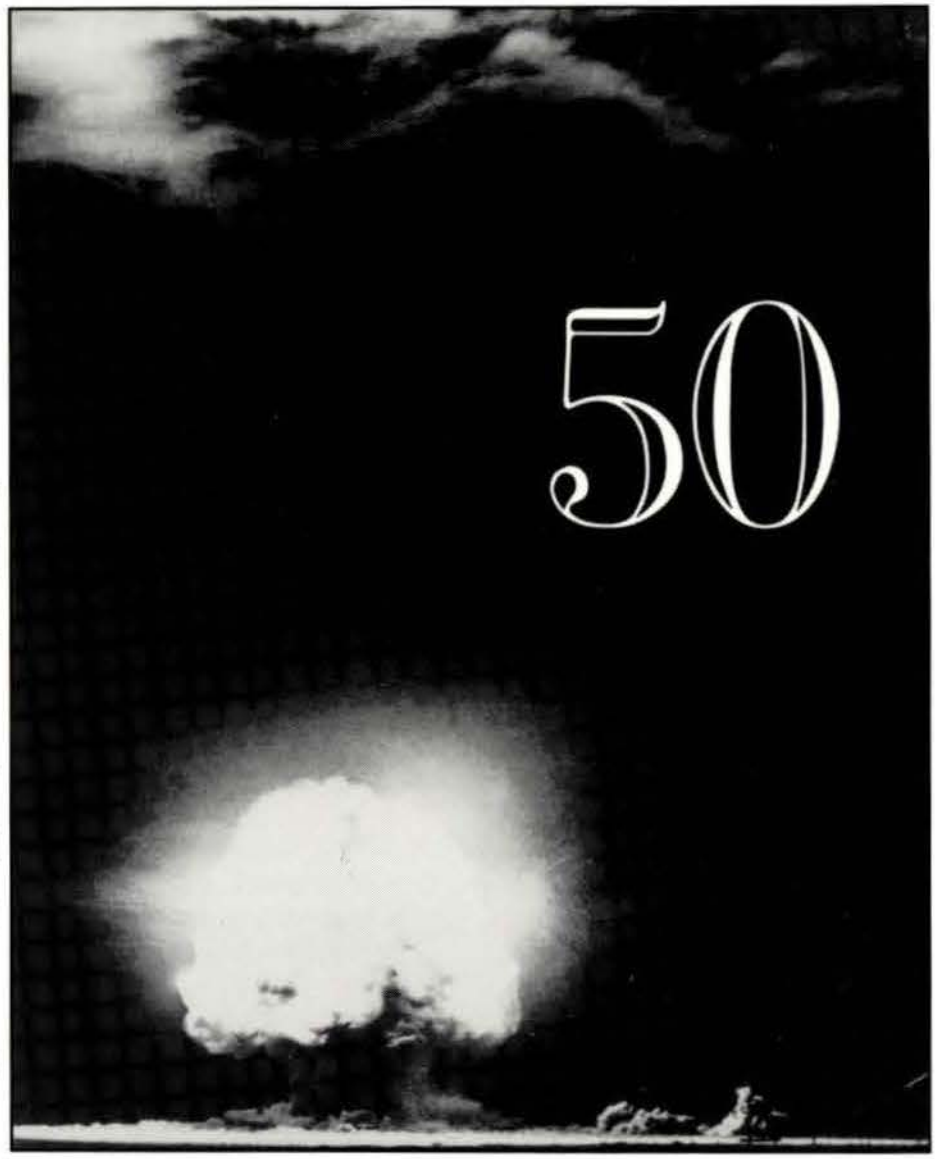
TRINITY AT



1945-1995

Written by
Morgan Rieder and
Michael Lawson

Edited by
Meliha S. Duran and
Beth Morgan

1995

WHITE SANDS MISSILE RANGE

HUMAN SYSTEMS RESEARCH, INC.

TRINITY AT FIFTY

THE ARCHAEOLOGY OF TRINITY SITE NATIONAL HISTORIC LANDMARK, WHITE SANDS MISSILE RANGE, SOCORRO COUNTY, NEW MEXICO

Morgan Rieder and Michael Lawson, Authors

Meliha S. Duran and Beth Morgan, Technical Editors

Contract No. DAAD07-94-D-0104
Delivery Order No. 22

Prepared for
White Sands Missile Range, New Mexico

Submitted by
Human Systems Research, Inc.
Tularosa, New Mexico

HSR Report No. 9439

WSMR Archaeological Report No. 95-8

1995

Cover photograph: Detonation of Trinity (WSMR photograph file).

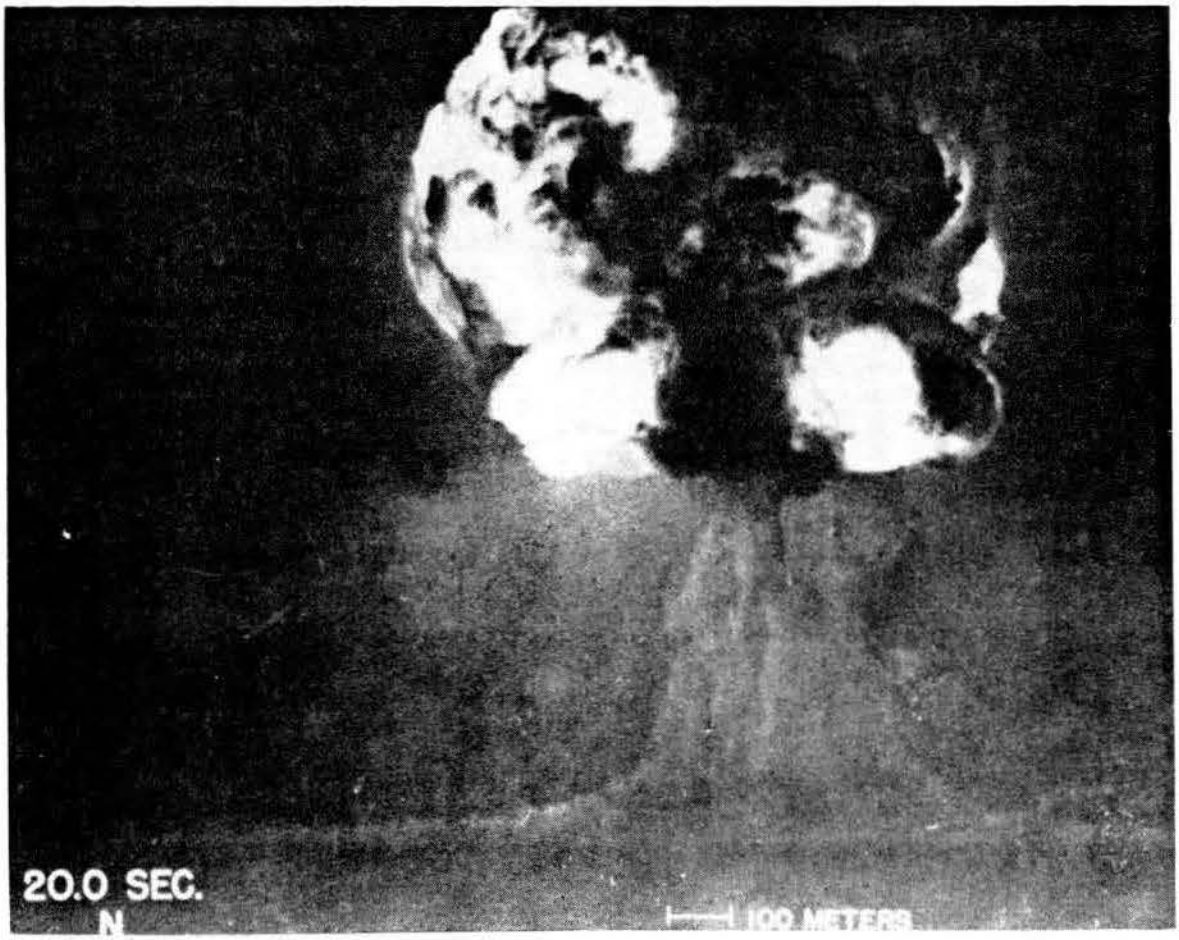
CONTENTS

INTRODUCTION

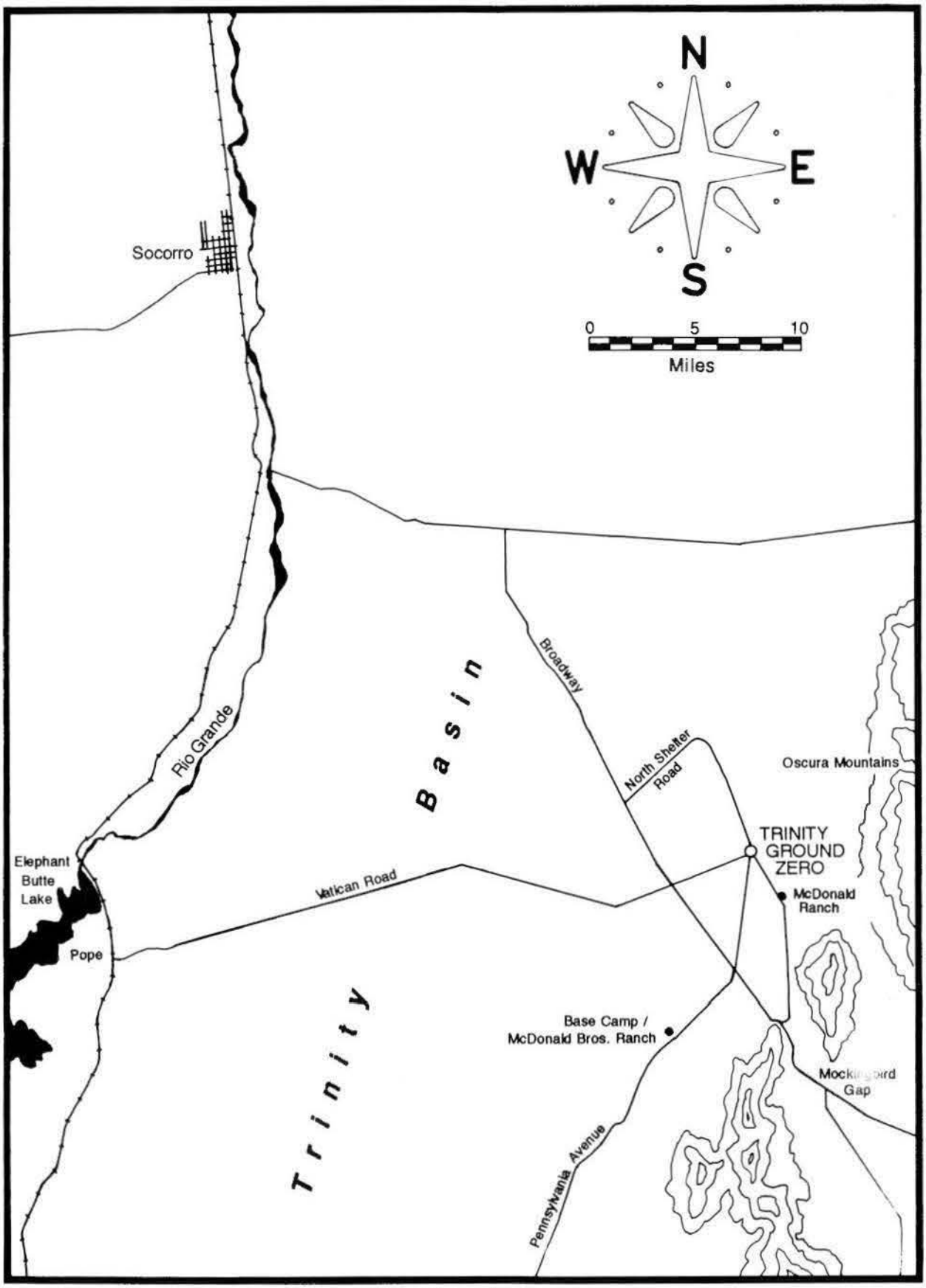
"The effects [of the Trinity Test] could well be called unprecedented, magnificent, beautiful, stupendous, and terrifying. No manufactured phenomenon of such tremendous power had ever occurred before." So General Farrell, deputy to General Groves, later wrote of the testing of the first atomic bomb at the Alamogordo Bombing Range on July 16, 1945.

The nuclear test represented the culmination of an unprecedented collaboration between scientists and the military, forged by the nation's defense needs arising from World War II. Development was spurred by intelligence that the Nazis were developing nuclear weapons. The war in Europe ended before the Trinity Test, but war in the Pacific arena continued. Soon after the successful nuclear test, the U.S. Army used atomic weapons against targets in Japan, contributing to an unconditional surrender by the Japanese and an end to world conflict.

Yet that event had a very humble beginning in an undeveloped, virtually abandoned, isolated ranching area in the Chihuahuan Desert, miles from the nearest town. This is the story of the archaeology of the Trinity



Detonation of nuclear device at Trinity (WSMR photograph file).



Map of Trinity Area.

Test—both what came before and what was required to test this most awesome device of the twentieth century.

The locus of the test is now designated as Trinity Site National Historic Landmark (LA 100,000). The site possesses several types of resources, including the facilities for the Trinity Test and prehistoric and historic sites potentially eligible to the National Register of Historic Places (NRHP). Recent archaeological surveys by Human Systems Research, Inc., have documented the remains of the infrastructure designed and built by Manhattan Project personnel to conduct and monitor the nuclear test at Trinity. Archaeologists also recorded premilitary historic ranching activities associated with the five family ranches operating here when the area was evacuated for military purposes in 1942.

The views, opinions, and findings contained in this report are those of the authors and editors and should not be construed as an official Department of Defense position, policy, or decision, unless so designated by other documentation.

ENVIRONMENTAL SETTING

The arid piece of desert now known as the Trinity Site fit the requirements of the Manhattan Project perfectly. While it is obvious that the personnel with the Manhattan Project were looking for an isolated piece of land for their test, it is more difficult to understand why nineteenth-century ranchers chose the barren Chihuahuan Desert, when they could have settled in lusher locations. It is even more difficult to imagine prehistoric peoples collecting or catching enough food here to sustain them year around.

The Chihuahuan Desert, which extends from around Socorro on the north into Mexico on the south, is characterized by extensive, closed alluvial basins and north-south trending, rocky mountain ranges. Trinity Site sits within the Jornada del Muerto (Journey of Death), just one of these extensive, closed alluvial basins. The Jornada is a long, broad to moderately narrow syncline, bounded by the uplifts of the San Andres and Oscura Mountains on the east and by a corresponding series of uplifts on the west that separate the basin from the valley of the Rio Grande (Darton 1928; Keyes 1905).

Trinity Site lies on the lower portion of the *bajada* or lower slope that extends west from the base of the Oscura, Little Burro, and Mockingbird Mountains into the Trinity Basin, as the northern portion of the Jornada is now called. Elevations within Trinity Site run from 4,690 to 5,280 ft.

From the foothills of the Oscura Mountains, the Trinity Basin opens to the west. Across the Trinity Basin is the uplift of the Little San Pascual Mountains, while to the northwest are the volcanic remnants of Cerro de la Campaña and Las Campanillas. To the north the land steadily rises into Chupadera Mesa. To the south are two passes through the mountains: Oscura Gap, between the Oscuras and the Little Burros, and Mockingbird Gap, between the Little Burros and the Mockingbirds. To the southwest, Trinity Basin extends to where the Jornada narrows between the Fra Cristobal range and the San Andres Mountains. The land rises slightly here to separate the Trinity Basin from the main part of the Jornada del Muerto.

The Environment Today

The climate is arid, with annual precipitation averaging only 8 to 9 in. (Houghton 1976). The greater part of this precipitation, which falls between July and September, is delivered by thunderstorms that drop their moisture very rapidly and locally. Seasonal variation in temperature tends to be extreme: the mean maximum in July is 93 degrees F, while the mean minimum in January is 21 degrees F. The Trinity Basin has a frost-free season of 245 days and receives sunlight for 80 percent of daylight hours (Taft and Hoidale 1969).

As if the barren, rocky terrain and the intense heat of summer were not daunting enough, water resources are very limited. Drainages in the basin only carry water after a storm. The drainages flow west from the mountains and south from Chupadera Mesa into the playa that, during the Pleistocene, was Lake Trinity (Neal et al. 1983). The playas here still hold water, albeit briefly. As in much of the Jornada del Muerto, groundwater here is readily available,

as evidenced by several wells drilled by ranchers, but the water contains gypsum and calcite.

Soils for the most part are sandy loams and loamy sands. The intense heat of the nuclear blast at Trinity in 1945 created trinitite by fusing the surface sands into a glassy substance. The ground surface becomes more gravelly where slope and precipitation have eroded much of the soil.

These soils support grassland and desertscrub plants, depending on elevation. The floor of the Trinity Basin preserves relic stands of the grama range that once covered this area. These grasses attracted the nineteenth-century ranchers to the Trinity Basin. Grama (*Bouteloua* sp.) is still present, but dropseed (*Muhlenbergia* sp.), tobosa (*Hilaria mutica*), and other grasses now predominate.

Invader plants, such as tamarisk or salt cedar (*Tamarix chinensis*), can be found in and around earthen tanks at historic ranching sites, and Russian thistle (*Salsola kali*) appears in recently disturbed areas.

Past Environment

How did the Trinity Basin look to prehistoric hunters? Gradual climatic changes have affected the vegetation during the past the 18,000 years. Plant and animal species living in the basin changed as the climate changed and undoubtedly affected the nature and distribution of settlements in the basin.

How do archaeologists know about the change in the environment? In particular, archaeologists and botanists study packrat middens; undisturbed soils and other areas also provide clues to past environments. Packrat nests and the fecal materials they contain provide the best clues, because the rats only collect plant materials from immediately around the nest, indicating the local plant communities. Often built in protected crevices and well-watered with urine, the nests can be preserved for thousands of years. Radiocarbon dating on the organic materials provides absolute dates for the nests and the microclimatic data they contain.

Beginning 10,000 years ago, the flanks of the mountain ranges around the Trinity Basin were probably covered by a juniper-oak woodland, which evolved into a desert grassland by the Middle Holocene (4,000–8,000 years ago). The Chihuahuan Desert, which is dominated by creosotebush (*Larrea tridentata*), was established by the Late Holocene (beginning 4,000 years ago). At higher elevations on the flanks of the Oscura and San Andres Mountains, the mixed conifer forest evolved to a juniper-oak woodland by 10,000 years ago. Beginning about 4,000 years ago, the woodland shifted to grassland.

Therefore, 10,000–12,000 years ago, during the moister conditions of the last major glaciation, the earliest hunters in the Southwest found grasslands for large mammals (now-extinct species of mammoth, bison, horse, sloth, and other animals). These species were concentrated on the basin floor.

A general drying trend has affected the Southwest for the last 10,000 years. As a result, grasslands became much more extensive within the foothills, making hunting there profitable, while gathering of the plants available in a number of environments in the basin and adjacent ranges provided additional food. By the Late Archaic, 2,000–4,000 years ago, conditions in the Chihuahuan Desert had undoubtedly forced many of the grazing species that lived on the grasslands to higher elevations.

CULTURAL HISTORY OF THE NORTHERN JORNADA DEL MUERTO

Except for occasional military facilities, the broad expanse of the Trinity Basin looks as it most likely looked during most of the last 10,000 years. However, archaeologists have found evidence of temporary camps and permanent residents in a variety of physical settings spanning the whole time period.

Paleoindian Hunters

The earliest evidence of human occupation in the area is the finely made lithic tools and projectile points of the Paleoindian period, dating from 11,500 to 7,500 years ago.

Traces of the Clovis technology practiced by hunters of 9500–9000 B.C. (Irwin-Williams and Haynes 1970) have been excavated at a few sites in the vicinity; isolated points may indicate a dart lost during hunting or dropped from the hide of a quarry. Archaeological evidence from the few excavated sites indicates that Clovis hunters lived in small family groups, leaving limited evidence of their camps near water sources on basin floors. Sites are rare, probably because of low population densities. Extensive erosion has also removed evidence of these early sites.

These earliest Paleoindian hunters subsisted on the extinct mammoth as well as smaller fauna. Pleistocene lakes such as Lake Trinity undoubtedly attracted herds of animals, which could be driven into the mud and then dispatched. Much of what is known about the Clovis culture comes from kill sites throughout the Southwest; however, some sites provide evidence of longer occupation, such as the Mockingbird Gap Site in the northern portion of the Jornada del Muerto. Robert Weber has spent 25 years working on this unique site. Located on a ridge along Chupadera Arroyo, it is an intermittently occupied camp that contains evidence of a wide range of Clovis-period domestic activities.

Gradual changes in the environment resulted in the extinction of the mammoth and other Pleistocene fauna, and Clovis points were replaced by Folsom points, also finely made points. The early Folsom people (dated to 9000–8000 B.C.) exploited a now-extinct form of bison (*Bison antiquus*), as well as other quarry. Their sites have been identified along the Rio Grande (Judge 1973), while isolated Folsom spear points have been found in the Trinity Basin. Upper levels of the deposits at the Mockinghird Gap site also contain Folsom artifacts (Weber and Agogino 1968). Occasionally later Paleoindian tools are also found in the area.

Archaic Hunter/Gatherers

In contrast to the Paleoindian period, archaeological remains beginning about 7,500 years ago indicate gathering as well as hunting within a variety of biotic communities found throughout the Chihuahuan Desert. As conditions became drier, Archaic peoples focused on exploiting probably all of the productive ecological zones in the area on a seasonal basis.

Technological differences between Paleoindian and Archaic archaeological remains are cited as evidence that Archaic groups did not

develop from the Paleoindian populations in response to climatic change. However, Paleoindian remains are so infrequent in the area that this is still conjecture.

Archaeologists Scotty MacNeish and Pat Beckett (1987) have defined the Chihuahua Archaic within the Chihuahuan Desert environment of south-central New Mexico and northern Chihuahua, Mexico. This culture is defined on the basis of Archaic artifacts (dart points, grinding stones) and hearths found in numerous rock shelters in southern New Mexico, including Fresnal Shelter near High Rolls in the Sacramento Mountains.

Archaeologists have removed dry materials from preserved layers in rock shelters and dated the radiocarbon in these materials. By matching the distinctive flaked-stone projectile points found in other sites to the dated materials from these rock shelters, it is possibe to characterize Archaic settlements of different time periods. The Chihuahua Archaic has four phases or time periods.

During the Gardner Springs phase (6000 to 4300 B.C.), early grinding tools have been found, although other materials are different from local Paleoindian artifacts. The tools suggest hunting and skin processing; plants were ground and cooked in pits.

During the Keystone phase (4300 to 2500 B.C.), larger family groups may have wintered in riverine environments in houses that consisted of brush domes built over shallow pits. During the warmer months, they spread out across the terrain to collect resources. The frequency of ground stone for plant processing increases during this phase.

The Fresnal phase (2500 to 900 B.C.) indicates greater change. Domesticated corn seeds from Mesoamerica have been found in Fresnal Shelter. Coinciding with the beginning of a period of less-arid desert conditions, collection of domestic corn may have been fortuitous, along with other food plants. The variety and number of dart points suggest continued dependence on large game, and the ground-stone industry continued to increase.

During the Hueco phase (900 B.C. to A.D. 200), new varieties of corn were introduced, in addition to beans and perhaps amaranth. Domesticated plants became more important. Sites were larger, probably with more pithouses; were occupied longer; and can be found throughout the Chihuahuan Desert, providing access to more plant resources.

The remains of the Chihuahua Archaic suggest a long, stable development from a hunting people to agriculturalists who learned the best environments within the Chihuahua Desert for planting their corn. The first plants may have been treated as one of a variety of locally available plants, each with its own season for gathering. Cultigens expanded the resources of the desert to provide a more reliable food source, allowing the local inhabitants to raise enough food to last the whole year.

Jornada Mogollon/Anasazi Agriculturalists

Drought conditions commenced about A.D. 100. Local cultures apparently responded with increased dependence on corn, beans, and other domesticated plants. Greater numbers of people gathered at locations of higher agricultural potential, forming pithouse villages in some areas by about A.D. 200. Ceramics were introduced about this same time.

To the south and east of the Jornada del Muerto, the occupation is

called the Jornada Mogollon (Lehmer 1948; Marshall 1973). During the Mesilla phase (A.D. 200–1100), people lived in pit houses excavated into the ground, with brush and probably mud covering the portion that extended above the surface. By A.D. 1000, during the late Mesilla phase, pithouse villages occurred in the Tularosa Basin in almost every location with agricultural potential. The ceramics made by this group were brown paste and undecorated. Mesilla-phase trade ceramics are mostly Mimbres White ware from the west.

By about A.D. 1100 or the El Paso phase, the architecture had developed to above-ground, rectangular adobe buildings. Red and black paint were used on the brown pots, and a wide variety of ceramics were traded from neighboring areas. The population was concentrated into larger villages. Major technological changes (possibly channeling runoff on the *bajada* slopes) may have been required to allow efficient control of agricultural production. From A.D. 1276 to the turn of the fourteenth century, drought occurred throughout the Southwest. By about A.D. 1350, all major village locations in the Tularosa Basin were abandoned, and only a few later sites have been found in the Trinity Basin. Sites along the Rio Grande were occupied into the fifteenth century, but these too were abandoned.

North and northwest of the Jornada del Muerto were two areas affiliated with the Anasazi culture. One area is Chupadera Mesa and the upper drainage of Chupadera Arroyo (Montgomery and Bowman 1989); the other is in the Socorro area of the Rio Grande (Marshall and Walt 1984). Both areas experienced a similar cultural development. The ceramic sequence began with both gray and brown wares; later, Elmendorf and Chupadero Black-on-white are the predominant decorated ceramics. By about A.D. 1300, glaze was added to the painted pots. Ceramics found within the Jornada del Muerto contain elements from these groups, as well as elements from the Jornada Mogollon, indicating that the area was a zone of cultural interface throughout this 1,200 year period.

