels include Pedernal and other cherts, quartzites, and igneous rocks such as basalt and rhyolite. With the exception of the obsidian biface fragment on Provenience 2 of LA 75288, only local materials were found on LA 75286 and in association with farming features on LA 75287 and LA 75288. Cortex, when present, was waterworn, indicating procurement in local gravels deposits.

Obsidian was the only material found that was not available locally. Examination of local gravel beds failed to locate any obsidian nodules. In addition, cortex on obsidian debitage was nonwaterworn, indicating that it was obtained at or near the source. Most obsidian was restricted to the artifact clusters that also contained diagnostic projectile points. In both cases, pre-Classic period occupations were indicated.

The presence of lithic artifact concentrations in the midst of agricultural features could simply indicate temporary on-site residence by the farmers who used this area. However, three lines of evidence suggest that this is not the case. These concentrations were the only areas where large bifaces were manufactured or used, exotic materials are mostly restricted to them, and projectile points diagnostic of earlier time periods were associated with both. While ceramic data indicates that the farming features on LA 75287 and LA 75288 were built and used during the Classic period, lithic artifact concentrations on both sites are indicative of earlier occupations--the concentration on LA 75287 represents an early Developmental period occupation, while Feature 22 on LA 75288 represents a middle Archaic use. This is discussed in more detail in the next chapter.

## Pollen Analysis

Though many attempts at recovering domestic pollen from farming features have been made, results have usually been unsatisfactory. On the rare occasions when domestic pollen has been recovered, it was present in such small quantities that interpretation was difficult. During this project, pollen samples were taken from tested farming features with little hope of obtaining useable information, but we felt that the effort was necessary to help confirm their presumed agricultural function. An experimental approach was taken in an attempt to find a way to provide more usable information.

Pollen analysis was completed by Castetter Ethnobotanical Laboratory (Dean 1991a). Four samples from LA 75287 and five from LA 75288 were examined (Table 15). In addition, control samples from active fields were analyzed to provide comparative data. All samples were "spiked" with tablets of pressed *Lycopodium* (clubmoss) spores to allow statistical manipulation of data. Earlier attempts at concentrating pollen from domesticated plants focused on screening residue to physically separate pollen types by size (Dean 1991a:4). During this analysis, however, a new method was used, that of intensive systematic microscopy.

As cultigen pollens are usually numerically rare, finding them requires a different approach from the standard 200 grain count. Dean (1991b:9) determined that with a sample size of 25 grams and a spike count of 36,300, between 594 and 1,005 spike grains must be counted before a rare pollen present in a concentration of two grains per gram of soil can be expected to show up in a sample. This was determined using the following equation:

$$PU=\frac{FP}{SC}\times\frac{SA}{WT}$$

where PU is the number of pollen grains per unit sample, FP is the number of fossil pollen counted, SC is the number of spike grains counted, SA is the number of spike grains added, and

**Table 15. Results of Pollen Analysis. (Number represents the total number of pollen grains counted, concentration represents estimated number of pollen grains per gram of sample)**

| Site no. | Location | Depth | *Zea* pollen | | *Gossypium* pollen | |
|---|---|---|---|---|---|---|
| | | | no. | conc.* | no. | conc.* |
| LA 75287 | Test Pit 1 | 10 cm | 1 | 3 | 0 | 0 |
| LA 75287 | Test Pit 2 | 15 cm | 0 | 0 | 0 | 0 |
| LA 75287 | Auger Hole 1 | 12 cm | 0 | 0 | 0 | 0 |
| LA 75287 | Auger Hole 2 | 12 cm | 0 | 0 | 0 | 0 |
| LA 75288 | Test Pit 1 | 10 cm | 1 | 1 | 0 | 0 |
| LA 75288 | Test Pit 2 | 31 cm | 0 | 0 | 1 | 3 |
| LA 75288 | Test Pit 3 | 16 cm | 0 | 0 | 1 | 1 |
| LA 75288 | Test Pit 4 | 10 cm | 0 | 0 | 1 | 2 |
| LA 75288 | Test Pit 5 | 15 cm | 0 | 0 | 0 | 0 |

WT is the weight (or volume) of the sample. Similarly, to find a rare pollen type present in concentrations of one grain per gram of soil it would be necessary to count between 1,006 and 3,200 spike grains.

Taking budgetary constraints and time into account, it was determined that scans would be aimed at finding rare pollen types present in concentrations of at least two grains per gram of soil. A minimum count of 750 spike grains was decided upon, representing the approximate center of the range. In practice, counts ended only when entire slides were examined to compensate for the uneven distribution of rare pollens on slides, and counts ended when rare pollens were found on a slide. Thus, spike counts ranged between 522 and 2,119. Total pollen concentrations for samples were estimated by tabulating the number of pollen and spike grains seen in two transects of each slide at 200X. The remainder of the slide was then scanned for rare pollens. Pollen samples from active corn, cotton, and squash fields were examined to provide a comparative data base (Table 16).

The experimental technique was more successful than we had anticipated. Domestic pollen was found in four of nine samples, and possible domestic pollen was identified in a fifth. A sample from Test Pit 1 on LA 75287 contained a corn *(Zea mays)* pollen grain, and was obtained from Feature 2, an eroded contour terrace wall. Three samples from LA 75288 yielded domestic pollen, and one contained possible domestic pollen. Two types of cultigen pollen were found in samples from Feature 2, an eroded grid that may have been gravel mulched. They included a corn pollen grain from Test Pit 1 and a cotton *(Gossypium hirsutum)* pollen grain from Test Pit 2. A cotton pollen grain was also found in a sample from Test Pit 4, and a possible cotton pollen grain was recovered from Test Pit 3. Both of these test pits were excavated into Feature 25, a gravel mulched grid.

