A National Register Inventory and Evaluation of the Talos Defense Unit at White Sands Missile Range, Otero County, New Mexico

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White Sands Missile Range in a
Cooperative and Joint Venture Agreement with
New Mexico State University

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14. ABSTRACT
This attached document is a National Register of Historic Places (NRHP) evaluation of the Talos Defense Unit site, also known as Gregg Site at White Sands Missile Range, Dona Ana County, New Mexico. The document provides a historic context and a building inventory and description of existing structures at Gregg Site. All of the structures at Gregg Site have been turned in and remain abandoned and unused, and are slated for demolition as part of the Facilities Reduction Program list for FY18. The National Historic Preservation Act, Section 106, requires federal agencies to review the effects of it undertakings upon historic structures. This review includes an evaluation of the structures for their eligibility to the National Register. Documents such as this are also highly important in preserving the history of the range and its activities and will become part of the public record. Presently this document will be included as a supporting document as the US Army initiates consultation with the New Mexico Historic Preservation Division regarding the proposed demolition of historic structures at WSMR.

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Phillip Esser served as the project manager and Nate Myers and Brad Beacham conducted the site survey work and field recordation for the project. Nate Myers was the principal author of the report, with valuable contributions and reviews from co-authors Phillip Esser and Brad Beacham. Justin Pooley created the maps for the report and managed the project spatial data, and the report was edited by Becki Graham.

List of Acronyms and Abbreviations

ABM	Anti-Ballistic Missile
ABRES	Advanced Ballistic Re-Entry Systems
ADC	Air Defense Command
AEC	Atomic Energy Commission
AIRDC	US Army Ionizing Radiation Dosimetry Laboratory
ARMS	Archaeological Resource Management System (New Mexico)
ARMTE	Army Materiel Test and Evaluation
ARTRAC	Advanced Range Testing, Reporting, and Control
APL	Applied Physics Laboratory
APRF	Atmospheric Profiling Research and Development Facility
ASL	(White Sands) Atmospheric Sciences Laboratory
ATMOS	Atmospheric Turbulence Measurement and Observation System
AuASAM	Automatic Aimpoint Selection and Maintenance
BOMARC	Boeing and Michigan Aeronautical Research Center (missile)
BMD	Ballistic Missile Defense
BTV	(Bumblebee) Burner Test Vehicle
CD-E	Communications Directorate, Engineering and Control Branch (WSMR)
DCD	Data Collection Directorate (WSMR)
DE	Directed Energy Directorate (WSMR)
DOD	Department of Defense
ERDA	Electronics Development and Research Activity (WSMR)
GAPA	Ground to Air Pilotless Aircraft
GPS	Global Positioning System
GRTS	Green River Test Site (Utah)
GTV	Guidance Test Vehicle

HCPI	Historic Cultural Property Inventory (New Mexico)
HEL	High Energy Laser
HELDAPS	High Energy Laser Acquisition and Processing System
HELSTF	High Energy Laser System Test Facility
HIDL	High Energy Laser Instrumentation Development Laboratory
HP	High Energy Laser Program Office (WSMR)
HPD	Historic Preservation Division (New Mexico)
HVAC	Heating, Ventilating, and Air Conditioning
ICBM	Intercontinental Ballistic Missile
IDC	Instrument Data Converters
IGOR	Intercept Ground Optical Recorder
IRM	Integrated Range Mission
JATO	Jet Assisted Take Off
JPL	Jet Propulsion Laboratory
LASER	Light Amplification by Stimulated Emission of Radiation
LC	Launch Complex
LSS	Land Locked Ship
LP	Liquid Propane
LTV	Launch Test Vehicle
MAD	Mutually Assured Destruction
MAR	Multi-functioning Array Radar
MHz	Megahertz
MIRACL	Mid-Infra-Red Advanced Chemical Laser
MTR	Missile Tracking Radar
NATIV	North American Test Instrument Vehicle
NATO	North Atlantic Treaty Organization
NHPA	National Historic Preservation Act

NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Aerospace Defense Command
NOTS	Naval Ordnance Test Station China Lake, California
NPS	National Park Service
NRHP	National Register of Historic Places
OD	Optical Dome
ONR	Office of Naval Research
ORDCIT	Ordnance and California Institute of Technology
RAM	Radar Advanced Measurement
RAMPART	Radar Advanced Measurement for Analysis of Re-Entry Techniques
RCA	Radio Corporation of America
RDT&E	Research Development Test and Evaluation
ROTI	Recording Optical Tracking Instrument
SAC	Strategic Air Command
SAGE	Semi-Automatic Ground Environment
SAM	Surface to Air Missile
SDI	Strategic Defense Initiative
SHPO	State Historic Preservation Officer
SODAR	Sounding Radar
STV	(Bumblebee) Supersonic Test Vehicle
TDRSS	(NASA) Tracking and Data Relay Satellite System
THAAD	Theater High Altitude Area Defense
THEL	Tactical High Energy Laser
TDU	Talos Defense Unit
TMDE	Test, Measurement and Diagnostic Support (WSMR)
USAF	United States Air Force
USNRC	United States Nuclear Regulatory Commission

V-1	Vengeance 1 (rocket)
V-2	Vengeance 2 (missile)
VAL	Vulnerability Assessment Laboratory (WSMR)
WSMR	White Sands Missile Range
WSPG	White Sands Proving Ground
WSSA	White Sands Signal Agency
WWII	World War II
XPM	(Bumblebee) Experimental Prototype Missile

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Appendices*

*The appendix for this study is found on a CD attached to the back cover of the report. Additionally, a large fold-out map calling out the inventory boundaries and resource locations is also found in the back of the report.

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1. Management Summary

The U.S. Army Garrison White Sands Missile Range (WSMR), with the assistance of the U.S. Army Engineering and Support Center Huntsville Facilities Reduction Program (FRP), is actively developing lists of properties that may be candidates for demolition. In accordance with Section 106 of the National Historic Preservation Act (NHPA) the WSMR Cultural Resource Program is actively evaluating all candidate buildings, structures, and objects for their National Register of Historic Places (NRHP) eligibility in addition to acquiring existing historic documentation on each.

In December 2014, Epsilon Systems Solutions, Inc. (ESS) was contracted by the WSMR Cultural Resources Program to conduct an inventory and evaluation of a facility targeted for future demolition, the Talos Defense (TDU) complex and adjacent Gregg Site (Figure 1). The scope of the inventory area was determined in consultation with William Godby, archaeologist at WSMR.

During the current inventory, a multi-disciplinary team of archaeologists and architectural historians conducted an on-site inventory in February 2015 and recorded a total of 20 buildings, structures, and objects as well as 21 features at the TDU and Gregg Site. All the recorded resources related specifically to RDT&E activities in the Cold War era – from 1953 to 1989; no prehistoric features were recorded or evaluated. The current inventory was logged as New Mexico Cultural Resource Inventory System (NMCRIS) number 133164 with the New Mexico Archaeological Resource Management System (ARMS).

Four of the properties recorded during the current inventory had been previously recorded and evaluated. Human Systems Research (HSR) conducted an inventory and evaluation of these properties between 1998 and 2001. The previously documented resources are Property 23101 (recorded in 2001), Property 23104 (recorded in 1998), Property 23106 (recorded in 2000), and Property 23108 (recorded in 2001). These previous recordings focused on the primary buildings at the site, and did not consider the associated Atmospheric Science Laboratory (ASL) Atmospheric Profiler Research Facility (APRF) properties, which at that time had only been recently decommissioned. Of the four buildings documented by HSR, three were recommended as ineligible to the NRHP (Properties 23101, 23104, and 23106). However, the New Mexico Historic Preservation Division (HPD) did not concur with the recommendation of ineligibility for Property 23106. In a letter dated April 13, 2001, Nancy Hanks of HPD stated that Property 23106 "…appears to be eligible due to its Cold War association with the Talos Defense Unit and the AN/FPS-16 Radar." Property 23108 was only recommended as "potentially" eligible under Criteria C and D as it was under 50 years of age at the time of the recording, but this recommendation did not receive an actual concurrence from the New Mexico State Historic Preservation Officer (SHPO).

As part of the current effort, all of the recorded resources, including the four previously consulted upon, were evaluated for NRHP eligibility. None of the recorded resources were recommended individually eligible for listing to the NRHP. Although Properties 23106 and 23108 possess intriguing Cold War associations as the only prototype of the TDU ever built, both properties retain minimal integrity from this period of significance. Additionally, although the

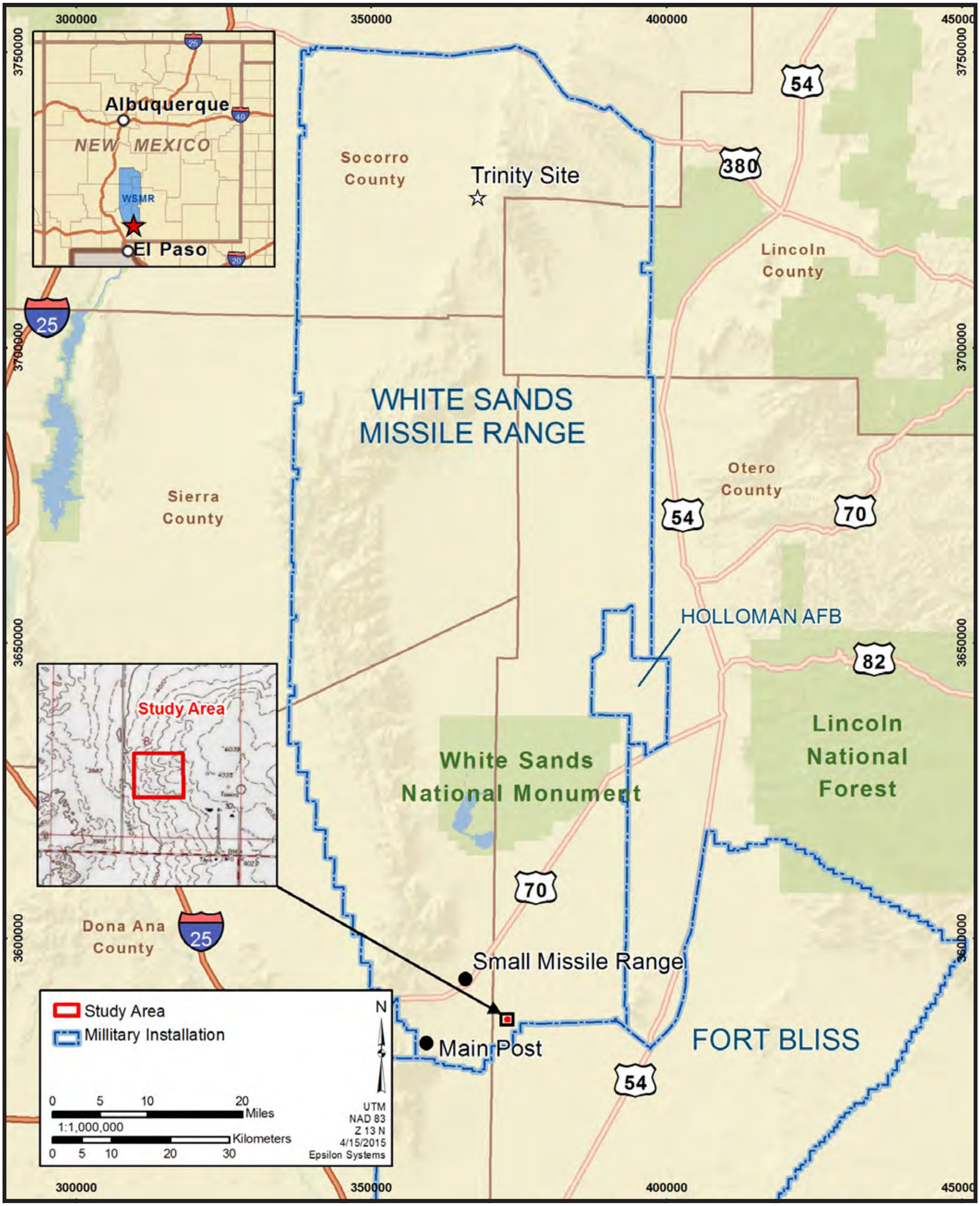

Figure 1. Map of the current inventory location within WSMR.

TDU and Gregg Site properties represent a definable concentration of resources, they are not united historically or aesthetically, nor are they the product of a single development or historical trend. In addition to the functional and chronological disparities of the site, the overall lack of integrity from the two defined periods of significance (1957 to 1959 and 1973 to 2000) also precludes the recommendation of the collective resources as a historic district.

2. Introduction and Project Background

The TDU at WSMR was constructed in the mid-1950s as a prototype land-based air defense system. It was based on the Navy Talos missile, which was created as a ship-borne anti-aircraft missile. The development of the land-based version of the missile at the TDU was funded by the Air Force and developed by the Navy using Radio Corporation of America (RCA) as the prime contractor. The only prototype of the land-based Talos air defense system ever built, the TDU is located east of the cantonment off of Nike Avenue, just west of Launch Complex 35 (LC-35) (Figure 2). The TDU prototype was decommissioned in the late 1950s and since then the facilities have been re-used for a variety of projects.

Although the TDU was established as an air defense system, the location was later expanded into what became known as Gregg Site (located immediately north and west of the TDU) during the 1970s. Beginning in the late 1970s, Gregg Site was used by ASL for atmospheric characterization studies. Gregg Site was the location of the ASL APRF beginning in the mid-1980s through 1996. The ASL research and the APRF activities were in support of the High Energy Laser Instrumentation Development Laboratory (HIDL) that was housed in Property 23106, the former TDU Operations Building, from 1973 to 2000. Though derived from different programs and time periods, the APRF and TDU resources are spatially comingled at the site, so this inventory is inclusive of both the TDU and Gregg Site resources.

In December 2014, ESS was retained by WSMR Environmental Stewardship to conduct an inventory and evaluation of the area for its NRHP eligibility. This task was limited to the visible built environment resources of the TDU and Gregg Site areas. Outlying sites that could not be documented as part of the known TDU and Gregg Site activities were not included in the inventory. The area north of Nike Avenue within WSMR is home to numerous launch complexes, instrumentation sites, and associated infrastructure. By limiting the scope of the current effort to the known TDU and Gregg Site resources, the current inventory avoided capturing unaffiliated resources that were not functionally related to the activities conducted at either the TDU or Gregg Site. The documented resource types include missile launch facilities, instrumentation facilities, maintenance and storage facilities, and miscellaneous facilities. The inventory also recorded isolated historic resources that were not identifiable as buildings, structures, or objects as features. No prehistoric archaeological resources were recorded as part of the inventory. In addition to the detailed recordation of the identified resources, each was evaluated for eligibility to the NRHP, both individually and as a contributing element to a possible district.