Protohistoric Hunters

In the area occupied by the Jornada Mogollon, little is known archaeologically of the years between the abandonment of the large agricultural villages and the arrival of the Spanish. It is possible that the people remained but abandoned agriculture and reverted to hunting and gathering. More information is available for the Socorro area, where ancestral Piro sites are dated by glaze ware ceramics to A.D. 1300–1540 (Marshall and Walt 1984). Toward the end of this period, the population increased substantially, resulting in an architectural coalescence into plaza-type villages and an expansion into previously unoccupied riverine areas.

Following the initial Spanish colonization of New Mexico in 1598, these Piro pueblos were incorporated into the Franciscan mission system. Missions were established at Senecu, Pilabo (Socorro), Alamillo, and Sevilleta (Hodge et al. 1945; Marshall and Walt 1984). There were also at least six *estancias*, or Spanish ranches, in the area (Marshall and Walt 1984). During the Spanish period in New Mexico, El Camino Real de Tierro Adentro (the main route of travel between Mexico City and Santa Fe) passed through a portion of the Jornada del Muerto. By the 1630s the wagon train supplying the entire province of New Mexico was making the round trip to Mexico City

at regular three-year intervals.

The Spanish were temporarily forced out of New Mexico by a concerted Indian uprising, the Pueblo Revolt of 1680. Most of the Colonial Piro pueblos in the Socorro area, as well as the Tompiro and Tiwa pueblos in the Salinas region of the Chupadera Mesa, had already been abandoned during the 1670s because of Apache raids, drought, and other problems. Converted Piro who went south with the Spanish were resettled in the El Paso, Texas, area. However, throughout the seventeenth century, small groups of Piro avoided Spanish control. Some may have found refuge in the Jornada (Tainter and Levine 1987; Weber and Agogino 1968).

Apache Indians

By the middle of the seventeenth century, Mescalero and Chiricahua Apache are documented in the Rio Grande Valley and in the major mountain ranges to the east and west. These groups were seminomadic, with few permanent campsites; they made rounds through a wide territory to hunt and gather seasonally ripe resources (Basehart 1973). Adoption of the horse, originally reintroduced to the New World by the Spanish, allowed them to expand their range and to engage in raiding on sedentary agriculturalists. However, the particular destructiveness of their raids against the Colonial Piro pueblos (as with the Colonial Tompiro and Tiwa pueblos of Chupadera Mesa) seems to have been directed primarily against the Spanish presence (Wilson 1985).

The Spanish attempted to control the Apache and convert them to Catholicism, which the Apache resisted. Their relationship with the Apache population was a recurring cycle of mutual antagonism.

Although identifying Apache material culture in the archaeological record is difficult, some evidence for the Apache presence within the region has been recovered. The Oscura Mountains are sacred to the Mescalero Apache (Laumbach 1991), and an extensive Apache campsite has been reported in the northern part of this range (Peter Eidenbach, personal communication 1994). To the east, a ceramic scatter near Chupadera Mesa at the northern end of the Tularosa Basin is considered to be Apachean (Sale and Laumbach 1989). To the south, at least one rock art site in the San Andres Mountains is definitely Apachean (Sale 1991).

Within the San Andres Mountains is the Hembrillo Battlefield where, on April 6 and 7, 1880, Victorio and his Warm Springs Apache camped and engaged the U.S. Army. It is noteworthy that only 63 years separate this event of the bow-and-arrow era from the nuclear age.

Historic Ranchers and Developers

After the Spanish *reconquista* (reconquest) of New Mexico in 1692–1696, the Piro pueblos in the Socorro vicinity were not reoccupied. Throughout the eighteenth century, the Rio Grande Valley from Belen south to El Paso had no settlements. However, the Camino Real along the river and through the dry Jornada del Muerto continued to be used. A series of *parajes* (campsites) marked the route of the Camino Real. During this period, only occasional travellers and the Apache and possibly some Pueblo refugees used the Jornada del Muerto.

The Rio Grande Valley south of the Rio Puerco was resettled in the eighteenth and nineteenth centuries as the result of grants to groups of Hispanic farmers. The largest land grants in the area, the two Pedro Armendaris grants, were made in 1819–1820. They encompass much of

the river valley and flanking desert terrain. For the remainder of the Colonial period and much of the succeeding Mexican period, settlement from Socorro to El Paso was prevented by Apache (and increasingly by Navajo) raiders. The Armendaris Grant had to be abandoned by 1825, because of tensions with Indians (Tainter and Levine 1987). Such efforts at settlement had more lasting success later in the Mexican period. Meanwhile, traffic on the former Camino Real, now the Chihuahua Road, increased with the advent of trade with the United States via the Santa Fe Trail.

The outbreak of war in 1845 between Mexico and the United States brought the military into the Rio Grande Valley. This region, along with lands of the future states of Arizona, California, and Utah, was ceded to the United States with the Treaty of Guadalupe Hidalgo, which brought an end to hostilities in 1848. Following the U.S. occupation, population in the area continued to increase because of the U.S. military, initially at Fort Conrad (1851) and then Fort Craig (1854).

After the annexation of New Mexico, the pressure of the expanding nonnative population and a war of attrition waged by the U.S. military forced the Apache onto reservations. The Chiricahua were eventually deported to the eastern United States; the Mescalero still occupy their reservation in the Sacramento Mountains, established in 1872.

The 1870s saw mining booms in the Magdalena Mountains and the Black Range, and to the east at White Oaks in the Sacramento Muntains. Prospectors also sought mineral resources in the Oscura and northern San Andres Mountains. Despite much optimistic promotion, production was relatively marginal, partly because of the ores and partly because of the difficulty of ensuring an adequate supply of water (Jones 1904). Some copper and lead ores were successfully mined in the Mockingbird Gap and Hansonburg Districts (Laskey 1932). The latter district also included the Carthage coal fields to the east of San Antonio. Coal was initially mined at Carthage by the U.S. Army in the 1850s; later, the field was a major commercial producer.

Transportation and communication improved as a network of stage lines was established across New Mexico territory. A line from White Oaks to San Antonio and Socorro passed through the area, stopping at Carthage and Hansonburg and at Ozanne at the north end of the Oscura Mountains. By 1880 the Santa Fe Railroad had reached San Marcial and proceeded across the Jornada del Muerto along the route of the Chihuahua Road. The railroad had a major effect on the economy and the material culture of the area, providing both market outlets and a flood of mass-produced consumer goods.

Ranching

The first General Land Office surveys of the New Mexico territory, undertaken in the 1850s, included much of the Jornada del Muerto. The Surveyor General, under orders to survey potential arable land in the public domain, had been informed that artesian-well development would rapidly transform the Jornada del Muerto into cropland (Westphall 1965). Although this proved to be untrue, Euro-American developers persisted in regarding the basin as a potential resource to be exploited, and various projects were seriously considered for diverting water from the Rio Grande on a scale sufficient to irrigate the basin for crop

production (Clark 1987). As it turned out, the immediate future of the Jornada del Muerto basin was in ranching rather than farming.

By the early 1880s, most of the arable lands in New Mexico that could be effectively irrigated for crop production were already claimed (Clark 1987; Westphall 1965). There remained large areas of arid lands in the public domain that were unsuitable for farming but were good range for grazing livestock. This situation is illustrated in the Jornada del Muerto. On the west, the Rio Grande valley was settled with farming communities dependent upon a network of *acequias* (irrigation ditches). In contrast, large parts of the Jornada del Muerto were controlled by a few ranchers who filed homestead claims on the small number of available springs or hand-dug wells.

In the early 1870s, Texans with longhorn cattle began moving into New Mexico. Within the next decade, the cattle industry boomed, encouraged by eastern and foreign capital. In Socorro County, cattle increased from 9,000 to 70,000 head between 1882 and 1884 (Ritch 1885). Overstocking damaged the range but also eventually resulted in lower beef prices, which along with other factors ended the boom. Climate also contributed to the problems: a three-year drought beginning in 1890 killed off much of the grama on the already depleted ranges of the Tularosa and Jornada basins (Hutchinson 1956; Sonnichsen 1963). Barbed wire, introduced in the 1870s, was the only effective means of enclosing large areas of range, but fencing the public domain was illegal (Westphall 1965). On the other hand, improved drilling equipment and windmills meant that new water sources could be developed.

The Stock-Raising Homestead Act of 1916 allowed applicants to claim 640 acres of grazing land per entry, which provided a larger patented nucleus for a family's operations. Most of the land entries in the area were of this type, although the oldest incorporated either a piece of purchased land or a traditional 40-acre homestead.

The Taylor Grazing Act of 1934 finally instituted the system of grazing leases on public-domain lands administered by the General Land Office (later the Bureau of Land Management). Many ranches had experienced financial difficulties in the 1920s, and the early 1930s brought drought, but by the beginning of the 1940s, conditions had stabilized (Clark 1987). However, by this time the War Department had decided that major portions of the Tularosa and Jornada basins, as well as the mountains between, would be needed for a bombing and gunnery range. Starting in late 1941, ranchers in those areas were ordered to leave with their livestock. Patented lands and state sections were leased; public lands were temporarily transferred from the Interior Department to the War Department. Although the intent behind this temporary removal was to someday allow the families to return to the lands, ranching never returned to the northern Jornada del Muerto and the Tularosa Basin once these lands became incorporated into the war effort.

World War II and the Cold War

Alamogordo Army Air Field, a bombing and gunnery range, became operational in the spring of 1942. The air field's range included the northern Jornada del Muerto, which was subsequently selected in 1944 for testing the first nuclear weapon. The successful Trinity Test took place on July 16, 1945. Within the following

weeks, the uranium gun weapon was dropped on Hiroshima and the plutonium implosion weapon on Nagasaki. A Japanese unconditional surrender followed shortly thereafter. The world war was over and the nuclear age had begun.

The military installations established within the region during the war continued in operation through the Cold War era and to the present. The Alamogordo Army Air Field was reactivated in 1946 and became Holloman Air Force Base in 1948. White Sands Proving Ground was established by Army Ordnance in July 1945 and extended over most of the former bombing and gunnery range. It was used for testing captured German V-2 rockets and was on its way to becoming the country's preeminent test and evaluation range for guided missiles. Initial facilities were built at the southern end of the range, in and to the east of the Post area. Beginning in the early 1950s, facilities were constructed in the northern portion of the range; these included Stallion Range Center and several cinetheodolite (i.e., camera recording) stations. The Army also conducted salvage operations at the Trinity test site in the 1960s. By the middle 1970s, the Defense Nuclear Agency had established its own testing ground for nuclear simulations in the Trinity Site area. Additional Cold War-era activities include improvement and maintenance of existing roads, construction of new roads, modern fencing of Ground Zero, drilling of wells at some of the former ranches, and construction of observation and timing stations associated with testing programs.

For a brief period after the war, the Army tried a cooperative-use arrangement with the ranchers, but this did not prove to be compatible with the proving ground's mission, and the private lands were again leased on an exclusive-use basis, as they had been during the war. Public lands were permanently transferred to the Department of Defense in 1952. The proving ground became White Sands Missile Range in 1958. The Army acquired the state sections within the missile range in 1984, by which time litigation over the private lands had also largely been concluded.

ARCHAEOLOGICAL METHODOLOGY

An archaeological survey in a complex area such as the Trinity Basin proceeds in several stages. First, a search is made of the records of the previous projects in the area. This began with a call to the Laboratory of Anthropology, housed at the Museum of New Mexico in Santa Fe, which is the central repository for all project and site information in the state. The computer-aided seach yielded information on the projects that have been conducted in the area and the location and dating of any sites found during these projects.

Archaeological Survey

Safety was a concern during the survey. However, according to the WSMR Draft Environmental Impact Statement (1994), the Atomic Energy Commission has determined that radiation in the area, and especially from the trinitite (the fused, green sand at Ground Zero), does not pose a health threat. On an average, the radiation levels are only 10 time greater than the region's natural background levels. Other hazards such as rattlesnakes, heat exhaustion, and twisted ankles were more of a threat.

The survey was conducted by archaeologists walking the area, generally spaced about 50 ft apart. If they found something, they took notes on the find, placed a point on a 1:24,000 scale (7.5-minute) USGS map to indicate where it was found, and determined whether the item was an isolated occurrence or part of an archaeological site. While one or a few artifacts represent isolated use of the area, a group of more items or features (such as prehistoric hearths, historic roads, or a building) represent more concentrated or repeated activities and is considered to be a site. Therefore they are handled differently.

Archaeological sites, identified as one or more features or a concentration of artifacts, are documented and mapped. The forms are filed with the Laboratory of Anthropology at the Museum of New Mexico, and each site is assigned a Laboratory of Anthropology (LA) number, which is unique in the state for that site. The numbers used in this report are LA numbers.

Several recent surveys have been conducted in the Trinity Area. Because of its size and complexity, the whole area was not surveyed. A 640-acre block centered on the point of detonation at Ground Zero was intensively surveyed. Linear surveys were then conducted along the portions of WSMR Range Routes radiating from Ground Zero. These roads were originally laid out for the Trinity Test, with the main instrumentation and communications lines paralleling them. The surveys were carried out to a distance of 12,000 ft from Ground Zero, so that remains of monitoring instruments systematically installed at intervals from the point of detonation could be documented. The former road from the George McDonald ranch house to Ground Zero was also surveyed.

For the documentation process, Trinity was treated as a separate archaeological site, defined as including all of the distinct areas relating to Trinity, such as instrumentation shelters with surrounding apparatus and artifacts. Other discrete Trinity-related features, such as individual

instrumentation stations, were recorded as features within the Trinity Site.

Archival Research

At Los Alamos National Laboratory Archives (LANLA), Record Group A-84-019 contains declassified Trinity Project instrumentation location maps, construction drawings, and memoranda, all of which were consulted to aid in the identification and interpretation of Trinity historic features. This archival source includes a schematic of the proposed test area, which had been prepared prior to staking the test site in the Jornada del Muerto. Over a mosaic of aerial photographs, Manhattan project staff rotated and adjusted this schematic until it fit the topography. The principal instrumentation, communication, and roadway corridors radiating from Ground Zero do not precisely correspond to the cardinal directions, although the designations of south, west, or north for the major installations were retained. The resulting test site layout, clearly discernible in aerial photographs taken immediately following the nuclear blast, remains visible today. Two schematics were obtained: one details the placement of instrumentation within 4,500 ft of Ground Zero. A more general schematic shows the placement of instruments outside the core area. Historic Trinity Project photographs also provided important information on the installations.

Primary and secondary sources provided additional information on the Trinity project. These include Bainbridge's (1976) text on the personnel and test results, a picture history by Los Alamos National Laboratory (1986), and histories by Hoddeson and others (1993), Kunetka (1979), Maag and Rohrer (1982), Rhodes (1986), and Szasz (1984).

For the historic ranching period, General Land Office and Grazing Service maps and the 1947 Corps of Engineers Master Acquisition Map were studied for information on land use. Socorro County tax records and U.S. Census Bureau records were routinely consulted as well.

Oral History

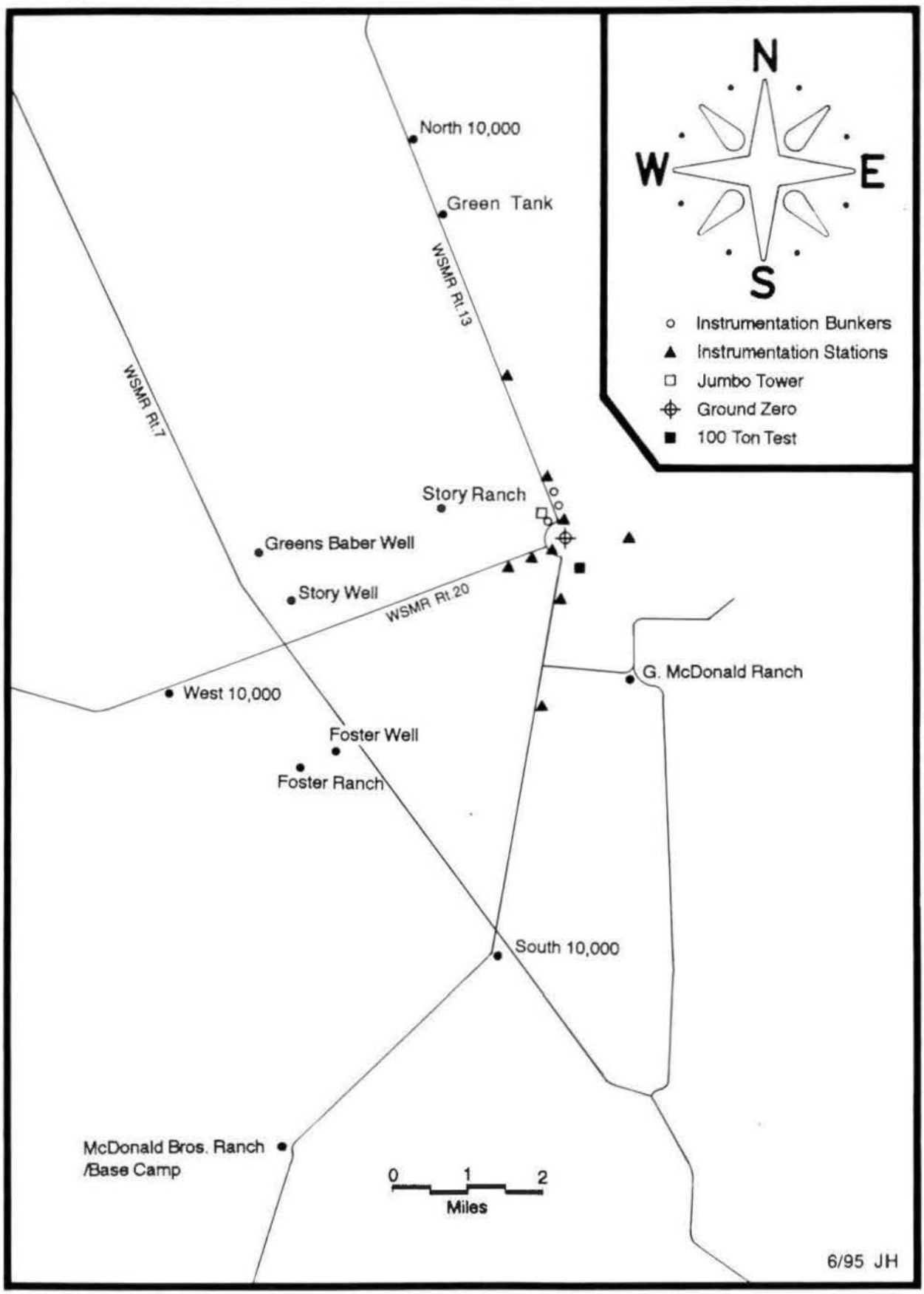
Taped interviews with four former Manhattan Project technicians were conducted on June 8 and 9, 1993, by oral historian Beth Morgan. The interviews were conducted during the 50th Manhattan District Reunion, June 7-11, 1993, in Los Alamos, New Mexico. Manhattan Project personnel have scattered from coast to coast since the bomb test on July 16, 1945, so the reunion provided the rare opportunity to talk to several people during one visit to Los Alamos.

Manhattan Project personnel interviewed included Berlyn Brixner, who set up the motion picture photography for the test of the first atomic bomb at Trinity Site; Joseph L. McKibben, who coordinated the timing of photography and experiments with that of the explosion; Benjamin C. Diven, who worked under Gen. Bruno B. Rossi on oscillograph measurements; and Richard J. Watts, who built and used health-monitoring equipment.

The information from these eyewitness Trinity Site participants is invaluable. As they had first-hand experience when the site was in use (McKibben slept at Ground Zero the night before the blast), and in some cases were involved in placing in the field many of the items later encountered by archaeologists, they are in a unique position to enlighten researchers about the World War II debris from the nuclear weapons research now strewn haphazardly

across the desert. For example, Diven described the nature of the coaxial cable running from the bomb tower to oscilloscopes in the field. Brixner was able to confirm the scene of the 100-ton TNT test preceding the test of the first nuclear bomb and to identify scored earth in photographs as an Alamogordo Bombing Range target.

In combination with archival research, these interviews have helped to determine purpose, placement, and function of the cables, wires, measurement instruments, and other gear still present at Trinity Site.



Features of Trinity and historic ranches.

The Manhattan Project

In 1942, the Manhattan Engineering District (MED) of the Corps of Engineers was formed to coordinate and direct the development of the U.S. nuclear capability. Later that year, Col. Leslie Groves of the Corps was promoted to General and appointed to direct the new district. He, in turn, appointed J. Robert Oppenheimer as director of MED Project Y, which would be based at Los Alamos Laboratory on the Pajarito Plateau north of Santa Fe. Work began in secret at the laboratory the following spring.

The Laboratory's mission was to undertake the research necessary to develop a practical nuclear weapon and to design and construct the actual device. This research, designated the Manhattan Project, proceeded under very tight security restrictions. Available fissionable materials, to be produced at Oak Ridge in Tennessee, Hanford in Washington, and other states, were uranium-235 (U-235) and plutonium-239 (Pu-239), both derived from ores mined at Ambrosia Lake, north of Grants, New Mexico, and at other locales.

As research progressed at the Laboratory, two alternate designs were developed. One used the gun method, in which one subcritical mass of fissionable material would be fired as a projectile at a target consisting of another subcritical mass of fissionable material. When projectile met target, the two together would constitute a supercritical mass, resulting in an explosion. The other method relied upon implosion, in which a subcritical mass of fissionable material is compressed to supercriticality by high explosives. To properly compress the plutonium to a fraction of its original size, explosives would have to be ignited within microseconds. Designing the gun-type device proved to be difficult but relatively straightforward, when compared with the almost insuperable problems involved in the implosive device (Hoddeson et al. 1993).

In the spring of 1944, sample studies of the newly produced plutonium revealed that it had a high rate of spontaneous fission and was therefore unusable in the gun-type device, although it was theoretically possible to use it in the implosive device. Thus, while work progressed on the gun (Little Boy), which would use U-235 for its fissionable material, others worked on the implosion weapon (Fat Man), which would employ Pu-239. There was sufficient confidence in the gun that a field test was not considered necessary, but the problematic implosion weapon would have to be tested.

The Setup

In order to quantify the effects of the test, the selected site had to be relatively level, with predominately clear weather. For safety and security, the area needed to be isolated and uninhabited (or depopulated). The site had to be close enough to Los Alamos to minimize travel and transport time, yet far enough away to disguise the connection, given the secrecy surrounding this unprecedented research. Finally, the site had to have a railroad line nearby for delivering Jumbo, the immense steel container that was being fabricated to enclose the implosion weapon, thereby allowing recovery of the plutonium, if

the test were unsuccessful. (By the time of the test, this idea had been abandoned, and Jumbo was not used).

The area that best fit all of these criteria was the northern Jornada del Muerto. In the early fall of 1944, arrangements were made with the Second Army Air Force, Alamogordo Army Air Field, to dedicate an 18-by-24-mi area for the nuclear test within the Alamogordo Bombing Range.

A base camp was established at the ranch of Dave and Ross McDonald (see following chapters), and construction was begun at the test site, increasing in momentum in the spring. At the center of the test site—Ground Zero—a 100-ft steel tower was erected, at the top of which the implosion weapon would be mounted. Radiating out from this detonation point were roads and cables leading to three groups of personnel and instrumentation shelters located at a radius of 10,000 yd to the south, west, and north. The personnel at these stations would be closest to the blast. Closer to Ground Zero were other shelters and stands for remote cameras and instrumentation. Instruments were installed at measured distances from Ground Zero. All of these facilities were designed to ensure scientific monitoring of the first nuclear weapons test.

A rehearsal for the test was conducted on May 7, 1945, when 100 tons of TNT were exploded on a 25-ft wooden tower. At that time, it was the largest single explosive event in history. Hundreds of pieces of equipment, designed to monitor the phenomena of the blast, gave preliminary results of the TNT blast. Some were unsuccessful because switches were not flipped to activate the recorders (Bainbridge 1976).

After this trial run, Manhattan-project staff suggested major modifications to the physical layout of the test area. The ranch house of George McDonald, elder brother of Dave and Ross, was adapted as a field laboratory for final assembly of the implosion weapon (see following chapter).

Fallout was raised as a consideration only a few months before the test. Joseph Hirschfelder suggested that it might be a problem and that the test day should be selected with no wind toward populated areas and no rain to settle the pollutants.

The facilities were planned to conduct specific tests during the Trinity Test. Many facilities were built to record the effects on state-of-the-art experimental equipment installed around the test area. The simplest test was conducted by Enrico Fermi, who dropped small pieces of paper before, during, and after the air blast reached him, in order to estimate the strength of the explosion.

Three major tests were planned, and the equipment was installed at the three observation stations located 10,000 yd from the center of the blast. The first task was to determine the character and timing of the implosion. The Manhattan Project scientists would attempt to time the difference between the first and last detonations, allowing calculations of the time between the initial explosion and the nuclear reaction from the core.

The second task was to record the intensity of the gamma rays released by the fission and, through the radiochemical analysis of the soil, determine the ratio of fission products to unconverted plutonium.

The third task was to measure the damage caused by the explosion. Equipment was designed to record blast pressure, earth shock, and radiant heat to ignite structural materials. Photographic and

spectrographic equipment would record the general effects of the blast. Cameras with both black-and-white and color film would record the blast and document the spectrum of light emitted by the ball of fire. Observation planes would drop, by parachute, pressure gauges and other equipment near the blast site.

Despite rain, which caused a delay, on Monday, July 16, 1945, at 05:29:45 A.M. Mountain War Time, the device was successfully detonated in the northwest corner of the Alamogordo Bombing Range. Its strength was equivalent to 18,600 tons of TNT.