## Table 16. Control Pollen Counts from Modern Fields

| Taxon | cornfield 1 | | cornfield 2 | | cornfield 3 | | squash garden | | cotton field | |
|---|---|---|---|---|---|---|---|---|---|---|
| | no. | conc. | no. | conc. | no. | conc. | no. | conc. | no. | conc. |
| Pinaceae | 16 | 310 | 11 | 333 | 7 | 678 | 4 | 415 | 1 | 6 |
| *Pinus* | 47 | 910 | 58 | 1755 | 10 | 968 | 72 | 7467 | 11 | 65 |
| *Picea* | 3 | 58 | 2 | 61 | 1 | 97 | 4 | 415 | 0 | 0 |
| *Juniperus* | 22 | 426 | 20 | 605 | 31 | 3001 | 8 | 830 | 5 | 29 |
| *Junip/Pop* | 0 | 0 | 0 | 0 | 6 | 581 | 0 | 0 | 0 | 0 |
| *Quercus* | 1 | 19 | 0 | 0 | 1 | 97 | 3 | 311 | 2 | 12 |
| *Ulmus* | 2 | 39 | 2 | 61 | 0 | 0 | 36 | 3734 | 0 | 0 |
| *Juglans* | 0 | 0 | 0 | 0 | 1 | 97 | 0 | 0 | 0 | 0 |
| *Elaegnus* | 1 | 19 | 0 | 0 | 0 | 0 | 1 | 104 | 0 | 0 |
| Cheno/Am | 51 | 987 | 81* | 2450 | 207* | 20,038 | 55 | 5704 | 161* | 946 |
| *Ephedra* | 1 | 19 | 0 | 0 | 1 | 97 | 2 | 207 | 1 | 6 |
| Gramineae | 9 | 174 | 3 | 91 | 2 | 194 | 5 | 519 | 5 | 29 |
| *Zea* | 26 | 503 | 9 | 272 | (23) | (111) | (1) | (23) | 0 | 0 |
| Lo-S Comp | 27* | 523 | 16 | 484 | 68 | 6582 | 8 | 830 | 1 | 6 |
| *Artemisia* | 0 | 0 | 0 | 0 | 2 | 194 | 1 | 104 | 1 | 6 |
| Hi-S Comp | 8 | 155 | 13 | 393 | 3 | 290 | 3 | 311 | 3 | 18 |
| Cichoreae | 2 | 39 | 2* | 61 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eriogonum* | 1 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Yucca* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 104 | 0 | 0 |
| *Cucurbita* | 0 | 0 | 0 | 0 | 0 | 0 | (1) | (23) | 0 | 0 |
| *Gossypium* | 0 | 0 | 0 | 0 | 0 | 0 | (1) | (23) | 3 | 18 |
| Solanaceae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 |
| Cactaceae | 1 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cruciferae | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 104 | 0 | 0 |
| Unknown | 2 | 39 | 1 | 30 | 1 | 97 | 32 | 3319 | 1 | 6 |
| Unident. | 13 | 252 | 19 | 575 | 9 | 871 | 38 | 3941 | 6 | 35 |
| Total | 233 | 4511 | 237 | 7169 | 350 | 33,880 | 274 | 28,418 | 202 | 1187 |
| Spike | 75 | - | 48 | - | 15 | - | 14 | - | 247 | - |

* one or more clumps of 3 or more grains seen during count.

( ) number of grains seen during scan of slide after count completed, and estimated concentration of that pollen type based on the total number of spike grains present on the slide.

In all five cases, contamination from off-site sources can probably be ruled out. Samples were obtained between 5 and 16 cm beneath the surface of prehistoric features, and there is no evidence that these areas were farmed historically. In fact, Bugé (1984:34) notes that modern farmers in the nearby Ojo Caliente Valley feel that there is insufficient moisture on the terraces for successful agriculture. These data indicate that prehistoric farmers grew corn and cotton at these sites. Both were grown in grids, and most likely in gravel mulched grids. Corn was also planted in unmulched contour terraces. The presence of both corn and cotton pollen in samples from Feature 2 on LA 75288 may be evidence of planting multiple crops in fields, but it could also have resulted from crop rotation. At this time it is impossible to determine which of these possibilities is more likely.

# DISCUSSION OF TESTING RESULTS

Multicomponent sites are common in the Chama Valley. Tested and excavated sites at Abiquiú Reservoir contained mixed assemblages documenting occupations ranging from the early Archaic to Historic periods (Bertram et al. 1989; Earls et al. 1989a). Mixed Archaic and Classic remains were also found along an interpretive trail at Poshu'ouinge (Lang 1990). Of greater relevance to this discussion, Archaic and Historic materials were mixed with Anasazi farming features on a site near Te'ewi (Lang 1980). As the lithic artifact concentrations on LA 75287 and LA 75288 seem to represent pre-Classic hunting and gathering components like those found elsewhere in the area, they will be discussed separately from the farming components.

## Lithic Artifact Components

Lithic artifact components were found at all three sites, comprising all of LA 75286 and relatively discrete clusters of artifacts on LA 75287 and LA 75288. Little can be said about LA 75286, which contained only a few undated artifacts. Analysis indicated that they were expediently reduced; no evidence of biface manufacture was found, and no formal tools were present. This suggests an Anasazi cultural affinity, even though no pottery was found. Conversely, a one-hand mano was noted at the site during survey. This type of artifact is often associated with Archaic occupations, but they were also used by the Anasazi. Though Archaic groups relied on a bifacial reduction strategy, expediently reduced debitage were also commonly produced. Testing near San Ildefonso showed that nonlocal materials were mostly bifacially reduced on Archaic sites, while local materials were usually expediently reduced (Moore n.d.). Thus, the presence of expediently reduced local materials is not a definite indication of Anasazi occupation, nor is the presence of a one-hand mano certain evidence of Archaic affinity. Thus, LA 75286 represents a temporary camp of unknown date; no more definite conclusions can be reached.

The lithic artifact concentrations on LA 75287 and LA 75288 are similar to other pre-Classic remains in the area. In both cases, analysis suggests occupation by mobile groups. Evidence of mobility is strongest at LA 75288, and includes a predominance of obsidian and the presence of several flakes removed from large bifaces. A side-notched dart point base was the only diagnostic artifact in this concentration. Chronological studies at Abiquiú Reservoir suggest that this style was used locally during the middle and late Archaic, occurring as early as 2321 $\pm$ 7 B.C. and lasting until at least 202 $\pm$ 30 B.C. (Earls et al. 1989b:347). The character of this feature suggests that it is restricted to the surface. Soil discoloration that would indicate the presence of midden deposits or long-term cultural occupation are lacking, even in eroded areas. No hearths or structures were noted, and formal tools used for processing plant foods are lacking. This locale appears to have been a temporary camp occupied during the middle to late Archaic.

A concentration of lithic artifacts was also found on Provenience 1 of LA 75287. Like the lithic component on LA 75288, this concentration seems unrelated to use of the site for farming during the Classic period. A small corner-notched projectile point was the only diagnostic artifact found. While usually assigned an early Developmental period date, this style may have spanned a longer period of time. Here, however, the traditional date will be retained. In addition to debitage and a projectile point, a few fragments of fire-cracked quartzite were also noted. A nearby hearth and scatter of obsidian debitage (Feature 37) may be related, but the association between these features is unclear. As no structures or clearly associated features were found, these remains probably represent a temporary hunting and gathering camp, similar to other Developmental period remains in the valley.