While individual resources were inventoried, a view towards a possible historic military landscape was taken per guidance in Loechl et al. (1994), particularly given the purpose-built nature of the facility. TDU and Gregg Site was modified by continual additions and alterations over the Cold War decades, and the characteristics of historic military landscapes outlined by Loechl et al. (1994) were relied upon to evaluate if the location represents an identifiable military landscape. The TDU and Gregg Site properties were constructed during different time periods and for divergent purposes, and the site therefore lacks many of the signatures of a recognizable military landscape as outlined by Loechl et al. (1994). The current inventory was logged as New Mexico Cultural Resource Inventory System (NMCRIS) number 133164 with

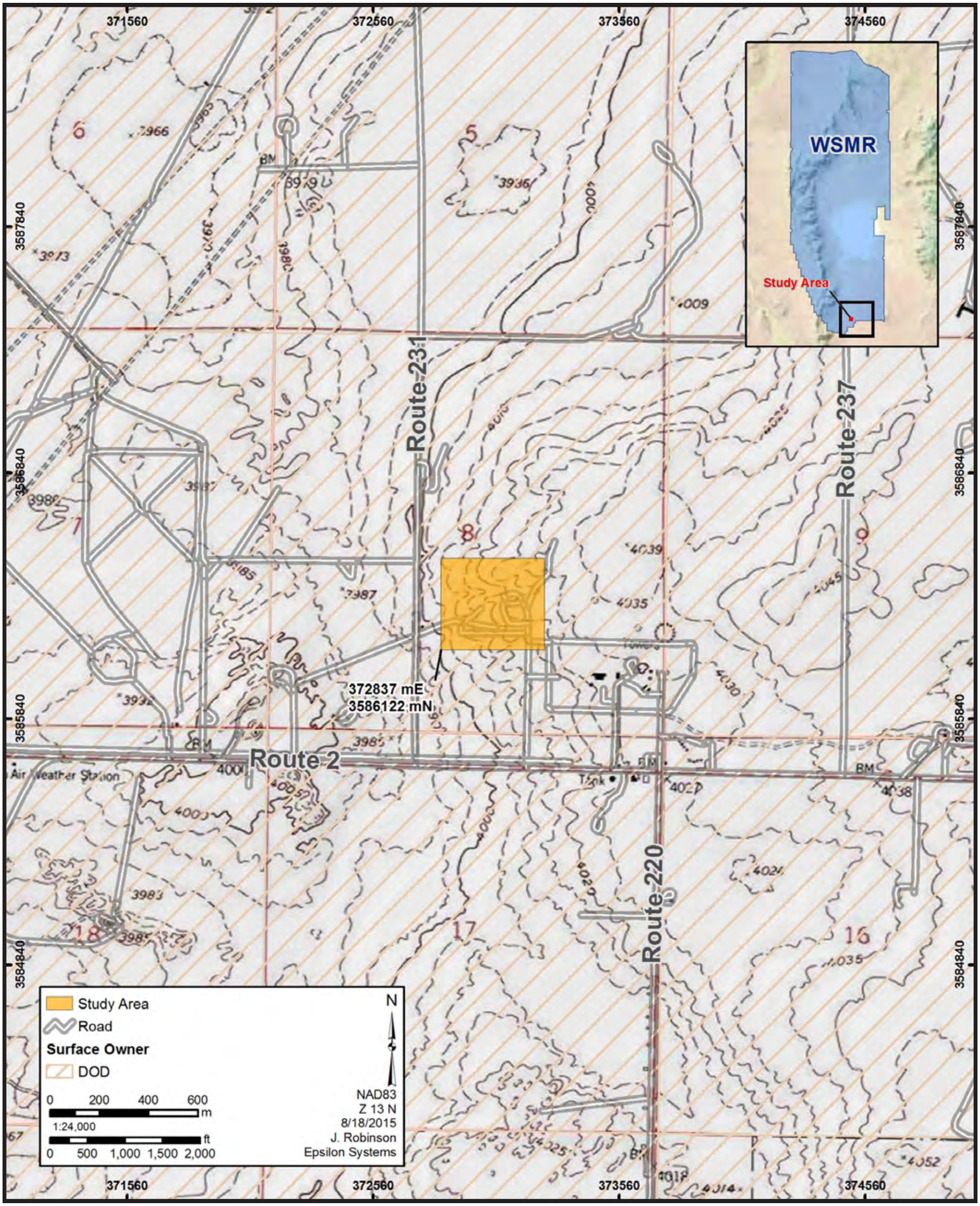

Figure 2. The current inventory location north of Nike Avenue and west of LC-35.

the New Mexico Archaeological Resource Management System (ARMS).

The results of the inventory effort and NRHP evaluation are provided herein. An attached large fold-out map identifying the inventory limits and recorded resource locations is also found in the back of the report. The recorded WSMR properties were assigned a New Mexico Historic Cultural Property Inventory (HCPI) number and were documented on HCPI forms tailored for use at WSMR and can be found in Appendix A on an enclosed CD. Cultural resource specialists Nathaniel Myers and Brad Beacham with ESS conducted the survey work and authored the report. Phillip Esser acted as project coordinator and report co-author. William Godby, archaeologist with WSMR Environmental Stewardship, provided support and guidance through the process.

3. Purpose of the Project

The purpose of the project is to inventory and evaluate the TDU and Gregg Site properties for NRHP eligibility. The project is in support of the WSMR FRP efforts and will ensure the US Army's compliance with the National Historic Preservation Act. The buildings to be inventoried are primarily along Nike Road (including the TDU) and in downrange areas of WSMR.

Historic resource inventories and evaluations have been undertaken at military installations since the passage of the NHPA in 1966 and issuance of Executive Order 11593 in 1971. Section 106 of the NHPA requires federal agencies to "take into account" the impact of their undertakings on historic properties, whereas Section 110 directs federal agencies to inventory historic properties under their care and management, beyond considerations related to specific projects. Historic properties are buildings, structures, sites, districts, and objects that meet the criteria for listing in the NRHP (36 Code of Federal Regulations [CFR] 60). Executive Order 11593 requires agency heads to locate, inventory, and nominate all eligible cultural resources to the National Register and to exercise caution until these inventories and evaluations are complete to ensure that no eligible federally owned property is transferred, sold, demolished, or substantially altered. The Order outlines procedures for meeting the inventory requirements of NHPA and the National Environmental Policy Act (NEPA) and establishes the principle of "interim protection," which means that until a resource has been evaluated, it must be treated as if it were eligible for listing in the National Register.

This report will assist WSMR in compliance with Section 106 and Section 110 of the NHPA. This document serves as a comprehensive inventory and NRHP evaluation of the TDU resources from the initial use of the location as an air defense prototype facility through the later evolution into Gregg Site and the APRF during the late Cold War period.

4. Research and Field Methodology

This document is the result of the completion of four components of research and fieldwork: revisiting and updating previous evaluations; on-site recordation; contextual historic research; and research into the evolution of the construction and function of individual buildings, structures, and objects.

Research was conducted at WSMR and from relevant published and archival sources. The ample published material on Cold War missile systems as well as unpublished historical data available at WSMR provided the basis for the historic context. The methodology for this project was to inventory and evaluate all of the resources located at the TDU site, which was later referred to as Gregg Site. The current study sought to remedy the lack of a comprehensive evaluation by taking a holistic approach which considers the macro view (i.e., historic military landscape and historic district) in addition to evaluating each resource individually.

On-site fieldwork included all those areas within the generally accepted limits of the TDU and Gregg Site; however, these limits are not clearly demarcated by fences or other boundaries. Period aerial images of the TDU installation indicate that it was primarily limited to the two major buildings of the system (Properties 23106 and 23108), with its outermost supporting equipment being the AN/FPS-16 (AN/FPQ-4) boresight towers located to the north of the facility. Similar overview photographs of the later APRF indicate that the limits of what is known as Gregg Site were the various radar profilers that are located to the north and west of the TDU buildings. All these buildings and structures are located in a relatively discrete area bounded by undeveloped desert to the north, LC-35 to the east, the edge of the TDU parking area to the south, and the seven acre APRF 50 MHz Radar Antenna Array to the west (see Figure 3). Per standard protocol in New Mexico, the current inventory was registered with ARMS assigned NMCRIS number 133164.

4.1 Resource Types

The NPS guidance for identifying NRHP-eligible properties recognizes buildings, structures, and objects, as well as two additional types of resources that may include multiple resources; sites and districts. The NRHP is by necessity oriented towards recognizing "physically concrete properties that are relatively fixed in location" (NPS 1995:4). The selection of categories should be dictated by "common sense and reason" (NPS 1995:4) and the NPS Bulletin 15 provides definitions for building, structure, and object as follows:

> A building, such as a house, barn, church, hotel, or similar construction, is created principally to shelter any form of human activity. "Building" may also refer to a historically and functionally related unit, such as courthouse and jail or a house and barn [NPS 1995:4]
>
> The term "structure" is used to distinguish from building those functional constructions made usually for purposes other than creating human shelter [NPS 1995:4]

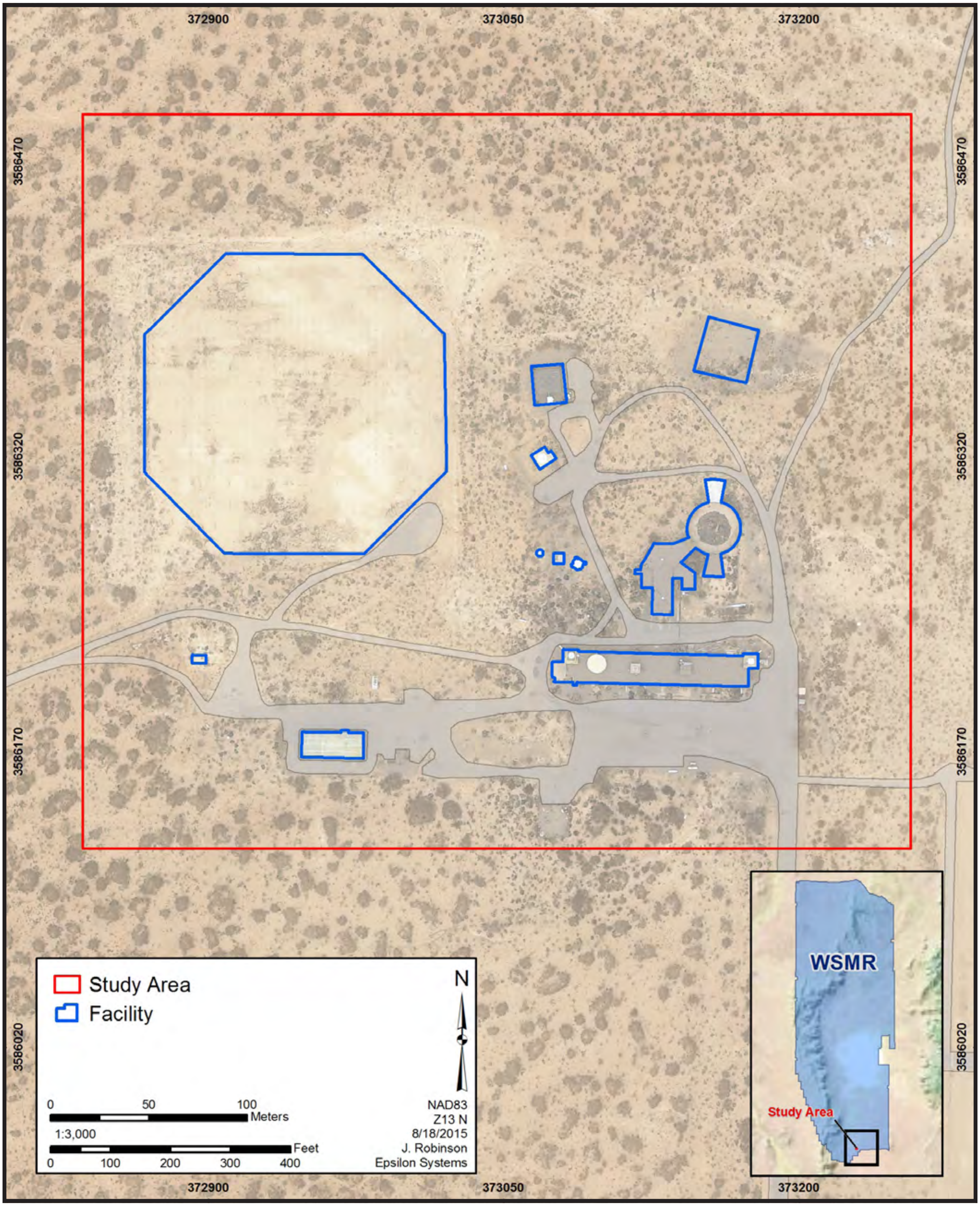

Figure 3. Limits of the current inventory effort as guided by the built environment of the TDU and Gregg Site.

> The term "object" is used to distinguish from buildings and structures those constructions that are primarily artistic in nature or are relatively small in scale and simply constructed.
>
> Although it may be, by nature or design, movable, an object is associated with a specific setting or environment [NPS 1995:5]

Additionally, the NPS defines sites and districts as:

> A site is the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archaeological value regardless of the value of any existing structure [NPS 1995:5]
>
> A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development [NPS 1995:5]

The resources present at the TDU and Gregg Site primarily consisted of buildings, structures, and objects, which were distinguished using the stated NPS definitions. The collective resources were also considered as a possible historic district, as the guidance states that "properties with large acreage or a number of resources are usually considered districts" (NPS 1995:4).

4.2 Historic Military Landscape Approach

The wider perspective of a historic military landscape was considered as part of the TDU inventory. Specific guidance on historic military landscapes defines them as:

> A historic military landscape is a military landscape that is significantly associated with historically important persons or events, or is an important indicator of the broad patterns of history, or represents a significant example of design or construction [Loechl et al. 1994:9].

An identified historic military landscape is usually nominated as a historic district or site. Per the guidance on DOD landscapes:

> For the purposes of the National Register, a historic military landscape is a category of property potentially eligible for listing in the National Register of Historic Places as a historic site or district. To be eligible for nomination to the Register, a historic military landscape must have sufficient integrity to convey its significance [Loechl et al. 1994:9].

As defined above, a historic district is a definable concentration of buildings, structures, or objects. A historic site is the location of a historic event or activity where the location itself possesses historical value regardless of any extant buildings or structures (Loechl et al. 1994:10).

4.3 Inventory and Feature Methodology

Isolated remnants of infrastructure and equipment are spatially or functionally associated with the TDU and later activities at Gregg Site, but these elements were not readily identifiable as a building, structure, or object. As such, they were recorded as features. In order to avoid capturing features that were unrelated to the focus of the current inventory, only those that were identified within the traditionally defined limits of the TDU and Gregg Site were recorded.

The survey team prepared field forms and took representative photographs of each building, structure, object, and feature. The purpose of the field inspection was to record every previously unrecorded resource and update those that had been previously evaluated, both at the individual level and as contributing elements to a possible historic district. The current inventory was logged as New Mexico Cultural Resource Inventory System (NMCRIS) number 133164 with the New Mexico Archaeological Resource Management System (ARMS).

Fieldwork was followed by research into each recorded building, structure, and object. This research included review of original construction information and alterations, historic images, and a variety of other manuscript materials collected over the decades by Public Works, WSMR Museum Archives, and WSMR Environmental Stewardship. This information was then checked against the range's extensive architectural drawings collection of original as-built and project drawings.

The results of the field inventory were organized by functional categories. These functional categories were based in part on property types defined by Thompson and Tagg (2007) for DOD Cold War RDT&E installations. Information gathered from WSMR archival and realty data were also relied on for the formulation of property type categories as well, and provided the basis for additional property types not defined by Thompson and Tagg (2007). In particular, Thompson and Tagg did not discuss general storage and maintenance facilities that are an often referenced type of property in WSMR Realty Records.

ESS also undertook additional research to create a historic context that builds on and expands the work of others. This expanded context spans the entire history of the TDU and Gregg Site activities, from the TDU testing in the 1950s through to the ASL APRF and HIDL usage of the location into the late Cold War era and beyond. Completion of this comprehensive context was aided by gathering oral histories from former ASL staff and scientists who were active in the APRF. At the time of writing, any resources evaluated that were constructed after 1965 were considered with the understanding that an argument for "exceptional importance" per NRHP Criterion Consideration G must be made for properties less than 50 years old.

5. Environmental Setting

WSMR lies within the Mexican Highland Section of New Mexico's Basin and Range Province. This province is characterized by narrow mountain ranges that separate internally drained structural basins and valleys of major drainages (Hawley 1986). The TDU is located in the southern portion of WSMR, in the southwest corner of the Tularosa Basin, which is a graben basin bounded by the Organ, San Andres, and Oscura Mountains to the west and the Sacramento Mountains to the east. Topographically, the TDU is located in the basin floor in flat terrain dotted with coppice dune formations. The TDU occupies a low lying area ranging from approximately 4,000 to 4,030 feet (ft) above mean sea level. Alkali flats associated with Parker Lake lie to the northwest, and the Organ and Jarilla Mountains provide a dramatic backdrop to the west and east, respectively.

The built environment associated with the TDU consists of a series of launch complexes and associated facilities located along Nike Avenue that were constructed from the mid-to-late 20th century. The nearest launch complex is the Navy LC-35 which includes the USS Desert Ship (LLS-1).

The climate of the TDU vicinity is characterized as semiarid (Muldavin et al. 2000b). Climatic data were collected at a weather station located at the White Sands National Monument, New Mexico from January 1, 1939 to March 31, 2013 (Western Regional Climate Center [WRCC] 2015). During this period, mean annual precipitation was 22.89 cm (9.01 inches). Rainfall was heaviest from July through September. Average minimum temperature was 5.2 degrees Celsius (C) (41.4 degrees Fahrenheit [F]), while average maximum temperature was 25.6 degrees C (78.1 degrees F). Average annual snowfall totaled 6.35 cm (2.5 inches). Snowfall was heaviest from December through January (WRCC 2015).