Light from the blast was seen as far away as Santa Fe, New Mexico, to the north and El Paso, Texas, to the south. The blast rattled windows as far away as Silver City and Grants, New Mexico. Some of the wives at Los Alamos watched for the blast from the top of Sawyer Hill, the ski slope. Others hiked into the Sandia Mountains for a view. Others missed the delayed blast.

The Archaeology of Trinity

Nearly 50 years later, major portions of the Trinity Test Site are still visible and recognizable. Archaeological survey was conducted on 640 acres around Ground Zero and on the four roads that radiated away from Ground Zero.

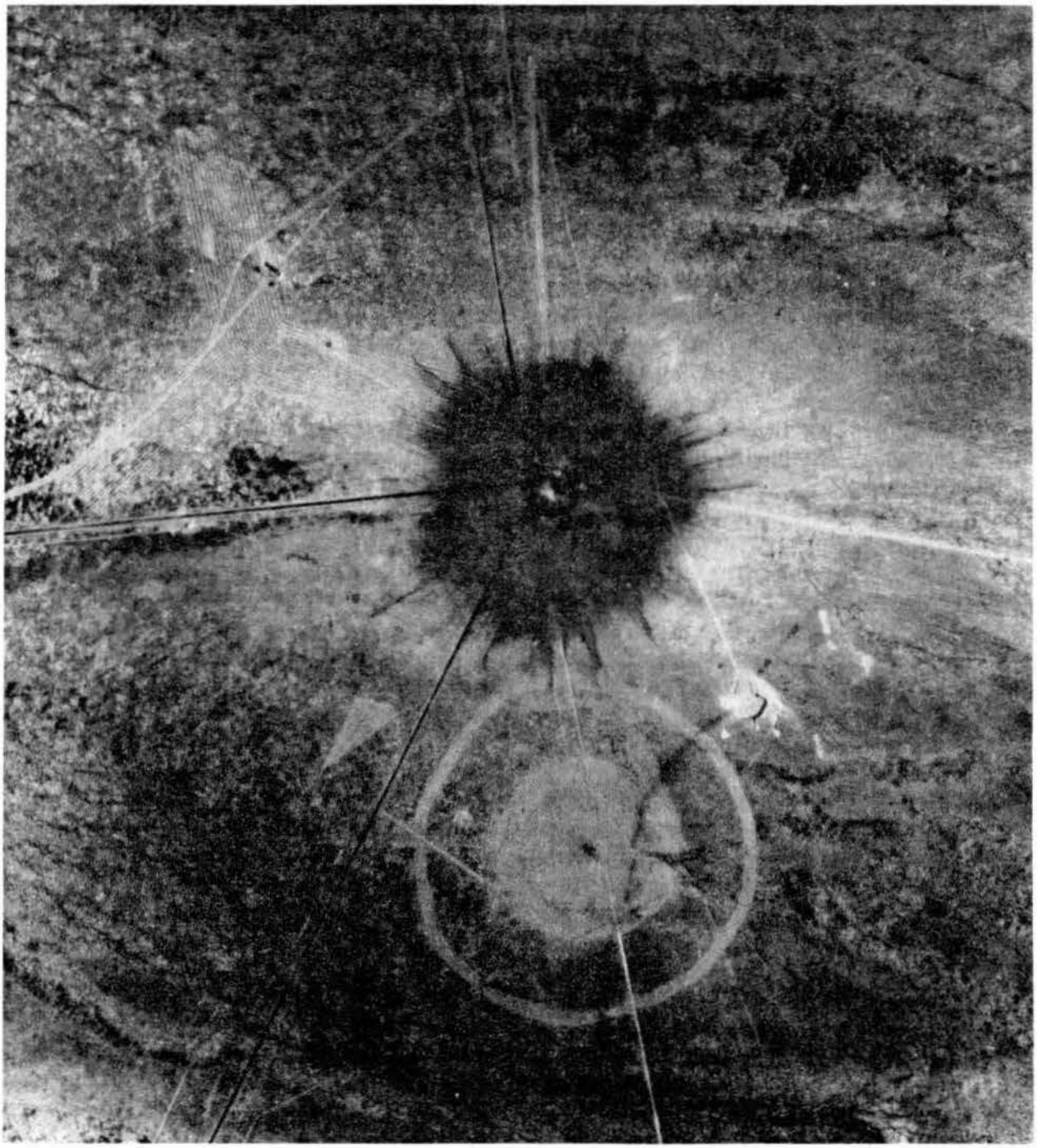
Trinity Site (designated as LA 100,000) consists of the detonation point, known as Ground Zero, and a variety of structures and features radiating from Ground Zero. These include instrumentation bunkers, photography bunkers, personnel observation bunkers, a quarry, and explosives magazines. Additional sites are Camp Trinity, the base camp for project personnel located at the McDonald Brothers Ranch, and the George McDonald Ranch, which was used as a field laboratory for assembly. During the use of Trinity Site, these areas were connected by roads, communications and electrical lines, and lines of sight necessary for recording instruments and documentary photographs.

Detonation Point

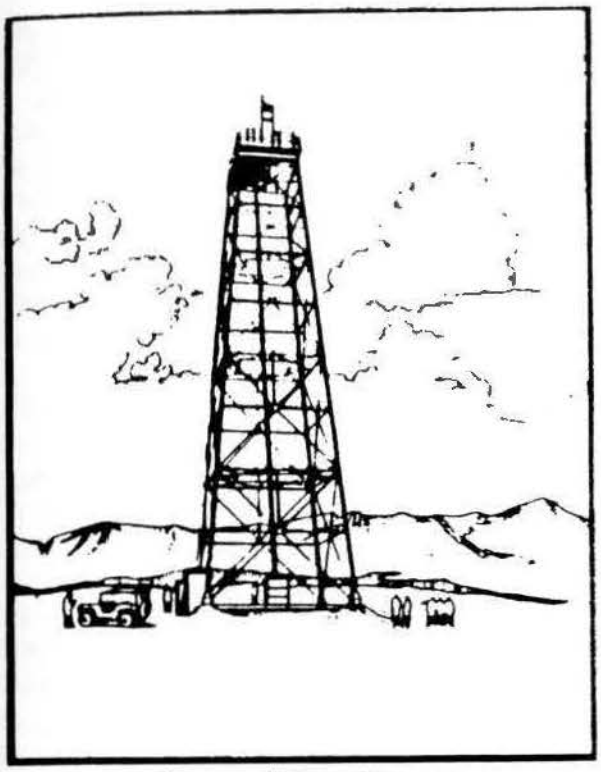
The active components had been installed within the core at the George McDonald Ranch on Friday the 13th. The plutonium hemispheres were assembled. From there, the device was transported by vehicle to Ground Zero, where the high explosive and the radioactive components were brought together in a tent at the base of a 100-ft tower. There the detonation device was inserted into the bomb. The next morning, July 14, the tent was removed, and the device was lifted to the top of the tower and installed inside a sheet-steel structure. The delicate detonator was inserted after the gadget was raised to a sheet-steel house at the top of the tower. Every 6 hours until it was detonated, the detonation crew climbed the tower to make final installations and inspections and to measure the neutron background level. When the weather cleared the morning of July 16, the decision was made to conduct the test.

On the following morning, a lead-lined Army tank drove into Ground Zero to recover equipment. Equipped with air tanks for the crew, the tank also had a scoop that could safely pick up debris.

The detonation of the first nuclear bomb actually left a shallow depression, which can still be seen. The depression was paved with green glass. At the center are the remains of the four reinforced-concrete pylons, extending to a depth of 6-8 ft below grade, that supported the legs of the



Ground Zero Shortly after explosion (WSMR photograph file).



Ground Zero Tower.

100-ft tall steel tower, which measured 25 ft square at its base. Today, west of the tower is a structure protecting a fragment (measuring approximately 18 by 48 ft) of the sheet of fused soil—trinitite—that was produced by the heat of the blast. The brittle trinitite layer, extending to an average depth of 1 1/2 in., is intact although partially covered by several inches of wind-blown fill. Approximately 6 acres around the tower remains and the trinitite bunker were bladed; any artifacts that survived the blast within this area no longer remain.

Between the inner and outer security fences, the site surface, with the exception of the 6-acre cleared area, has been only partially bladed. Within this area is a series of linear mounds, the result of attempts to dispose of the trinitite. After the test, the sheet of trinitite extended for 350 to 400 yd from Ground Zero. By the early 1950s, the sheet had fragmented, and the deteriorating trinitite, as dust, posed a potential radiation hazard. In 1952, the Atomic Energy Commission let a contract to clean up the site. Much of the trinitite was scraped up and buried in mounds. However, in large areas, fragments of trinitite still cover the surface.

The principal features found between the security fences are four sets of reinforced-concrete piers. Each set consists of three piers, 11 1/2 in. square and averaging 5 ft high, placed 30 ft on center in a right angle. The only documentary reference for these features is a sketch draft of the instrumentation location map done sometime before June 23, 1945. On the map, in approximately the same locations, are features labeled tank stands, with emergency tank roads leading away from Ground Zero. According to Ted Brown (personal communication, 1994), the Albuquerque contractor whose crew did most of the construction at the test site, there had been a plan to actually station Army tanks at these points, but the idea was abandoned. Adjacent to the northern tank stand are the remains of several pieces of equipment designed for test measurements: steel frames clad in copper and concentric copper pipes. Inside the outer fence are the remains of the original 4-by-4-in. fence posts and sheep wire installed around Ground Zero in November 1945.

Ground Zero is now marked by a monument, and the immediate vicinity is protected by a security fence.

The explosion was described by observers as a blinding light more intense than the sun. Those up to 20 mi away also felt a sensation of heat on exposed skin. Looking through dark glasses, observers saw a conglomerate of rising flames. Within a few seconds, the flames lost their brightness, turning into a pillar of

Northwest 600 today (HSR photopgraph file).

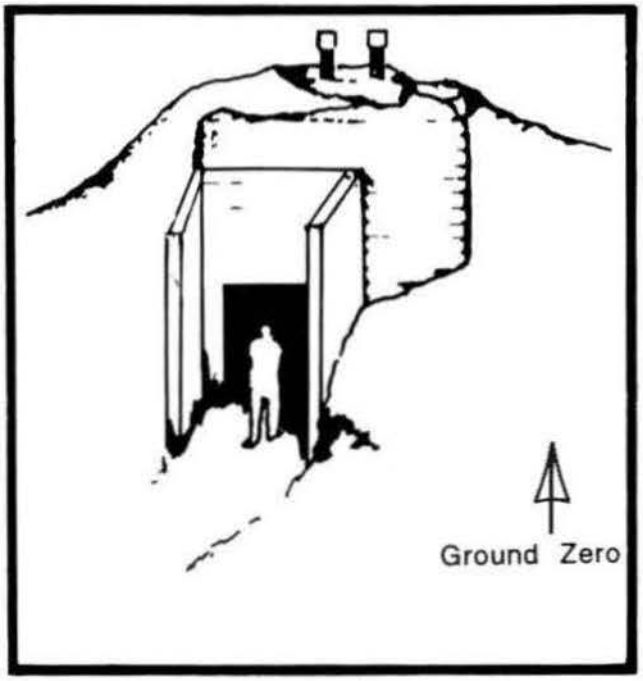
Remains of North 800 bunker (HSR photograph file).

smoke. This huge smoke cloud billowed into the sky, expanding like a gigantic mushroom toward the clouds (Fermi estimated up to 30,000 ft). The cloud hung there, until the wind began to disperse it. As the sun came up, air currents swept radioactive fallout down into the basin from where it had been trapped in the inversion layer.

Photographs taken of Ground Zero after the explosion show a circular scar on the ground. Trinitite was one result of the intense heat generated by the Trinity Test. However, the heat caused the vegetation to burn in a starburst pattern outward from Ground Zero up to 2,000 ft. It is suggested that the flames lept outward, stopping only at major vegetation that would not catch instantly. Some evidence of the burned soil has been found a few inches deep in eroded areas near Ground Zero. These have yet to be tested. The vegetation had started to come back by 1947.

Northwest 600 Shelter

A series of unstaffed instrumentation and camera bunkers were built radiating out from Ground Zero. Northwest 600 shelter is the closest bunker to Ground Zero, 600 yd from the detonation point. This subterranean shelter is constructed of reinforced concrete, with an earthen berm above. Beyond the entry is a baffled passage that leads to a chamber measuring 7 by 12 ft. The wooden forms were retained to serve as sheathing for the walls and ceiling. Two steel pipes project above the chamber, on the exterior, with steel plates bolted over the tops. No obvious shaft connects these pipes with the chamber below. No historic drawings exist for the shelter to explain the purpose of the pipes. Since the shelter was not built until June 1945, it was probably designed in response to a late decision to provide more means of obtaining radiation measurements and data relating to the fission process. Today, the wooden retaining walls at the entrance are deteriorating and the door is missing, but the structure itself is intact and structurally stable. No artifacts were observed in the vicinity of the shelter.



Instrumentation bunker at Northwest 600.

800 Shelters

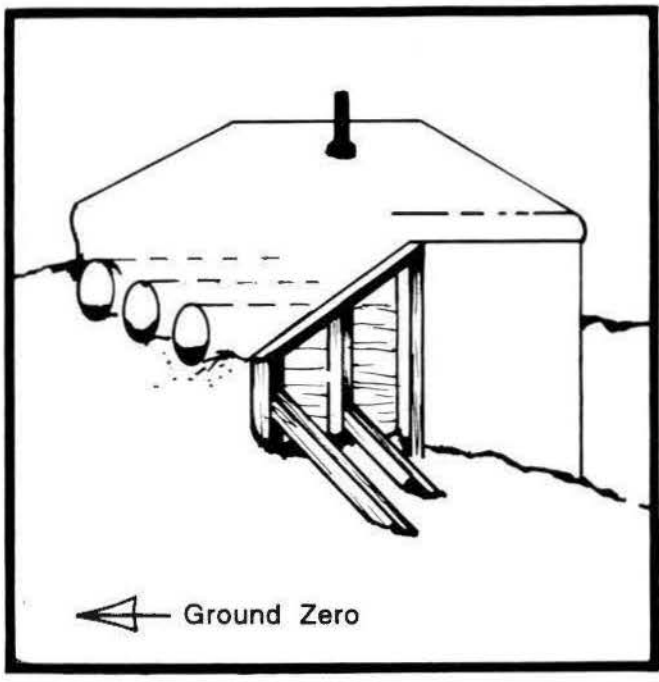
Visible from Ground Zero, the West 800 shelter is an instrumentation bunker. It consists of a cubical chamber of reinforced concrete surrounded by an earthen berm. The wooden forms were retained on the interior for sheathing. Large concrete pipes are set into the berm, protecting the chamber's three viewing ports toward Ground Zero; a fourth viewing port, of steel pipe, is set in the south wall at an angle. Over the chamber is earthen fill and a concrete slab. The west wall of the chamber extends to form a retaining

wall for the fill. In front, the slab slopes down to the tops of the pipes. The bunker was designed for high-speed Fastax cameras, but it was later decided to mount the cameras outside the bunker, on sleds attached to cables for retrieval. During the test, the bunker contained equipment for measuring implosion characteristics (Bainbridge 1976).

The bunker as built involved substantial changes from the construction drawing. The chamber was set on grade rather than partly below, and the configuration of the berm was modified. To protect the front viewing ports, concrete pipe of 18-in. and 24-in. interior diameter was substituted for the three 16-in. steel pipes that were specified. Because the fronts of the concrete pipes were not cut on an angle as the steel would have been, the sloped slab had to be extended by a third of its length. The chamber is relatively intact, although its door is missing. Only one of theviewing ports still has a 1/2-in. lens of bulletproof glass. The blast blew away much of the berm and earth fill; wind and water erosion continue to destabilize the top slabs and the concrete pipes. Portions of the berm's wooden revetments are collapsing.

Fragments of concrete to the south of the bunker may be the remains of the slab for the camera sled. West of the bunker, a few fragments of glass and a small amount of building debris (lumber fragments and nails) were observed.

The North 800 bunker, also an instrumentation bunker, is identical to that at West 800, except for minor details. It had also been designed to contain Fastax cameras. As at West 800, the cameras were ultimately placed outside for the test, and the bunker was used for recording radiation (Feature A). Today, structurally, the condition of this bunker is worse than that of West 800, since more of the berm and earth fill have eroded. The wooden revetments have almost entirely collapsed. To the east are concrete fragments that are probably the remains of the slab for the camera sled. Posts for the communication line are still visible. A stake placed southwest of the bunkers helped scientists measure earth displacement. Their locations were surveyed before and after the blast.

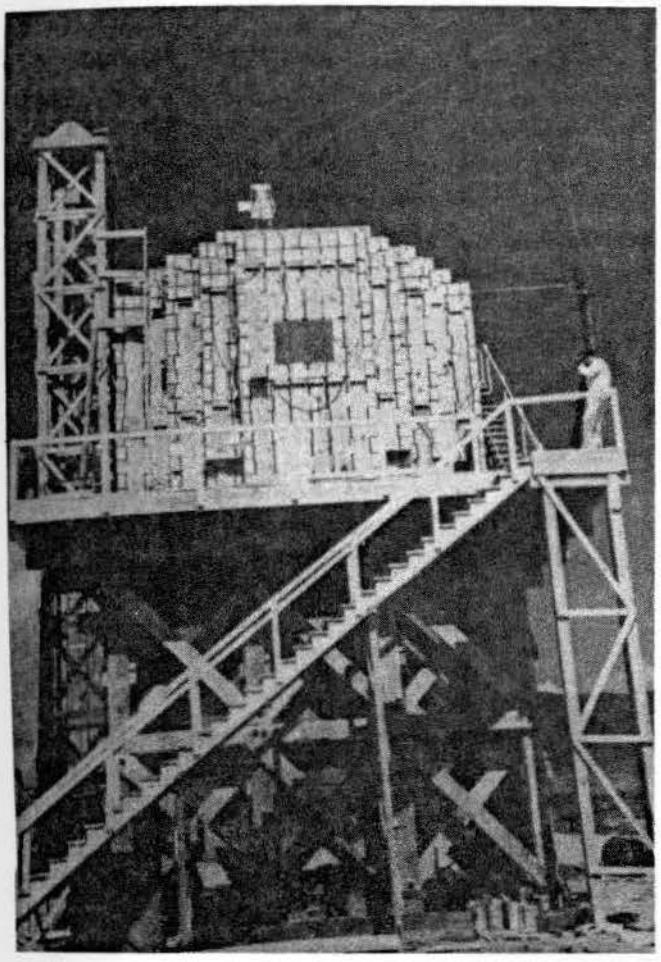


Instrumentation bunker at North 800.

100-Ton Test Area

A 100-ton TNT test provided data to build shock-proof shelters for the final test and helped determine the types of equipment needed for the final test. For the May 7 trial run at Trinity, 100-tons of TNT were stacked on a wooden platform approximately 20 ft high. Some fissionable material was included in the test, "to simulate, at a low level, the radioactive products expected from the nuclear explosion" (Los Alamos National

Laboratory 1986). During the trial blast, the wooden platform was completely obliterated.



Platform for 100-ton TNT test, prior to explosion (WSMR photograph file).

The test site for the 100-ton blast was 800 yd south-southeast of the Trinity Ground Zero. The blast made a crater 5 ft deep and 30 ft in diameter. No trace of the structure or this ground zero remains, but 1,100 ft due west of this point is a small earthen and wood bunker used for recording the rehearsal blast. The bunker, measuring 4 by 5 ft, is framed with 4-by-6-in. timbers, sided with 2-by-6-in. lumber, and roofed with 2-by-10-in. boards. The west entrance is 3 ft wide and flanked by revetments of 2-by-12-in. planks. The interior, with a layer of fill, has a current height of 2 ft 6 in. On top of the bunker is a box, 2 ft square and 1 ft high, constructed of 2-by-8-in. boards. In the top of the box is an opening 4 in. square. The bunker was built partly below grade and was covered with earth, but much of this has eroded. The entire structure is deteriorating, and the roof is unsound. No artifacts were observed in the immediate vicinity of the bunker.

Jumbo and its Tower

During the initial planning for the test, Manhattan Project personnel realized that testing the implosion bomb would use one-third of the available supply of radioactive plutonium. Jumbo was originally designed as a large cannister to trap the plutonium during the explosion for later reuse. Robert Oppenheimer specified that the Jumbo be 25 ft long and 12 ft in diameter, with 6-in. walls reinforced with an 8-in. steel band. The cannister was built by Babcock and Wilcox Corporation in Barberton, Ohio, and transported to New Mexico on a special railroad car. Jumbo was unloaded from the Atchison, Topeka, and Santa Fe Railway at Pope, New Mexico, in the Spring of 1945. The container was transported on a 64-wheel trailer pulled by bulldozers, which were also undoubtedly used to develop what is now known as the Government Road.

Today, 700 yd northwest of Ground Zero are the remains of the tower originally erected in June 1945 to hold Jumbo. For the test, the empty container was set on end, its lower hemisphere set below grade in concrete. The upper end was attached by a tension cable to the top of the surrounding rectilinear steel tower, which was 75 ft high and 18 ft square (Szasz 1984).

By July, subsequent testing made

Transporting Jumbo from Pope, New Mexico, to Trinity (WSMR photograph file).

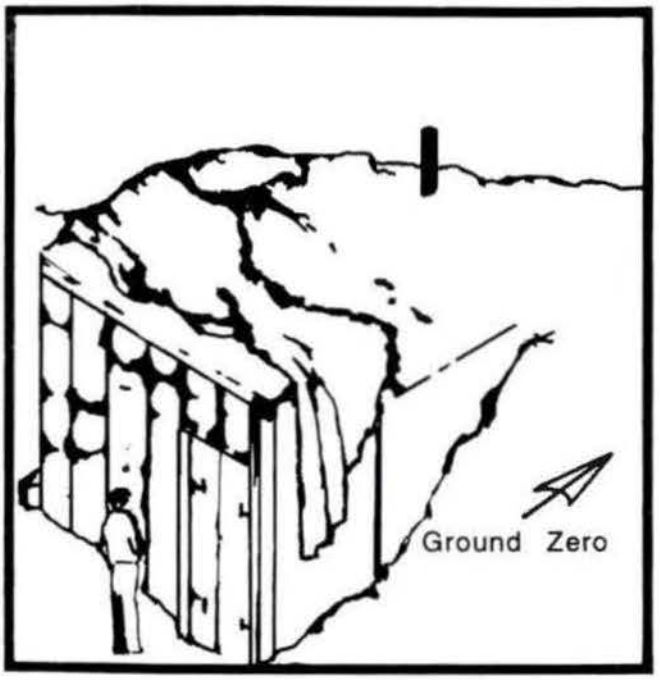
Jumbo and tower after tower after explosion (WSMR photograph file).

it evident that Jumbo would not be needed, but it remained at the site. The Trinity test flattened the tower, but only tilted Jumbo. After the test, much of the tower wreckage was removed, and Jumbo remained in place until 1947. General Groves realized that the money spent on building and moving Jumbo, over $1,000,000, might be viewed unfavorably by a congresional investigation. He sent an explosives expert to blow it up. An improperly conducted explosives test blew out the ends. Two fragments are visible in the vicinity of the lower remains; one landed 1,800 ft away.

The central feature of this area is an excavation 15 ft deep and averaging 100 ft across, with a track leading out to the southwest. Jumbo was buried here after its partial destruction, was disinterred in 1951, and was finally removed to the outer Ground Zero gate in the early 1970s. Around the excavation are mounds of fill. Two of these, on the east, have high concentrations of trinitite. In and around the mounds are sections of steel and fragments of concrete, the remaining wreckage of the Jumbo tower and its footings. Other building debris consists of piles and scatters of lumber.

North 1000 Bunker

The instrumentation bunker at North 1000 is a rectangular reinforced-concrete chamber. Its north wall is raised to form a retainer for the earthen berm. The 2-by-4-in. boards of the interior wooden form, which were left in place, served as nailers for wooden sheathing that was then overlaid with sheets of copper. A steel pipe protrudes through the roof, above the berm. In the south wall are conduits for coaxial cables carrying an electromagnetic signal from detectors at Ground Zero to oscilloscopes in the bunker (Berlyn Brixner interview, June 9, 1993). Like the bunker at Northwest 600, this bunker was designed as a late addition for the purpose of obtaining more data relating to implosion characteristics (J. H. Williams to K. T. Bainbridge, memorandum, 18 May 1945).



Instrumentation bunker at North 1000.

Most of the copper lining has been stripped from the interior of the bunker and the door is missing, but otherwise it is intact and structurally stable. A frame extension was built in the rear, but no building debris was observed at or near that location. To the north of the bunker are the remains of two pieces of recording equipment, apparently for recording radiation. One consisted of three 16-in. sheet-metal cylinders set into a wooden stand. The other involved metal foil in a wooden frame. Two other features to the north consist only of deteriorated lumber and are unidentifiable. A communication-line post is visible. A stake marked LASL

(Los Alamos Scientific Laboratories), located southwest of the bunker, dates to post-1945 activity.

Artifacts consist of a few glass and metal fragments, two paint cans, and part of a louvered hood from the two generators that provided power to the bunker.

Explosives Magazines

The explosives magazines are located approximately 3,500 yd south of Ground Zero. On the south are the remains of a rectangular structure oriented east-west with 18-in. reinforced-concrete walls. The structure is open on the west end; the other sides are bermed with earth. The space inside the walls is 10 by 20 ft; measuring from a layer of fill within the walls, the maximum height of the walls is 6 1/2 ft. Along the top of the walls is a 2-by-6-in. plate. The roof is missing, as are the framework and door that enclosed the structure on the west. Not surprisingly, the scatter of building debris around the structure consists of fragments of lumber and asphalt roofing, nails, bolts, and hinges. Approximately 850 ft to the north are two small, deteriorated wooden structures. These were used for storing primacord and explosive caps or signal rockets for the test, while the concrete structure was built to hold 6,000 lb of explosive charges.