Unfortunately, Classic period reuse of these areas for farming has muddied our picture of the early occupations. Not only are those remains overlain by later features, they were probably also mined for artifacts. This type of activity was clearly demonstrated during investigations at Abiquiú Reservoir (Earls et al. 1989b:314). Multiple cuttings for obsidian hydration dating showed that artifact reuse was commonplace at sites in that area. This might account for the large biface tip found in Classic period farming features on Provenience 2 of LA 75288. Rather than having been made by a Classic period farmer, this artifact may have been scavenged from an earlier site. Applying this logic across the board, it is possible that the projectile points, large biface flakes, and obsidian in these concentrations were scavenged from earlier sites and reused by later farmers. This is unlikely, however. Currently available information suggests that these components represent transient use of the area for hunting and gathering.

## Classic Period Agricultural Use

Both LA 75287 and LA 75288 include numerous agricultural features that were built and used during the Classic period. Neither contained definite evidence of fieldhouses; only Feature 9 on LA 75287 and Feature 23 on LA 75288 were potential field structures, and this is very tenuous in both cases. Feature 9 on LA 75287 is a pile of rocks that may be the remains of a field structure. Unfortunately, the area that contains this feature was damaged during transmission line construction, and it is now impossible to determine what it actually was from surface indications alone. Even if it was a structure, its association with the agricultural features is questionable--it could also be related to the early Developmental period lithic artifact scatter. The identification of Feature 23 on LA 75288 as a field structure is even more tenuous. While this feature did not appear to be natural, it is more likely a deteriorated grid or discard area. If field structures were built at these sites, they were probably temporary constructions of brush and poles that left no surface indications.

Agricultural features at LA 75287 and LA 75288 are similar to others found in the Chama Valley and the Upper Río Grande. Grids occur throughout an area stretching from Taos on the north to Zia on the south. They are also common in the Hohokam, Mogollon, and Western Anasazi regions. What distinguishes grids in the Chama Valley from those in other areas is the use of a gravel mulch. With one possible exception along the Gila River (Dart 1983:410), gravel mulched grids are found nowhere else in the Southwest. As these features dominate on LA 75287 and LA 75288, a detailed discussion of their function and the benefits they provide is necessary.

### *Grids and Erosion*

Several processes cause erosion and gullying (Cooke and Reeves 1976). Soil loss on farmland often results from the reduction of surface roughness through field clearing. Removal of vegetation and rocks causes accelerated runoff and erosion (Evans and Patric 1983; Tadmor and Shanan 1969). Grids replace the surface roughness lost because of agricultural impact to the vegetative mat and the clearing of stones from fields. Cobble borders slow runoff by presenting barriers to flow, and mulches prevent impact of raindrops on bare soil and detachment of soil particles. In form and probably function, grids resemble the low earth ridges that are recommended for reducing wind-caused soil loss in modern farming (Armbrust et al. 1964; Hausenbuiller 1972; Schwab et al. 1981; Tibke 1988).

Rather than representing a reaction to active erosion like contour terraces and checkdams, grids demonstrate an attempt to prevent the initiation of erosion on farmland. Still, both contour terraces and checkdams occur alongside grids on these sites, implying that the area was actively eroding while it was being farmed. There are two possible explanations for this--contour terraces and checkdams may have protected grids by stopping gullying and sheet wash that was occurring before the features were built, or they are evidence of the failure of gridding to check the initiation of erosion, making it necessary to build devices to counter the process.

### *The Costs and Benefits of Mulching*

Use of a gravel mulch incurs high costs in time and labor. Grid border construction was perhaps the easiest and least expensive step. Observations made during testing indicate that cobbles used to build grid borders were obtained on-site or nearby. Gravel was procured from the borrow pits found near many grids. As material was removed from the pits, cobbles and large gravels were sorted out and discarded in piles, while suitable material was carried to grids. Sand and silt were probably removed before the gravel was applied to fields, as these materials clog and reduce the effectiveness of the mulch. Infiltration of silt and sand into pores eventually reduces a gravel mulch's moisture-conserving abilities (Fairbourn 1973). For this reason, annual regeneration is necessary--an expensive proposition in an economy lacking mechanization. In most cases it is likely that farmers simply built new grids next to the old rather than going to the trouble of removing and cleaning the mulch.

Even though gravel mulching was expensive, the benefits it provides offset the cost. Mulches effectively control runoff and erosion in fields by intercepting raindrops before they impact the surface, dissipating their force and preventing detachment of soil particles (J. Adams 1966; Mannering and Meyer 1963). They are also effective in preventing wind-caused soil loss (Chepil et al. 1963; Finkel 1986). A gravel cover increases the rate of water infiltration during rainfall, and prevents soil compaction through raindrop impact (Corey and Kemper 1968; Epstein et al. 1966; Fairbourn and Gardner 1975; Wang 1972). They then conserve moisture by forming a barrier to evaporation (J. Adams 1966; Fairbourn and Gardner 1975; Wang 1972). Evaporative losses are minimized because large pores in the gravel bed prevent the rise of moisture to the surface through capillary action, forcing water to move across pores as vapor (Fairbourn 1973; Fairbourn and Gardner 1975:377). However, experiments suggest that when a gravel mulch is used, wind evaporation rates are similar to or somewhat greater than those in unmulched plots (Hanks and Woodruff 1958). Thus, the moisture-conserving benefits of gravel mulches may be partially offset by windy conditions.

In addition to soil and moisture conservation, gravel mulches significantly affect soil temperature. Unlike vegetal mulches, which reduce the soil temperature profile, gravel mulches increase upper soil temperature (J. Adams 1965; Allmaras et al. 1964; Burrows and Larson 1962; Fairbourn 1973; Lamb and Chapman 1943; Van Wijk et al. 1959). Warming is restricted to upper soils because of the effect of increased soil moisture on heat transfer. While moist soils transfer heat more readily than dry soils, they also require more energy per unit to raise their temperature (Hausenbuiller 1972). Thus, the heat provided by gravel mulching is probably only sufficient to raise the temperature of the upper 10-15 cm of soil. These benefits are more likely to accrue when dark-colored materials are used; experiments demonstrate that dark gravels increase upper soil temperatures because their lower albedo increases their ability to absorb radiation (Fairbourn 1973:927; Wang 1972:440).