Vegetation typical of the area is Plains Mesa Sand Scrub (Dick-Peddie 1993). Deep-sand areas throughout New Mexico, such as coppice dunes, were historically dominated by grasslands associated with the periphery of old floodplains and playas that have given way to successional communities of expanding Plains Mesa Sand Scrub (Dick-Peddie 1993:128). Plains Mesa Scrub is typically dominated by deep-sand tolerant or deep-sand adapted species that can manifest in various combinations of floral species. White Sands serves as an oft-cited example of this successional ecotone (Dick-Peddie 1993:129). The flora within the TDU were observed to be variable, defined by co-dominance of four-wing saltbush (*Atriplex canescens*) and honey mesquite (*Prosopis glandulosa*) with an understory of forbs and grasses including broom snakeweed (*Gutierrezia sarothrae*), soaptree yucca (*Yucca elata*), and mesa dropseed (*Sporobolus flexuosus*). This phenomenon of variable scrubland/shrubland has been documented by comprehensive vegetation mapping at WSMR (Muldavin et al. 2000a; Muldavin et al. 2000b). The floral community observed at the TDU aligns with the Honey Mesquite-Fourwing Saltbush or Mesa Dropseed Coppice Dune Shrublands Plant Associations defined by Muldavin et al. (2000b) under the Mesquite Shrubland.

6. Historic Context

A historic context is fundamental for understanding the significance of any given property, as physical resources do not occur in historical vacuum but are rather by-products of larger trends and patterns (NPS 1995). These patterns occur at the local, regional, and national levels, and even at the global scale. Often, these tiered patterns are intertwined, and the significance permeates from the local level to the national and beyond.

The built environment of WSMR is largely an outgrowth of the Cold War that is generally attributed to the period between 1946 and 1989. Most of the historic properties at the range were constructed during this period, and were the result of the competitive arms race between the US and the Soviet Union. However, many programs at WSMR that were initiated during the Cold War only reached maturation in the years following the end of that era, so the historic context is often required to reach into the post-1989 years to fully account for the operational life and use of many resources.

Per NPS guidance, only resources that are 50 years of age or older are to be considered “historic” as a half-century is generally considered the minimum amount of time required to assess whether events or trends are significant to the wider patterns of history. However, the NPS guidance also allows for the inclusion of recent properties if they are of “exceptional importance.” As of this writing, properties that were constructed after 1965 would be considered for eligibility to the NRHP only if they meet the standards of exceptional importance as outlined in *NPS Bulletin 22*.

In order to provide a complete historical perspective for WSMR, a brief summary of the area prior to the establishment of WSMR is presented. The thematic focus then narrows to the trends of air defense at the close of World War II (WW II) and how these set the precedent for Cold War Air Defense programs. The Cold War history of WSMR, with an emphasis on the national debate on Air Defense that brought about the development of the TDU, is then presented. Typical of many WSMR properties, the TDU and its immediate environs underwent an extensive cycle of re-use and modification; the context also summarizes these later programs.

6.1 The Tularosa Basin before WSMR

The US history of the Tularosa Basin begins with the incorporation of the region into the US by the Treaty of Guadalupe Hidalgo in 1848. Although known by the Spanish and Mexican colonial powers, the Tularosa Basin remained a remote and sparsely settled area that was considered largely uninhabitable due to the constant threat posed by the Apache. Fort Stanton was established along the Rio Bonito in 1855 in order to provide settlers with protection against the Mescalero Apache, but even so, settlement away from the fort in the Tularosa Basin remained a risky affair and the population in southern New Mexico remained focused in the Mesilla Valley of the Rio Grande.

By the 1860s however, several factors conspired to change the uninhabited nature of the Tularosa Basin. The onset of the Civil War made New Mexico a subject of military interest among both the Union and Confederate armies, and several engagements were fought for control of the Territory. These conflicts eventually saw the Union victorious, and the military presence across the area continued following the end of the war. The establishment of a series of military outposts across the region somewhat ameliorated the Apache threat, and the perceived security encouraged settlers to move into the area between the Sacramento Mountains and the San Andres.

Figure 4. Colonel Albert Fountain, who disappeared in 1896.

The earliest Territorial settlement in the Basin began even before the end of the Civil War. In the fall of 1862 Hispanic settlers fled the destruction wrought by the flooding of the Rio Grande in the Mesilla Valley and established a community at the mouth of Tularosa Creek at the western base of the Sacramento Mountains. This community, known as Tularosa, was carefully cultivated by its settlers and became a permanent oasis of civilization in the valley. By the early 1870s the Apache were largely contained on reservations which mostly ended the threat of further raids from that quarter (Sonnichsen 1960:15). By the early-1880s, Anglo ranchers, mostly Texans, had discovered the Tularosa Basin, which at the time was especially verdant after several years of higher-than-average precipitation. The Texas cattle growers found in New Mexico a continuation of the open range grazing that was under assault by waves of post-war settlers and farmers in their native state, and these roving cattlemen rapidly established cattle ranching as an industry in the Tularosa Basin (Sonnichsen 1960).

The rise of cattle ranching in the late 19th century eventually led to “range-war” type conflicts that were experienced in New Mexico and elsewhere across the west. In the Tularosa Basin, this saga culminated in the disappearance of Albert Fountain and his son Henry on February 1, 1896. The site of the disappearance is located within WSMR, at a low ridge known as Chalk Hill that Highway 70 now bisects near the Doña Ana/Otero County line (Eckles 2013:57). The Fountain case was a polarizing incident that encapsulated much of life in and around the Tularosa Basin at the close of the 19th century, and endures as a compelling mystery today.

The arrival of the railroad at the newly established railroad town of Alamogordo in 1898 brought the Tularosa Basin into wider contact with the rest of the nation, but after the conclusion of the turbulent events of the 1890s, the area remained little changed during the early years of the 20th century. The main economic activity continued to be cattle ranching, with ranchers relying on a mixture of their own private property and large grazing leases of federal lands in order to make a living in the sparsely vegetated Chihuahuan Desert landscape. The carrying capacity for grazing was calculated at only five or six cattle per 640 acres in some areas of the Tularosa Basin (Eckles 2013:67). With the capacity for grazing so minimal, it took many thousands of acres to make cattle grazing a feasible endeavor for ranching families in the area.

New Mexico became the 47th state of the US on January 6, 1912. Thomas Catron of Mesilla, and Albert Fall, who resided in Las Cruces, were elected as the first US Senators of the state, ensuring that southern New Mexico was well-represented. As a state, New Mexico began to benefit from infrastructural improvements, and a state highway system was well underway by the 1920s. The old trail between Alamogordo and Las Cruces through San Augustine Pass was replaced with US Highway 70 during the 1930s (Wallace 2004:118). However, the lives of the people in Tularosa Basin area were not much affected. The area remained much the same by the time White Sands National Monument was established in 1933 to preserve the unique white gypsum dunes that formed from the winds blowing off the Lake Lucero playa in the basin interior. However, the entry of the US into WW II would change the area forever.

With its open air space and reliably clear weather, the Tularosa Basin was an ideal place for training military pilots. The first flight training facility was under development for the training of British pilots when the attack on Pearl Harbor brought the US into the war in December 1941. The training school was subsequently re-directed into the Alamogordo Army Air Field and US bomber flight crews began training there in May 1942 (Kennedy 2009:19). The greatest conflict of the 20th century would bring many changes to the Tularosa Basin, and would also re-define concepts of offensive and defensive weapons for the remainder of the century.

6.2 Air Defense through World War II

The strategic use of aerial bombing by aircraft was introduced during the first World War and encouraged the development of the first anti-aircraft artillery units. These consisted of modified field artillery units, which were marginally effective against the low speeds and altitudes that aircraft were capable of at the time. By the onset of WW II, bombers were much more advanced and capable of altitudes and ranges undreamed of during World War I. Additionally, WW II was the first conflict that involved the widespread bombing of civilian centers, which demanded the establishment of air-defense networks around major cities. These defenses primarily consisted of ground-based defense weapons; although fighter planes also provided defense against bombers, in most areas ground-based systems downed more bombers during the war than fighters (Werrell 2005). Ground based systems were in a state of constant readiness, whereas it was much more difficult to scramble fighters quickly enough to intercept bombers. Continuous sky patrols by fighters were an impractical use of aircraft that were needed in other theaters of the war, and it was particularly difficult for fighters to intercept night-time air raids, against which anti-aircraft batteries were often the only defense (Werrell 2005). The British development of the Chain Home radar early warning system enhanced the effectiveness of the antiaircraft guns, as did the American development of SCR-584 radar for use in automatic gun-laying against incoming aircraft. Throughout the war, anti-aircraft artillery continued to be the primary line of ground-based defense against aerial high-altitude bombing raids, with the 90 and 120 mm guns being the primary weapons used by the US (Cagle 1968:2). Other Allied and Axis forces used weapons with generally similar capabilities.

However, the effectiveness of these systems did not lay in their ability to destroy large numbers of aircraft, but rather because they forced bombers to divert course, which limited the accuracy of the bomb drops. This strategy was a slow battle of attrition which made the cost of repeated ineffectual bombing raids and the gradual accumulated loss of aircraft higher than any strategic gains made. Bombers still routinely survived to make it near the target, but if they were unable to strike the targets of highest strategic value, then the ground-based defense networks were considered successful.

The effectiveness of ground-based anti-aircraft weapons advanced steadily throughout the war while advances in bomber aircraft were relatively static. The development of radar and proximity fuzes enhanced the effectiveness of ground-based flak, which was the most effective and lowest-cost tool in the ground-based air defense arsenal during the war (Werrell 2005). However, by the war's end, two major technological advances — high-speed jet aircraft and the atomic bomb — essentially mollified the improvements in ground-based air defense systems that had been made (Werrell 2005:270-271). As summarized by Werrell:

> The end of the war brought two other developments that seemed to override these advantages gained by the defense. The first was jet propulsion that greatly increased aircraft performance, further complicating the defender's task. The other was the atomic bomb that extended the prospect that one aircraft and one bomb could destroy one city, which was very different from the massive formations of hundreds of bombers returning day after day. This development overturned the attritional concept of defense that dominated the air war. This, then, was the air defense situation in the immediate post-World War II era (2005:59)

The sudden outmoding of the carefully orchestrated WW II air defenses was not overlooked by American military planners. It was clear that the technological advances of jet-aircraft, the atomic bomb, and the guided missile would require new anti-aircraft systems that were capable of faster responses, increased range and accuracy, and higher attrition rates. It is notable that even after the Vengeance Weapon 2 (commonly known as V-2) bombing campaign carried out against England by Germany during the war, in the immediate post-war years US defense planners did not perceive ballistic missiles as a significant threat to national security, as they lacked the necessary range and accuracy. However, the potential of guided missiles had been demonstrated by Germany's V-1 and V-2 programs, and the next-generation of defensive ground-based anti-aircraft weapons would obviously need to incorporate this powerful new technology. Even amid the post-war drawdown that cut funding, manpower, and programs, plans were in motion to develop the next generation of air defense systems.

6.3 The Establishment of White Sands Missile Range

Throughout WW II, a group at the California Institute of Technology (Caltech) had been working on an Army Air Corps project to develop a rocket booster for aircraft, referred to as the Jet Assisted Take Off (JATO). By 1944, German use of missiles in Europe led the Army Ordnance Department Guided Missile Program to assign a new contract to the Caltech rocket group to develop a greatly expanded missile program (Kennedy 2009:14; Miles 1961). The new Caltech project was known as the Ordnance-California Institute of Technology (ORDCIT) program, which began testing the Private series of rockets in California in 1944. The next ORDCIT series was the Corporal series, which was a larger and more powerful rocket that required a larger range in order to test it safely (Kennedy 2009:16; Miles 1961). Concurrently, intelligence gained through the course of WW II further emphasized the need for enhanced missile testing facilities.

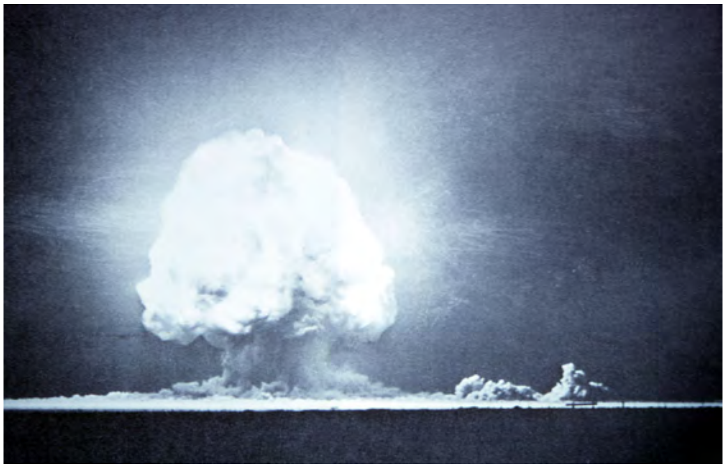

Figure 5. The flash and mushroom cloud of the world's first atomic bomb at the Trinity Site.

As hostilities drew to a close in Europe, the US was able to capture parts, equipment, and research materials from the German V-2 rocket program at Mittelwerk prior to the Russian advance into eastern Germany. Additionally, Werner Von Braun, chief scientist of the German missile program, and key members of his staff surrendered to Allied forces on May 2, 1945 (Eidenbach et al. 1996). With both the parts and the minds behind the V-2 program in hand, the US now had the means to accelerate the rocket research the ORDCIT program had begun. In support of this, Project Hermes was established by the Army in 1944 as a parallel program to ORDCIT. Both programs required a suitable testing and proving ground; the Army began to search for an appropriate location for a new test range (Kennedy 2009).

The proposed proving ground required attributes of flat and open ground, a sparse population, and predominantly clear weather. Other preferred characteristics included surrounding hills or mountains for observation sites and natural barriers, access to railroad lines and utilities, and proximity to an established military post for support. The Tularosa Basin was identified as the best choice, possessing nearly all of the desired characteristics. The location was selected in February 1945 and named White Sands Proving Ground (WSPG) after the adjacent National Monument. Some of the land in the proposed proving ground was already under federal lease, and additional property was acquired from private landowners in the area via annual lease payments. The lease payments for the use of the ranchers' properties were used in lieu of outright purchase of their lands, as the range was conceived as being a temporary extension of the existing bombing ranges, and it was believed that the new missile mission would eventually be completed (Eckles 2013:87). This, of course, was not the case and the formation of the new proving ground effectively ended the ranching lifestyle in the Tularosa Basin which had been ongoing since the 1870s. WSPG was formally established by July 1945; on July 16, 1945 the world's first atomic bomb was detonated at the Trinity Site in the northern portion of the new range. The flash and rumble of the Trinity explosion was reported as far away as Silver City, New Mexico and El Paso, Texas (Sonnichsen 1960).

As the range continued to develop, the 1950s proved to be a significant period of advancement for the range instrumentation and communications systems. The installation of range-wide instrumentation, communications, and timing networks was a significant, but often overlooked, part of the effort required to turn the desert landscape of the Tularosa Basin into a world-class missile test range. In many ways, the capability to precisely track, measure, record, and generate data from tests, while synchronizing these activities across long distances, is what truly defined the facility as a proving ground. Pioneering work on range instrumentation systems were undertaken by a group led by Ernst Steinhoff and select group of optical, electronics, and geodesy experts at Holloman Air Force Base. Steinhoff originally was brought to the US as part of Operation Paperclip and came to HAFB in 1949 after working at Fort Bliss. There he selected additional German experts that were brought into the country in 1951 as part of Project 63. Steinhoff and his instrumentation group published early guidelines and plans for range instrumentation systems and infrastructure that were eventually incorporated into WSPG.

Figure 6. Little Bright Eyes, one of the first tracking telescopes at WSMR.

Early instruments that met the requirements for range instrumentation were limited, and existing equipment had to be adapted to fit the role. Some of the best early optical instruments were Askania cinetheodolites recovered from the German rocket program and re-used at WSPG. Fastax and Mitchell high speed cameras and surplus WW II SCR-584 radars were also staples of the early range instrumentation, while more specialized instruments had to be custom fabricated. For example, the first tracking telescope was hand-assembled by planetary astronomer Dr. James B. Edson (Delgado 1981; Mabe 1958:2). This early precision instrument was known as “Little Bright Eyes” and was built on a surplus M45 gun mount and relied on telescopes pieced together with spare refractors, a 35 mm motion picture camera, and a pair of high power Japanese Navy binoculars Edson acquired via barter during WWII (Delgado 1981). Edson was unable to remain at WSMR, but recruited fellow astronomer Clyde Tombaugh to continue the tracking telescope effort. In December 1946, Tombaugh captured a V-2 tumbling near the apex of its flight, a previously unknown flight characteristic (Mabe 1958:2). This landmark film heralded the tracking telescope as a revolutionary new kind of instrumentation that was critical to further missile development.

By the late 1950s, technology had caught up to the need for range instruments, and the instrumentation became increasingly specialized and sophisticated. New instruments included the AN/FPS-16 radar, the first tracking radar built expressly for use at test ranges. New optical instruments included two new tracking telescopes; the advanced Intercept Ground Optical Recorder (IGOR), developed by Clyde Tombaugh, and the Recording Optical Tracking Instrument (ROTI). Both these devices possessed far greater ranges than the original Bright Eyes and were significant advances in the state of the art at the time of their introduction. Also during this period, the Army contracted with Land-Air Corporation for the operation and maintenance of most of the range instrumentation. This greatly streamlined the compatibility and standardization of the range instrumentation, the repair and operation of which had formerly been handled by a mixture of various contractors and military personnel.