Quarry and Roads

One complaint from the TNT test in May was the condition of the roads (Bainbridge 1976). As people and equipment were moved to the Base Camp and construction progressed at the test site, the dirt roads became a major problem. During the dry spring, they undoubtly became deep in dust; after rain storms during summer, the deep ruts would have turned into mud traps. A source of micaceous gravel was found close to Ground Zero. This gravel was spread 6 in. deep on the roads, watered, and then primed with asphalt (Szasz 1984). Over 20 mi of roads were treated in this fashion. Historic maps name these roads—Vatican Road to the west toward the Rio Grande, Pennsylvania Avenue to Base Camp, and Broadway to the northwest, toward what is now Stallion Range Center.

In addition to the Vatican or Government Road, over which Jumbo was transported, possibly the most important road was the 2-mi-long road built from the George McDonald Ranch to the detonation point. This road was used to transfer the core of the bomb from its assembly location in the northeast room of the George McDonald Ranch to Ground Zero. This road is no longer used, although its location can be traced on aerial photographs.

Instrumentation and Communication Lines

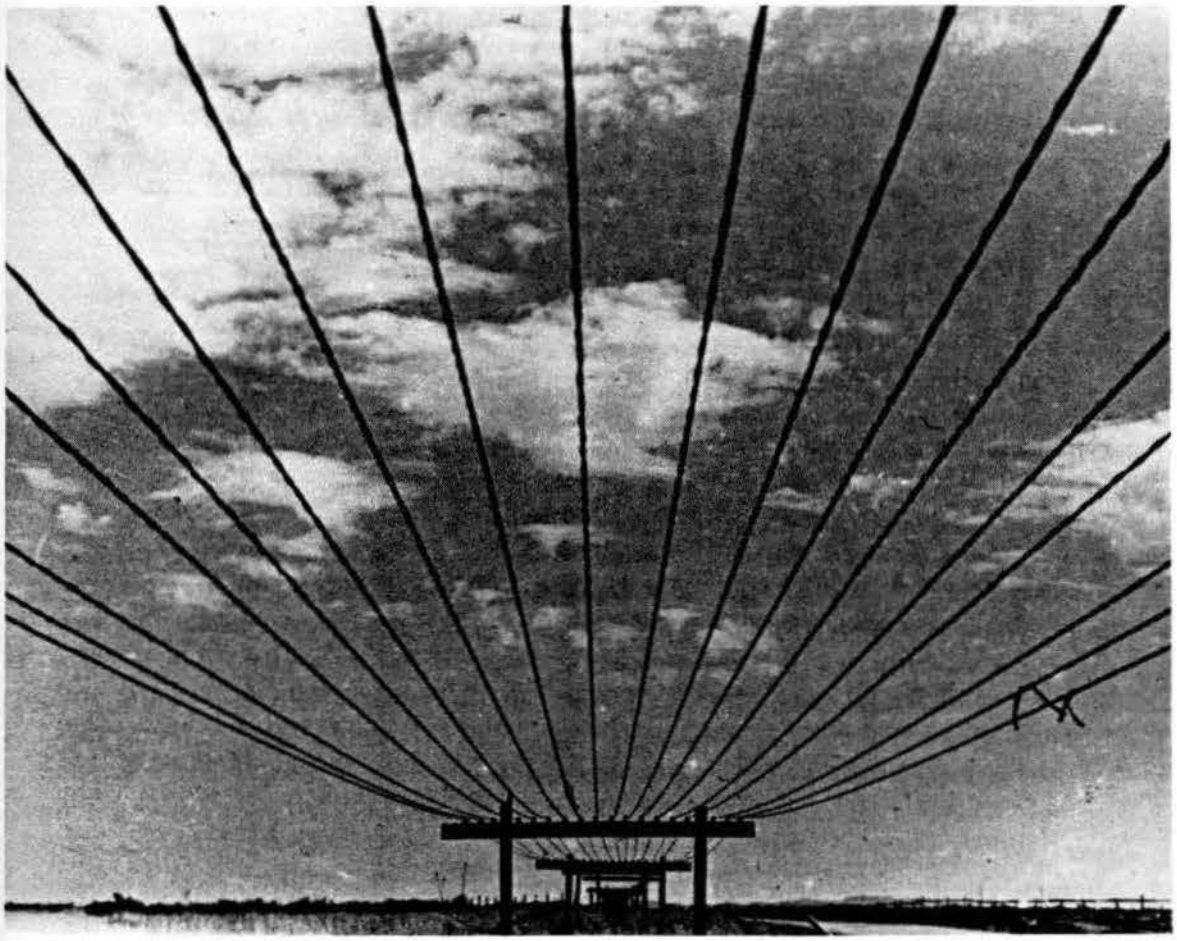
The lack of communication became obvious during the May TNT test. A second request was made for additional communications lines, and lines were needed for the monitoring instruments. The equipment lined the roads from Ground Zero toward the stations at 10,000 yd north, south, and west. These were joined by a series of communication lines.

Some of the equipment was set to start recording prior to the blast, while other pieces of equipment required a pulse 1000th of a second ahead of the test to start. Timing for the equipment was important, and Joseph McKibben was in charge of coordinating all the requirements of the various tests. Additionally, the observation bunkers and the Base Camp were connected by telephone lines and a public-address system.

The latter contributed to the morale at Base Camp, reputed to be a happy camp, as continuous updates on the test were broadcast during the last tense hours.

Some of the instrumentation stations were linked by coaxial cable buried beneath the ground. These cables were buried shortly before the blast, reflecting ongoing technical adjustments being proposed, approved, and constructed by Manhattan Project personnel as the nuclear countdown approached (Ted Brown, personal communication 1994). Other wires provided communication links between the observation bunkers, Base Camp, and other features. A secondary line cross-cuts these lines, 1,500 yd from Ground Zero, between the roads to West 10,000 and South 10,000. This relief line through an instrumentation station along the road to Base Camp was planned in the event that the blast destroyed the main line.

Some 500 mi of communication wire were strung across the site. Standing posts, some with crosspieces, remain in place along the three main roads to the site, with ceramic insulators, batteries, and fragments of wire scattered on the ground below. Those along WSMR Route 13, north and south of Ground Zero, consist of pairs of posts averaging 6 ft tall and 8 ft apart, with 2-by-6-in. crosspieces. The posts south of West 800 average 5 ft in height and are single, with braced 2-by-4-in. crosspieces. There is no



Main communication lines at Trinity Site (WSMR photograph file).

~~SECRET~~

to this office and the 25% increase in volume turned in direct to the Disposal Yard.

Personnel of the Disposal Unit are now at Trinity Site, which is located one-hundred miles from the base and is the location of the first Atom Bomb explosion, reclaiming electric cable, wire, and other valuable salvage materials. Negotiated bids are in progress for the sale of 60 tons of scrap iron and steel at this same location.

During the April period, reclamation and salvage operations at Trinity Site were completed with the result that approximately $60,000 worth of material was reclaimed and channeled back for government use. Eight-thousand pounds of copper and approximately 50,000 telephone insulators were retained in the disposal yard for re-sale. The total cost to the government for this operation was something less than $500.00.

Report of salvage operations at Trinity Site, Historical Report of 1 March to 30 April, 1953, 6540th Missile Test Wing, Air Force Missile Test Center, Holloman Air Force Base, New Mexico (HSR Microfilm, Roll 31733, p. 60).

evidence that lines were strung on fence posts.

To protect the wires from the weather, 10,000 ft of rubber garden hose was ordered. In addition to the other supplies needed, rubber hose was just one of the supplies that were difficult to obtain for the test (Los Alamos National Laboratory 1986).

Archaeological survey has yielded stands of a few poles, and lengths of communication wire and insulators are found on the ground. Also along the lines are instrumentation stands and boxes and piles of batteries. The lines have been traced toward the north, west, and south personnel bunkers. No evidence of an eastern line or road has been found, although an eastern road appears on the schematic of the instrumentation.

In the 1950s, the Army conducted salvage operations at the Trinity test site, removing the wooden cross arms, insulators, and copper wire of the communication and instrumentation lines. Other salvaged items included steel and iron fragments.

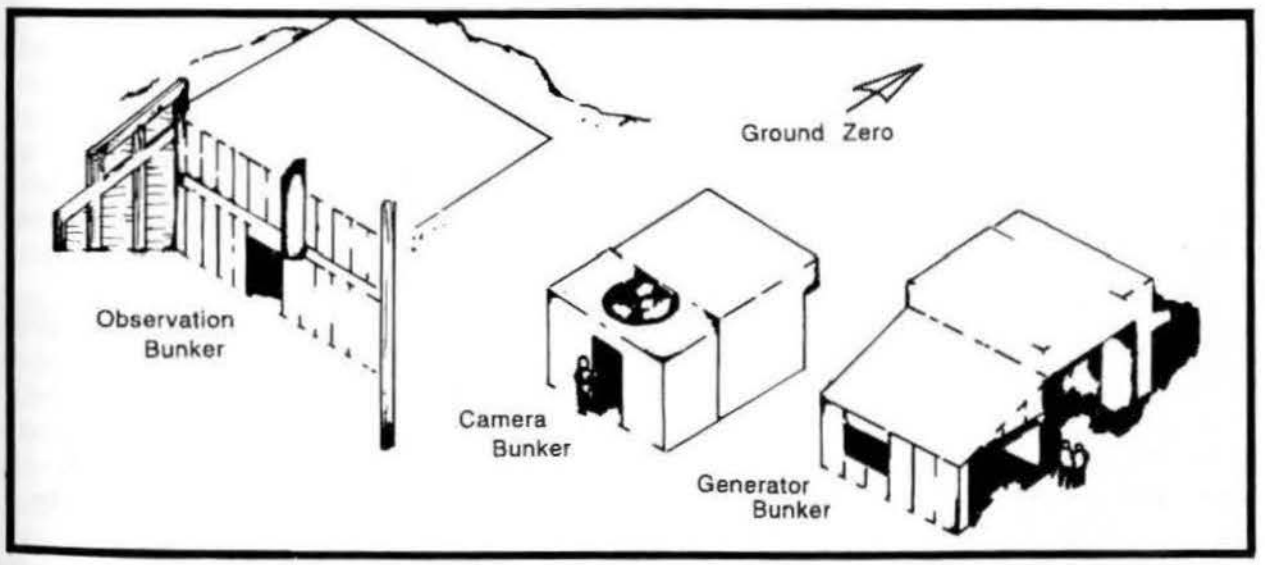
Guard Stations

Maps show locations of guard stations, but these were very temporary. Photographs from the test show guard stations in lean-to tents or vehicles parked along the road to control access to different parts of the test area. Since these were such ephemeral structures, little or no evidence of them would be expected on the ground, except possibly C-ration cans.

Observation Bunkers

Three major personnel observation bunkers were built at 10,000 yd from Ground Zero; these were the only bunkers staffed during the blast.

Each bunker was under the leadership of a different scientist; specialized tests were slated for each bunker. As planned, each location had a personnel bunker, a camera bunker, and a generator bunker. South 10,000 also included a water-storage tank.



Layout of North 10,000.

The observation bunkers were built of wood; the walls were reinforced with concrete, as were the roofs. To protect the observers, the bunkers were buried under layers of earth. Circular windows glazed with bullet-proof glass allowed observation of the detonation.

Robert R. Wilson and Henry Barnett were in charge of the North 10,000 bunker. Wilson was in charge of calculating the nuclear reaction time. John Manley and Jim Nolan were responsible for the West 10,000 bunker. Manley was supervising equipment to record blast pressure. Frank Oppenheimer and Louis Hemplemann were in charge of South 10,000. From here, Robert Oppenheimer watched the blast, and Donald Hornig supervised the Stop switch, the only way to prevent the explosion once the countdown began.

Once the explosion occurred, medical personnel took charge of each observation bunker. "At first there was no sign of danger. Then suddenly, the instruments at North 10,000 began clicking rapidly, showing that radioactivity was on the rise. Henry Barnett, in charge of the sbelter, gave the order to evacuate" (Los Alamos National Laboratory 1986:55). It was a false alarm, and none of the other bunkers was evacuated.

South 10,000 (LA 81601) is located on the lowest portion of the gradual slope that extends from the base of the Little Burro Mountains into the Trinity Basin.

South 10,000 originally consisted of a control and personnel bunker, with generator bunker and radar facility to the west. The bunkers, constructed of earth and wood with concrete slabs above, were identical to facilities at West and North 10,000 (LA 100,890 and LA 15868). Communication and instrumentation lines entered the area from the northeast, connecting South 10,000 with the rest of the nuclear test site. A water tower and a 16-ft-sq Army hutment were located south of the personnel bunker.

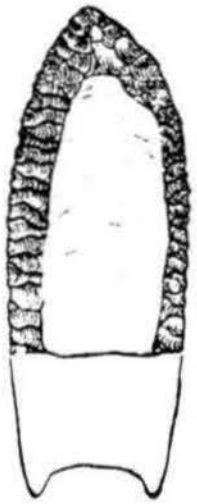
The bunkers were demolished by the Army in the 1960s because the deteriorating buildings posed a safety hazard. On the location of the former personnel bunker is a mound of earth intermixed with building debris; fragments of the concrete slab may lie beneath. To the west is the concrete slab of the generator bunker, surrounded by more building debris. The slab measures 13 ft 6 in. by 16 ft and according to Trinity construction documents was 2 ft 6 in. thick. Only the upper 6 in. is exposed. At the north end of the site are stubs (average height 16 in.) of two 6-by-6-in. juniper posts, two 7 in. diameter posts, and a pole 10 in. diameter post. Their location indicates that these objects are remnants of the communication and instrumentation lines, although their alignment is now irregular.

Building debris on the site is composed of lumber mixed with nails, bolts, and other hardware. Several steel tie-rods are scattered across the site. In the southwest portion of the site there is a small scatter of concrete fragments with a small concentration of ceramic insulators located nearby. In the southeast portion of the site near the base of the mound is a small concentration of ceramic housings for electrical switches. These remains indicate extremely thorough demolition.

The military debris lies over the remains of a prehistoric activity area consisting of a fire-cracked rock concentration with three fragments of ground stone and three pieces of chipped-stone debitage. During previous recordation of the site, an isolated Folsom projectile point fragment was observed.

West 10,000 (LA 100,890)

included an observation bunker, a generator bunker, and a camera bunker, all affiliated with the test. The observation and generator bunkers were constructed of earth and wood with concrete slabs above. The camera bunker was constructed of concrete with a frame extension in the rear. Communication and instrumentation lines connected Trinity West 10,000 with the rest of the test site to the east. West of the personnel bunker was a radar antenna and an Army hutment. The installation also included a searchlight.



Paleoindian point found at South 10,000.

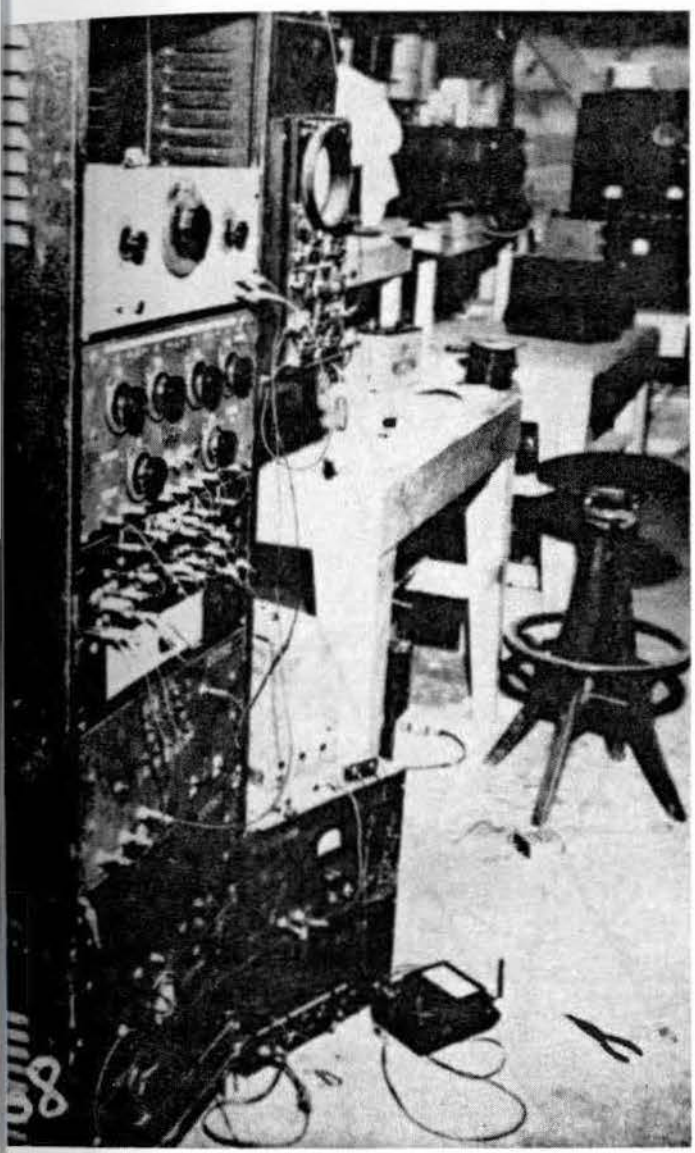
The observation and generator bunkers were demolished by the Army in the 1960s because the deteriorating buildings posed a safety hazard, but the camera bunker is extant. South of the camera bunker, elevated on a low mound, is the concrete slab, measuring 13 ft 4 in. by 16 ft, that formed the roof of the generator bunker; only the top surface of the slab is visible. Further to the south, where the personnel bunker would have been, is now a mound. The area north of this mound contains much building debris, primarily lumber fragments mixed with nails, bolts, and other hardware. Two wooden post stubs in the extreme northern portion of the site are remnants of the communication and instrumentation lines. Scattered in and around the building debris are associated artifacts: ceramic insulators, batteries, fuel cans, and numerous unidentifiable metal items and fragments.

A few premilitary domestic artifacts occur east of the camera bunker at West 10,000: a lock fragment with a mineral doorknob, one earthenware sherd, and three fragments of purple glass. The assemblage could indicate a possible occupation of the site during the historic ranching period. However, the disturbed condition of the site and the lack of historic documents make it difficult to identify the type of site.

The eastern portion of the site, where the bunker building debris and artifacts are scattered, has been subjected to extensive ground disturbance.

North 10,000 (LA 15868) is another observation bunker with a generator bunker and a camera bunker. The personnel and generator bunkers were constructed of earth and wood with concrete slabs above. The camera bunker was constructed of concrete with a frame extension in the rear. The bunkers were grouped, with the personnel bunker on the east, the generator bunker on the west, and the camera bunker between them. Radiating from Ground Zero to the south, communication and instrumentation lines connected North 10,000 with the rest of the test site. North of the personnel bunker was an Army hutment. The installation also included a searchlight.

Trinity South 10,000 before blast (WSMR photograph file).



Instrumentation inside North 10,000 (WSMR photograph file).

The personnel and generator bunkers were demolished in the 1960s, but the camera bunker is extant. Partially buried in a low mound north of the camera bunker is the concrete slab that once formed the roof for the generator bunker, while to the south and southeast are two large fragments, also partially buried, of the concrete slab for the personnel bunker. Building debris, which is much less evident on this site than at South 10,000 or West 10,000, is limited to steel tie-rods and fragments of concrete scattered between the camera bunker and the former concrete roof of the generator bunker. Also contrasting with other Trinity 10,000-yd facilities is the extent of preservation of the communication line here. Although collapsed, much of the crosspieces, wire, and insulators are intact on the ground.

Only three Trinity-related artifacts were observed on the site: two C-ration cans and a fuel can. A prehistoric granitic one-hand mano represents earlier use.

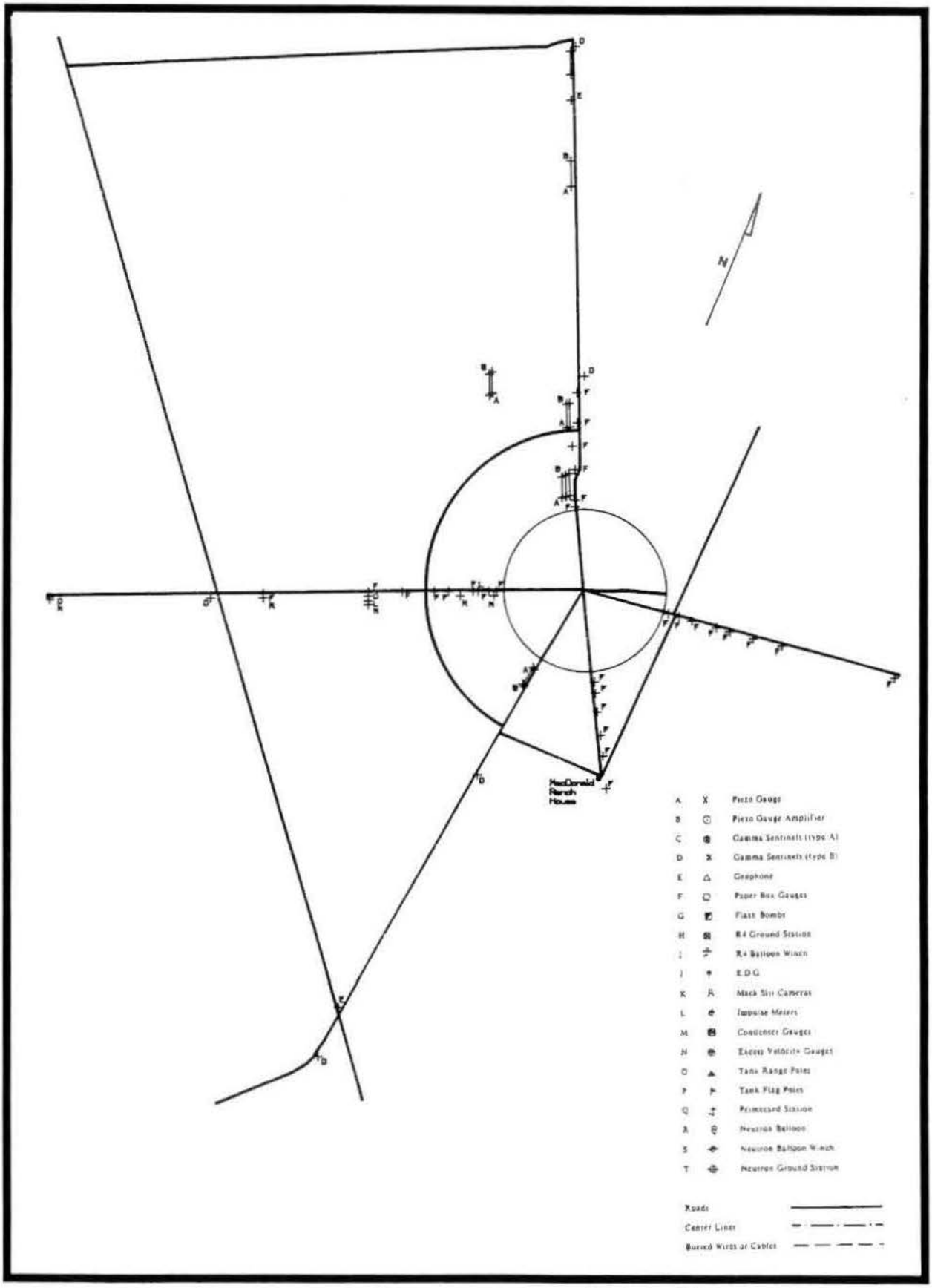
When the personnel and generator bunkers were demolished in the 1960s, a depression was created around the camera shelter. As a result, water erosion has undercut the bottom slab of the structure and is destabilizing it.

Instrumentation Debris

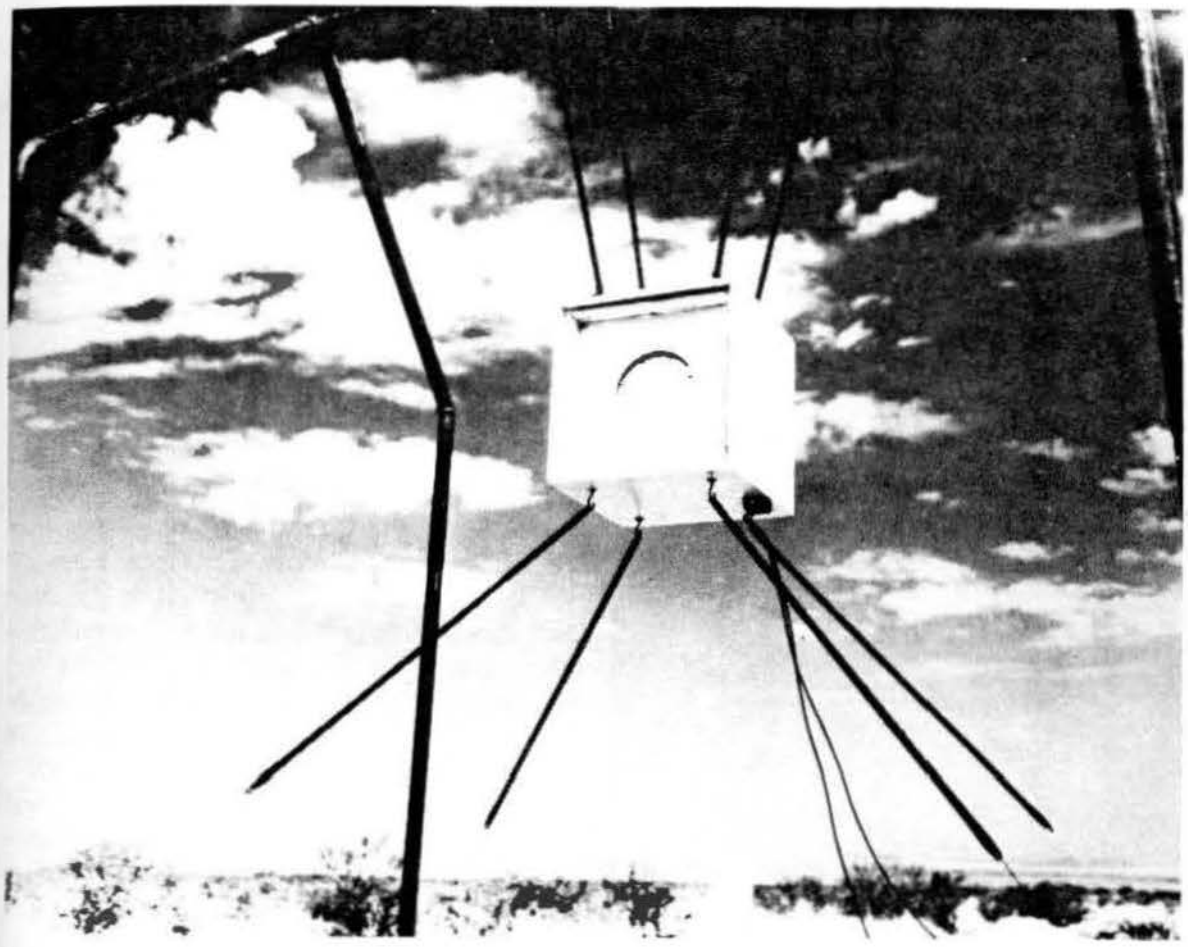
Instrumentation boxes, batteries, pieces of wood, and other debris were documented throughout the Trinity area.