Mulches stabilize air temperature at and above the ground surface and, like plant canopys, act as a barrier to heat flow from below, minimizing soil temperature variation (Hausenbuiller 1972). By decreasing moisture loss through capillary action and reducing air movement next to the ground surface, they also curtail evaporative cooling (Wang 1972). Thus, gravel mulches not only increase surface soil temperature, they also help retain that heat. These are important benefits in an area like the Chama Valley where the growing season is short and cold-air drainage is a problem.

*The Pollen Record*

A wide array of domesticated and wild plants were used in the prehistoric Southwest. Evidence of economic use comes from examination of macrobotanical remains, studies of coprolites, pollen analysis, and ethnographic studies. Unfortunately, while analysis of sediments can often identify domestic pollen in fields, it is usually impossible to determine whether wild plant pollen represents weeds or species that were encouraged to grow because they were useful. For this reason, our study focused on domesticated plants. Analysis of pollen samples from LA 75287 and LA 75288 indicate that corn and cotton were grown in these fields, and our discussion will focus on those plants. This does not mean that they were the only crops raised in these fields. Other domesticates like squash or beans may also have been grown, but evidence for them is lacking.

Corn pollen has been recovered from agricultural contexts in a number of areas, but always in small quantities. Corn pollen is relatively rare, even in active corn fields. Martin and Byers (1965) examined three samples from active corn fields and the amount of corn pollen present ranged from .14 to 1.09 percent. A more recent study of pollen in active corn fields at Santa Clara Pueblo produced percentages ranging from 3 to 11 (Table 9). In one case, no corn pollen was noted in the initial scan; not until the entire slide was examined was it found. These studies imply that corn pollen can be very rare in active fields, and that the simple presence of corn pollen may be indicative of cultivation.

Cotton pollen appears to be even rarer in fields. A control sample from an active cotton field (Table 9) contained 1.5 percent cotton pollen (3 grains out of 202). Cotton pollen is rare because its flowers are open for only one day, and begin to close after only a few hours (Dean 1991b:5).

The closed flowers fall off the plant by the end of the next day, with the pollen sealed inside (Dean 1991b:5). Even if the flowers deteriorate in place, little pollen can be expected in field sediments because each flower produces only a small amount. Thus, cotton pollen should be even rarer than corn pollen in prehistoric fields.

Both corn and cotton pollen have been found in sediments from prehistoric farming features as well as probable fields. Corn pollen occurs in farming contexts throughout the Southwest. At Hovenweep, it was found in farming features and akchin fields (Winter 1978). Berlin and others (1977) found corn pollen in 13 of 20 samples taken from a ridged field near Sunset Crater. The field contained basaltic ash ridges alternating with swales from which ash was removed, a concept similar to gravel mulching. A sample from a checkdam near Kingman, Arizona contained one corn pollen grain (Linford 1979). While the author cautions against attaching much meaning to this, our control counts indicate that the presence of even a single corn pollen grain is significant. Corn pollen was recovered from behind a terrace wall in the Gila Butte-Santan region (Rice et al. 1979), and from contour terraces near Tucson (S. Fish et al. 1984). Samples from two suspected fields at Cochiti Lake contained corn pollen; in both cases a single grain was noted (S. Fish 1982). Thirty possible fields were sampled along the lower Chaco River in northwest New Mexico, and seven were concluded to be prehistoric fields when corn pollen was recovered from lower soil horizons (Winter 1983:435).

Only a few prehistoric cotton fields have been identified, and in each case they were associated with corn fields. During investigations along the Salt-Gila aqueduct in southeast Arizona it was determined that both corn and cotton were dry-farmed in rock pile fields in addition to being grown in irrigated fields (Dart 1983:543). Both corn and cotton pollen were also recovered from irrigated features along Beaver Creek in central Arizona (P. Fish and Fish 1984). Finds of corn pollen in contour terrace, rock pile fields, and charred cotton seeds in associated roasting pits suggested that both crops were grown in dry-farmed fields near Tucson (S. Fish 1987; S. Fish et al. 1985). Finally, investigation of gravel mulched grids near Medanales in the Chama Valley found that both corn and cotton were grown in those features (Clary 1987; Cummings 1988; Dean 1991a).

### *Gravel Mulching and Crops*

Experiments indicate that both corn and cotton benefit from gravel mulching. Late killing frosts in spring are a problem in the Chama Valley (Cordell et al. 1984); early fall frosts often damage maturing crops (Bugé 1984). When plants that require a relatively long growing season, like corn and cotton, are planted early, late frosts can cause severe damage and require replanting. This increases the probability that crops will not mature before growth is halted by the first fall killing frost. Not only are gravel mulches effective in lessening the effects of late killing frosts, they actually stimulate early growth and accelerate crop maturation.

By increasing upper soil temperature and reducing heat loss at night, gravel mulches help protect seedlings from frost. This probably allowed prehistoric farmers to plant earlier with more confidence than they would if severe crop loss from late frosts was an ever-present concern. Increased and stabilized soil temperature during the early growing season stimulates corn germination and early growth. Planting in a gravel mulch hastens germination by two to three days, and tasseling can occur four to seven days earlier in comparison to crops grown on bare soil (Fairbourn 1973:927). Mulching also conserved soil moisture in experimental plots, making more water available for plant use; corn on bare soil showed severe water stress on hot summer days, while corn in gravel-mulched plots did not experience severe wilting or leaf rolling (Fairbourn 1973:927). Water conservation was needed in fields on higher topographic features because those areas lack reliable water supplies.

Though directly comparable studies have not been conducted on cotton, experiments using black plastic as a mulch suggest that similar results can be expected. In experimental plots, mulching stabilized upper soil temperatures and had a dramatic effect on early growth and fruiting (Ashley et al. 1974:23). Seedlings emerged seven to ten days earlier than on unmulched control plots, and by early June were 20 to 25 cm higher than controls (Bennett et al. 1966:58). Earlier growth and fruiting was attributed to higher minimum temperatures and moisture content near the soil surface (Bennett et al. 1966:58).

Cotton maturation is also hastened when no irrigation is used, though yield is significantly decreased (Bennett et al. 1966; Stibbe and Hadas 1977). While irrigation is needed to obtain maximum yields, cotton can be dry farmed. Experiments show that plants subjected to water stress during development are hardier and less sensitive to later droughts (Cutler and Rains 1977). By growing cotton in gravel mulched grids without benefit of irrigation, both early growth and maturation were hastened; water stress probably also helped speed maturation and produced plants that were less sensitive to drought.