6.4 Air Defense, WSMR, and the Cold War

As WSPG was established in the desert landscape of the Tularosa Basin in the immediate post-war years, the Soviet threat coalesced and the Cold War assumed a recognizable form. Following the end of the war, the Soviets began to take an increasingly aggressive stance in Eastern Europe, prompting Winston Churchill to deliver his “Iron Curtain” speech in March 1946. This speech is widely considered by the public and many historians to mark the beginning of the Cold War. The relations between the West and Soviet Union continued to degrade, culminating in the Berlin Blockade of 1948 to 1949. Following the end of the Berlin Blockade and the inability to come to treaty terms with the Soviet Union, Germany was partitioned into Federal Republic of Germany (West) and the German Democratic Republic (East), a division that would remain throughout the Cold War. The defense of West Germany against a potential Soviet advance was a major strategic priority for the US and its allies for the remainder of the Cold War. In the spring of 1949, contemporaneous with the Berlin Blockade, the US, Canada, and 10 western European countries signed a mutual defense treaty that created the North Atlantic Treaty Organization (NATO). NATO member countries each committed troops and resources to the defense of Western Europe against Soviet expansionism. The Soviet equivalent was the Warsaw Pact, which consisted of the communist countries of Eastern Europe including Poland, Czechoslovakia, Hungary, Romania, and Bulgaria (Lavin 1998:18).

For the early years of the Cold War, US military policy focused on the use of the atomic bomb as a deterrent against Soviet military aggression in Europe. The national defense budget was greatly reduced from $81.5 billion in 1945 to $44.7 billion in 1946, and then to $13.1 billion in 1947. However, missile research and development continued, albeit on a smaller scale than what otherwise might have been possible (Lonnquest and Winkler 1996:19).

Due to the post-war budget constraints, early efforts at WSPG focused on the use of the captured German V-2 missile materials and the creative use of available surplus materials. In November 1944, the Army established Project Hermes as a long-term ballistic missile research and development effort with General Electric (GE) as the prime contractor. GE worked in parallel with ORDCIT, and was responsible for the processing of the V-2 materials that began to arrive at WSMR in 1945.

The first launch area at WSPG, Army Launch Complex 1, later known as Launch Complex 33 (LC-33), was constructed about six-and-a-half miles to the east of the headquarters. The WAC Corporal became the first rocket launched at WSPG on September 26, 1945 (Kennedy 2009:29). Around the same time, the recovered German V-2 rocket equipment began to arrive via railroad, generating a massive wave of activity at the new range. The development of the V-2 program under Project Hermes was quickly undertaken at WSPG, and the first American launch of a V-2 took place on April 16, 1946 (Kennedy 2009:37). The V-2 program at WSPG was active through the remainder of the 1940s. In addition to the V-2 work, Project Hermes developed a number of other experimental projects, including the Hermes A-1 and A-2 series, A-3 rocket, Hermes C1, Hermes II, and the Bumper series. The Air Force was also active at the range during this period, with the development of the MX-774, NATIV, and GAPA missile platforms, while the Navy developed the Aerobee and the innovative Viking atmospheric research rocket (Kennedy 2009).

While American missile technology progressed at WSPG, Western strategic planners were increasingly concerned by the Soviets' technological advances. These included the introduction of the Soviet Tupolev Tu-4 long range bomber in 1947, which was a reverse engineered copy of the Boeing B-29 Superfortress. The Tu-4 had a range of nearly 3,500 miles, which would allow it to reach targets along the US coast in a one-way flight. Even more worrisome was the end of the US monopoly on nuclear weapons on August 29, 1949, when the Soviet Union detonated its first atomic bomb at the Semispalatinsk Test Site in Kazakhstan (Kennedy 2009:70). Within a few short years, the Soviets had developed both the atomic bomb and the ability to deliver it to targets in Europe and the US, and this situation demanded a serious evaluation of the capabilities of the US early warning and air defense systems against the threat of atomic-bomb equipped Soviet bombers.

In response to the evolving Communist threat, the Truman administration in 1947 pledged to contain Soviet expansion in Europe, which became known as the Truman Doctrine. The same year, the National Security Act substantially restructured the US military and intelligence agencies, creating what would become the Department of Defense (DOD) and separating the Army Air Forces into the independent service branch of the Air Force. The creation of the Air Force initiated a period of friction with the Army as both organizations struggled to delineate under whose jurisdiction the development of new rocket and guided missile technology fell.

At WSPG, the division between the Army and Air Force was expressed in a lengthy debate about how the range was to be divided between the two service branches. This issue was finally settled by the Integrated Range agreement of 1953. The Integrated Range allowed the Army, Air Force, and Navy to use the same ranges and test facilities. It also effectively combined the WSPG and Holloman ranges into a single large range accessible to all three service branches, but under command control of the Army (Redmond 1957).

By the mid-1950s work on missiles at WSPG had expanded beyond the V-2 and Hermes series into new, large solid propellant vehicles such as the Sergeant missile. Work on Project Hermes ended at WSPG in 1954. Although Project Hermes never produced a deployable ballistic missile system, it did make substantial contributions to the state of the art in guidance, tracking, and propulsion technologies. It also played a major role in the growth of WSPG; at its peak in the early 1950s, the project directly employed more 1,250 people (Kennedy 2009:61). Additionally, the Hermes C1 system, a design that dated back to 1946, was never built but served as the basis for the Redstone ballistic missile that was completed in 1952 (Redstone Arsenal 2015).

Communist expansionism in Asia contributed to a pessimistic, if not paranoid, outlook in the West during the late 1940s and the early 1950s. By 1949, Communist forces under the leadership of Mao Zedong had prevailed over the Nationalists in China, forcing Chiang Kai-Shek and the remnants of his government into exile in Taiwan. Soviet forces had occupied the northern half of Korea since 1945, ostensibly in preparation for the invasion of Japan, but continued to entrench themselves following the surrender of Japan. In agreement with the Soviet Union, the US had occupied Korea south of the 38th Parallel, and by 1948 independent governments had been established in both halves of the country. This temperamental stalemate finally broke on June 25, 1950 when North Korean forces invaded South Korea, initiating the US involvement in the Korean War.

The Korean War ended in 1953 and reestablished the boundary between North and South, which remains today. The Korean War was significant in that it clearly demonstrated that the US could no longer simply rely on the tremendous surplus of WW II-era conventional weapons, but would need to devote more energy and funding to the development of new technology and weapons. The Korean War also demonstrated that the threat of nuclear weapons was not enough to prevent the outbreak of conventional warfare in regional conflicts, in which the consequences of deploying nuclear weapons outweighed their strategic value (Kennedy 2009:72). It also was the first of several proxy conflicts where the Cold War superpowers would indirectly engage each other via limited wars in satellite states (Salmon 2011:14).

Figure 7. A Nike-Ajax launch at the Red Canyon Range in 1956 (*photo by JP Moore, courtesy frontier.net*).

After the onset of the Korean War, spending on defense increased drastically, and programs such as the Nike Ajax, which had progressed slowly through the 1940s due to lack of support, were placed on expedited schedules. Kennedy (2009:72) notes that in 1951, Army spending on missile programs was increased to 55.4 million dollars, nearly equal to the 56.5 million dollars that had been allocated in the five-year period from 1944 to 1949. This re-invigorated the effort to establish a nationwide network of air-defense systems, and the Navy, Air Force, and Army independently developed ground-to-air defensive missile systems during the 1950s.

Between 1954 and 1957 Army anti-aircraft gun batteries across the country were converted to missile battalions armed with the Nike-Ajax missile, America's first guided air defense missile (Berhow 2005:19). The training of these battalions was a major undertaking for the Army, and in 1953 the Red Canyon Range Camp was established in the northeast corner of WSPG for the training of air-defense units (see Figure 7). In addition to training soldiers in how to operate and launch the missile, the camp also served as an important tool for educating foreign and public officials about the Nike Ajax. From 1953 to 1959 the camp hosted more than 10,000 visitors from 45 countries and 40 states, and approximately 3,000 Nike Ajax missiles were launched from the site (Eckles 2013:241).

The technology and capabilities of ballistic missiles evolved very quickly during the 1950s, and by mid-decade an attack by long range ballistic missiles began to eclipse fears of a strike via bomber aircraft. By 1957, it was apparent to the military establishment that the future of long-range delivery of nuclear weapons was not with aircraft but with long-range ballistic missiles, generally referred to as Inter-Continental Ballistic Missiles (ICBMs) or shorter range Intermediate Range Ballistic Missiles (IRBMs). The arcing trajectory and extremely high speeds of these missiles made their detection and interception very difficult, much more so than conventional bombers. Additional impetus was given to the development of anti-ICBM defense systems by the successful launch of a Soviet ICBM in August 1957, followed by the launch of Sputnik I in October of that year (Missile Defense Agency 2009). American efforts were lagging behind the Soviets, and the fear that the Soviets now held the strategic advantage in missilery became known as the Missile Gap. John F. Kennedy successfully used the Missile Gap as a campaign issue in his 1960 presidential bid (Werrell 2005:186), and it also added urgency to the US Space Program, energizing the Space Race. Variants of the Redstone missile, whose origins could be traced directly to Project Hermes, launched into the orbit the first American satellite in 1958 and the first American astronaut in 1961 (Kennedy 2009:61).

The anti-aircraft oriented air defense systems created by the Army and the Air Force (the Nike Ajax and Hercules and the USAF BOMARC) were ineffective against ICBMS and IRBMs, which rendered these sophisticated systems semi-obsolete. These systems were designed for intercepting aircraft, which approached at more horizontal trajectories at lower speeds and altitudes than ballistic missiles. Due to the high angle trajectories and very high speeds of IRBMs and ICBMs, the window for interception is minimal. Anti-ballistic missile systems would be required to intercept ICBMs traveling at speeds up to 5,000 miles per hour at altitudes up to 100 miles above the surface.* This would require powerful early warning radar networks, long-range precision guidance systems, rapid automated responses, and high-performance missiles that simply did not exist as of the late-1950s (Schaffel 1991:255-256). Accordingly, next generation Ballistic Missile Defense (BMD) and Anti-Ballistic Missile (ABM) systems became the primary focus of land-based air defense systems. The Army began to modify the existing Nike program into a BMD system known as the Nike-Zeus in 1957, while the Air Force gradually phased out its BOMARC installations and focused on its early warning radar and ICBM programs.

WSPG was re-designated White Sands Missile Range in 1958, a change that reflected the emphasis on the development of ICBMs and BMD systems that were a major focus at the time due to the Missile Gap and the ongoing Cold War arms race. In 1962, WSMR initiated the Advanced Ballistic Re-Entry Systems (ABRES) program, which studied the re-entry characteristics of ICBMs using the sophisticated Radar Advanced Measurement (RAM) and Radar Advanced Measurement Program for Analysis of Re-entry Techniques (RAMPART) systems. The goals of this program were to improve both offensive and defensive systems (Feit et al. 2014; WSMR 1968). The ABRES program established the WSMR Green River Test Site (GRTS), in Green River, Utah. It served as a launch site for the Air Force Athena missile, which impacted at White Sands. The ABRES program launched Athena missiles from Green River to WSMR until 1973. Following the Athena launches, the GRTS served as the launch area for the Pershing missile through the mid-1970s (Feit et al. 2014; WSMR 1968).

In addition to ICBM and BMD development, WSMR would make important contributions to the American Space Program. During the late 1950s and 1960s the centralized tracking, command, and communications networks pioneered by Ozro Covington at WSMR became the basis for the global networks created for support of the Mercury and Apollo Programs. WSMR participated in the tracking networks for the Mercury, Gemini, and Apollo Programs, using the

* These figures state the anticipated capabilities of early ICBMs as reported in Schaffel (1991:255). Modern ICBMs possess significantly more advanced capabilities; the Minuteman III ICBM travels at approximately 15,000 MPH in its terminal flight phase and reaches altitudes of approximately 700 miles

AN/FPS-16 radar to track the orbiting spacecraft (Corliss 1974; Tsiao 2008). Across the San Andres Mountains from WSMR, the NASA Johnson Space Center established the Propulsion Systems Development Facility (PSDF) in 1963 to support the development of Apollo propulsion and power systems. In 1965, the PSDF was renamed the White Sands Test Facility (WSTF) and it continues to be an important test facility of the Johnson Space Center today (NASA 2015).

Figure 8. President Kennedy shakes hands during his 1963 visit to WSMR.

The Cuban Missile crisis in 1962 marked the nadir of US and Soviet relations, and was the closest that the two nations came to an actual nuclear exchange during the Cold War. As a result of the crisis, both the US and Soviet Union undertook steps to improve communications, as expressed in the establishment of the Moscow-Washington teletype hotline in 1963 (Salmon 2011:23).

In 1963, President John F. Kennedy visited WSMR to view a series of missile demonstrations, an event known as Missile Exercise White Sands or Project MEWS (Eckles 2013:291). While the visit was brief, President Kennedy viewed firings of the Honest John, Little John, Sergeant, and Hawk missiles from LC-32, followed by launches of the Nike Hercules, Navy Talos, and a Nike Zeus at LC-37 (Eckles 2013:292-293). The timing of President Kennedy's visit to WSMR was not coincidental, with the Cuban Missile Crisis less than a year behind and the Missile Gap and Space Race still very prominent in the public consciousness. Earlier in the year President Kennedy attended a similar demonstration at Redstone Arsenal, and the same tour he also visited the US Air Force Academy and NORAD in Colorado. These highly publicized visits helped to encourage the public's confidence that America's military and technological prowess remained competitive against that of the Soviets (Eckles 2013:291).

Despite the thaw in US-Soviet relations following the Cuban Missile Crisis, the US soon became entrenched in another war against an expansionist Communist state in Asia. After a purported North Vietnamese attack on the USS Maddox and the USS Turner Joy in August 1964, known as the Gulf of Tonkin incident, Congress passed a resolution proposed by President Johnson to commit conventional US military forces to the conflict without an actual declaration of war (Lavin 1998:40). The military build-up on both sides of the conflict rapidly escalated in the following years, with the North Vietnamese Army (NVA) committing conventional military and supporting the massive guerrilla campaign of the Viet Cong in South Vietnam. In January 1968, the NVA and Viet Cong launched the widespread Tet Offensive across the country, which caught US forces by surprise but ultimately was a tactical failure. However, the Tet Offensive was an ideological success in that it made a victory in Vietnam seem unlikely to the American public and caused a dramatic increase in the already simmering opposition to the war (Lavin 1998:40; US Army Center for Military History 2009:214).

The incoming Nixon administration in 1969 inherited a very unpopular war, and began to take steps to withdraw US forces while leaving South Vietnam intact. These efforts finally led to the signing of the Paris Peace Accords in 1973, which established a temporary ceasefire and allowed the withdrawal of US forces from Vietnam. South Vietnam nationalist forces were expected to maintain the partition against North Vietnam without further US support. The ceasefire was short-lived, and by 1975 the South Vietnam government had collapsed and Vietnam was reunified under a Communist regime (Salmon 2011:26).

Figure 9. A West Point class poses in front of the Nike Zeus at WSMR (*photo courtesy US Army Space and Missile Defense Command)*.

Despite reduced spending on research and development due to the cost of supporting the Vietnam War, technological advances continued to be made at WSMR. During the early 1960s, the Nike Zeus Ballistic Missile Defense system was tested at WSMR, after which field testing operations for the missile were moved to Kwajalein Missile Range in the Marshall Islands (see Figure 9). The Nike Zeus was not deployed as a BMD system due to several concerns about its targeting capabilities. The improved Nike X system was developed at WSMR and incorporated a modified Nike Zeus missile, now renamed the Spartan missile, and the high-speed Sprint missile. The Sprint was developed and tested at WSMR at LC-38 and LC-50 (Eckles 2013:9). The Nike X also incorporated a new phased array radar system that could detect and track multiple targets simultaneously, a major advance over the Nike Zeus. The prototype of this system, the Multi-Function Array Radar (MAR), was built and tested at WSMR during the early 1960s (Eckles 2013:456; Lonnquest and Winkler 1996:111). The Nike X served as the basis for the Sentinel and Safeguard BMD systems that were proposed during the 1960s.