Instrument boxes served many documentation functions during the test. According to Bainbridge (1976), radiation was recorded by instruments at ground level and over Trinity on balloons and airplanes. Delayed neutron levels were obtained from a catcher with cellophane and 25 plates (T on the instrumentation diagram) and in airplanes over the site. Delayed gamma rays were recorded with ionization chambers and recorders (C and D on diagram).

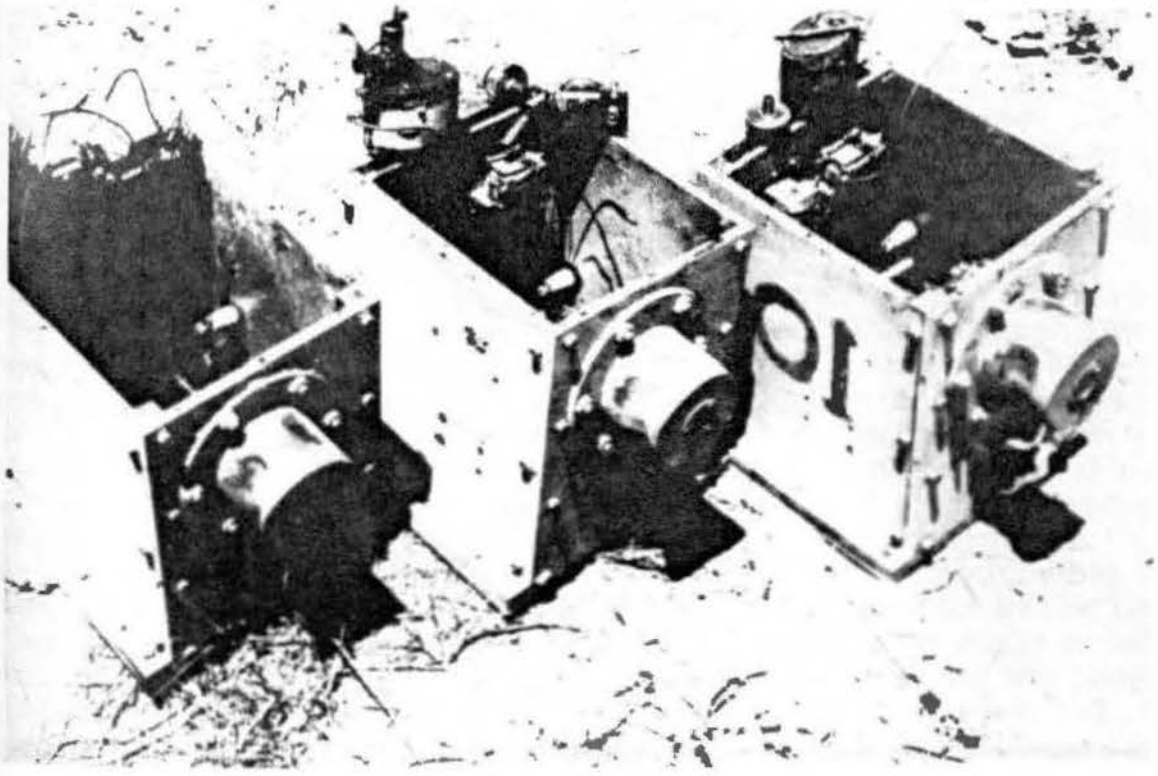
Piezo quartz gauges and amplifiers provided information at ground level on the blast pressure; these were installed along the main roads to the North 10,000 and South 10,000 facilities (A and B on diagram). Also



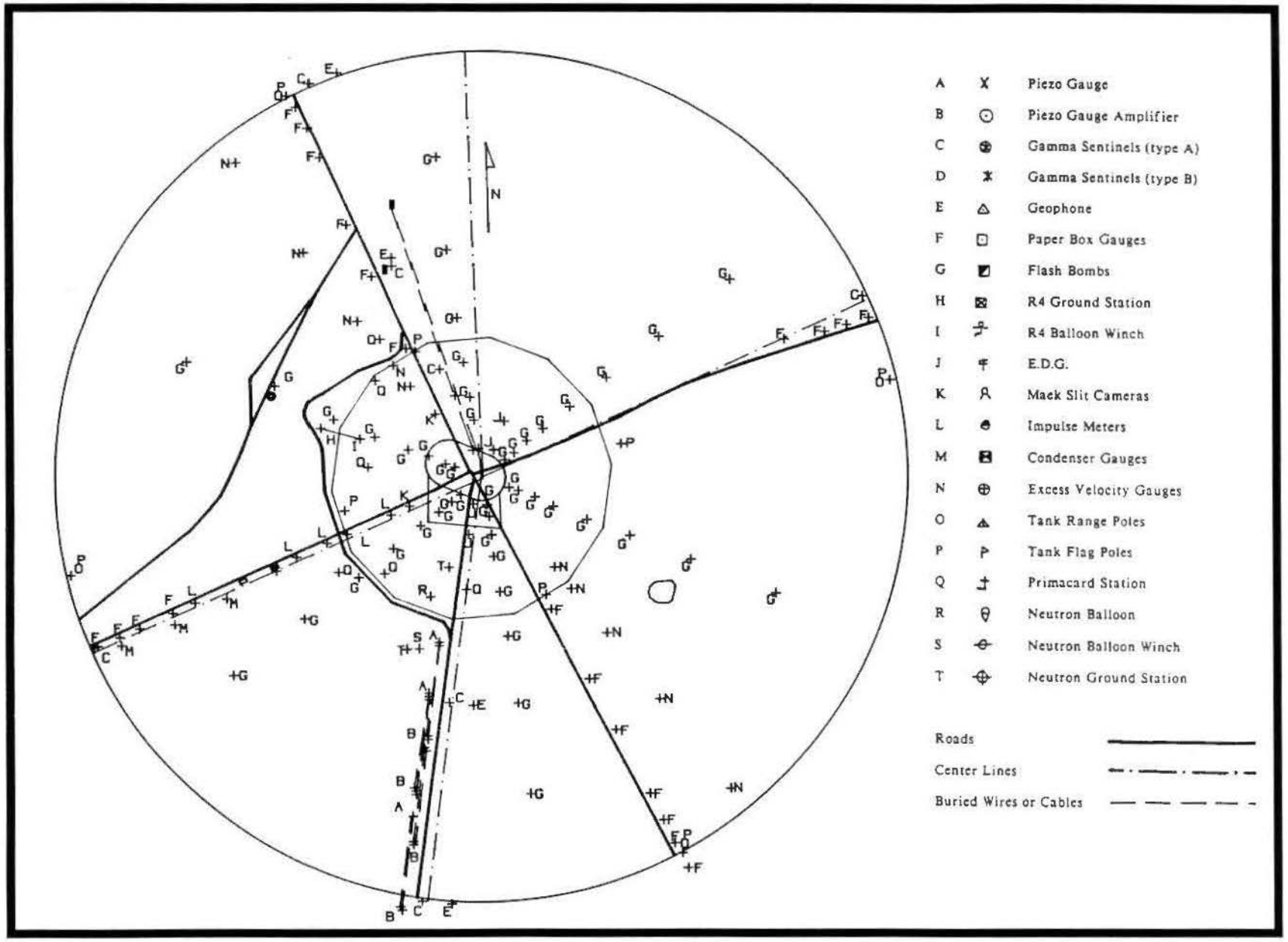
Schematic of instrumentation of Trinity Site.



Suspended microphone for excess velocity measure (WSMR photograph file).



Instrumentation boxes (WSMR photograph file).



Planned instrumentation for Trinity core area.

measuring blast pressure were condenser gauges, which were installed along the road to West10,000 and dropped from B29 planes (M on diagram).

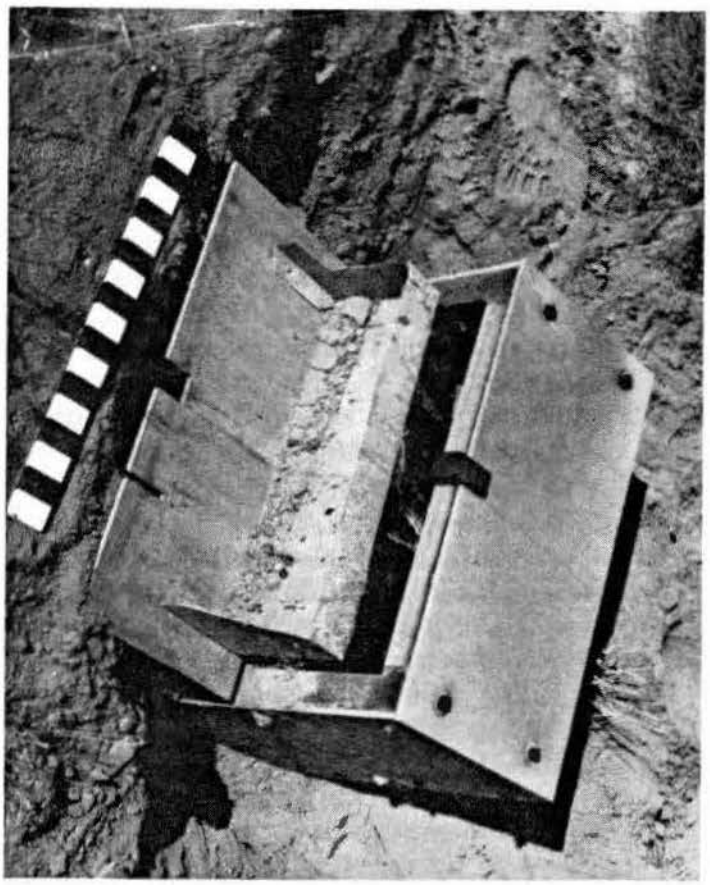
Excess velocity gauges were installed away from the road but on a linear alignment through Ground Zero and out about halfway to the George McDonald Ranch House (N on diagram). These were designed to pick up the blast wave and record its time of arrival. Approximately 50 switch-operated torpex flash bombs within the core area provided similar information (G on diagram); they went off with blast pressure and were recorded photographically. Within the core area, these instruments were the major ones set up away from the major access roads.

Peak pressure of the blast wave was recorded with piston liquid and orifice gauges designed to force water through a set of constrictions (L on diagram) and paper gauges (F on diagram). The paper gauges were boxes with an aluminum diaphragm covering 12 holes; the pressure was measured by noting which holes blew out. These were installed along the major access roads.

Mass velocity was documented with suspended primacord and magnesium flash powder, which was recorded by Fastax cameras (Q on diagram). These were placed within 1,500 ft of Ground Zero.

To measure earth shock, geophones were installed along the access roads to North and South 10,000. Five seismographs were installed at Trinity, and remote seismographs were placed in Tucson, El Paso, and Denver. Steel stakes were used to measure horizontal and vertical displacement of the earth.

Cameras were used to record many other aspects of the test, including size, shape, behavior, and path of the fire ball; radiation and temperature of the fire ball; and mach wave and air velocity. It is estimated that over 100,000 photographic images, mostly from motion-picture frames, were taken to document different aspects of the test. The color photographs were not released, because the color of the blast provided information on the temperature of the fire ball.



Instrumentation box found during survey (HSR photograph file).

Further historic documentation of the types of instrumentation that were used is necessary. Historic photographs show various styles of metal boxes with instruments. These raise questions about what the recorders and cameras in the boxes looked like and what might be left of the instruments among the artifacts recorded within the Trinity Site. The instruments and recorders

undoubtedly were removed, in most cases, leaving only stands, wires, batteries, or similar nondiagnostic traces of what might have been installed there.

Detached Areas

Three Trinity-related areas have not been documented since they lie beyond the NHL boundaries. These areas consist of Campaña Hill, the Government Road, and a possible range camp.

Manhattan Project scientists and VIPs assembled during the early morning hours of July 16, 1945, to observe the nuclear test at the Cerro de la Capana (commonly called Campañia or Compagnia in the literature), 22 mi northwest of Ground Zero. This area lies outside the Trinity Site boundary on public land administered by the Bureau of Land Management (BLM). At present, WSMR leases the area.

Whether facilities to monitor the nuclear blast had been constructed at this observation point has not been ascertained. From the air it is possible to see the jeep road to the top of the hill.

Government Road was constructed in 1944–1945 to transport Jumbo from a railroad siding at Pope, south of Trinity, to Ground Zero. Paralleling this roadway, instrumentation and communication lines were constructed, connecting Ground Zero to facilities erected at West 10,000 (LA 100,890). Within the Trinity Site, the former Government Road is now a paved range road. Portions of the road may exist across BLM land to Pope.

Bainbridge (1976:34) mentions tests scheduled for a range camp at the Lava Bed. There is a lava bed between Trinity site and Pope, to the west of the present WSMR boundary. This is almost certainly not the lava bed on Mailpais to the east of the Oscura Mountains, because observation of the explosion would have been blocked. Survey at the western lava bed may reveal evidence of a camp used for observation, alpha and gamma meters, tolerance tests, and radio communication.

Trinity Summary

Throughout the Trinity test, from its inception at Los Alamos to the final countdown, the operations were characterized by adaptability, flexibility, and innovation. Before the test site on the Jornada was staked, a schematic had been prepared. At the same time, the teams identified existing local improvements—roads, wells, houses—that could be used for the project.

The equipment used to monitor the test was fabricated especially for this test except for only a few cases. An example is the mechanical impulse gauges. Conversely, most of it was devised on-site, with considerable ingenuity, from commonly available materials and hardware. As a result, the archaeological record is sometimes difficult to interpret, since much of it consists of generic fragments of pipe, lumber, nuts and bolts, etc., rather than specialized (and thus specifically identifiable) apparatuses.

Changes in bunker designs began at Los Alamos, prior to construction of the Trinity Site. A comparison of the preliminary site designs with the final construction drawings shows a concern for strength and protection. In the designs for the personnel and generator bunkers, structural members were consistently scaled upward (8-by-8-in. posts rather than 6-by-6-in. posts, 10-by-10-in. beams rather than 6-by-10-in. beams, and so on). The original design for the Fastax camera bunkers at West and North 800 had only a front berm; this was

expanded to surround most of the structure. According to Bainbridge (1976), the bunkers were ultimately designed to withstand the force of a 200-kiloton blast.

Modifications continued in the field. For the main camera bunkers at West and North 10,000, the ports were reconfigured and the projecting slab on the bunker at North 10,000 was reduced by two-thirds. For the Fastax camera bunkers, concrete culvert sections were substituted for the steel pipe that was specified. Two new bunker designs, for Northwest 600 and North 1000, were produced just before the test, because of last-minute concerns about obtaining sufficient data on implosion and radiation.

As construction continued on facilities at Trinity, procurement was identified as a problem (LANL 1986). Some of the adaptations may have been dictated by availability of supplies.

The physical remains of the Trinity test, from artifacts to structures, reveal that this was an enterprise with constantly changing parameters, influenced by the availability of time, materials, and equipment, and by both continually revised calculations and sheer guesswork, since nothing like this had ever been attempted.

Trinity Site Since July 1945

In a memorandum written in May 1945, K. T. Bainbridge expressed his concerns about the effects of the test on the immediate landscape itself: "It may be that sufficient 49 [plutonium] is left in the soil in the vicinity of the shot to make it hazardous for a considerable time after the shot....If this land is heavily contaminated and must be fenced in for a considerable time after the test, then certain legal problems will arise because some of this land is homestead entry land, some is federal grazing land, and some is state grazing land." The land is still contaminated, but now at such a low level as to pose a negligible hazard. The radioactivity is concentrated in the trinitite, which possesses gamma and beta radiation. The gamma radiation is in minute quantities, while the beta radiation would only pose a hazard if a sizable quantity were ingested. Much of the trinitite has been buried or removed by souvenir hunters over the years. Buried trinitite was later retrieved from pits, placed in barrels, and removed from the area.

Ground Zero was initially fenced with barbed wire and wooden posts in late August 1945, and mounted patrols continued around the perimeter until early 1947 (Maag and Rohrer 1982). In 1946, an octagonal reinforced-concrete bunker was constructed 40 ft below grade at a point 550 yd east of Ground Zero, for the purpose of testing the design of an alpha-n initiator. The radioactive charge did not detonate successfully, but the experiment was repeated at a point 550 yd north of Ground Zero; the second time it worked.

In 1947, Jumbo was damaged during an improperly conducted explosives test of the container's design. Buried after this test, Jumbo was disinterred in 1951 and finally removed to the outer Ground Zero gate in the early 1970s.

The Army authorized salvage operations at the Trinity test site in 1952. These activities included the removal of the wooden cross arms, insulators, and copper wire from the communication and instrumentation lines. Steel and iron fragments were salvaged. By the mid-1970s, the Defense Nuclear Agency had established its own testing ground for nuclear simulations south of the Trinity Site area.

Although severely restricted before,

during, and after the nuclear blast, visitation to Ground Zero is increasing. Systematic scientific study of Ground Zero occurred immediately following the nuclear blast and continued through the 1950s. The military, Manhattan Project personnel, and academicians all conducted on-site investigations (Szasz 1984). Additional investigations, particularly health studies, have taken place since.

Preservation and interpretation have been the objectives of National Park Service visitations to Ground Zero. Beginning a short time after the blast, the general public has been allowed to visit Ground Zero in increasing numbers. An interpretive sign, first erected by the Army in the 1950s, addresses public education about the site. A new chain-link fence erected in the 1950s replaced the original 1945 barbwire and wooden post fencing surrounding Ground Zero.

Radiation levels in the fenced area at Ground Zero are low. On an average, the levels are only 10 times greater than the region's natural background radiation. A one-hour visit to the inner fenced area will result in a whole body exposure of .5 to 1 milliroentgen, roughly equivalent to a 3-hr jet flight. Current standards are 100 milliroentgen per year for members of the general public. The green, glassy trinitite is still radioactive and must not be picked up.

Today, tours open to the public are conducted in April and October. Points of interest include the George McDonald Ranch, Ground Zero and the shelter protecting an area still paved with trinitite, the remains of Jumbo, West 800, and communications-line poles.

GEORGE MCDONALD RANCH

The George McDonald Ranch (LA 100,001), located on the slopes of the Oscura Mountains, is a historic ranch dating to the late nineteenth or early twentieth century. The former sheep and cattle ranch is listed on the National Register of Historic Places for its role as a field laboratory used to assemble the core of the first atomic bomb, detonated nearby on July 16, 1945.

Ranch History

Local historian C. L. Sonnichsen (1965:119-120) states that the fugitive Texas outlaw Henry (Baldy) Russell developed a well 1 mi west of Lava Gap and later another well, farther north, to water his livestock. The first of these was purchased by Thomas McDonald; the second was part of the property Russell sold to two Germans, from near Engle, New Mexico, Fred and Frank Smith, in 1895.

There is some evidence that German immigrant Franz Schmidt may be the Frank Smith that Sonnichsen referred to. Granddaughter Rosemary Hall, in a letter to the WSMR Public Affairs Office in 1986, notes that Schmidt immigrated to this country at the age of 17. The Socorro County Census for 1900 lists a Frank Schmidt and a Fred Schmidt as county residents with the occupation of stock-raiser. Frank Schmidt's birth year is listed as 1863, and his date of immigration as 1882, two years later than Hall estimates. Henry Russell is listed as a Socorro County resident at the same time.

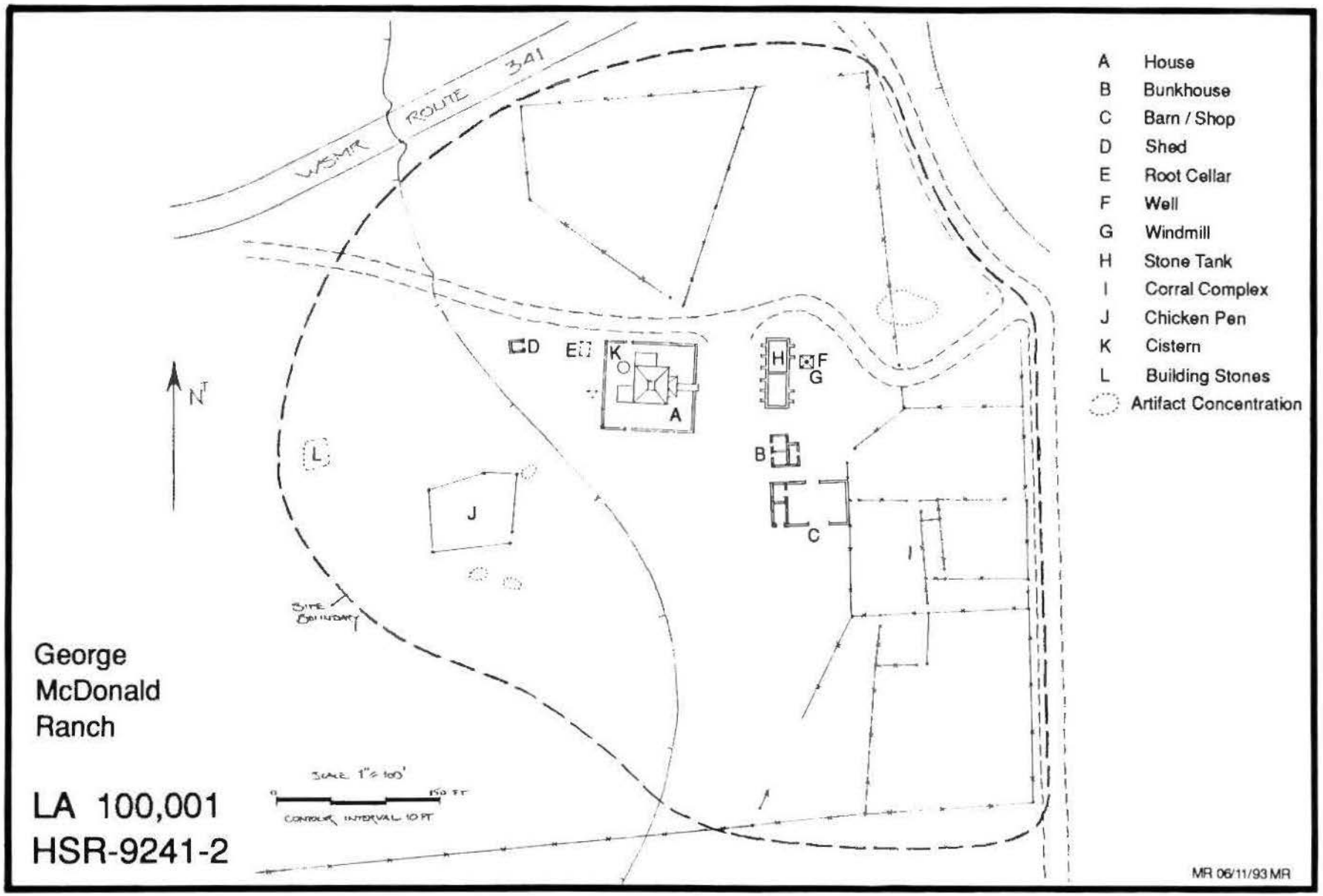
In her letter, Rosemary notes that Franz Schmidt married her grandmother, Esther Holmes, of Pearsall, Texas, in 1906. The couple then reportedly established a ranch near the Oscura Mountains on land that was partly purchased and partly homesteaded. She credits Schmidt with having built the existing ranch house in late 1912 and early 1913.

"The original homestead and house was 1 mi down range," wrote Hall. "It was burned when my grandmother was in town for the arrival of her second baby....The house at Trinity Site was then built." The family lived in a barn at the original homesite while the current house was being built.

The Schmidt family apparently lived in the new house only a few years (Rieder 1992). It was sold to a rancher named Snyder when Schmidt's health began to fail (Hall 1986). In a 1991 interview, Howard McDonald reported that George McDonald had bought the ranch from Snyder (Rieder 1992).

The McDonald family had ranched in the area for some time. Dave McDonald (1984) states that his grandfather, Michael, immigrated from Cork County, Ireland; fought in the Confederate army; and moved to Texas. Michael's son, Thomas, was born in Texas in 1870, and at the age of 4 or 5, helped the family move to the Sacramento Mountains of New Mexico. Upon his marriage, Thomas took his bride to Arizona briefly, returning to New Mexico in the late 1880s. Michael McDonald had decided to go into farming near Tularosa, so Thomas bought Michael's cattle and moved to the Mockingbird Ranch in the Jornada del Muerto.