Though gravel mulching was costly in time and labor input, it was an effective means of buffering against environmental adversity. As cold air drainage was a serious problem in the valley bottom, a variety of topographic zones were farmed, including high mesa tops and river terraces. Studies at Hopi showed that, because of cold-air drainage, growing seasons in narrow canyons were 10 to 30 days shorter than on nearby mesa tops (E. Adams 1979:293). By planting on higher features like second terraces and mesas, the Chama Valley Anasazi may have been able to extend the growing season for part of their crop. Still, it is likely that the growing season was barely long enough for crops to ripen, and it was necessary to risk an early planting to ensure crop maturity. Gravel mulches took some of the risk out of this. With their ability to protect seedlings from frost as well as stimulate early growth, gravel mulches helped extend the growing season at both ends. Crops could be planted earlier with less risk of loss from late frosts; they could also be harvested earlier, protecting them from early frosts. By spreading their fields across diverse topographic zones and manipulating soil temperature and moisture retaining capability in many of those fields, prehistoric farmers in the Chama Valley were able to support themselves for at least 300 years. The cost of gravel mulching and need for continual expansion probably led to abandonment of this farming system. But while it was in use, gravel mulching made farming possible in areas that today can only be used for livestock grazing.

## RECOMMENDATIONS

Three sites were examined during this project. All three contain lithic artifact components; those on LA 75287 and LA 75288 date to the middle Archaic and early Developmental periods, respectively. No date could be assigned to the remains at LA 75286. Both LA 75287 and LA 75288 also contain Classic period farming features.

Testing showed that cultural remains at LA 75286 are mostly restricted to the surface. While two pieces of debitage were found in the upper 10 to 13 cm of one test pit, we concluded that they reached those depths through natural rather than cultural processes. No features or buried cultural deposits were found within proposed project limits at LA 75286, and we feel that no further archaeological investigations are needed within proposed project limits.

Both LA 75287 and LA 75288 are mostly outside proposed project limits, with only about 1 percent of each occurring within that zone. It is our opinion that the parts of LA 75287 and LA 75288 within proposed project limits are unlikely to yield information beyond that recovered during testing. Our studies show, however, that even though agricultural sites in the Chama Valley may appear to be superficial, information on prehistoric subsistence can often be recovered, and there is a good possibility that more than one component is present. Thus, it is likely that the parts of these sites outside proposed project limits have the potential to yield more information. While we feel that no further archaeological studies are needed within proposed project limits, we suggest that existing right-of-way fences be left in place at LA 75287 and LA 75288 during construction to prevent inadvertent traffic outside proposed project limits.

## REFERENCES CITED


Acklen, John C., et al.

1983 *Supplemental Inventory of 53 Prehistoric Archeological Sites for the Ute Mountain Land Exchange*. PNM Archeological Report No. 4 [Draft]. Public Service Company of New Mexico, Albuquerque.

Adams, E. Charles

1979 Cold Air Drainage and Length of Growing Season in the Hopi Mesa Area. *The Kiva* 44:285-296.

Adams, John E.

1965 Effect of Mulches on Soil Temperature and Grain Sorghum Development. *Agronomy Journal* 57:471-474.

1966 Influence of Mulches on Runoff, Erosion, and Soil Moisture Depletion. *Soil Science Society of America Proceedings* 30:110-114.

Allmaras, R. R., W. C. Burrows, and W. E. Larson

1964 Early Growth of Corn as Affected by Soil Temperature. *Soil Science Society of America Proceedings* 28:271-275.

Anschuetz, Kurt F., Timothy D. Maxwell, and John A. Ware

1985 *Testing Report and Research Design for the Medanales North Project, Rio Arriba County, New Mexico*. Laboratory of Anthropology Notes No. 347. Museum of New Mexico, Santa Fe.

Armbrust, D. V., W. S. Chepil, and F. H. Siddoway

1964 Effects of Ridges on Erosion of Soil by Wind. *Soil Science Society of America Proceedings* 28:557-560.

Ashley, D. A., J. E. Elsner, O. L. Brooks, and C. E. Perry

1974 Factors Affecting Early Growth of Cotton and Subsequent Effects on Plant Growth. *Agronomy Journal* 66:20-23.

Bandelier, Adolph F.

1892 *Final Report of Investigations Among the Indians of the Southwestern United States, Carried on Mainly in the Years From 1880 to 1885, Part II*. Papers of the Archaeological Institute of America 4. Cambridge University Press, Cambridge.

Beal, John D.

1987 *Foundations of the Rio Grande Classic: The Lower Chama River, A.D. 1300-1500*. Southwest Archaeological Consultants, Inc., Santa Fe.

Bennett, O. L., D. A. Ashley, and B. D. Doss
1966 Cotton Responses to Black Plastic Mulch and Irrigation. *Agronomy Journal* 58:57-60.

Berlin, G. Lennis, J. Richard Ambler, Richard H. Hevley, and Gerald G. Schaber
1977 Identification of a Sinagua Agricultural Field by Aerial Thermography, Soil Chemistry, Pollen Plant Analysis, and Archaeology. *American Antiquity* 42:588-600.

Bertram, Jack B., Jeanne A. Schutt, Steven Kuhn, Amy C. Earls, W. Nicholas Trierweiler, Christopher Lintz, John C. Acklen, Charles M. Carrillo, and Janette Elyea
1989 *Report of Surface Collection and Testing at 18 Sites Near Abiquiu Reservoir, Northern New Mexico.* Mariah Associates, Inc., Albuquerque.

Breternitz, David A.
1966 *An Appraisal of Tree-Ring Dated Pottery in the Southwest.* Anthropological Papers of the University of Arizona No. 10, Tucson.

Bugé, David E.
1984 Prehistoric Subsistence Strategies in the Ojo Caliente Valley, New Mexico. In *Prehistoric Agricultural Strategies in the Southwest*, edited by S. K. Fish and P. R. Fish, pp. 27-34. Arizona State University Anthropological Research Papers No. 33, Tempe.

n.d. *Preliminary Report: 1978 Excavations at NM-01-1407, Ojo Caliente, New Mexico.* Unpublished Ms. on file at the Laboratory of Anthropology, Museum of New Mexico, Santa Fe.

Burrows, W. C., and W. E. Larson
1962 Effect of Amount of Mulch on Soil Temperature and Early Growth of Corn. *Agronomy Journal* 54:19-23.