The Sentinel BMD system, reorganized as the Safeguard system in 1969, possessed political momentum even though the prevailing anti-military sentiment of the time made the systems unpopular with the public, particularly in cities where the missile batteries were to be installed. The Federation of American Scientists added intellectual weight to the grass roots movement that opposed the installation of a nationwide BMD system (US Army Center of Military History 2009:214). During the same period, the Soviet Union also developed and fielded a series of BMD systems, including the Griffon, Galosh, and Gammon (Werrell 2005:189-191). The Soviet investment in BMD systems was much higher than that of the US, estimated at 4 to 5 billion dollars by 1967 compared to the 2 billion dollars expended by the US (Werrell 2005:191). The continuing cost of developing these systems in order to maintain parity with US BMD technology likely influenced Moscow to engage in arms limitation talks.

By 1969, the first of the Strategic Arms Limitation Treaty talks had been conducted and in 1972 the Anti-Ballistic Missile (ABM) Treaty was signed. The ABM Treaty limited the number of both deterrent and defense missile systems, and while research and development of these concepts would continue, it was at much diminished scale for the remainder of the Cold War. By the mid-1970s the ABM Treaty, along with increasingly negative public sentiments, had ended the era of nationwide anti-aircraft and BMD systems. The funding for BMD systems dropped from around one billion dollars annually in the late 1960s to one-tenth that amount by 1980 (Werrell 2005:196).

Despite the reduction in defense budgets in the 1970s, pioneering efforts in new technology continued at WSMR. Examples include early work on lasers and the study of atmospheric effects on laser beams (Eckles 2013:453). This work culminated in the Mid-Infra-Red Advanced Chemical Laser (MIRACL) which was first fired or "lased" in 1980 (Federation of American Scientists 2015). In 1976, WSMR was selected as the site of the DOD-wide laser development facility known as the High Energy Laser System Test Facility (HELSTF), construction of which was undertaken at the former MAR site during the early 1980s. By 1980, a detachment of the Navy responsible for the testing of sub-systems related to the Sea Lite Beam Director was stationed at WSMR (Bingham 1980:14). HELSTF was completed and officially operational in 1985, and the same year the MIRACL laser was used to destroy a static Titan I booster (Bingham 1985:10).

The reduced funding levels and transition to a volunteer force in the 1970s left the Army understaffed and poorly equipped, a period that historian Mary Lavin refers to as the "Hollow Army" (Lavin 1998:52). However, by the mid-1980s the state of readiness of the Army conventional forces had substantially improved due to the increased defense budgets of the Carter and Reagan administrations (Lavin 1998:52). The Reagan administration also launched the Strategic Defense Initiative (SDI), a plan that would protect the US from a ballistic missile attack using, in part, advanced concepts such as orbiting intercept systems and lasers. The concept of massive retaliation, or Mutually Assured Destruction (MAD), as a deterrent to nuclear attack had been in place since the 1950s and was the major defense strategy against an ICBM attack since ABM systems had been banned by treaty in 1972. With the SDI, President Reagan sought to "create a nationwide defense shield against ballistic missiles that would make nuclear weapons impotent and obsolete" (Werrell 2005: 198; Lonnquest and Winkler 1996:116). Although the deployment of BMD systems like those proposed in the SDI would violate the ABM Treaty, there was no limitation on their research and development. The SDI program never produced a functional system, but proponents of the effort hold that it hastened the end of the Soviet Union by forcing it to invest in unproductive defense programs that overburdened its already stagnant economy (Lavin 1998:58; Salmon 2011:28; 32).

The HELSTF facility and MIRACL programs at WSMR were part of the effort to develop laser weapons for the SDI (Eidenbach et al. 1996:189; Eckles 2013:455). The Patriot Surface to Air Missile (SAM), which would later become well known to the American public during the Gulf War, was also developed in this period and deployed in 1984 (Werrell 2005:202-203). The Patriot proved to be an effective BMD system against the Soviet-designed Scud missiles, and was the only US BMD system actually used in combat (Werrell 2005:204). Also during the 1980s, the NASA WSTF became home to the primary ground terminal for the NASA Tracking and Data Relay Satellite System (TDRSS), which continued the long association of WSMR with the American Space Program. The TDRSS is the modern descendent of the NASA global networks used for the Mercury and Apollo Programs (Tsiao 2008).

In DOD guidance, the year 1989 is generally acknowledged as the end of the Cold War period, when revolutions against the Communist regimes in Poland, Hungary, East Germany, Bulgaria, Czechoslovakia, and Romania initiated the dissolution of the Warsaw Pact and the Soviet Union. However, the Soviet Union was not officially dissolved until December 26, 1991. After the collapse of the Soviet Union in 1991, WSMR focused on the development of technology and weapons suited for the changing nature of defense programs in the Post-Cold War era. Examples of these systems include the Theater High Altitude Area Defense (THAAD) missile, a modernized BMD system, and the Tactical High Energy Laser (THEL) System (Eckles 2013).

6.5 US Cold War Air Defense Systems

American strategic missile systems essentially took two forms during the Cold War: air defense systems — specifically land-based defense systems designed to protect specific areas from bombers or ICBMs — and deterrent systems, the ICBM and IRBM systems that provided the threat of massive retaliation should an attack occur. In many cases, the defense systems were arrayed to protect the deterrent systems (primarily ICBM installations) to ensure that the retaliatory second strike capability would remain intact against a preemptive strike. This discussion focuses on the deployment of several defensive systems that were intertwined with the development of the unique but short-lived land based Talos system that is the subject of the current inventory. The development of the land-based Talos was as much a political creation as it was a technological one, as the ensuing discussion will demonstrate.

To the average American, the air defense systems such as Nike Ajax, Nike Hercules, and the USAF BOMARC were among the most visible and controversial manifestations of the Cold War. As the deployment of these systems and the inter-service rivalry in their development were important factors in the story of the land-based Talos system, these systems are briefly summarized.

6.5.1 The Army Nike Ajax and Hercules

Development of the first US air defense missile began on August 17, 1944 when First Lieutenant Jacob W. Schaefer of the Army Ordnance Office submitted a memorandum that outlined the concept of a remotely controlled anti-rocket rocket (a guided missile in today's terminology). Schaefer, a former employee of Bell Telephone Laboratories, described how the operation of the system would involve two radars, one for tracking the target and one for tracking the missile, and a computer that would relay guidance commands to the missile in order to guide it towards intercept of the target. This was the genesis of the Nike-Ajax Air Defense system, and the Army Ordnance and Army Air Corps contracted with Bell Telephone Laboratories in February 1945 to evaluate the technological feasibility of Schaefer's proposal (Berhow 2005:18). Research and development efforts on the Nike-Ajax continued through the end of the war and the remainder of the decade, but were hindered by the post-war austerity measures imposed on the military as the country rapidly reverted back to a peacetime economy. During the Truman administration military expenditures were slashed, and the number of Army personnel dropped from over eight million in 1945 to under one million in 1947. While these staff and budget reductions were underway, the Army still bore a substantial responsibility for occupation and reconstruction in Korea, Japan, and Europe (Lavin 1998:17), which left little financial support for R&D efforts.

After the Korean War began, spending on defense and missile programs drastically increased. The Nike Ajax was placed on an accelerated "crash" schedule, and the DOD scheduled the program to complete 1,000 production missiles by the end of 1952 (Lonnquest and Winkler 1996:56). The expedited Nike program successfully intercepted and destroyed a drone B-17 bomber flying at an altitude of 29,000 feet over WSPG on November 27, 1951 (Eidenbach et al. 1996:43; Kennedy 2009:133). After some initial firings at LC-33 at WSPG, the system was primarily launched from LC-37, which was constructed for the Nike Ajax testing and original-

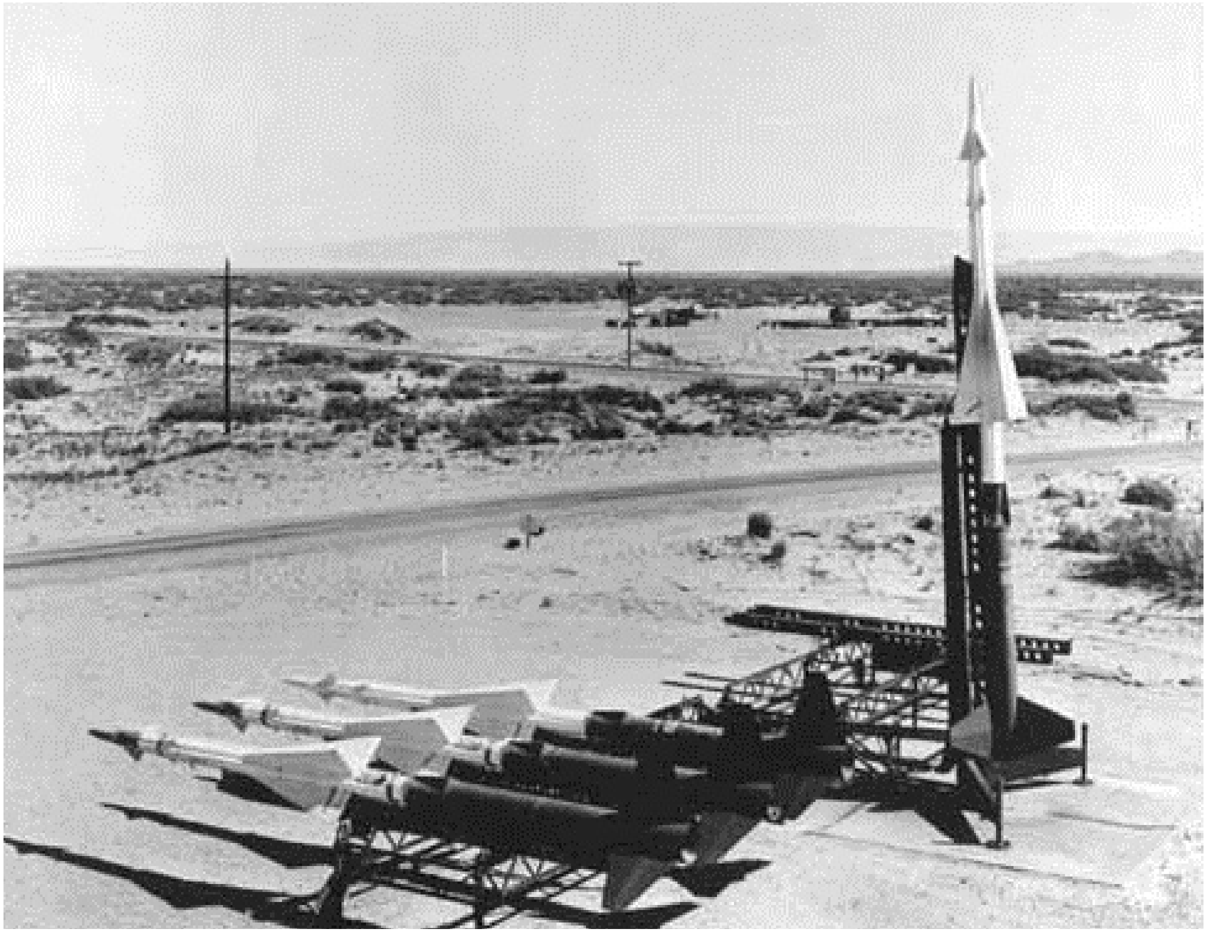

Figure 10. A Nike Ajax missile at Launch Complex 37 at WSPG, circa 1950s (*photo courtesy WSMR Museum)*.

ly known as Army Launch Area 3 (Eckles 2013:9).

The first production version of the Nike, called the Nike I, was launched in early 1952 despite the need for additional R&D work on the system. Additional modifications and improvements were still being made to the Nike I system as late as 1955 when the Nike I was listed as standard system by the Army (Kennedy 2009:135). The final Nike I missile was almost 20 feet long and 12 inches in diameter and possessed a range of about 25 miles (see Figure 10). The missile traveled at speeds up to 1,600 miles per hour and could reach an altitude of 15 miles. It was equipped with three warheads that would detonate into a cloud of shrapnel designed to maximize damage to enemy aircraft (Eckles 2013:245). The first Nike Ajax battery was installed at Fort Meade, Maryland and was fully operational on May 30, 1954. Nike Ajax batteries were installed in defensive locations around major cities and industrial areas across the nation, with 222 Nike Ajax sites installed in the continental US and an additional 24 built in Europe by 1958 (Kennedy 2009:138).

The development of a more powerful and longer range replacement for the Nike Ajax, originally called the Nike B, started in 1953. Released as the Nike Hercules, it was a much larger missile


Figure 11. A Nike Hercules at LC-37 at WSMR, July 1971 (*US Army photo)*.

that possessed an increased range of up to 50 miles (see Figure 11). The most significant change was that it was capable of carrying a nuclear warhead. Later modifications to the missile increased its range to over 75 miles (Berhow 2005:21). The Nike Hercules was also capable of greater speed and altitude than its predecessor, traveling as a fast as 2,700 miles per hour and altitudes over 18 miles (Berhow 2005:21; Bender 2004).

The nuclear capability of the Nike Hercules was an important asset to military planners who were concerned that large bomber formations would overwhelm the capabilities of the Nike Ajax system by sheer numbers. The Nike Ajax could only track one target at a time and was unable to coordinate launches between batteries. It was hoped that the nuclear capability of the Nike Hercules would enable a single missile to destroy large formations of bombers (Kennedy 2009:138-139). The nuclear warhead carried by the Nike Hercules was the W-31 variable yield unit, which could be adjusted to yields of 3, 20, or 40 kilotons (Bender 2004). It also did away with the liquid-fueled second stage of the original Nike, relying on a more reliable solid-fuel design. The Nike Hercules continued to use the same facilities, radar, and computer systems as its predecessor, easing its installation cost, but the systems were upgraded with solid state electronics (Lonnquest and Winkler 1996:108). Improved computerized command and control systems, including the AN/FSG-1 Missile Master and the AN-ASG-5(V) Battery Integration and Radar Display Equipment (BIRDIE), were released along with the Hercules. These systems allowed the efforts of multiple Nike Hercules batteries to be merged into a single coordinated response, a significant improvement over the Nike Ajax, which was unable to coordinate launches between multiple batteries (Berhow 2005:21-22).

Like its predecessor the Nike Ajax, the Nike Hercules was tested and launched at LC-37 at WSPG. The LC-37 complex consisted of six launch sections that were located several hundred yards north of the Integrated Fire Control (IFC) area that included the missile control and guidance radar components. From 1956 to 1967, 646 Nike Hercules missiles were fired at WSPG, mostly from LC-37 (Eckles 2013:9; Piland 2006).

The Nike Hercules was deployed amid a controversy between its relative effectiveness versus the USAF BOMARC system, which was still under development. This competition between the Army and Air Force was in many ways a spillover from the competition between the Army Redstone and the USAF Thor IRBM programs, but the air defense controversy proved to be more antagonistic. As the BOMARC program began to score some testing successes in the mid-1950s, the Air Force began to openly question the viability of the Nike Hercules in the press. For example, an article in the May 21, 1956 issue of the *New York Times* was entitled "Air Force Calls Army Nike Unfit to Guard Nation" (Lonnquest and Winkler 1996:60). In 1955, this competitive bid against the Army air defense program led the Air Force to fund the development of the land-based version of the Navy Talos missile which the Air Force hoped to field in advance of its BOMARC, therefore providing a more direct competitor to the Nike Hercules (McMullen 1962). This campaign accelerated as the Nike Hercules began to replace Nike Ajax installations in 1958; across the country, articles favoring the BOMARC appeared in the local papers of cities scheduled to receive the Nike Hercules. This appeared to be a strategic campaign from the Air Force to denigrate the Nike Hercules, and the Army responded with a promotional campaign for the Nike Hercules called "Project Truth" (Lonnquest and Winkler 1996:61-62).

The Missile Gap of the late 1950s encouraged the development of interim BMD systems, and the Nike Hercules was tested in this role. In 1960, a modified Nike Hercules intercepted a Corporal missile during a test over WSMR, the first time a missile had been successfully intercepted in flight (Kennedy 2009:140). The Nike Hercules intercepted another Nike Hercules missile later the same year at WSMR (Walker et al. 2003:26). The system could also be used as a surface-to-surface missile within ranges of about 114 miles, which was the transmission range limit of the Missile Tracking Radar (MTR) used in the system (Bender 2004). The Nike-Hercules began to replace the original Nike batteries in 1958, and continued to do so until the last Nike-Ajax was retired in 1964. In total, the DOD installed 145 Nike-Hercules systems nationwide (Kennedy 2009:140). The system was deactivated across the country in 1974, and overseas units in allied nations were mostly deactivated by 1979 (Berhow 2005:24-25).