Thomas McDonald set about acquiring wells and springs and bought eight other ranches near the Mockingbird Ranch. Dave McDonald (1984) refers to this ranch as the



Site LA 100,001 (HSR 9241-02), George McDonald Ranch plan.

home ranch. George McDonald, Dave's brother, was another of Thomas' eight children. When George acquired the property that is now known as the George McDonald Ranch is uncertain. However, he filed a homestead patent for 320 acres in 1942.

Starting in 1942, the Army acquired much of the 3,200-sq-mi area now known as White Sands Missile Range for a bombing range. Six McDonald ranchers were displaced: Tom, his sons George, Dave, Rube, and Ross, and his daughter Emma (Mrs. Cicero) Green. The George McDonald Ranch was acquired by the U.S. Army in 1944, according to the Historic American Building Record (HAER). The ranch probably was used by military police who occupied the area that year. They reportedly used horses, and a photograph indicates that they may have been stabled at the ranch (Historic American Engineering Record [HAER] n.d.).

On July 12, 1945, scientists assembled the bomb's plutonium core here, in the presence of Robert Oppenheimer. It was then driven to the base of the tower at Ground Zero and inserted into its housing (HAER n.d.).

The House and Related Structures

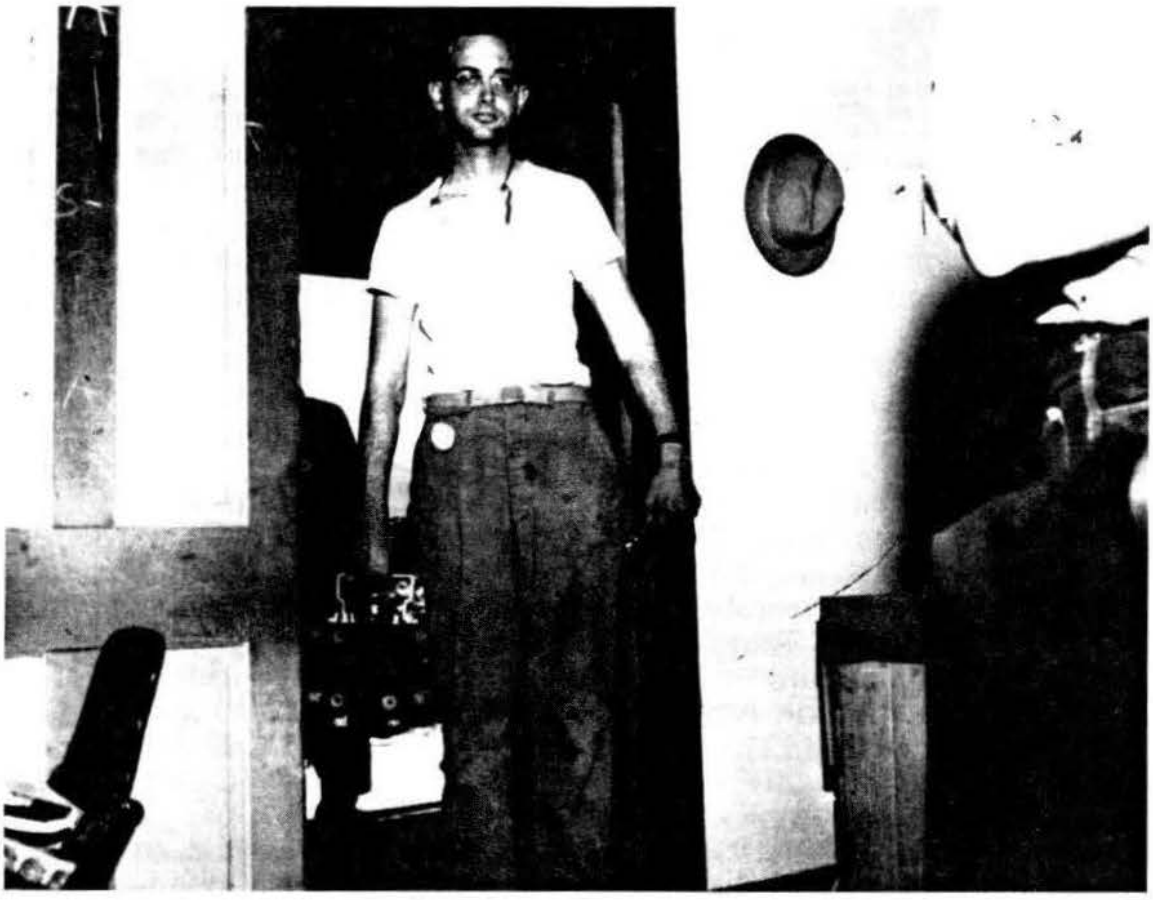
The house, which faces east, was adobe bricks that were reported by Hall to have been made on the site. The exterior walls had a "pebble-dash" finish, while the interior walls were smooth plaster. The house had wood floors, a tin roof that was bolted to the walls because of high winds, and semicircular concrete steps at the front. HAER documented a wooden porch 7 ft deep and 20 ft long with railings and balusters on the front of the house. In 1983, HAER (n.d.) noted damage that occurred as the result of the blast 2 mi away and reported that the porch roof had collapsed, and its deck was rotting.

The main portion of the house measured 36 by 32 ft. Its long side faced east. The interior of this portion was divided into four rooms—one room was a kitchen and one served as a parlor or dining room (HAER n.d.). Hall notes that the kitchen was pale gray and had a Magic Chef woodstove for cooking. Kitchen lighting was two kerosene lamps with reflectors. The southeast room, the living room, was pink or peach colored. The master bedroom, the northeast room, was pale green. This room was later usd to assemble the bomb core. The northwest room, which was blue, belonged to Hall's mother, Frances. The younger children slept with their parents (Hall 1986).

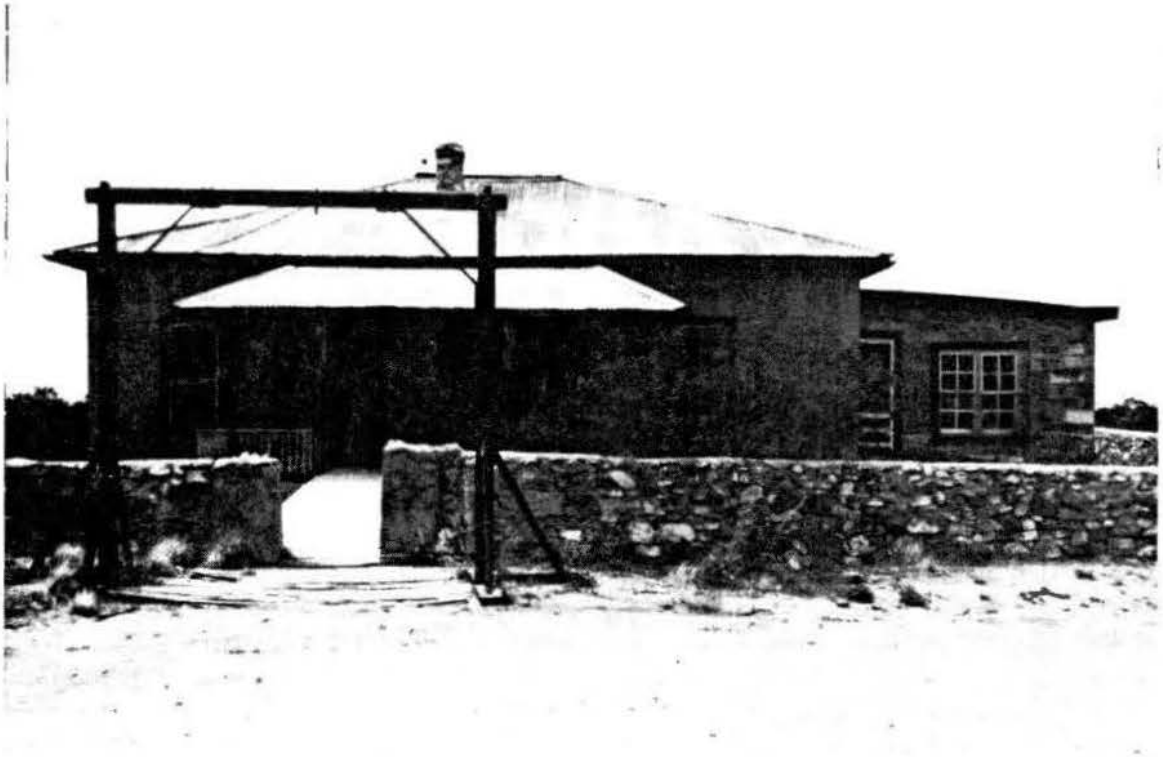
Ceilings were cream-colored. This lighter paint also extended 18 in. down the wall from the ceiling, and in the southeast room, the lighter paint was separated from the rest of the wall with a stenciled design. The stencil scrollwork reportedly was executed by Mike Walsh of Chicago, who drove and maintained the Schmidts' car, a Dodge, which was among the first in the area (Hall 1986).

Additions were built onto the house on the north and west. The north addition, 15 by 21 ft, consisted of two rooms. It was built of stone with adobe mortar. The interior was plastered; the exterior was not. On the west, an 11-by-16-ft addition served as an ice house. It was plastered with adobe mud inside and out. Inside were two closet-sized rooms over a basement where the ice was stored (HAER n.d.)

"The ice house area was joined to the house by an open breezeway, roofed but no doors on either end," wrote Hall. "The steps [like those at the front of the house] were half



Delivery of the active material to the George McDonald House (WSMR photograph file).



George McDonald House after NPS reconstruction (HSR photograph file).

circle, also."

The house had 13 windows: 8 on the main portion of the house and 5 on the northern addition, two of which formed a double window on the east side (HAER n.d.). Two doors, one from the southeast and one from the northeast room, led onto the porch on the east side of the house. The northern addition also had two doors. A back door opening from the kitchen on the west provided access to the ice house.

The house is believed to have been heated by butane, probably from a tank buried somewhere near the house (HAER n.d.). Although there are no fireplaces in the house, there are flue openings and two chimneys. Water was supplied by runoff from the roof, which passed through a charcoal filter before it was collected in a cistern that measures 9 ft deep and 7 ft in diameter located just west of the house (Hall 1986; HAER n.d.).

When the house was used for the Manhattan Project, workbenches, electric lights and outlets, and a telephone were installed in the northeast room. Also in this room, windows were covered to make them dust-tight. A sign was painted on the door, "Please use other doors-keep room clean." Shortly before the bomb test, a wooden ramp and platform were built over the porch (HAER n.d.).

The house was surrounded by a low stone wall, about 4 ft high and 1 ft thick. It was made of rubble held in place with adobe mortar (HAER n.d.). The stone work on the wall and elsewhere was done by a Norwegian stone mason, John Finago, who reportedly did similar work on a house at Hansonburg Hills, also a part of the ranch (Hall 1986).

The ranch had a number of appurtenances and outbuildings. Outside the wall surrounding the house, at the northwest corner, was a concrete-lined root cellar. Across from the front of the house was a concrete water tank 65 ft long, 20 ft wide, and 6 ft deep. The tank was divided into two compartments. Water was supplied to the tank by a windmill just east of it (HAER n.d.). The mechanisim for the windmill is lying on the ground; a gas-powered engine apparently replaced it.

At the time the ranch was being used as a field laboratory for the bomb test at Trinity, the water tank provided a much-needed diversion from the long hours, the tension, and the heat. The scientists and technicians sometimes used the tank across from the house to cool off.

"I remember a fairly large concrete tank at the McDonald Ranch house," said Benjamin Diven, a Trinity Site technician. "I don't remember swimming—you couldn't exactly swim, it was too small for that. But in the 110-degree weather, it was nice to jump in the water and splash around" (Diven interview by Beth Morgan, 1993).

South of the reservoir was an L-shaped bunkhouse built of rubble rock held together with adobe mortar. It had four rooms, one of which had a fireplace, and a 12-ft-deep cistern just south of it.

"The bunkhouse was a small tool/tack room, a room for my grandmother's brother, Frank Holmes, and Mr. John Finago. The room on the back of it was a storeroom for groceries and other supplies," Hall (1994) wrote.

There was a large barn south of the bunkhouse, with two rooms on the west and a large central interior room. The barn measured 41 by 71 ft. Railroad rails supported the ceiling beams and formed door lintels. Joining it on the east were the corrals, holding pens and watering troughs (HAER n.d.). Also in this area were a number of corrugated metal sheds for storage and housing poultry

and hogs.

Restoration and Stabilization Efforts

Some damage occurred at the ranch at the time of the bomb test at Trinity. Most or all of the glass windows were broken, the barn and house roofs were damaged, and chimneys may have collapsed at that time (HAER n.d.). After the test, the house apparently sat empty for many years. In 1984 the National Park Service restored the house to its appearance just before the bomb test (Rieder and Lawson 1994). Walls of outbuildings were also stabilized at that time. The house has not recieved any routine maintenance; it continues to be impacted by explosives tests in the area and an increasing volume of visitors. Outbuildings are deteriorating (Rieder and Lawson 1994).

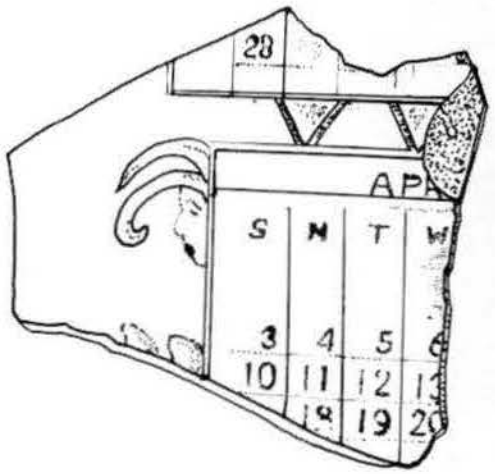
MCDONALD BROTHERS RANCH

The McDonald Brothers Ranch/ Trinity Base Camp (LA 82956) is a historic cattle ranch probably predating to 1910 (Rieder and Lawson 1994). It lies at the end of the gradual slope running west-northwest from the Mockingbird Mountains into the basin, about 9 mi southwest of Ground Zero (HAER n.d.). During preparations for the test of the first atomic bomb, it served as base camp for scientists and military personnel. In addition to these uses, an artifact scatter found at the ranch suggests that it was first used by Mogollon or Anasazi peoples during prehistoric times.

Ranch History

Little is known of the prehistoric occupation of the ranch area. If structural remains or other features were present, they have been obscured by ranch and base-camp disturbances (Rieder and Lawson 1994). The evidence includes a low-density chipped-stone scatter that covers the western portion of the ranch/base camp site. Several concentrations of artifacts are present. In addition to flakes of chert, chalcedony, and quartzite that are the byproducts of stone-tool manufacture, four projectile points, three cores, a scraper, and a metate fragment were found. One of the projectile points dates to the Late Archaic period (1800 B.C. to A.D. 200); two others may date to the Early Pithouse period (A.D. 200 to 750). The fourth is thought to date to between A.D. 1000 and 1700.

Architectural evidence suggests that the adobe ranch house was built about 1910. A piece of historic white ware collected from the ranch helps date it. The plate fragment reveals a portion of a calendar for the month of April, with the 3rd day of the month falling on a Sunday. This dates the plate to either 1904 or 1932. Historic records do not reveal the identity of the original rancher (Rieder and Lawson 1994).



Calendar plate fragment.

Tom McDonald purchased the ranch from Vivian Eanes (Ria Lee Sidwell interview, by Beth Morgan, 1995). The earliest mention of the property in Socorro County tax records, a tax payment by Dave and Rube McDonald to Dave's sister-in-law Vivian Eanes for "improvements made on government land," is recorded for 1925. Eanes was granted a stock-raising homestead patent in 1927 (Rieder and Lawson 1994). According to county records, that same year, Eanes sold the ranch to Dave and his brother for $100. Dave McDonald (1984) states the house was bought in November 1924.

Rube, Dave and his wife Mertis, and brother Ross McDonald lived in the adobe ranch house year-round. After their marriage in 1935, Rube's

Base camp with historic ranch buildings (WSMR photograph file).

wife, Ria Lee joined them. Rube later sold his share in the ranch to Dave and Ross. In 1938, upon his marriage, Ross built a frame house at the ranch, where his son Howard was born. Until 1942, the brothers ran up to 500 head of cattle on their 640 acres of patented land and additional leased land. At that time, the government established the Alamogordo Bombing Range and the ranchers were evacuated (Rieder and Lawson 1994).

Two years later, the ranch was selected as base camp for the Trinity test, and in 1945, some 350 staff members were stationed there, using existing ranch facilities, newly constructed buildings, and Army hutments with wooden floors. Once the test was completed in July 1945, the base camp was dismantled and vacated. Following the conclusion of the war, the McDonalds were allowed to return to their ranch under a cooperative-use arrangement. However, this did not last. The ranchers were again evacuated in the early 1950s. After lengthy litigation, the government formally acquired the ranch in the late 1980s (Rieder and Lawson 1994).

Houses and Other Structures

When the government took possession of the ranch in 1944, two ranch houses, several outbuildings, an earthen reservoir, two or more windmills, and a water tank were present (HAER n.d.).

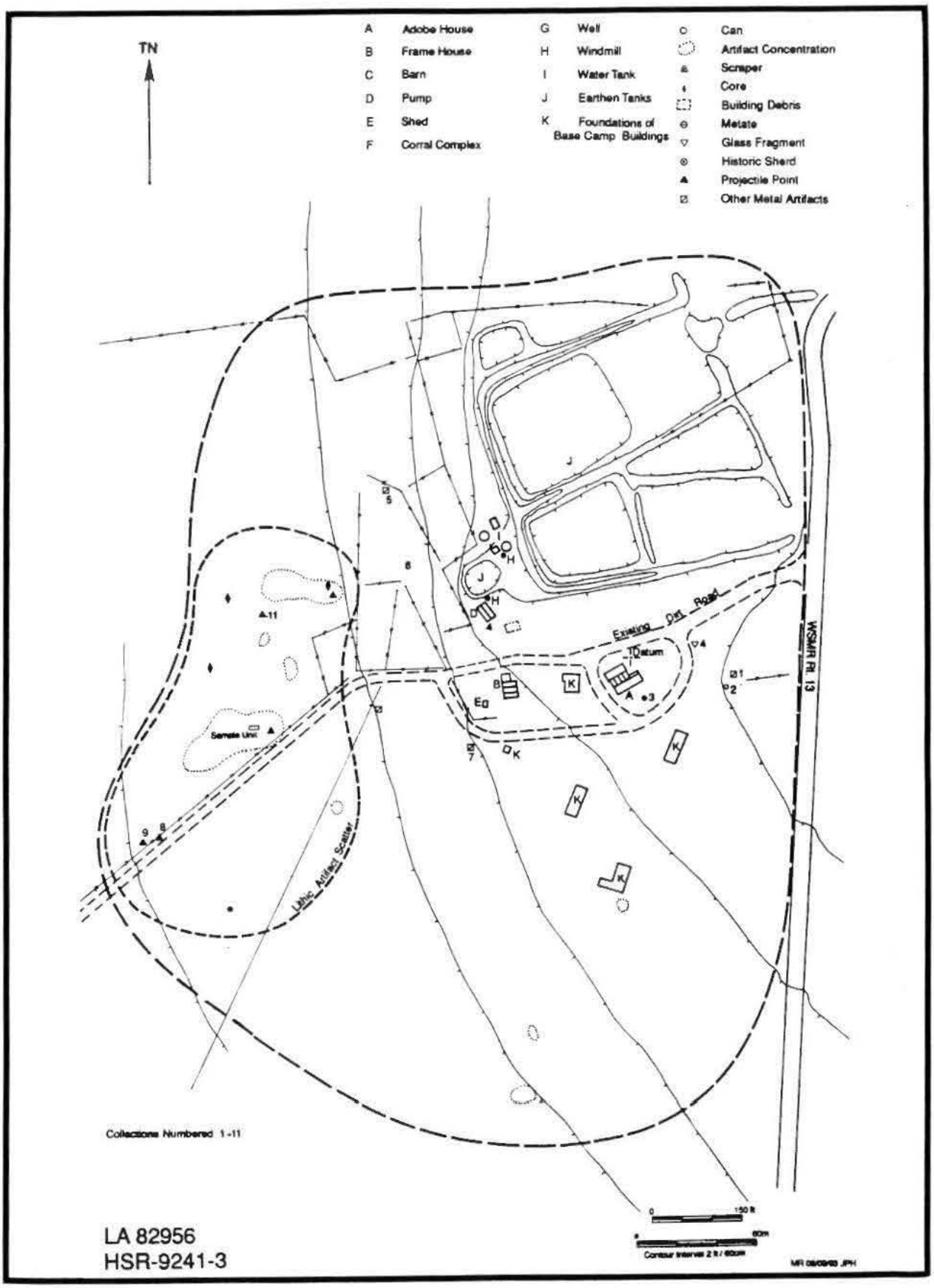
The H-shaped adobe house, the easternmost of the two houses, had three main sections. The central section measured 20 by 30 ft. The northern wing was about 35 by 20 ft, and the southern wing was about 50 by 25 ft. There were porches on the west side of the central portion, and on the north side of the south wing. The central portion of the building had a pitched roof; the wings had shed roofs. All roofs were corrugated metal. There was at least one interior fireplace (HAER n.d.).

The frame house, about 100 ft west of the first house, was a simple rectangular wood-frame structure, measuring about 25 by 40 ft. It had a 20-ft-wide addition running the full length of the north side. Exterior walls were finished with tongue-and-groove siding. The roof was corrugated metal. The house probably was heated with a wood-burning stove (HAER n.d.). Photographs of the base camp show that the wooden house was covered with a light-colored paint.

Both buildings apparently had four-over-four wood sash windows, except the northern addition to the second house, which historic photographs indicate had three windows with six panes each (HAER n.d.).

The frame house apparently was used as a laboratory in March 1945 and had a photographic trailer backed up to its south side. Later, a hutment was attached to its north side. Electricity and running water were provided to it for processing photographs (HAER n.d.). Since 1945 the roof has collapsed and most of the windows are missing.

There were several outbuildings near the houses. To the north were two adobe structures, between the houses and the earthen reservoir. One, about 20 ft sq, may have been a barn or garage. The remaining walls are no more than a few adobes high. A second building, about 15 by 25 ft, may have housed a gas motor to operate the water pumps or a DC generator and battery. The walls for this building have collapsed, but the roof is mostly intact. Inside is a cistern or well. Historic photographs indicate that a pump jack may have been situated between the windmill and this building. A wood shed was



McDonald Brothers Ranch and Base Camp plan

about 40 ft west of the frame house. All of these buildings had corrugated metal roofs (HAER n.d.).

Another building, referred to as a garage, was situated between the two ranch houses (HAER n.d.). For purposes of the Trinity Test, a concrete floor was poured in it, and it was used to house a 50-kW generator plant. This building appears to have been of wood-frame construction, with tarpaper roof and wall coverings and two additions. Another building, referred to in Trinity Site memoranda as "southwestern ranch building" or "ranch building number 3," may have been one of the adobe buildings already described or a barn south of the ranch houses. It was also used as a laboratory.

Richard J. Watts, who built health-monitoring equipment for the Trinity Test, noted in a 1993 interview that he had some equipment in one of the adobe buildings, which he identified from a photograph as the one nearest the pump jack (Richard J. Watts interview by Beth Morgan, 1993).

Which building was actually the laboratory is unclear. However, several improvents were made during 1945: work tables, shelving, and electricity were added.

Three large exhaust vents remain on the ground. It is vague from the historic photographs which building they came from.

On the north side of the ranch complex was a series of earthen tanks. The banks of these were about 10 ft above grade level. A windmill stood to the south of these tanks. The pump jack mentioned above was roughly south of the windmill and was attached to machinery inside the closest of the adobe buildings. It appears that a water tank on a tower was installed during April 1945 (HAER n.d.).

In addition to the existing buildings, 10 Civilian Conservation Corps portable buildings, including four 20-by-100 ft units, a 20-by-60-ft unit, a mess hall and kitchen, three 20-by-50 ft buildings, and a 150-man latrine were brought in. These were erected south of the ranch houses (HAER n.d.). Later, an additional 20-by-100-ft unit was brought in and the latrine was expanded. Today there are two concrete foundations with plumbing for sinks, toilets, and showers. The portable buildings were used as barracks, and for supply, shop, and office functions. Around May, 1945, a swamp cooler was added at the Mess Hall. Besides the portable buildings, approximately 20 Army hutments, each about 16 ft sq, were set up at the base in the spring of 1945.

One of the buildings was used as a warehouse, which Trinity informants fondly called "Fubar" (fouled up beyond all recognition). It housed all kinds of electrical supplies, plumbing supplies, and hardware (Diven interview, 1993).

HAER (n.d.) documents state that in 1983, little was left of the McDonald Brothers ranch or base camp. The adobe ranch house was the most intact structure at that time. The frame house was deteriorating. The small wood shed west of the houses was still standing. All windows and doors were gone. The concrete foundations of at least two of the portable buildings remained.

Considering that there were up to 350 Army staff and scientists assigned to the base camp for more than 6 months, very few artifacts were found. One trash dump includes some military trash; lumber scraps, nails, and broken glass in the area of the temporary structures that may date to this usage of the site.

Reconstruction and Stabilization Efforts

Beginning in November 1994, WSMR, with HSR's services, undertook stabilization efforts focused solely on the adobe ranch house. Portions of the north and south walls of the house were replaced with adobe bricks made on the site, and three windows were reconstructed. During cleanup of the wall trash, a brick was found with a date. However, the end of the brick with the last two digits of the year had been cut off. Several areas were in critical need of plaster. The roof was covered with new tin, all openings covered with plywood, and the exterior grade around the house was corrected to allow water to run off.