Chapman, Richard C.
1977 Analysis of the Lithic Assemblage. In *Settlement and Subsistence Along the Lower Chaco River: The CGP Survey*, edited by C. A. Reher, pp. 371-452. University of New Mexico Press, Albuquerque.

Chapman, Richard C., and Jeanne A. Schutt
1977 Methodology of Lithic Analysis. In *Archeological Investigations in Cochiti Reservoir, New Mexico* (Vol. 2), edited by R. C. Chapman and J. V. Biella, pp. 83-96. Office of Contract Archeology, University of New Mexico, Albuquerque.

Chepil, W. S., N. P. Woodruff, F. H. Siddoway, D. W. Fryrear, and D. V. Armbrust
1963 Vegetative and Nonvegetative Materials to Control Wind and Water Erosion. *Soil Science Society of America Proceedings* 27:86-89.

Clary, Karen H.
1987 *Pollen Evidence for the Agricultural Utilization of Late Classic Period (A.D. 1350-1500) Puebloan Gravel Mulch Terrace Gardens, the Rio Chama in the Vicinity of Medanales, New Mexico.* Castetter Laboratory for Ethnobotanical Studies Technical Series, Report

No. 198. University of New Mexico, Albuquerque.

Cooke, Ronald V., and Richard W. Reeves
1976 *Arroyos and Environmental Change in the American Southwest.* Clarendon Press, Oxford.

Cordell, Linda S.
1979 *Cultural Resources Overview: Middle Rio Grande Valley, New Mexico.* Government Printing Office, Washington, D.C.

Cordell, Linda S., Amy C. Earls, and Martha K. Binford
1984 Subsistence Systems in the Mountainous Settings of the Rio Grande Valley. In *Prehistoric Agricultural Strategies in the Southwest*, edited by S. K. Fish and P. R. Fish, pp. 233-241. Arizona State University Anthropological Research Papers No. 33, Tempe.

Corey, A. T., and W. D. Kemper
1968 *Conservation of Soil Water by Gravel Mulches.* Hydrology Papers No. 30. Colorado State University, Fort Collins.

Cummings, Linda S.
1988 *Phytolith Analysis at the Medanales Gardens, New Mexico.* PaleoResearch Laboratories, Denver. Ms. on file at the Office of Archaeological Studies, Museum of New Mexico, Santa Fe.

Cutler, J. M., and D. W. Rains
1977 Effects of Irrigation History on Responses of Cotton to Subsequent Water Stress. *Crop Science* 17:329-334.

Dart, Allen
1983 Agricultural Features. In *Hohokam Archaeology Along the Salt-Gila Aqueduct, Central Arizona Project* (Vol. 3, Part 4), edited by L. S. Teague and P. L. Crown, pp. 345-574. Arizona State Museum Archaeological Series No. 150, Tucson.

Dean, Glenna
1991a *Pollen Analysis of Archeological Samples from Basketmaker and Anasazi Agricultural Features at LA 75287 and LA 75288, Abiquiu West Project, Rio Chama Valley, New Mexico.* Castetter Laboratory for Ethnobotanical Studies, Technical Series Report Number 302. University of New Mexico, Albuquerque.

1991b *Archeobotanical Analysis of Pollen and Phytolith Samples From Prehistoric Structural and Agricultural Features at LA 2742, LA 70577, LA 71189, and LA 71190, Pot Creek Project, Taos County, New Mexico.* Castetter Laboratory for Ethnobotanical Studies, Technical Report Number 303. University of New Mexico Department of Biology, Albuquerque.

Dethier, David P., and Karen A. Dempsey
1984 Erosional History and Soil development on Quaternary Surfaces, Northwest Española

Basin, New Mexico. In *Rio Grande Rift, New Mexico*, edited by W. S. Baldridge, P. W. Dickerson, and J. Zidek, pp. 227-233. 35th Annual Field Conference, New Mexico Geological Society, Albuquerque.

Dethier, David P., and Blake A. Martin
1984 Geology and Structure Along Part of the Northeast Jemez Mountains, New Mexico. In *Rio Grande Rift, New Mexico*, edited by W. S. Baldridge, P. W. Dickerson, and J. Zidek, pp. 145-150. 35th Annual Field Conference, New Mexico Geological Society, Albuquerque.

Earls, Amy C., Christopher Lintz, and W. Nicholas Trierweiler
1989a *Analysis of Three Cobble Ring Sites at Abiquiu Reservoir, Rio Arriba County, New Mexico*. Mariah Associates, Inc., Albuquerque.

Earls, Amy C., W. Nicholas Trierweiler, and Christopher R. Lintz
1989b Artifact and Chronological Analysis. In *Analysis of Three Cobble Ring Sites at Abiquiu Reservoir, Rio Arriba County, New Mexico*, by A. C. Earls, C. Lintz, and W. N. Trierweiler, pp. 144-210. Mariah Associates, Inc., Albuquerque.

Epstein, E., W. J. Grant, and R. A. Struchtemeyer
1966 Effects of Stones on Runoff, Erosion, and Soil Moisture. *Soil Science Society of America Proceedings* 30:638-640.

Evans, James O., and James H. Patric
1983 Harvest Trees, Reap Water. *Journal of Soil and Water Conservation* 38:390-392.

Fairbourn, Merle L.
1973 Effect of Gravel Mulch on Crop Yields. *Agronomy Journal* 65:925-928.

Fairbourn, Merle L., and H. R. Gardner
1975 Water-Repellent Soil Clods and Pellets as Mulch. *Agronomy Journal* 67:377-380.

Fenneman, Nevin M.
1931 *Physiography of the Western United States*. McGraw-Hill Book Co., Inc., New York.

Findley, James S., Arthur H. Harris, Don E. Wilson, and Clyde Jones
1975 *Mammals of New Mexico*. University of New Mexico Press, Albuquerque.

Finkel, Herman J.
1986 *Semiarid Soil and Water Conservation*. CRC Press, Inc., Boca Raton.

Fish, Paul R., and Suzanne K. Fish
1984 Agricultural Maximazation in the Sacred Mountain Basin, Central Arizona. In *Prehistoric Agricultural Strategies in the Southwest*, edited by S. K. Fish and P. R. Fish, pp. 147-159. Arizona State University Anthropological Research Papers No. 33, Tempe.

Fish, Suzanne K.
1982 Pollen Study. In *Bandelier: Excavations in the Flood Pool of Cochiti Lake, New Mexico*, edited by L. Hubbell and D. Traylor, pp. 432-439. National Park Service, Southwest Cultural Resources Center, Santa Fe.