6.5.2 The USAF BOMARC

Like the Nike-Ajax, the Air Force's air defense program began in the 1940s with the Ground to Air Pilotless Aircraft (GAPA) program, which was developed by Boeing. From GAPA research, the Air Force proposed an interceptor missile program, which was contracted to Boeing and the Michigan Aeronautical Research Center in 1949. The program derived its name from a combination of the initials of the two contractors; BOMARC. Development of the system was slowed by numerous technological obstacles, and the Air Force finally issued a contract for production of the missile in 1957 even though the developmental testing was incomplete (Berhow 2005; McMullen 1962).

Like many early Air Force missiles, the BOMARC was a winged vehicle that was more akin to a remotely piloted aircraft than a ballistic missile (see Figure 12). It used a liquid fueled rocket to launch itself vertically to an altitude of 60,000 feet, at which point it was propelled by ramjet engines and flew like an airplane towards the target. It used internal homing radar to guide itself once it was within 10 miles of its intended target, and had a range of approximately 265

Figure 12. An Air Force BOMARC missile battery with launcher rails and cells, ca. early 1960s.

miles (Berhow 2005). Unlike the Nike Ajax, the BOMARC could be armed with a nuclear warhead. The BOMARC was linked to the Semi-Automatic Ground Environment (SAGE), an early warning air defense radar network that automatically displayed information about incoming aircraft at central SAGE command centers (Lonnquest and Winkler 1996:59). The SAGE system was eventually incorporated into the North American Aerospace Defense Command (NORAD).

Figure 13. An Air Force BOMARC missile launch, ca. 1960s.

The USAF had originally planned an ambitious deployment of the BOMARC at 52 sites, each with 120 missiles. But development of the system was slow due to numerous technical problems, and the establishment of the SAGE early warning system drained funding away from the program. Compared to the Army Nike Hercules system, which had the benefit of drawing from the technology of the existing Nike Ajax system, deployment of the BOMARC was lagging several years behind. This would allow the Army to establish the Nike Hercules in a dominant role within the nationwide air defense system, and possibly supplant the role of the BOMARC missile entirely. However, the Air Force was unwilling to cede any ground to the Army in the field of missilery without resistance.

In addition to a public relations campaign promoting the BOMARC and denigrating the Nike Hercules, the Air Force also initiated a research program with the Navy for the adaptation of its Talos missile into a ground-based air defense system in hopes that the land-based Talos would be deployable sooner as an alternative to the Nike Hercules. However, before the land-based Talos prototype was completed, the Secretary of Defense assigned all missile systems with a range of less than 200 miles to the Army in 1956, which effectively passed the incomplete USAF Talos initiative to the Army (Lonnquest and Winkler 1996:49). The Air Force was thus left with the BOMARC as its primary land-based air defense system, which it continued to aggressively promote against the Nike Hercules.

In October 1957, the Missile Gap controversy had erupted after the launch of the Russian Sputnik, which placed the BOMARC under Congressional scrutiny due to its lack of anti-missile capabilities. Members of Congress were not keen on funding systems that were not effective against the new threat posed by ICBMs (Lonnquest and Winkler 1996:62). Nonetheless, in 1958 Secretary of Defense Neil H. McElroy announced that both the Nike Hercules and BOMARC systems would be deployed in the nationwide air defense network. However, this did not settle the issue as the decision split funding between both programs which prevented either from achieving their planned number of installations. Both services argued that the diminished deployment would result in an ineffective air defense grid (Lonnquest and Winkler 1996:62). After lengthy congressional debate in 1959, it was decided that the BOMARC air defense system would still be deployed alongside the Nike Hercules, albeit in scaled back numbers (Berhow 2005:28). The BOMARC was ultimately only deployed in eight US installations and two locations in Canada from 1959 to 1960, compared to the 134 installations of the Nike Hercules that were completed by 1963 (Lonnquest and Winkler 1996:63). In this particular battle between the Air Force and Army, the Army appeared to be the clear victor.

The BOMARC was a relatively short-lived system as, like the Nike Hercules, the BOMARC was not effective against ballistic missiles. The first version of the missile was maintenance intensive and required dangerous refueling procedures due to its liquid fueled primary motor, and was replaced by the solid fueled BOMARC B beginning in 1961. The improved BOMARC B boasted a range of over 500 miles (Berhow 2005:29). Despite the improvements to the system, the USAF soon began to phase out the BOMARC sites and concentrate on its ICBM programs. The remaining liquid fueled BOMARC A sites were deactivated by 1964, and the BOMARC B sites were deactivated starting in 1969. The last remaining BOMARC installation, at McGuire AFB, was shut down in 1972 (Berhow 2005:29).

6.5.3 The Navy Talos

The Talos was the Navy's solution for a long-range air defense missile. The development of jet powered aircraft and air-to-ship guided missiles meant that traditional anti-aircraft guns were insufficient to protect the fleet. In response to a request by the Navy Bureau of Ordnance, the Johns Hopkins Air Propulsion Laboratory (APL) proposed during the fall of 1944 the development of a supersonic, radar guided, solid fuel boosted, ramjet propelled missile that could carry a 600 pound warhead (Garten and Dean 1982). The development of a missile meeting these guidelines led to the formation of the APL Bumblebee program. The program involved the development of a ramjet motor using a simple missile called the Cobra. The power and size of the ramjet engine steadily progressed, and the Cobra evolved into the Burner Test Vehicle (BTV) by 1947. Another APL test vehicle for the beam riding guidance system, the Supersonic Test Vehicle (STV), was so successful that it quickly evolved into the Terrier missile, the Navy's first guided anti-aircraft missile (Kennedy 2009:143).

The goals of the Bumblebee missile were relatively modest; it was expected to be effective at horizontal ranges up to 10 miles and altitudes of 30,000 feet. The program produced promising results in the form of the Bumblebee Experimental Prototype Missile (XPM) which incorporated the results of the BTV and STV prototype vehicles. The XPM demonstrated the soundness of the ramjet motor, and first flew in 1949 (Hays 2014). The XPM intercepted an aerial target drone in 1951, and was followed by several other successful flights later the same year (Hays 2014; Kennedy 2009:143). Given the success of the Bumblebee program, its goals were extended to include an increased range of 50 nautical miles and to include a homing guidance system that would activate during the terminal flight phase. The longer range missile complimented the shorter range of the Terrier and created layered air defense for the fleet (Garten and Dean 1982:118).

Figure 14. Navy Talos missiles on launchers at LC-35, ca. 1950s.

The Navy Bureau of Ordnance believed that the Bumblebee XPM required a name with more gravitas. It was thus re-named the *Talos*, after the Greek God of Brass which guarded the island of Crete for King Minos (Wind and Sand 1957a: 8). Talos was said to be able to fly through the air so rapidly that his brass body would turn red hot, and he would burn his enemies to cinders by clutching them to his chest. The name seemed appropriate for the supersonic missile and was approved by the Navy Bureau of Ordnance on January 5th, 1948 (Garten and Dean 1982:118); however, it was not applied to the missile until 1952 with the introduction of the First Tactical Talos.

The majority of the Bumblebee and early ramjet vehicle testing took place at the Naval Ordnance Test Station (NOTS) China Lake, California. As the range of the ramjet vehicles increased beyond the available range at NOTS, the Navy shifted the program to WSPG. As the system would eventually require installation into the limited confines of a ship, in 1951 the Navy constructed a concrete building that simulated shipboard conditions for prototype installation and testing at LC-35 of WSPG (Eckles 2013:205). This building was commissioned as the LLS-1 USS Desert Ship, with the *LSS* standing for "Land Locked Ship" (Kennedy 2009:143). The first launch of the Talos from the Desert Ship occurred in October 1952, and it supported testing of various versions of the Talos until 1965 (Eckles 2013:205; Brown and Meyer 1982:160). Jim Eckles relates that the complicated Talos often suffered from delays to launch, and Physical Sciences Lab employee Gilbert Moore jokingly stated in a cartoon that Talos stood for "Try And Launch On Schedule". The Navy was not amused and Moore was reprimanded for his comical jab at the missile (Eckles 2013:205).

The Talos was a beam rider missile: it followed a radar beam that tracked and "illuminated" the target. However, it did not track the beam directly, but rather followed an arcing trajectory above the course of the beam that was much more economical in fuel consumption. Since the beam riding guidance lacked accuracy at the maximum ranges of the missile, a semi-active guidance seeker that would lock onto the radar signal reflected off the target during the terminal guidance phase was incorporated into the Talos (Garten and Dean 1982:118). The first pilot production versions of the Talos, known as the First Tactical Talos, were flown in 1952. The final production Talos was a large missile: the complete missile and booster was 32 feet long with a wingspan of nine feet, and weighed just under 8,000 pounds. The large size of the Talos and its radars required substantial conversions to the ships that were to carry it, and it was not released to the fleet until 1958 (Garten and Dean 1982:119; Hays 2014). The first Navy ship to be equipped with the Talos was the *USS Galveston* in May of 1958 (Garten and Dean 1982:119).

Figure 15. A Navy Talos on the launcher at LC-35 in 1958 with the Desert Ship in the background (*photo courtesy WSMR Museum Archives)*.

Figure 16. The Navy Terrier missile, another development of the Bumblebee Program and "little brother" to the Talos.

An improved version of the Talos capable of carrying a nuclear warhead, the First Tactical Talos W, was tested in 1953 after a short 18-month developmental period (Hays 2014). It was the Talos W version of the missile that was later incorporated into the prototype land-based version of the system at WSPG.

Later versions of the Talos were modified for use against land-based targets and ships. Anti-ship Talos missiles did not require warheads as the tremendous mass and velocity of the missile could inflict severe damage to ships upon impact. An anti-radiation Talos, which homed in on radars, was also developed in the 1960s. Extended range versions of the Talos that could engage targets at 130 nautical miles were also developed. The Talos served the Naval fleet until 1979 when it was retired in lieu of smaller, more versatile systems that were easier to fit on ships and more capable of engaging multiple targets. The USS Oklahoma City CLG-5 fired the last ship-launched Talos on May 1, 1979 (Hays 2014).

6.6 The Talos Defense Unit

The Navy Talos missile was adapted as a land-based air defense system in a unique tri-service effort at WSPG during the latter half of the 1950s. The story of the one-of-a-kind installation began in 1954, as the Air Defense Command (ADC) of the USAF was optimistically planning the locations of BOMARC squadrons to defend USAF and Strategic Air Command (SAC) installations across the country. Between 1952 and 1954, early plans for the BOMARC discussed the deployment of 53 BOMARC squadrons (McMullen 1962:174), which would cost well in the billions of dollars. In light of the exorbitant cost, this number was diminished to 40 squadrons. Although the USAF was eager to establish the BOMARC system, it was still in technical development as of 1954, so the newly-established service branch began to consider other systems that could be deployed sooner. Both the Air Force and the Army were eager to establish dominance in the air-defense field, but the Army was significantly ahead in the deployment of the Nike Ajax and follow-on Nike Hercules system, which added urgency to the Air Force air defense program development.

The Navy Talos missile was in an advanced stage of technical development as of the early 1950s and near the final production stages (Brown and Meyer 1982:161). In addition to being closer to a state of deployment than the BOMARC, the Talos was also a very sophisticated,

Figure 17. Aerial overview of the TDU under construction in early 1957 (*photo courtesy WSMR Museum Archives)*.

semi-automated system that was “a considerable advance in the state of the art” (Brown and Meyer 1982:161). For these reasons, the Air Force found the Talos appealing as a potential land-based system that could be deployed alongside, and complementary to, the BOMARC. The Talos was effective up to altitudes of 65,000 feet and possessed a range of 150 miles, which put its capabilities in between that of the Army Nike Hercules and the BOMARC (McMullen 1962:174). The First Tactical Talos W provided the capability to carry a nuclear warhead which could destroy large fleets of aircraft, an important tactical advantage over the non-nuclear Nike-Ajax system (Garten and Dean 1982). The land-based Talos was therefore designed around the “W” version of the Talos missile.

The USAF was designated as the service branch responsible for the land-based Talos on June 7, 1955, and a design proposal for the system was prepared by Johns Hopkins APL. After approval of the APL proposal, USAF funding was supplied to the Navy for the construction of the system. The Navy Bureau of Ordnance in turn issued a contract for the development and production of the land-based Talos to RCA of Moorestown, New Jersey (Wind and Sand 1956:1; Brown and Meyer 1982:161). RCA served as the prime contractor for the land-based

Figure 18. Another angle of the nearly complete TDU in early 1957 (*photo courtesy WSMR Museum Archives)*.

Talos, and was responsible for the physical facilities, targeting radar, and guidance systems for the prototype installation (Brown and Meyer 1982:161). The facility was constructed by C.H. Leavell & Company of El Paso, Texas, a sub-contractor to RCA. Other sub-contractors involved with the development and installation of sub-systems of the TDU were the American Machine and Foundry Company; the Reeves Instrument Company of New York, New York; Hycon Manufacturing Company of Pasadena, California; McKiernan Tierney Company of Dover, New Jersey; and ITE Circuit Breaker Company of Philadelphia, Pennsylvania (Las Cruces Sun-News 1958; Wind and Sand 1956:1; Wind and Sand 1957a:8).

As with the BOMARC, the ADC ambitiously planned for a large network of 53 land-based Talos missile installations in support of SAC and Atomic Energy Commission (AEC) installations. The USAF more realistically called for the installation of eight land-based Talos units. Preliminary planning called for these installations at Lockbourne AFB in Ohio; Bunker Hill AFB in Indiana; Peoria, Illinois; and Kirksville, Missouri. In March 1956, it was recommended that the land-based Talos be installed in defense of four major SAC bases: Offut AFB in Nebraska, Barksdale AFB in Louisiana, and March and Castle AFBs in California (McMullen

Figure 19. Aerial view of the completed TDU in 1957, AN/FPS-16 radars and launcher are installed in this photo (*photo courtesy WSMR Museum Archives)*.

1962:175).

However, before any further progress could be made in the location survey project, a controversy over the efficiency and economy of the land-based Talos and the Army Nike Hercules erupted during review by a congressional committee in the late spring of 1956 (McMullen 1962:175; Wind and Sand 1957b:1). The two systems offered similar capabilities, and therefore were seemingly redundant; some kind of comparative testing seemed necessarily to determine which system should receive the funding for further testing and development (McMullen 1962:176). This controversy was in large part driven by the schism over which service was responsible for the development and deployment of air defense missile systems: the Army or the USAF. Due to the ongoing Hercules/land-based Talos debate, the site survey effort was postponed indefinitely (McMullen 1962:176).

In 1956, Secretary of Defense Charles E. Wilson attempted to settle the Army/Air Force controversy over missile defense systems in a memorandum to the Armed Forces Policy Council. Wilson assigned the responsibility for land-based SAM systems for point defense to the Army. These point defense system were focused on the protection of specific urban areas and military installations and possessed ranges of less than 200 miles (Brown and Meyer 1982:161; Walker et al. 2003:27; Werrell 2005:183). Missiles with ranges exceeding 200 miles were to be the

Figure 20. Photo taken during the 1957 ceremony for the transfer of the TDU from the Navy to the Army. From left to right are Dr. Elmer Engstrom, senior executive vice president of RCA; Rear Admiral F.S. Withington, US Navy; Major General W.E. Laidlaw, WSMR Commanding Officer; and Lieutenant General E.L. Cummings, Chief of Army Ordnance. Man at right not identified (*photo courtesy WSMR Museum Archives)*.

domain of the Air Force, as were early-warning radar networks. Subsequent decisions in 1957 by a joint Army and Air Force committee and in 1958 by new Secretary of Defense Neil McElroy further clarified that the Army held primary responsibility for the BMD mission (Walker et al. 2003:27). Since its maximum range was less than 200 miles, the land-based Talos system became an Army project as of the fall of 1956.

Just a little more than a month after the Wilson Memorandum assigned the Army responsibility of the land-based Talos system, the ribbon cutting of the land-based Talos prototype facility, dubbed the TDU, was made at WSPG. The TDU was the first and only of its kind ever built. In late December 1956, the opening ceremony was held for the recently completed TDU facility, which was constructed in a "record time" of 282 days by RCA sub-contractor C.H. Leavell & Company of El Paso, Texas, at a cost of nearly $800,000 (Wind and Sand 1956:1). Originally, 30 months had been allotted to C.H. Leavell to complete its portion of the project, but the firm completed the construction in less than ten months (Wind and Sand 1956:1). The completion of the facilities marked the end of the first construction phase, but the next phase involved the installation of the complex electronics and launching systems by RCA. Another sub-contractor to RCA, the American Machine and Foundry Company, was responsible for most of the mechanical portions of the TDU (Wind and Sand 1957a:8).