HISTORIC RANCHING

A number of additional ranches were once occupied within the boundaries of the Trinity Site National Historic Landmark. Six of these were recently documented. Ranching-related sites have features such as houses and outbuildings, earthen tanks for stock watering and corral complexes, and trash dumps.

Story Ranch

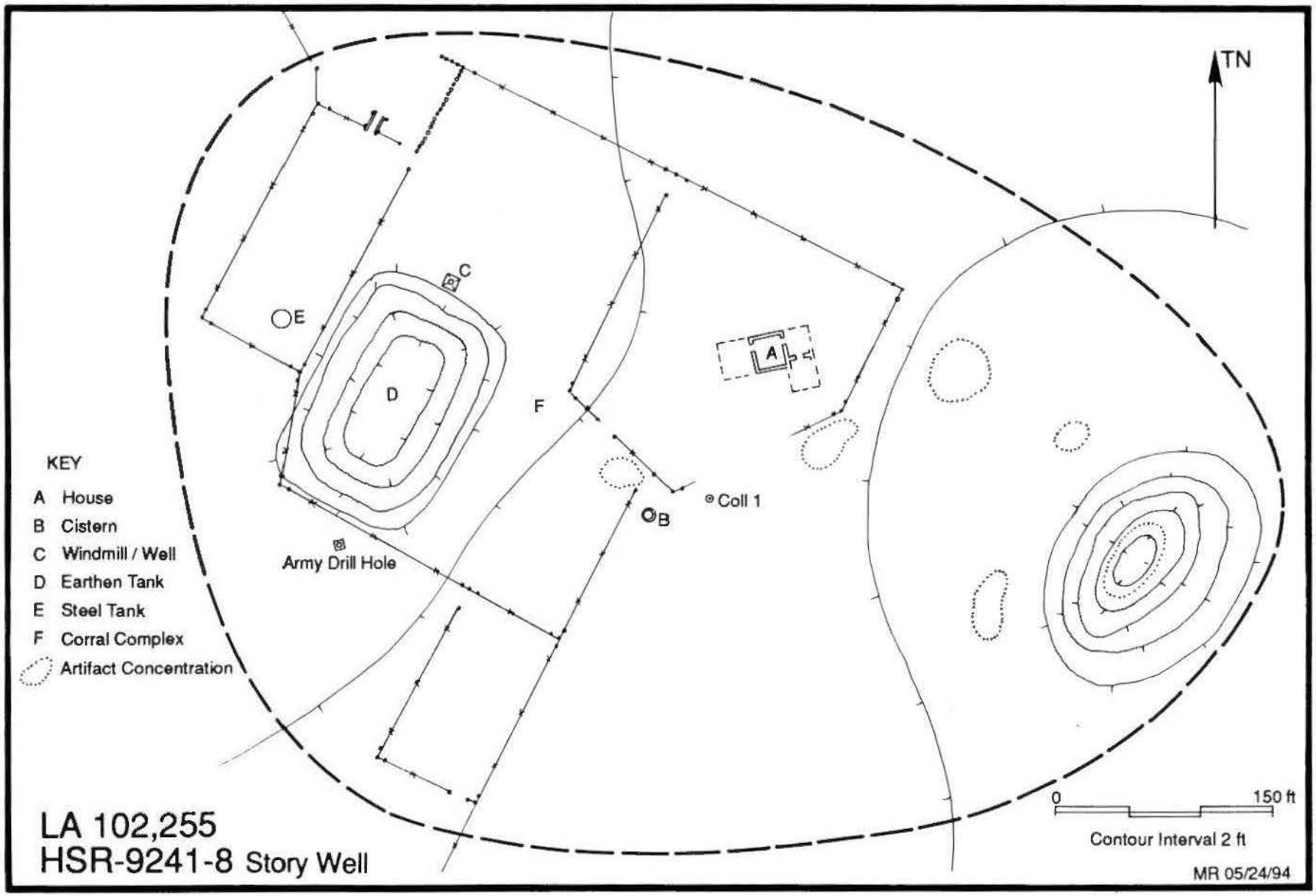
Story Ranch (LA 103,779) dates from the New Mexico Statehood/ World War II period (1912–1945). The site lies on the lower part of the gradual slope running west from the base of the Oscura Mountains into the Trinity Basin. This historic ranch consists of a house, outbuildings, several structures, and dispersed historic artifacts associated with a livestock economy.

The ranch house, built of adobe brick finished with lime plaster, had four rooms in a T-shaped plan and a pitched roof of corrugated iron (Feature A). The front yard was enclosed within a low sandstone wall. East of the house are two outbuildings of sandstone masonry, which had shed roofs at one time (Features B and C). Remains of other domestic features include a root cellar (Feature D) and two cisterns for catching water (Feature I). A well, originally hand-dug, which has a wooden tower with an Aermotor windmill (Feature E), is located adjacent to the sandstone masonry outbuilding on the north (Feature B). A walking beam connected the pumping mechanism of the well to an engine in this outbuilding. North of the well is an earthen tank of moderate size, with a stone revetment along the west berm (Feature G). Beyond this earthen tank is a complex of corrals that occupies the northern portion of the site (Feature F). A steel tank for livestock watering is also located within a fenced pasture east of the corral complex and north of the earthen tank (Feature H).

Historic artifacts occur in greater frequencies in the vicinity of the ranch buildings. This assemblage has a high proportion of glass fragments, the most common being purple, amber, and clear with some aqua and dark green. Purple glass is a temporal indicator. After 1880, manganese was added to molten glass to make it clear, but exposure to the sun turned the glass purple. Since the manganese was imported from Germany, it was not available during World War I and not used after that. Cans are mostly of the sanitary-seal type, with a few older-style hole-in-top cans. Sanitary-seal cans have lapped seams like modern cans; seams on hole-in-top cans were sealed with solder, and, as the name implies, the lid had a hole through which the can was filled. The cap for the hole was also sealed with solder. These older cans were replaced after 1902, providing another time indicator for this site. Ceramics include fragments of earthenware and white ware, which has transfer designs from the early years of the century as well as designs and colors characteristic of the 1930s. Other artifacts include both wagon and motor vehicle parts, oil cans, and miscellaneous hardware.

An isolated ground-stone fragment represents the only prehistoric artifact observed.

Modern intrusive artifacts include sections of sheet-metal ductwork, circuit boxes, a steel desk, and other



Site LA 102,255 (HSR 9241-08), Story Well plan.

facilities were used simply as a service node for ranching operations headquartered at the Story Ranch. This pattern was common throughout the area. Historic records indicate that Charles Story was established in the area by 1910; tax records indicate 1915 as the likely date for the construction of this adobe house at Story Well.

The house has collapsed, but the corral complex is largely extant, although deteriorating. While the wooden tower of the windmill is standing, the mill itself has collapsed. The Army has since drilled a well south of the earthen tank in the southwestern portion of the site.

Foster Ranch

Foster Ranch (LA 103,781) is a historic ranch dating to between 1912 and 1940. The site is located in the Trinity Basin; portions of the site are within playas.

The historic ranch consists of a house, an outbuilding, several structures, and scattered historic artifacts with one trash concentration associated with a livestock economy. The ranch house is built of adobe brick with lime and mud plaster. It probably consisted of an original two-room section, with two rooms added later to result in an L-shaped plan. A windmill is located just beyond the northeast corner of the fencing that marks a rectangular yard around the house (Feature E). Southwest of the ranch house are the remains of a frame and stone outbuilding, possibly a barn or shop (Feature B). Cisterns immediately west to northwest of both the ranch house and outbuilding collected water (Feature G). Beyond the outbuilding are a corral and a well (originally hand dug) with a collapsed windmill and small earthen tank (Features C, D, and F). An extensive earthen tank system with diverting berms (Feature F) collects water running into the playa.

Historic artifacts are scattered across the site. These consist primarily of purple, aqua, and clear glass container fragments, white ware and earthenware ceramics, and solder- and sanitary-seal cans. Several motor vehicle parts were observed intermixed with debris of the outbuilding, possibly indicating the vehicle was abandoned in a shed, which later collapsed around it. The range of historic artifacts, in conjunction with hewn juniper lintels and some cut nails in the older portion of the house, suggest that the site could date originally to the 1890s or the late Territorial period.

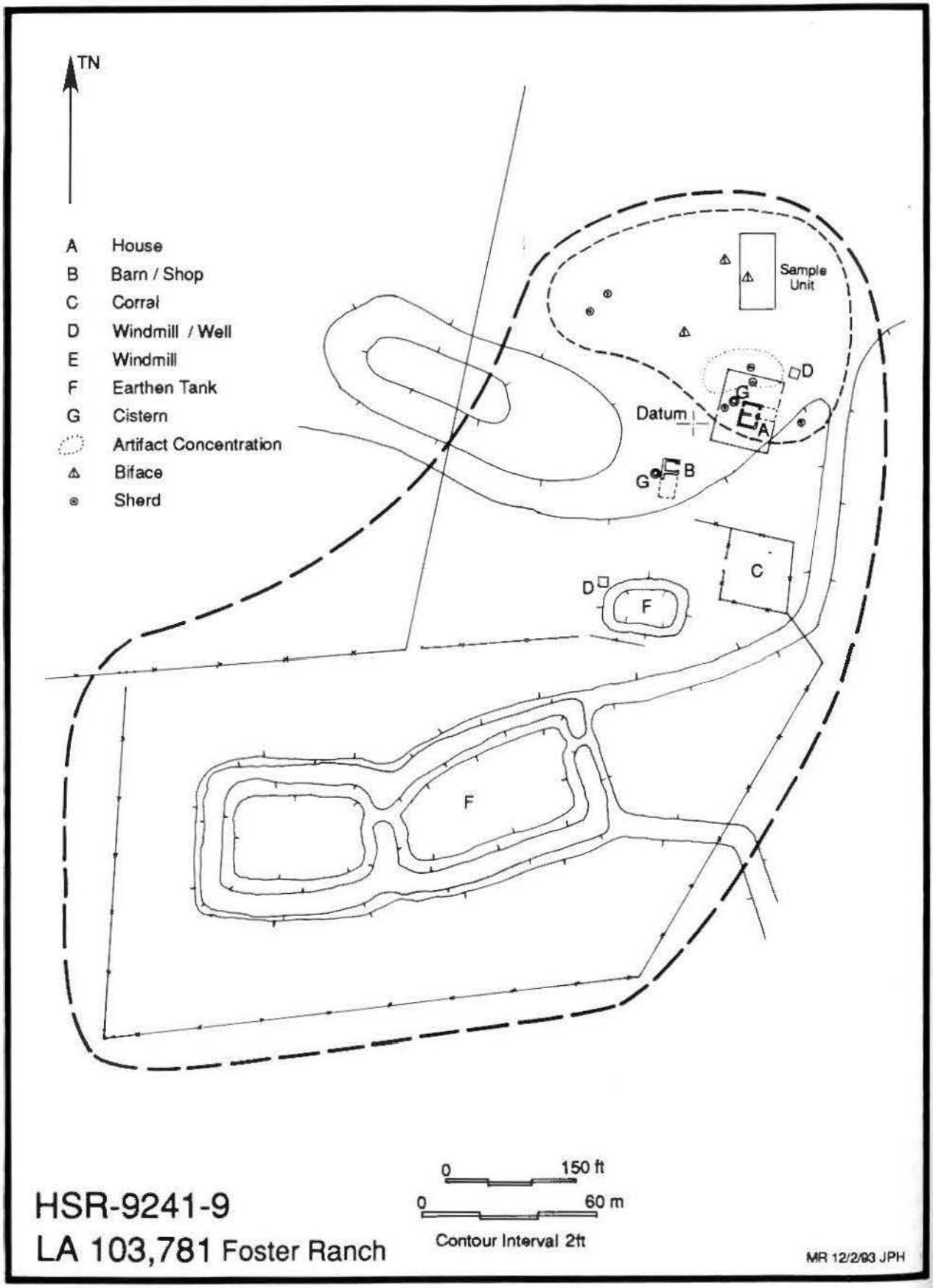
The roofs and several walls of the house have collapsed, and the outbuilding is entirely in ruins. Much of the corral is standing but deteriorated, and the windmill has collapsed.

Prehistoric peoples also found this to be a good area. Artifacts representing this earlier use include flakes, sherds, and three bifaces. Chipped-stone materials include chert, quartzite, petrified wood, and obsidian. Two of the sherds are Agua Fria Glaze-on-red dating from A[illegible]. 1275 to 1350. No prehistoric features were observed.

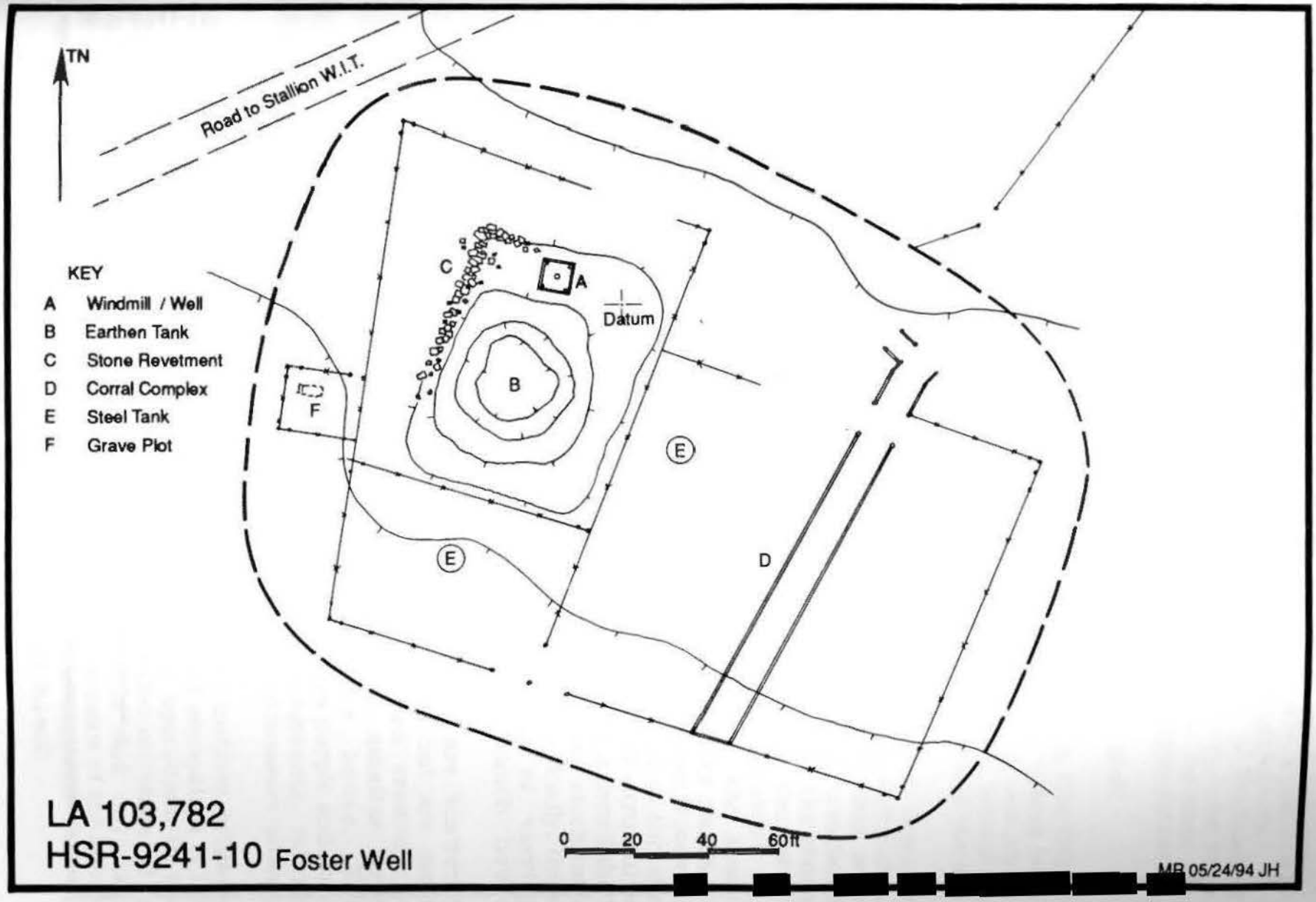
Foster Well

Foster Well (LA 103,782) is a historic ranching site dating to the early twentieth century. The site is located on the lower part of the slope running west-southwest from the base of the Mockingbird and Little Burro Mountains into the Trinity Basin.

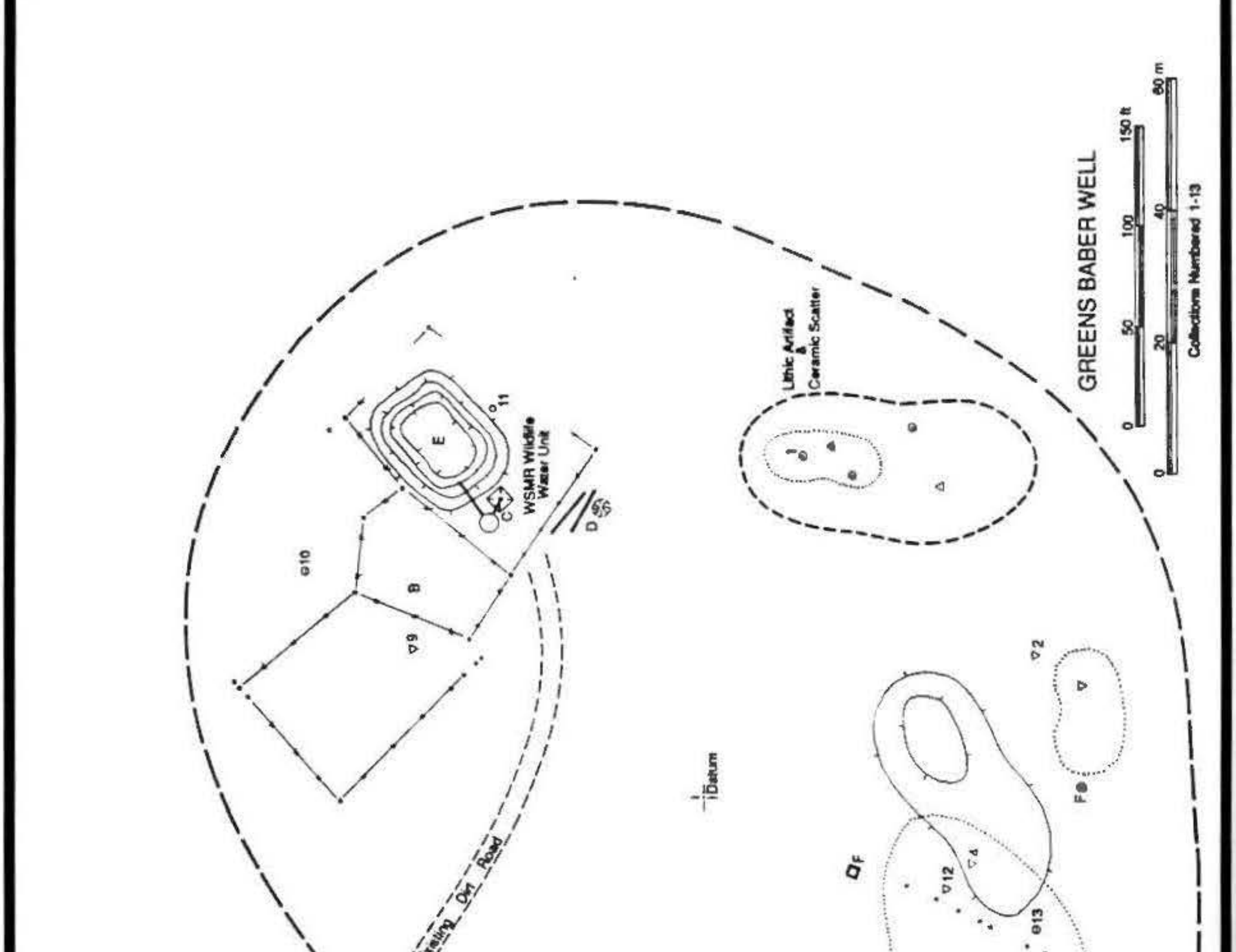
The site consists of several structures and a historic artifact scatter affiliated with a livestock economy. A drilled well, with wooden



Site LA 103,781 (HSR 9241-09), Foster Ranch plan.

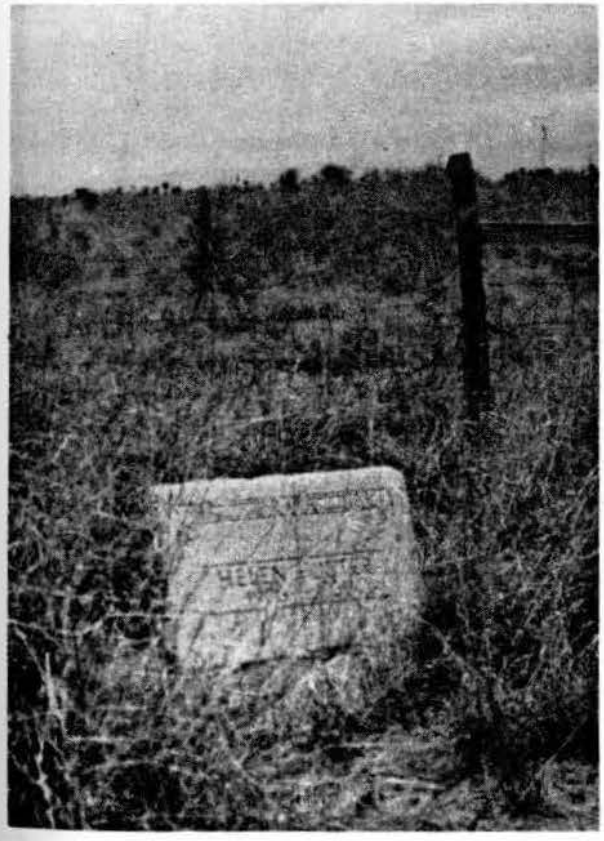


Site LA 103,782 (HSR 9241-10), Foster Well plan.



Site LA 103.780 (HSR 9241-11), Greens Babar Well plan.

tower and windmill (Feature A), is located in the northeast portion of the site, adjacent to an earthen tank (Feature B). This stock tank is surrounded by an earthen berm with a stone revetment in the northeast portion (Feature C). Fencing separates these structures from two corrals (Feature D), one of which formerly included a loading chute. West of the stock tank is a fenced plot with a headstone marking the grave of Helen Foster (Feature F). Two steel stock tanks are located within the corral areas (Feature E).



Tombstone for Helen Foster at Foster Well (HSR photograph file).

The historic artifact assemblage consists of a low-density scatter of purple and clear glass container fragments, along with miscellaneous hardware, horseshoes, and metal fragments. The range of artifacts and historic records suggest a post-19[redacted]0 date of use for this ranching site.

With the exception of the loading chute, which appears to have been demolished, the site's features are deteriorating but are largely extant.

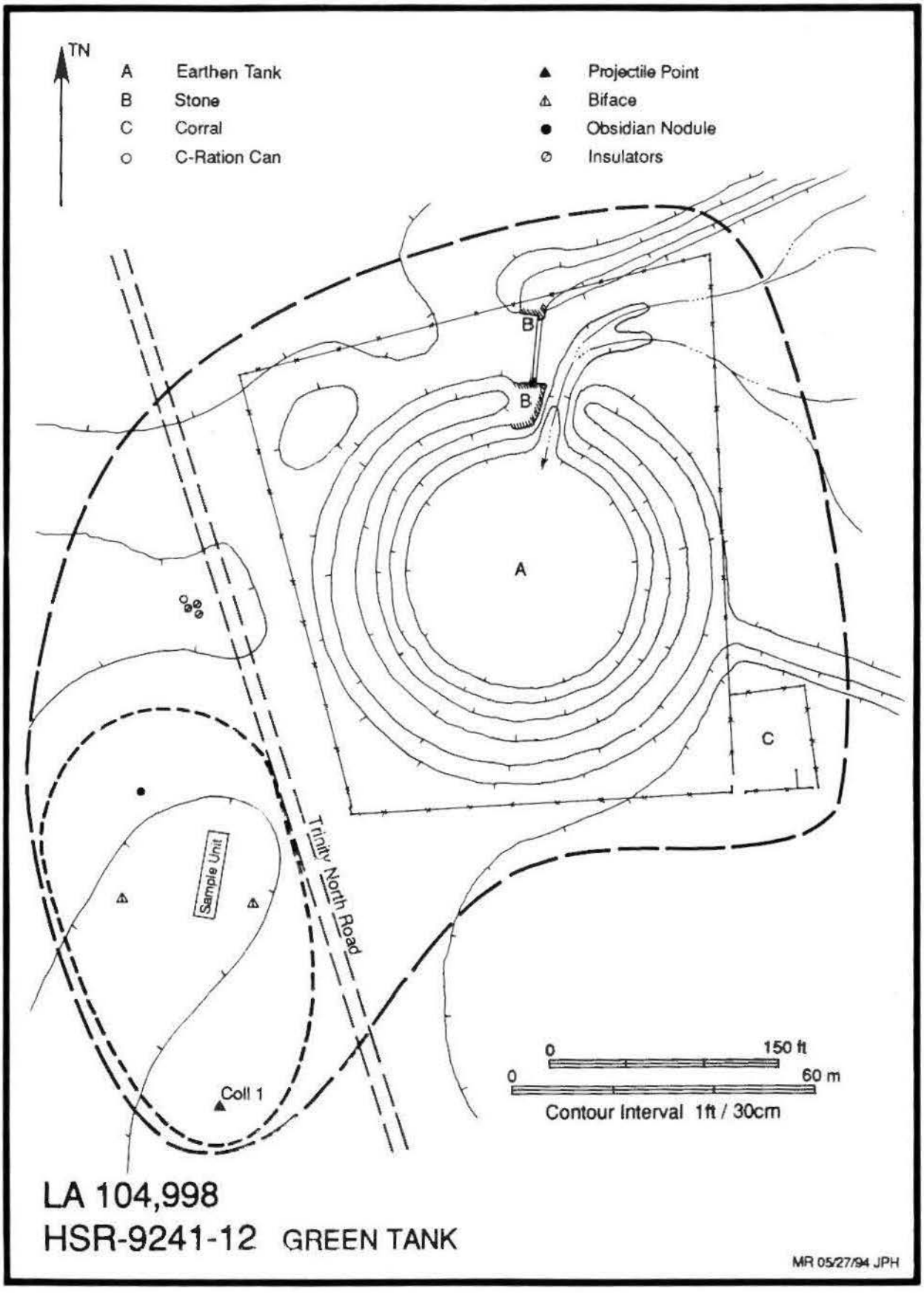
Greens Baber Well

Greens Baber Well (LA 103,780) is a historic ranching site dating from the end of the nineteenth century to World War II. The site is located in the Trinity Basin; portions of the site are within playas.