1987 An Evaluation of Subsistence and Specialization at the Marana Site. In *Studies in the Prehistoric Community of Marana*, edited by G. Rice, pp. 235-248. Arizona State University Anthropological Field Studies 72, Tempe.

Fish, Suzanne K., Paul R. Fish, and Christian Downum
1984 Hohokam Terraces and Agricultural Production in the Tucson Basin. In *Prehistoric Agricultural Strategies in the Southwest*, edited by S. K. Fish and P. R. Fish, pp. 55-71. Arizona State University Anthropological Research Papers No. 33, Tempe.

Fish, Suzanne K., Paul R. Fish, Charles Miksicek, and John Madsen
1985 Prehistoric Agave Cultivation in Southern Arizona. *Desert Plants* 7(2):107-112, 100.

Gabin, Vickie L., and Lee Lesperance
1977 *New Mexico Climatological Data -- Precipitation, Temperature, Evaporation, and Wind: Monthly and Annual Means, 1850-1975.* W. K. Summers, Socorro.

Glassow, Michael A.
1980 *Prehistoric Agricultural Development in the Northern Southwest: A Study in Changing Patterns of Land Use.* Ballena Press Anthropological Papers No. 16, Socorro.

Hanks, R. J., and N. P. Woodruff
1958 Influence of Wind on Water Vapor Transfer Through Soil, Gravel, and Stone Mulches. *Soil Science* 86:160-164.

Hausenbuiller, R. L.
1972 *Soil Science: Principles and Practice.* Wm. C. Brown Company Publishers, Dubuque.

Hibben, Frank C.
1937 *Excavation at the Riana Ruin and Chama Valley Survey.* University of New Mexico Bulletin, Anthropological Series 2(1), Albuquerque.

Irwin-Williams, Cynthia
1973 *The Oshara Tradition: Origins of Anasazi Culture.* Eastern New Mexico University Contributions in Anthropology 5(1), Portales.

Jeançon, Jean A.
1923 *Excavations in the Chama Valley, New Mexico.* Bureau of American Ethnography Bulletin 81, Washington, D.C.

Kelley, Robert L.
1988 The Three Sides of a Biface. *American Antiquity* 53:717-734.

Kelley, Vincent C.
1979 Geomorphology of the Española Basin. In *New Mexico Geological Society Guidebook, 30th Field Conference, Santa Fe Country*, edited by R. V. Ingersoll, L. A Woodward, and H. L. James, pp. 281-288. New Mexico Geological Society, Albuquerque.

Kues, Barry S., and Spencer G. Lucas
1979 Summary of the Paleontology of the Santa Fe Group (Mio-Pliocene), North-Central New Mexico. In *Guidebook of Santa Fe Country*, edited by R. V. Ingersoll, L. A. Woodward, and H. L. James, pp. 237-241. 30th Field Conference, New Mexico Geological Society, Albuquerque.

Lamb, J., Jr., and J. E. Chapman
1943 Effect of Surface stones on Erosion, Evaporation, Soil Temperature, and Soil Moisture. *Journal of the American Society of Agronomy* 35:567-578.

Lang, Richard W.
1980 *Archaeological Investigations at a Pueblo Agricultural Site, and Archaic and Puebloan Encampments on the Rio Ojo Caliente, Rio Arriba County, New Mexico.* School of American Research, Contract Archaeology Program Report No. 007, Santa Fe.

1982 Transformation in White Ware Pottery of the Northern Rio Grande. In *Southwestern Ceramics: A Comparative Review*, edited by A. H. Schroeder, pp. 153-200. The Arizona Archaeologist 15. Arizona Archaeological Society, Phoenix.

1990 *The Archaeology of the Poshu'ouinge Interpretive Trail Right-of-Way: Data Recovery and Comparative Lithic Analysis.* Southwestern Archaeological Consultants Research Series 236, Santa Fe.

Linford, Laurance D.
1979 *Archaeological Investigations in West-Central Arizona: The Cyprus-Bagdad Project.* Arizona State Museum Archaeological Series No. 136, Tucson.

Luebben, Ralph A.
1953 Leaf Water Site. In *Salvage Archaeology in the Chama Valley*, assembled by F. Wendorf, pp. 9-33. Monographs of the School of American Research 17, Santa Fe.

Maker, H. J., J. J. Folks, J. U. Anderson, and V. G. Link
1973 *Soil Associations and Land Classification for Irrigation, Rio Arriba County.* New Mexico State University Agricultural Experiment Station Research Report 254, Las Cruces.

Mannering, J. V., and L. D. Meyer
1963 The Effects of Various Rates of Surface Mulch on Infiltration and Erosion. *Soil Science Society of America Proceedings* 27:84-86.

Marshall, Sandra L.
1989 *A Cultural Resource Survey of U.S. 84 West of Abiquiu and Borrow Pit A, F-052-1(28).* New Mexico State Highway and Transportation Department Environmental

Section/Project Development Bureau Report No. 89-120, Santa Fe.

Martin, Paul S., and William Byers
1965 Pollen and Archaeology at Wetherill Mesa. In *Contributions of the Wetherill Mesa Archaeological Project*, assembled by D. Osbourne, pp. 122-135. Memoirs of the Society for American Archaeology 19, Salt Lake City.

Maxwell, Timothy D., and Kurt F. Anschuetz
1987 *Variability in Garden Plot Locations and Structure in the Lower Rio Chama Valley, New Mexico*. Paper presented at the 52nd annual meeting, Society for American Archaeology, Toronto.

Mera, H. P.
1935 *Ceramic Clues to the Prehistory of North Central New Mexico*. Laboratory of Anthropology Technical Series, Bulletin No. 8. Museum of New Mexico, Santa Fe.

Moore, James L.
1980 Archaic Settlement and Subsistence. in *Human Adaptations in a Marginal Environment: The UII Mitigation Project*, edited by J. L. Moore and J. C. Winter, pp. 358-381. Office of Contract Archeology, University of New Mexico, Albuquerque.

1986 Prehistoric Settlement and Subsistence in Lower Salyers and Ancho Canyons, Vermejo Park Ranch, New Mexico. *Papers of the Philmont Conference on the Archeology of Northeastern New Mexico*, edited by C. J. Condie, pp. 125-135. New Mexico Archeological Council Proceedings 6(1), Albuquerque.

n.d. *Testing at Nine Archaeological Sites Along State Road 502 Near San Ildefonso, Santa Fe County, New Mexico*. Office of Archaeological Studies, Museum of New Mexico, Santa Fe [DRAFT].