At the time of the ceremony, Wilson's decision to turn the project over to the Army was known, but no orders directing the transfer of the facility to the Army had been received locally at WSPG. The Air Force funding program for the TDU extended through July 1, 1957 (Wind and Sand 1956:6) and transfer of the facility to the Army was not initiated until after that date (Wind and Sand 1957c:8). Despite the ongoing Army/Air Force rivalry in missile development, the local paper referred to the inter-service competition as "…only so many snowflakes on the desert…" at WSPG (Wind and Sand 1957b). From the beginning, the TDU at WSPG had been a tri-service project: the USAF provided the impetus and the funding, development of the system was completed by the Navy, and the Army provided the property and the range services necessary for the project. This sort of tri-service arrangement was unique among Cold War-era missile projects.

In March 1957, Captain Victor Hammond, the USAF project officer for the TDU project, was reassigned in order to vacate the position for an Army replacement (Wind and Sand 1957b:1). On October 15, 1957, the TDU facility was turned over to the Army for testing and evaluation in an official ceremony. The ceremony involved representatives of RCA, the Navy, and the Army, and a Talos missile strike against an airborne target was planned as the grand finale. The Talos launched successfully, but a booster malfunction prevented it from intercepting the B-17 drone flying at approximately 20,000 feet in altitude (Wind and Sand 1957a:1). This ceremony marked the first public demonstration of the Talos missile (Wind and Sand 1957a:1).

6.6.1 TDU Architectural and Engineering Firms

Numerous subcontractors under RCA were brought in for the project. Key among these was the American Machine and Foundry Company (AMF) which was responsible for most of the mechanical portions of the TDU (Wind and Sand 1957a:8). Known primarily for their commercial products such as bowling equipment and Harley-Davidson motorcycles (1969-1981), the company was one of the leading manufacturers of automatic and semi-automatic industrial machinery in the US. After World War II, the company expanded significantly with defense contracts; from 1948 to 1953, defense-related products rose from 7 percent to 50 percent of overall sales. Later, AMF became heavily involved in the construction of nuclear reactors. In 1955, AMF was retained to design and develop an underground launching system for the Titan ICBM (Harvard Business College 2015). The firm was also the builder of the Atlas ICBMs and developed the rail-car launching system for the solid-fueled Minuteman ICBM. Referred to as "RCA's close associate and principal subcontractor, [the TDU] provided a challenge and opportunity... to apply its skill in developing and producing an automatic missile launcher" for AMF (Phillips 1958).

Another sub-contractor to RCA was the architect and engineering (A&E) firm of Burns and Roe of New York who drew the architectural plans for the two primary buildings: the Property 23106 Operations Building and Property 23108 Launcher Complex. The firm was founded in 1932 by Ralph Roe, Allan Burns, C.E. Lakin, and J.P. Mailler; three out of the four left the company and the name was retained for continuity with clients. The company's first large commission was for a power plant in 1936 (Mesothelioma Cancer Alliance 2015). Under leadership from Ralph Roe's son, Kenneth A. Roe, the company expanded into the postwar defense industry, constructing numerous missile defense systems and missile installations for the DOD. Burns and Roe would go on to undertake large-scale projects in the aeronautics and nuclear power industries (Narvaez 1991). Kenneth Roe's signature can be found on the original construction drawings for the TDU.

Another subcontractor involved in the TDU is worthy of note within the context of missile development, though nothing more than the company name is mentioned. The Reeves Instrument Corporation (RICO) was founded by Hazard E. Reeves (1906–1986), a pioneer in sound and sound electronics, best known for introducing magnetic stereophonic sound to motion pictures and helping to develop and market the Cinerama process. His first foray into military work came at the beginning of WW II, whereupon he formed the Reeves-Ely Laboratories specifically in response to a contract to manufacture a very sophisticated electrical crystal circuit for the U. S. Army Signal Corps (Cinerama 2015). After the war, RICO was awarded another contract for Project Cyclone, a Navy-run project for the development and operation of a guided missile simulator and the establishment and operation of a simulation laboratory (Bauer 1953; Computer History Museum 2015). The Reeves Electronic Analog Computer (REAC) was launched in 1947, and by 1949 the company demonstrated a functioning three-dimensional guided missile simulator (Bauer 1953). The company went on to develop several SAC combined radar, computer, and communications systems known as "Q" systems (Smith and Byrd 1991).

6.6.2 Operation of the TDU

The TDU prototype at WSMR consisted of a launcher in a circular pit with three attached two-cell missile storage cells or magazines, one of which was combined with the missile checkout/assembly portion of the building. In a 1950s film on the TDU, a scale model of the land-based Talos system built by RCA displays that the original concept for the site was more elaborate. The original RCA concept model incorporated two launcher pits that shared a common missile assembly/checkout area. Surrounding each launcher pit were 30 Talos missile storage cells, arrayed 360 degrees around the launcher. These numerous launcher cells were incorporated under a common roof that encircled the perimeter of the building, giving the launcher cell a more streamlined plan. Obviously this model was scaled back for the prototype at WSMR, which was based on a single launcher cell and two storage cells each containing two internal bays.

The separate, windowless control building held the computers and support systems for two C-band, monopulse radar units mounted on the roof of the building. These radar units were variants of the AN/FPS-16 radar adapted as target trackers for the TDU under contract NOrd-15642 that were designated as the AN/FPQ-4 radar (Mills 1959:2-5). The difference between the AN/FPS-16 and AN/FPQ-4 radars appears to be primarily one of technical nomenclature; most sources identify the TDU radar units as AN/FPS-16s (Brown and Meyer 1982; Phillips 1958). Two additional C-band guidance radars were also centrally located on the roof of the control building. The RCA scale model of the TDU incorporated four of these radars to accommodate the two Talos launchers, but was otherwise consistent with the actual constructed building. The AN/FPQ-4 radars tracked and illuminated the targets once acquired, while the guidance radars supported mid-course guidance. The system was also capable of multiplexing, where it could guide several missiles simultaneously to multiple targets by switching the radar illumination from target to target during the terminal flight phase of each missile. The TDU incorporated an elaborate self-testing and fault identification process that could automatically identify issues with the system without human inspections (Brown and Meyer 1982:161; Wind and Sand 1957a:1, 8).

The RCA AN/FPS-16 monopulse radar was a major advance in radar systems, and was the first radar designed expressly for use at missile test ranges. At the time of its introduction, it was the most accurate radar system in the world (Barton 2011; 2014). The TDU AN/FPQ-4 variants of the AN/FPS-16 radars were likely among the very first installations of the new radar; additional units were installed at WSPG beginning in 1957 as electronic instrumentation at the range. The other AN/FPS-16 radars were installed on specialized buildings of uniform design and construction. The TDU AN/FPQ-4 versions were the only units installed at WSPG that were not housed by these standardized buildings.

An additional component of the AN/FPS-16 and AN/FPQ-4 installations that was integral to the proper functioning of the radars was the boresight tower (visible in Figures 17 and 21). These structures, fitted with transmitting and receiving equipment, were designed to calibrate the highly accurate radar units before use. According to radar operators, calibration must be performed before each use and usually begins hours before any tracking activities. According to the Navy Branch Head for instrumentation at San Nicolas Island, a variety of factors, particularly climatic, can affect the performance of the units, so "warming up" the systems through the calibration process results in better overall accuracy (Dean Medlock personal communication 2014). Calibration tolerances were so sensitive that operators in Australia recalled that leveling the radar pedestals was done at night when the pedestals cooled to ambient temperatures.

Two boresight towers, one per AN/FPQ-4 radar, were originally part of the TDU installation. The towers are indicated on the original architectural plans for the facility and are also visible in period photographs of the TDU. The towers were located to the northeast and northwest of the building; based on the architectural drawings, the towers were located approximately 750 feet to the north of Property 23106, and offset to the east and west by approximately 450 feet from the building centerline. Each had an associated small equipment shed, one of which was Property 23114. Neither the boresight towers nor associated equipment sheds remain in place today. One appears to have been removed soon after the cessation of the TDU testing in the early 1960s, while the other probably remained in place until the 1970s to calibrate the one remaining AN/FPQ-4 radar. Guy line anchors that were likely part of the west boresight tower installation were recorded as features during the current inventory (see Features 17 and 18 in results section).

The TDU was touted as a near fully automatic air defense missile system, which the senior executive president of RCA described as "…bringing modern warfare one step beyond the push button stage" (Wind and Sand 1957a:1). The TDU received target designation information from general search radars, either at the TDU location itself or from the larger early warning radar network. The system would perform a self-diagnosis and system-check while the target information was processed by the primary system computer. If the system-check was successful, the system would automatically begin the loading process (Wind and Sand 1957a:8).

Figure 21. The south elevation of Property 23106 in 1957 soon after it was built. The radars are not yet installed, but the east boresight tower is visible in the background (*photo courtesy WSMR)*.

To load the Talos onto the launcher, the steel doors of one of the missile cells attached to the circular launcher pit would open. Each of the missile cells had two-foot thick concrete walls to direct the blast from an accidental missile discharge upward through the cell roof rather than towards the adjacent missile cells. When the cell was opened, the launcher would rotate to face it and send a cart down a railed bridge to the cell door. Automated machinery would roll the missile onto the cart, which pulled it onto the launcher (Wind and Sand 1957d:1). The launcher would then orient itself into the firing position as designated by the targeting computer. After a final self-check, the missile was fired and accelerated through its early flight stage by the booster motor. During this phase of the flight, the C-band guidance radars would direct the missile to the general vicinity of the target. Terminal guidance was achieved with the high-precision AN/FPQ-4 radars, and a homing device would lock onto the target when the missile was in its final stage of flight (Wind and Sand 1957d:1). All this could be completed automatically, while personnel monitored the process for any issues that would require troubleshooting. However, the system could also be operated in less automated modes that involved more input from human operators. The TDU could continue to fire against multiple targets until its magazines ran empty (Wind and Sand 1957d:1).

After the failed intercept during the 1957 opening ceremony, the TDU was fired again in December 1957 by Navy personnel in cooperation with the Army. The unarmed Talos missile launched from the TDU successfully intercepted a B-17 drone "flying far down range at a medium altitude" (Wind and Sand 1957e:1). Actual Army testing of the TDU was planned to begin in early 1958, and an intensive testing period of 18 months was anticipated. Army firings of the Talos were conducted in April through May 1958 and during a public demonstration

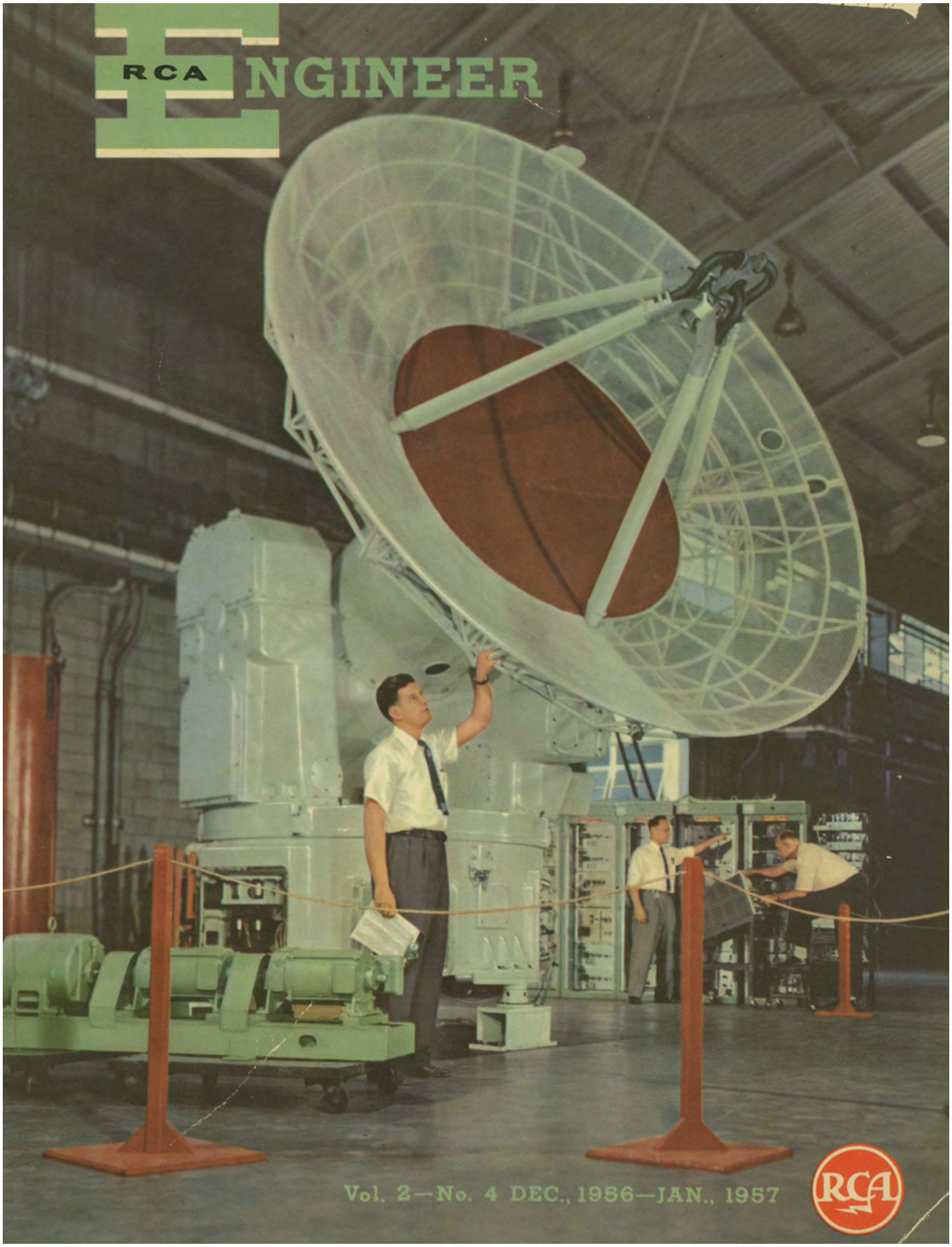

Figure 22. Cover of 1957 RCA Bulletin Issue featuring the new AN/FPS-16 radar (*courtesy David Barton)*.

Figure 23. A Talos test round on the launcher pedestal within the Property 23108 Launcher Complex, 1957. Missile cells visible in background (*photo courtesy WSMR Museum Archives)*.

of the various Army missile systems at WSPG in July 1958 known as Project AMMO (Wind and Sand 1958a; Wind and Sand 1958b). The TDU also launched a Talos missile against a Lockheed supersonic XQ-5 drone target in 1959, which it successfully intercepted (Wind and Sand 1959:1).

6.6.3 The Fate of the WSMR TDU

Despite ongoing testing of the TDU by the Army between 1958 and 1959, the political and financial backing for the program was rapidly dissipating during the same period. In early 1958, the Director of Guided Missiles at the Army Office of the Chief of Research and Development (OCRD) issued a memorandum stating that all efforts to develop an operational BMD system should be directed towards the Nike Zeus or the Talos, but that priority should be given to the new Nike Zeus (US Army Center of Military History 2009:188). Likely the result of this memorandum, nuclear-warhead equipped Talos missiles launched from the TDU were briefly under consideration as a “last-ditch” defense against ICBMs; however, no testing of the ABM capability of the TDU was ever actually conducted (Brown and Meyer 1982:161).

In an Army memorandum dated April 23, 1958, it was stated by the Army Director of Research and Development that the available Army funding could not support the TDU program beyond a minimal industrial effort and limited evaluation at WSPG. When the Army had inherited the land-based Talos program in the wake of the 1956 decision by Secretary of Defense Wilson, it had planned on establishing approximately 25 operational units of the system (US Army Center of Military History 2009:189). However, funding limitations had precluded this effort, especially since the Army was in the process of testing the Nike Hercules as a replacement for the Nike Ajax as well as funding RDT&E for the Nike Zeus BMD system. It also seems justifiable to speculate that the sour politics between the Air Force and the Army during this period, as evidenced in the public dispute over the Nike Hercules and BOMARC, probably reduced support within the Army for the inherited Air Force TDU project.

The waning Army funding levels mandated the termination of the TDU industrial effort as of May 1, 1958 (US Army Center of Military History 2009:189). Typical of many test programs at WSPG, the TDU departed with none of the fanfare associated with its arrival. A 1963 memorandum notes that the TDU facilities were reassigned as of June 1959 and RCA began to remove equipment from the site. Less than two years after its official turnover to the Army, the TDU was slated for disassembly and plans were quickly underway for the re-use of the new facilities for other programs. Following the removal of the TDU equipment, beginning sometime in the early 1960s, the location also became known as Gregg Site. Although the Navy would rely on the shipboard version of the Talos for air defense and other applications until 1979, the land-based TDU never entered into the Army arsenal of air defense systems. Instead, the Army relied upon the Nike series and the HAWK missile, and the USAF achieved a limited deployment of its BOMARC system.