The historic ranching remains consist of a house, several structures, and a historic artifact scatter wi[redacted] two concentrations, all associated with a livestock economy. The ranch house is located in the southwest portion of the site (Feature A). Constructed of adobe, the house appears to have had three rooms at one time. A corral complex is located in the northeast portion of the site (Feature B). Associated structures nearby consist of a well, a demolished windmill, and an earthen stock tank (Features C, D, and E). Finally, three cisterns are located at varying distances from the ranch house (Feature F).

Historic artifacts are scattered throughout the site but are most densely concentrated around the house and in a smaller area southeast of the house. The assemblage includes purple and aqua glass container fragments, refined white ware and earthenware sherds, and metal buttons.

The range of historic artifacts indicates an initial occupation of the site for ranching operations in the 1890s; a date further corroborated by hand-hewn lintels and cut nails observed in the remains of the house. Historic evidence suggests that the



Site LA 104,998 (HSR 9241-12), Green Tank plan.

ranch complex could have been established by William or George Baber (or Babers), brothers who were in the area by the turn of the century. The property, a 160-acre homestead entry, was patented in 1913 and was acquired by J. F. Green in 1915. The headquarters for his and his son Cicero's ranch was about 6 mi to the northwest. Cicero was married to Emma McDonald, a sister to the McDonald brothers. After this, the site was used for ranching operations, and the house was no longer occupied.

The adobe house has mostly collapsed, as have the corrals. The former wooden windmill tower and mill are now wreckage, having been replaced by a steel tower and newer mill to serve as a wildlife water source. The wildlife water unit is accessed by a dirt road.

Located within the same area is a low-density artifact scatter of chipped stone and ceramics. The artifacts include flakes, two bifaces, and several fragments of ground stone. Chipped-stone materials include chert, quartzite, and siltstone. Six brown ware sherds were recorded both within the concentration and throughout the scatter. One sherd is an El Paso Brown ware body sherd dating from A.D. 900 to 1350. On the basis of the ceramic evidence, the prehistoric assemblage represents a probable unspecified Jornada Mogollon occupation dating from A.D. 900 to 1350. No features associated with the prehistoric component were observed.

Green Tank

Green Tank (LA 104,998) is an earthen tank dating to the beginning of the twentieth century, and the remains of a historic military installation associated with the Trinity Project of 1944–1945. The site is located on the gently rolling plain that extends north of the Trinity Basin toward Chupadera Mesa.

The historic ranching component consists of a large earthen tank and related structures associated with a livestock economy. The tank is located northeast of the Trinity North Road (Feature A). The tank is distinguished by its geometrical regularity, forming a circle 230 ft in diameter at the top of the berm. Berms on the north and east divert drainages, which are then channeled through well-laid stone revetments (Feature B) into the tank. The tank is enclosed by a quadrilateral fence, at the southeast corner of which is appended a small corral (Feature C).

No artifacts dating to the historic ranching period were observed. The tank is known historically to have been built around 1918 and definitely before 1927, as it appears on the General Land Office survey plat.

The historic military component consists of the remains of communication and instrumentation lines erected by the Army to connect Ground Zero with North 10,000. Erected between 1944 and 1945, these lines pass through the site, paralleling the associated Trinity North Road. Trinity-related artifacts observed within the site boundaries consist of several ceramic insulators and a C-ration can associated with activities related to the communication and instrumentation lines.

The tank, except for silting and a thick stand of tamarisk around the water channel, is intact; the fences and corral are deteriorated but standing. However, the Trinity communication line through this section is entirely down.

Evidence of earlier peoples was also found. The prehistoric artifacts consist of flakes, three cores, two bifaces, and a tested obsidian nodule.

A projectile point is possibly Late Archaic. The base of this projectile point has been reworked; it could have been picked up by a later hunter and modified. The temporally diagnostic projectile point suggests a Late Archaic occupation, possibly dating from 1800 B.C. to A.D. 200. No prehistoric features were observed.

Summary

In terms of land use, the historic ranching sites in the project area illustrate a shift that occurred in the first years of this century. Starting in the 1870s, cattle herds were trailed through Lava and Mockingbird Gaps and across this portion of the Jornada del Muerto, passing westward. Then, with the arrival of the Atchison, Topeka, and Santa Fe railroad in 1880, Engle, New Mexico, became a cattle shipping point. A handful of relatively large outfits dominated the cattle industry here at this time. In the 1880s and 1890s, one of these outfits, the Bar Cross, had their headquarters in Engle and Aleman, but the northern extent of their range included the project area (Hutchinson 1956; Rhodes 1968).

At the turn of the century, this part of the northern Jornada del Muerto was still mostly open range, practicable for large outfits, but the pattern was changing. A few families had already started ranching here on a smaller scale. This change from large-scale to small-scale livestock operations accelerated during the next decade and a half, as seen in the 1910 census and in the Socorro tax records for 1910–1915. By 1915, the pattern of relatively small, self-sustaining family ranches that existed here in 1941 had been established. Further to the north, a system of large holdings prevailed, as exemplified by H. O. Bursum's extensive sheep and cattle operations. These ranching families were isolated, for their only physical link was a rudimentary network of bad roads over long distances. However, as neighbors, they shared another network, less obvious but no less tangible, of cooperation and mutual assistance.

Exemplifying this new livestock economic pattern within the northern Jornada were such men as J. F. Green; Charles Story; Franz Schmidt; Thomas McDonald and his sons George, Dave, Rube, and Ross; George Eanes; and Mr. Foster. Through time, these men and their families lent their names to such enduring landmarks as Greens Baber Well, Story Ranch, Foster Ranch, and the McDonald ranches.

PREHISTORIC USE OF THE TRINITY SITE

For most people, Trinity Site is associated exclusively with the beginning of the nuclear age. However, over 8,000 years of human activity have left evidence in the archaeological record. Prior to the military takeover of the area in the 1940s, this activity was based upon adaptations to and exploitation of a challenging natural environment. Similarly, historic and Trinity-related use of the Trinity Basin were adapted to available water, vegetation, terrain, and factors such as isolation.

Without written documentation, the interpretation of prehistoric peoples requires more sites viewed from a larger area. Prehistoric use of the Trinity area has been identified through more than 20 archaeological survey projects, but these have covered less than one-quarter of the 50,000 acres. Such surveys are required when there is a potential that planned military use will affect the prehistoric or historic property.

Almost 50 prehistoric sites have been documented in the area. These prehistoric artifact scatters, some with hearths, provide a pattern of use for the Trinity area and the northern Jornada del Muerto.

In the absence of architecture, archaeologists can only surmise that prehistoric use of the basin floors within the Basin and Range Province was restricted to ephemeral camps. The artifacts and hearths represent repeated, dispersed use of an area, with no one episode of use representing more than a short stay. As expected with such a scenario, the majority of the archaeological remains are scattered and of low density.

The few sites that are found with high densities of surface artifacts present a puzzle. Do the higher densities represent repeated use by the same or a different group (potentially thousands of years apart) or high-intensity use representing a longer stay within one season or over a few years.

Low-density artifact scatters, which are assumed to represent very low intensity of use, are difficult to date without the datable or stylistical distinctive artifacts—painted ceramics or projectile point styles.

Two archaeological sites contain remains that were identified as Paleoindian. Some Paleoindian lithic tools are very distinctive shapes and easy to recognize, while the materials used by the Paleoindian hunters were of better quality than selected by later flintknappers and are sometimes heat treated so that they are easier to work. Within the Trinity Area, only two individual artifacts have been attributed to the Paleoindian. This could represent the tools of a very dispersed population, which required game that browsed a large area. On the other hand, the climate has changed significantly since the Paleoindian hunters used the area. Paleoindian sites may not be evident because of erosion and redeposition of deposits.

Pleistocene Lake Trinity undoubtedly dates from the same time period. However, extensive survey by HSR archaeologists on the south end of the lake only yielded limited Paleoindian remains, including portions of a lithic tool assemblage.

The later Archaic sites are dated by distinctive styles of dart points, stone bifaces or oval-shaped tools worked along all edges, and chipping debris. Ground stone indicates processing of

plant remains. Extensive Archaic materials have been identified within Trinity Site.

Mogollon sites contain similar types of artifacts, except the artifact styles are different, indicating to the archaeologist different functions. The points were fitted to arrows and are thus smaller. The ground stone represents other styles, adapted from processing corn. Hearths are common. However, the most diagnostic artifacts are the ceramics. These can be identified—based on clay types, vessel forms, styles, and paint colors, if there are any—and assigned to a date range. Some ceramics, such as brown wares, were probably made locally, and the abundance indicates that they were used as utility wares—for cooking, storing water, etc. The painted wares are later in the sequence and may be made locally or imported.

Hearths provide the key for dating some of these sites. Hearths and stains may contain the remains of burned plant or animal materials containing low densities of natural, radioactive carbon. By measuring the deterioration of the radioactive carbon against normal carbon, it is possible to calculate an age for the burned material. To date materials from these sites, however, it might be important to determine whether the sample was contaminated by the Trinity test.

Of almost 50 sites already documented in the Trinity area, almost 20 are Archaic sites (identified by projectile point styles), but only about one-quarter contain evidence of hearths. These sites may represent resource-collection sites—lithic resources for making stone tools, plants for food, etc. They may have been used so temporarily that no evidence of overnight stays, such as camp fires, were left. Possibly nearby, but in a more hospitable area, are base-camp sites, which may contain hearths, heavier ground-stone artifacts that were not moved but left from year to year, etc.

Of the previously recorded sites, about one-fifth are Mogollon sites. These are identified by ceramics dating from A.D. 200-1400. Only one such site contained evidence of a hearth. The Archaic represents approximately 5000 years of prehistory, while the Mogollon represents only 1200 years, which may account for the lower density of sites. But the fact that only one of the sites has a hearth suggests an even more ephemeral pattern of use. A few sites have been excavated immediately outside the Trinity Site that contain evidence of more permanent Mogollon occupation.

Two categories of sites are more difficult to characterize, based on surface remains. More than one third of the sites contain remains that cannot currently be dated. Often they are a few scattered artifacts with no datable materials or hearths.

More challenging is the situation of sites that clearly contain evidence of more than one time period. When a site has an Archaic projectile point and a scatter of flakes overlain by the remains of a ranching complex consisting of corrals and an earthen tank, the division of materials is fairly clear. If a site has, on the surface, an Archaic projectile point, ceramics of two or three types, and a scatter of flakes, the division may be more difficult. The remains do indicate, however, that attractive resources were available in the area, even though each group may have been attracted by different resources at different times of the year.

A few unique sites have been recorded. Two stone circles were recorded by archaeologists working for the WSMR. Similar features represent tepee rings elsewhere in Apache

country. To test whether they may have been made by the Apache, several test pits were excavated at the site; no subsurface materials were found, prehistoric or historic.

A small rock shelter was recorded; the remains did not contain much direct information on the inhabitants, although a projectile point, a few flakes, and small pieces of charcoal were found. More important, the site also included a pack rat midden, which provided information on the past environment of the Trinity Basin. By studying past climates, we can better understand prehistoric inhabitants, their activities, and their relation to the environment. Such studies have the potential to help us study our modern relationship with and impact on the environment.

TRINITY PRESERVATION

The Trinity Site (LA 100,000) is a National Historic Landmark (NHL) that contains diverse cultural resources, including Trinity-related properties as well as prehistoric and historic ranching sites. These are on or potentially eligible to the National Register of Historic Places. Preservation of these prehistoric, historic, and test-related resources within Site LA 100,000 will provide an important data base for these periods.

The nuclear test related features of the Trinity Site NHL have local, regional, national, and international significance. They embody the features of the first test of an important scientific and technological development, the first nuclear device and the efforts employed to document and monitor the test. The test and subsequent detonation of two nuclear bombs over Japan led to a swift termination of World War II in 1945 and, ironically, opened the Cold War period in international relations. White Sands Proving Ground became White Sands Missile Range, the largest national missile test facility within the United States.

The premilitary historic remains within the Trinity Site, in addition to historic documents and oral history, provide important information on the ranching adaptations prior to 1942 in the Trinity Basin. They preserve information on architecture, family lifeways, and the use of resources such as water, land, and grass. Development of WSMR led to a reorganization of the regional economy away from a reliance on ranching and significantly affected the lives of the ranching families in the area.

Prehistoric sites within Site LA 100,000 also document Paleoindian, Archaic, and Puebloan occupation of the Trinity Basin. These materials preserve evidence of an adaptation to a dry basin with limited plant and lithic resources. Potential research topics for Paleoindian, Archaic, and later prehistoric remains include people's adaptation to the Trinity Basin and the distribution of sites in relation to the Pleistocene Lake Trinity, a fossil lake. The Puebloan materials have the potential to provide information on interactions along the boundary between the Anasazi to the north and the Jornada Mogollon to the south.

Administrative Status

In 1965, Trinity Site was designated as a National Historic Landmark. The following year this important site was entered in the newly defined National Register of Historic Places. In 1968, the Southwest Regional Office of the National Park Service (NPS) began preparing a draft Master Plan for a National Historic Site (NHS) at Trinity, to be administered by NPS. The proposed NHS incorporated an area of about 51,500 acres. The proposal did not progress beyond the draft stage.

In 1975, the NPS Landmark Review Task Force completed the National Register nomination for the Trinity Site NHL. In addition to Ground Zero (i.e., the point of detonation), the nomination listed five historical features associated with the Trinity Site: North 10,000, West 10,000, South 10,000, the George McDonald Ranch, and the Trinity Base Camp located at the former McDonald Brothers Ranch. The boundary defined an irregular quadrilateral or

diamond shape that encloses approximately 36,480 acres.

Although Trinity Site had achieved NHL status by the 1970s, several significant features had already been lost. Whereas the NPS had always defined Trinity Site as the entire test site, including the various shelters and other installations, the U.S. Army (until the 1970s) understood "Trinity Site" to mean only the point of detonation, or Ground Zero (Rieder 1992). As a result, shelters and other features were allowed to deteriorate; salvage operations were conducted in the 1950s; and several Trinity features were determined to be safety hazards and were demolished in the 1960s.

Management and use of Trinity Site NHL is currently guided by the National Historic Preservation Act of 1966, as amended; federal regulations concerning cultural resources and the National Historic Landmark Program; an agreement between the U.S. Army and the New Mexico State Historic Preservation Division; and a WSMR Regulation.

Trinity Recording Project and Architectural Conservation

In 1982–1983, Trinity Site was documented for the Historic American Engineering Record (HAER). Documentation resulted in a historic-properties report (HAER n.d.) with large-format photographs of extant features and reproductions of the construction drawings for the shelters erected to monitor the nuclear blast. The George McDonald Ranch House was recorded with measured drawings (Documentation Level I).

In 1982, a 12-acre area around the ranch house was surveyed by archaeologists from Eastern New Mexico University (Schermer 1983). The purpose of the survey was to locate and identify architectural and other artifacts of potential use in the planned restoration project.

In 1983, the George McDonald ranch house was stabilized by WSMR Facilities Engineering. In the following year, a team from the NPS Denver Service Center supervised the restoration. The project included stabilization of the ranch outbuildings. A preservation guide is being prepared for the ranch house. In addition, a stabilization plan has been developed for the adobe ranch house at the McDonald Brothers Ranch, the site of Trinity Base Camp (Reider 1994). Stabilization has commenced there, as well.

The extant bunkers at Trinity West 800 and North 800 also require stabilization. Minimal intervention is needed to replace eroded berms and earthen fill and to correct drainage problems at North 10,000 (LA 15868). No actual repair or replacement of concrete or timbers would be involved, since the goal is simply to maintain the bunkers in their present state, preventing further deterioration. Chemical treatment of extant timbers according to NPS standards is also recommended to prevent additional decay and preserve the integrity of the bunkers, as well as the communication-lines poles and the wooden instrument stands.

Development

Since the 1950's, White Sands Missile Range has continued to use the area of the Trinity Test. Areas slated for development have been subjected to archaeological survey and testing projects, resulting in documentation of a portion of the archaeological resources within the Trinity Site NHL.

The major types of potential impacts to Trinity Site include but are not limited to the following: (1) facilities maintenance and constuction; (2) surface clearing,

grading, and grubbing; (3) utilities, fencing, and transportation rights-of-way; (4) off-road travel; (5) looting and vandalism; and (6) visual elements.

Potential impairment of the visual integrity of Trinity Site is particularly important, given the original line-of-sight corridors established by Manhattan Project personnel for the nuclear test site. Activity that may potentially impact visual integrity includes the past or future construction of towers, communication lines, buildings, structures, or features. The isolated nature of the test site also needs to be protected.

One nearby project, the Aerial Cable Test Range, made every effort to design their towers, buildings, and other facilities so they are not visible from Trinity.

REFERENCES CITED

Bainbridge, K. T.
1976 *Trinity*. LA-6300-H, Los Alamos Scientific Laboratory of the University of California. Los Alamos, New Mexico.

Basehart, Henry
1973 Mescalero Apache Subsistence Patterns. In *Technical Manual: 1973 Survey of the Tularosa Basin, The Research Design*, pp. 144-181. Human Systems Research, Inc., Albuquerque.

Clark, Ira G.
1987 *Water in New Mexico: A History of Its Management and Use*. University of New Mexico Press, Albuquerque.

Darton, N. H.
1928 *"Red Beds" and Associated Formations in New Mexico, with an Outline of the Geology of the State*. Bulletin No. 794. U.S. Geological Survey, Washington, D.C.

Hall, Rosemary
1986 Letter on Schmidt House. On file, Office of Public Affairs, White Sands Missile Range, New Mexico.

Historic American Engineering Record
n.d. *Photographs, Copies of Reduced Drawings, Written Historical and Descriptive Data*. HAER No. NM-1A. National Park Service, Department of the Interior. Washington, D.C.

Hoddeson, Lillian, Paul W. Henriksen, Roger A. Meade, and Catherine Westfall
1993 *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943-1945*. Cambridge University Press, Cambridge.

Hodge, Frederick W., George P. Hammond, and Agapito Rey, editors
1945 *Fray Alonso de Benavides' Revised Memorial of 1634*. University of New Mexico Press, Albuquerque.

Houghton, Frank
1976 Climate. In *Soil Survey of White Sands Missile Range, New Mexico*, by Raymond E. Neher and Oran F. Bailey, pp. 59-60. U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C.

Hutchinson, W. H.
1956 *A Bar Cross Man: The Life and Personal Writings of Eugene Manlove Rhodes*. University of Oklahoma Press, Norman.

Irwin-Williams, Cynthia, and C. Vance Haynes, Jr.
1970 Climatic Change and Early Population Dynamics in the Southwestern United States. *Quaternary Research* 1(1):59-71.

Jones, Fayette A.
1904 *New Mexico Mines and Minerals*. New Mexico Bureau of Immigration, Santa Fe.

Judge, James W.
1973 *The Paleoindian Occupation of the Central Rio Grande Valley, New Mexico*. University of New Mexico, Albuquerque.

Keyes, C. R.
1905 Geological Structure of the Jornada del Muerto and Adjoining Bolson Plains. *Iowa Academic Scientific Proceedings* 12:160-167.

Kunetka, James W.
1979 *City of Fire: Los Alamos and the Atomic Age, 1943-1945*. rev. ed. University of New Mexico Press, Albuquerque.

Lasky, Samuel G.
1932 *The Ore Deposits of Socorro County, New Mexico*. Bulletin No. 8. New Mexico Bureau of Mines and Mineral Resources, Socorro.

Laumbach, Karl W.
1991 Executive Summary. In *The Aerial Cable Test Capability Project: An Archaeological Evaluation of the Jim Site and Fairview Alternatives, White Sands Missile Range, New Mexico*, by Human Systems Research, Inc., Staff, pp. i-vii. HSR Report No. 9025. Tularosa, New Mexico.

Lehmer, Donald J.
1948 *The Jornada Branch of the Mogollon*. Social Science Bulletin No. 17. University of Arizona, Tucson.

Los Alamos National Laboratory
1986 *Los Alamos 1943-1945; The Beginning of an Era*. Los Alamos National Laboratory, Los Alamos, New Mexico.

Maag, Carl, and Steve Rohrer
1982 *Project Trinity, 1945-1946*. Defense Nuclear Agency, Washington, D.C.

MacNeish, Richard S., and Patrick H. Beckett
1987 *The Archaic Chihuahua Tradition of South-Central New Mexico and Chihuahua, Mexico*. Monograph No. 7. COAS Publishing and Research, Las Cruces.

Marshall, Michael P.
1973 The Jornada Culture Area. In *Technical Manual: 1973 Survey of the Tularosa Basin*, pp. 49-119. Human Systems Research, Inc., Albuquerque.

Marshall, Michael P., and Henry J. Walt
1984 *Rio Abajo: Prehistory and History of a Rio Grande Province*. Historic Preservation Division, Santa Fe.

McDonald, Dave
1984 Statement. In *Hearing before the Subcommittee on Public Lands and Reserved Water of the Committee on Energy and Natural Resources* (1983). U.S. Senate, 98th Congress. U.S. Government Printing Office. Washington, D.C.

Montgomery, John, and Kathleen Bowman
1989 *Archaeological Reconnaissance of the Chupadera Arroyo Drainage, Central New Mexico*. Agency for Conservation Archaeology Report CD89.1, Eastern New Mexico University, Portales.

Neal, James T., Robert E. Smith, and Blair F. Jones
1983 Pleistocene Lake Trinity, an Evaporite Basin in the Northern Jornada del Muerto, New Mexico. In *New Mexico Geological Guidebook, 34th Field Conference, Socorro Region II*, pp. 285-290. New Mexico Geological Society.

Rhodes, Eugene Manlove
1968 *The Proud Sheriff*. Norman, Oklahoma.

Rhodes, Richard
1986 *The Making of the Atomic Bomb*. Simon and Schuster, New York.

Rieder, Morgan
1992 *Preservation of Historic Properties at Trinity Site National Historic Landmark, White Sands Missile Range, Socorro County, New Mexico*. Human Systems Research Report No. 9042. Tularosa, New Mexico.

1994 Proposal for Stabilization of the Dave McDonald Ranch House, Trinity Site National Historic Landmark. Human Systems Research Project No. 9412. Manuscript on file, Human Systems Research, Inc., Las Cruces.

Rieder, Morgan, and Michael Lawson
1994 *Trinity at Fifty: Technical Report No. 1, Trinity Site National Historic Landmark, White Sands Missile Range, Socorro County, New Mexico*. Human Systems Research Report No. 9241. Tularosa, New Mexico.

Ritch, William G.
1885 *New Mexico and Its Resources*. New Mexico Bureau of Immigration, Santa Fe.

Sale, Mark
1991 Apaches in the San Andres. In *Jornada Mogollon Archaeology: Collected Papers from the Fifth and Sixth Jornada Mogollon Conferences*, edited by Meliha S. Duran and Patrick H. Beckett, pp. 53-68. COAS Publishing and Human Systems Research, Inc., Las Cruces.

Sale, Mark, and Karl Laumbach
1989 *Reconnaissance in the Upper Jornada del Muerto and Hembrillo Canyon and Other Special Projects, White Sands Missile Range, New Mexico*. Human Systems Research Report No. 8721. Tularosa, New Mexico.

Schermer, Scott C.
1983 *Examination of the McDonald Ranch Complex on the White Sands Missile Range, Southcentral New Mexico*. Vol. 3. Agency for Conservation Archaeology, Eastern New Mexico University, Portales.

Sonnichsen, C. L.
1963 *Tularosa: Last of the Frontier West*. Devin-Adair, New York.

1965 *Outlaw: On the Dodge with Baldy Russell*. Swallow Press, Athens, Ohio.

Szasz, Ferenc Morton
1984 *The Day the Sun Rose Twice: The Story of Trinity*. University of New Mexico Press, Albuquerque.

Taft, P. H., and M. M. Hoidale
1969 *White Sands Missile Range Climatography No. 4 White Sands Desert Site, WSMR*. Atomospheric Sciences Office, White Sands Missile Range, New Mexico.

Tainter, Joseph A., and Frances Levine
1987 *Cultural Resources Overview, Central New Mexico*. U.S. Forest Service, Albuquerque, and Bureau of Land Management, Santa Fe.

Weber, Robert H., and G. A. Agogino
1968 Mockingbird Gap Paleoindian Site: Excavations in 1967. Paper presented at the 33rd Annual Meeting, Society for American Archaeology, Santa Fe.

Westphall, Victor
1965 *The Public Domain in New Mexico, 1854-1891*. University of New Mexico Press, Albuquerque.

Wilson, John P.
1985 Before the Pueblo Revolt: Population Trends, Apache Relations and Pueblo Abandonments. In *Prehistory and History in the Southwest, Collected Papers in Honor of Alden C. Hayes*, edited by Nancy Fox, pp. 113-120. Archaeological Society of New Mexico, No. 11, Santa Fe.