Ortiz, Alfonso
1979 San Juan Pueblo. In *Handbook of North American Indians* (Volume 9), edited by A. Ortiz, pp. 278-295. Smithsonian Institution, Washington, D.C.

Peckham, Stewart
1958 Salvage Archaeology in New Mexico, 1957-58: A Partial Report. *El Palacio* 65:161-168.

1981 The Palisade Ruin (LA 3505): A Coalition Period Pueblo Near Abiquiú Dam, New Mexico. In *Collected Papers in Honor of Erik Kellerman Reed*, edited by A. H. Schroeder, pp. 113-147. Papers of the Archaeological Society of New Mexico No. 6, Albuquerque.

Renaud, Etienne B.
1942a *Reconnaissance Work in the Rio Grande Valley, Colorado and New Mexico*. University of Denver Department of Anthropology Archaeological Series No. 3, Denver.

1942b *Archaeology of the Upper Rio Grande Basin in Southern Colorado and Northern New Mexico.* University of Denver Department of Anthropology Archaeological Series No. 6, Denver.

1942c The Rio Grande Points. *Southwestern Lore* 8:33-36.

Rice, Glen, David Wilcox, Kevin Rafferty, and James Schoenwetter
1979 *An Archaeological Test of Sites in the Gila Butte-Santan Region, South-Central Arizona.* Arizona State University Anthropological Research Papers No. 18, Tempe.

Schaafsma, Curtis F.
1976 *Archaeological Survey of Maximum Pool and Navajo Excavations at Abiquiú Reservoir, Rio Arriba County, New Mexico.* School of American Research Contract Archaeology Program, Santa Fe.

1978 Archaeological Studies in the Abiquiú Reservoir District. *Discovery 1978*:41-69. School of American Research, Santa Fe.

Schroeder, Albert H.
1979 Pueblos Abandoned in Historic Times. In *Handbook of North American Indians* (Volume 9), edited by A. Ortiz, pp. 236-254. Smithsonian Institution, Washington, D.C.

Schroeder, Albert H., and Dan S. Matson
1965 *A Colony on the Move: Gaspar Castaño de Sosa's Journal, 1590-1591.* School of American Research Press, Santa Fe.

Schutt, Jeanne A., and Bradley J. Vierra
1980 Lithic Analysis Methodology. In *Human Adaptations in a Marginal Environment: The UII Mitigation Project*, edited by J. L. Moore and J. C. Winter, pp. 45-65. Office of Contract Archeology, University of New Mexico, Albuquerque.

Schwab, Glenn O., Richard K. Frevert, Talcott W. Edminster, and Kenneth K. Barnes
1981 *Soil and Water Conservation Engineering* (3rd edition). John Wiley and Sons, New York.

Snow, David H.
1983 *The Llano Piedra Lumbre Site: A Multicomponent Lithic Scatter in Rio Arriba County, New Mexico.* Laboratory of Anthropology Notes No. 111c. Museum of New Mexico, Santa Fe.

Sollberger, J. B.
1986 Lithic Fracture Analysis: A Better Way. *Lithic Technology* 15:101-105.

Spielman, Katherine A.
1983 Late Prehistoric Exchange Between the Southwest and Southern Plains. *Plains Anthropologist* 28:257-272.

Stibbe, E., and A. Hadas
1977 Response of Dryland Cotton Plant Growth, Soil-Water Uptake, and Lint Yield to Two Extreme Types of Tillage. *Agronomy Journal* 69:447-451.

Stuart, David E., and Rory P. Gauthier
1981 *Prehistoric New Mexico: Background for Survey*. Historic Preservation Division, Santa Fe.

Tadmor, N. H., and L. Shanan
1969 Runoff Inducement in an Arid Region by Removal of Vegetation. *Soil Science Society of America Proceedings* 33:790-794.

Thoms, Alston
1973 Review of Northeastern New Mexico Archeology. *Awanyu* 4(1):8-36).

Tibke, Gary
1988 Basic Principles of Wind Erosion Control. *Agriculture, Ecosystems, and Environment* 22/23:103-122.

Tuan, Yi-Fu, Cyril E. Everard, Jerold G. Widdison, and Iven Bennett
1973 *The Climate of New Mexico* (revised edition). New Mexico State Planning Office, Santa Fe.

Van Wijk, W. P., W. E. Larson, and W. C. Burrows
1959 Soil Temperature and the Early Growth of Corn From Mulched and Unmulched Soil. *Soil Science of America Proceedings* 23:428-434.

Vierra, Bradley J.
1980 A Preliminary Ethnographic Model of the Southwestern Archaic Settlement System. In *Human Adaptations in a Marginal Environment: The UII Mitigation Project*, edited by J. L. Moore and J. C. Winter, pp. 351-357. Office of Contract Archeology, University of New Mexico, Albuquerque.

Wang, J. Y.
1972 *Agricultural Meteorology* (3rd edition, revised). Milieu Information Service, San Jose.

Warren, A. Helene
1974 The Ancient Mineral Industries of Cerro Pedernal, Rio Arriba County, New Mexico. In *New Mexico Geological Society Guidebook, Twenty-Fifth Field Conference, Central-Northern New Mexico*, edited by C. T. Siemers, L. A. Woodward, and J. F. Callender, pp. 87-93. New Mexico Geological Society, Albuquerque.

Wendorf, Fred
1953 Excavations at Te'ewi. In *Salvage Archaeology in the Chama Valley, New Mexico*, assembled by F. Wendorf, pp. 34-93. Monographs of the School of American Research 17, Santa Fe.

1954 A Reconstruction of Northern Rio Grande Prehistory. *American Anthropologist* 56:200-227.

Wendorf, Fred, and Erik K. Reed
1955 An Alternative Reconstruction of Northern Rio Grande Prehistory. *El Palacio* 62:131-173.

Winter, Joseph C.
1978 Anasazi Agriculture at Hovenweep, 1: Field Systems. In *Limited Activity and Occupation Sites*, edited by A. E. Ward, pp. 83-97. Center for Anthropological Studies, Contributions to Anthropological Studies No. 1, Albuquerque.

1983 A Comparative Study of Prehistoric, Historic, and Contemporary Agriculture Along the Lower Chaco: I--The Anasazi. In *Economy and Interaction Along the Lower Chaco River: The Navajo Mine Archeological Program, Mining Area III, San Juan County, New Mexico*, edited by P. Hogan and J. C. Winter, pp. 421-444. Office of Contract Archeology and the Maxwell Museum of Anthropology, University of New Mexico, Albuquerque.