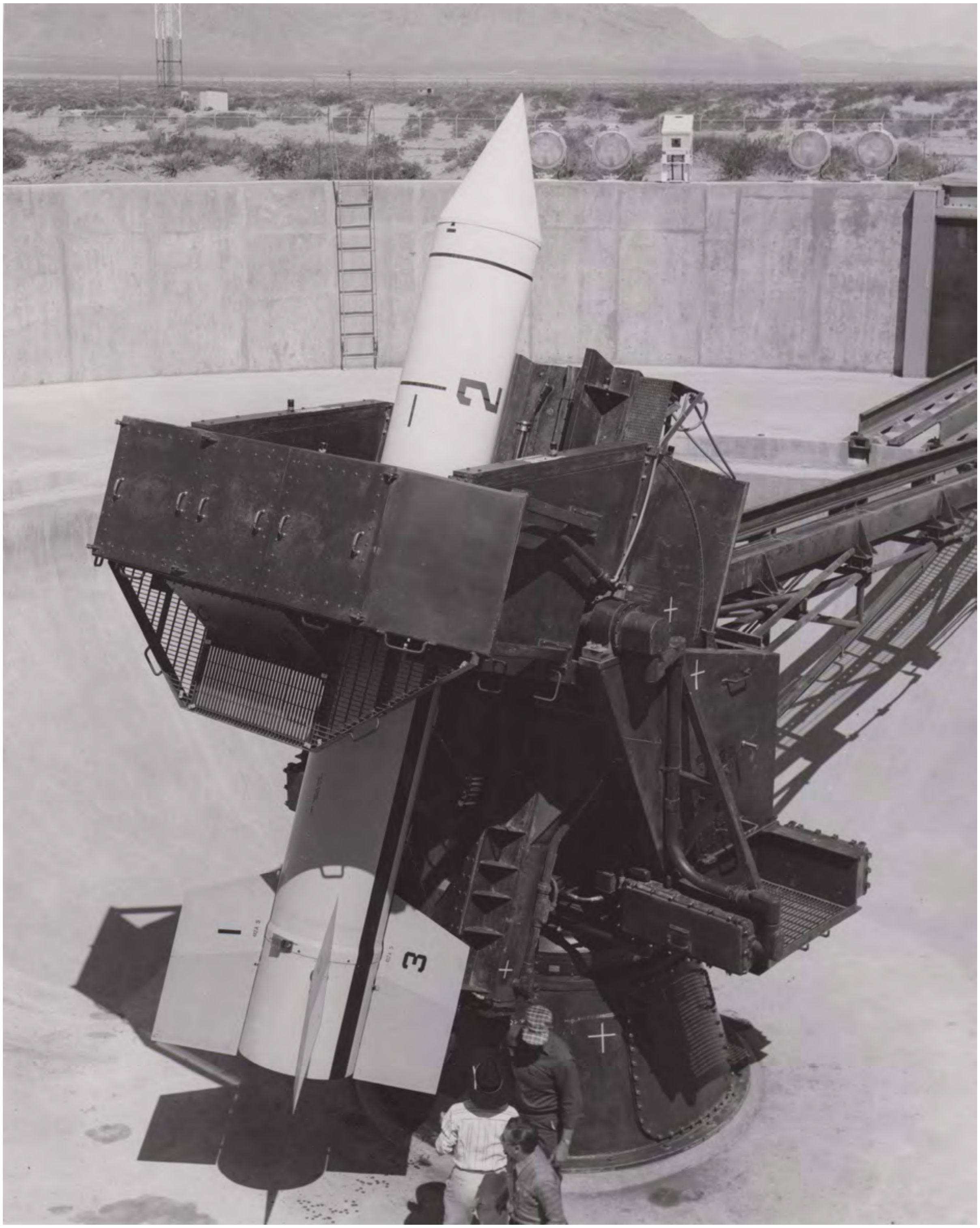

Figure 24. The TDU Launcher Pit in 1957, with Talos test round loaded in launcher pedestal. The workers at the bottom of the depression demonstrate the size and depth of the original launcher depression (*photo courtesy WSMR Museum Archives)*.

6.7 Laser and Atmospheric Research at Gregg Site

The new and substantial buildings of the TDU were soon repurposed for other applications at WSMR. Property 23108, after a period of several interim uses, became the Nucleonics Counting and Calibration Laboratory. After a transitional period, Property 23106 would become an important facility for the researching, characterizing, and understanding of how atmospheric conditions affected laser-based weapon systems.

Laser technology was originally developed by Dr. Arthur Schawlow and Dr. Charles Townes in 1958. The word "LASER" was originally an acronym for Light Amplification by Stimulated Emission of Radiation, but the application of the word as an acronym is no longer in common use (Kopp 2008). The technology developed quickly during the 1960s, and by the early 1970s the first high energy lasers were developed. These early high energy lasers demonstrated the kind of output required for the development of laser-based weapons systems, and DOD efforts to develop such a system were soon underway. WSMR was chosen as the location for the DOD-wide HELSTF laser research facility in 1976, and the Air Force and Navy both initiated laser-based weapons projects during the 1970s.

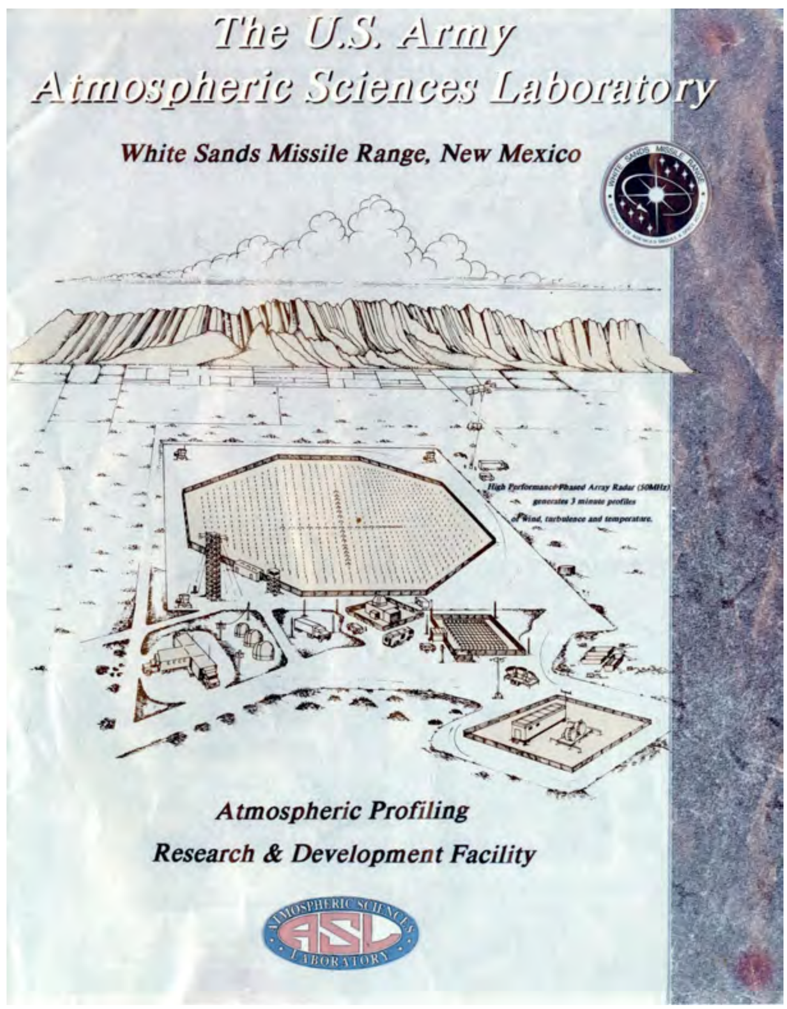

Figure 25. Cover page of a brochure for the ASL APRF with illustrated overview of the site, ca. late 1980s (*courtesy WSMR)*.

In advance of the construction of HELSTF, the former TDU Operations Building (Property 23106) became the home of the HIDL in 1973. HIDL focused on the development of instrumentation for the direction and control of directed energy weapons, and was a focal point of early efforts to understand the effect of atmospheric distortion on directed energy beams, particularly lasers.

One of the major technological hurdles of developing these systems was overcoming atmospheric distortion and diffusion of the laser beam, a problem compounded as distance to the target increased. Water molecules, water droplets, and carbon dioxide molecules absorb heat from the beam and dissipate it as it travels, a phenomena known as thermal blooming

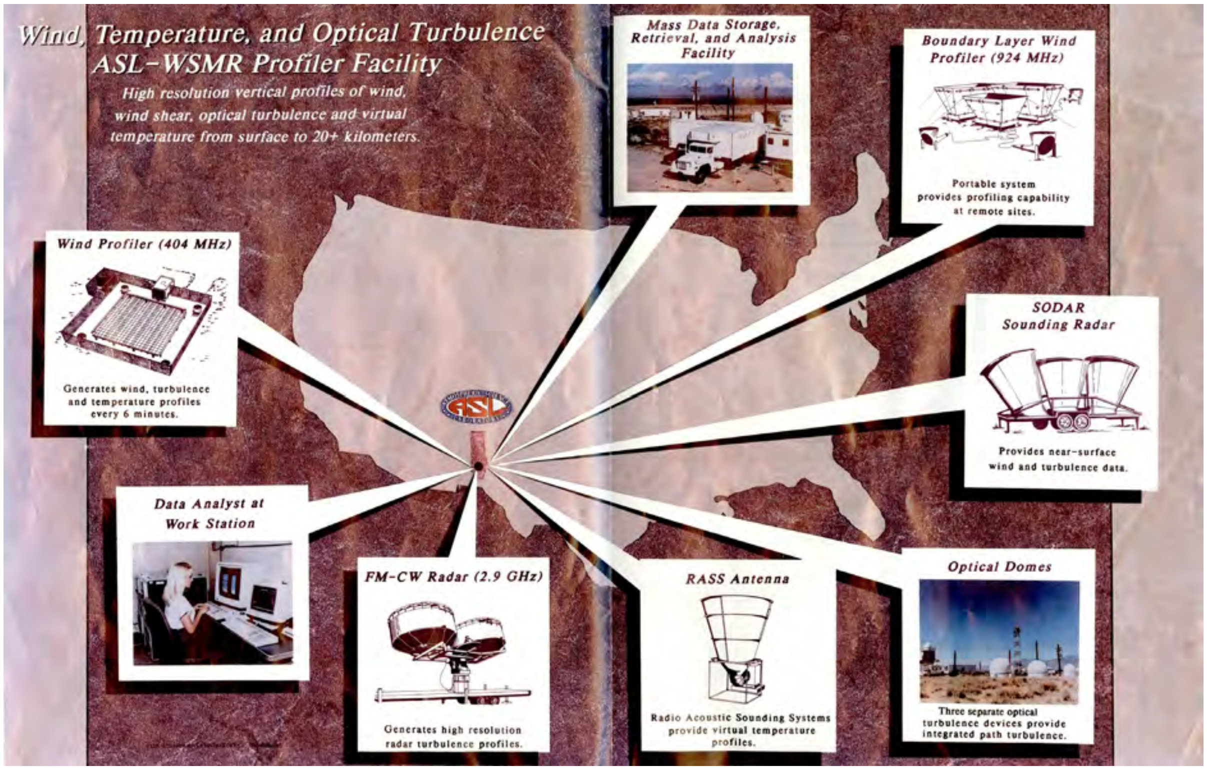

Figure 26. Interior pages of ASL APRF brochure describing the APRF profilers and support systems (*courtesy WSMR)*.

(Kopp 2008). Another major issue was the problem of beam scintillation due to atmospheric turbulence, generally caused by air pockets with different temperatures. The differing atmospheric temperatures resulted in different air densities, and the beam would refract slightly as it passed through these shifts in air density. Over the course of the beam, thousands of these shifts might occur, resulting in significant distortion and dissipation of the beam. The presence of dust particles and aerosols in the atmosphere are also culprits in the scattering and absorption of the laser beam. These effects are the most noticeable in the lower atmosphere, due to high air density and the complex shifts caused by the atmospheric interaction with the Earth's surface. This made achieving useful accuracy and range with high energy laser weapons a difficult proposition. Only through the careful study and detailed characterization of atmospheric conditions could these issues be compensated for in the direction and aiming of the beam (Kopp 2008; Wayne Flowers personal communication 2015).

Therefore, scientific study of the atmosphere conducted by the ASL at WSMR beginning in the early-to-mid-1970s was essential to the development of laser based weapons systems. The ASL atmospheric research developed methods of high-accuracy atmospheric characterization for the purposes of laser beam propagation. According to Wayne Flowers, the senior civilian scientist assigned to the ASL team, these early efforts were initiated by Don Walters of the ASL in the early-to-mid-1970s. Walters moved on from the project and was replaced by Frank Eaton during the mid-1980s, who led the program to its end in the mid-1990s (Wayne Flowers personal communication 2015).

This work was initiated at the HIDL as part of beam director research conducted by the Lincoln Laboratories of the Massachusetts Institute of Technology (MIT). According to John Hines, who was the ASL engineering team lead for the project, this early work was focused on the definition and monitoring of "seeing" conditions, or the ability of the atmosphere to conduct directed energy (such as lasers) without degradation. This effort used a variety of specialized atmospheric monitoring equipment to improve the understanding of the lower atmosphere characteristics prior to, during, and after live laser tests (John Hines personal communication 2015). Similar research efforts were eventually conducted onsite at HELSTF, and the meteorological support system developed by the ASL at that location was eventually turned over to HELSTF personnel for operation (John Hines personal communication 2015).

Figure 27. Cover of brochure on the ATMOS instrument, Optical Dome 1 is featured (*courtesy WSMR)*.

The atmospheric characterization work conducted at HIDL was expanded by the ASL during the early-to-mid-1980s into the facility that became known as the Atmospheric Profiling Research and Development Facility (APRF). John Hines recalls that Property 23109, the on-site office for the APRF, was referred to as "Gregg Site" around this time. However, over time the name appears to have encompassed the general area of the APRF rather than just one property (John Hines personal communication 2015). John Hines recalls that the ASL had already established some infrastructure at the site in support of the HIDL effort, and therefore Gregg Site seemed a logical location for continuing the research effort. The expansion included the installation of several atmospheric profilers (see Figure 26). These consisted of the large 50 MHz radar that covered a seven acre site west of the old TDU, a 2.9 GHz FM-CW radar, and a 404 MHz radar profiler. The cylindrical towers at each corner of the 404 MHz antenna array are Radar Acoustic Sounding System (RASS) antennas added to the profiler in order to detect vertical temperature gradients above the antenna, an upgrade purchased by ASL for the system (John Hines personal communication 2015). The data from the 404 MHz profiler was shared with the National Oceanic and Atmospheric Administration (NOAA) as part of the NOAA Wind Profiler network that commenced in 1986 and was completed in 1992 (Ackley et al. 2002). The various profilers ran on a continuous basis from the time of their installation to the mid-1990s, providing complete data profiles on wind, optical turbulence, and temperature from the ground surface up to 20,000 feet above ground surface. A helium filled aero blimp was also occasionally deployed for calibration of the profilers (John Hines personal communication 2015).

Figure 28. Aerial overview of TDU and the APRF installation at the Gregg Site. The back of this image in dated 1986 (*courtesy WSMR)*.

A series of optical sensors housed in astrodomes were also part of the APRF instrumentation. Scott McLaughlin, who worked at Gregg Site as an ASL technician, believes that the domes were surplus units that were tracked down at WSMR and elsewhere by John Hines and the ASL staff (Scott McLaughlin personal communication 2015). Each of the optical domes housed a Celestron 14-inch reflector telescope mounted on an adjustable azimuth/elevation mount that was controlled by an Apple II computer. Specialized sensors with data collection systems were mounted at the focal point of each telescope, and the instruments were also fitted with a customized eyepiece (John Hines personal communication 2015). The tracking functions of these optical sensors were automated, but required constant supervision by ASL staff; the team worked 16-hour shifts day and night collecting data (John Hines and Scott McLaughlin personal communication 2015).

The large Parabam astrodome on top of Property 23109 was also used to house optical sensors early in the APRF program. The large size of the astrodome accommodated at least two sensors at a time. Later in the program the sensors were relocated and the astrodome was used for dry storage. Another trailer-mounted astrodome was used for ASL special support missions across the range (John Hines personal communication 2015).

In addition to the profilers, a gas and particulate sensor system, an optical sensor array mounted on towers, an acoustic sensor, and other point-type sensors were in use at the APRF (John

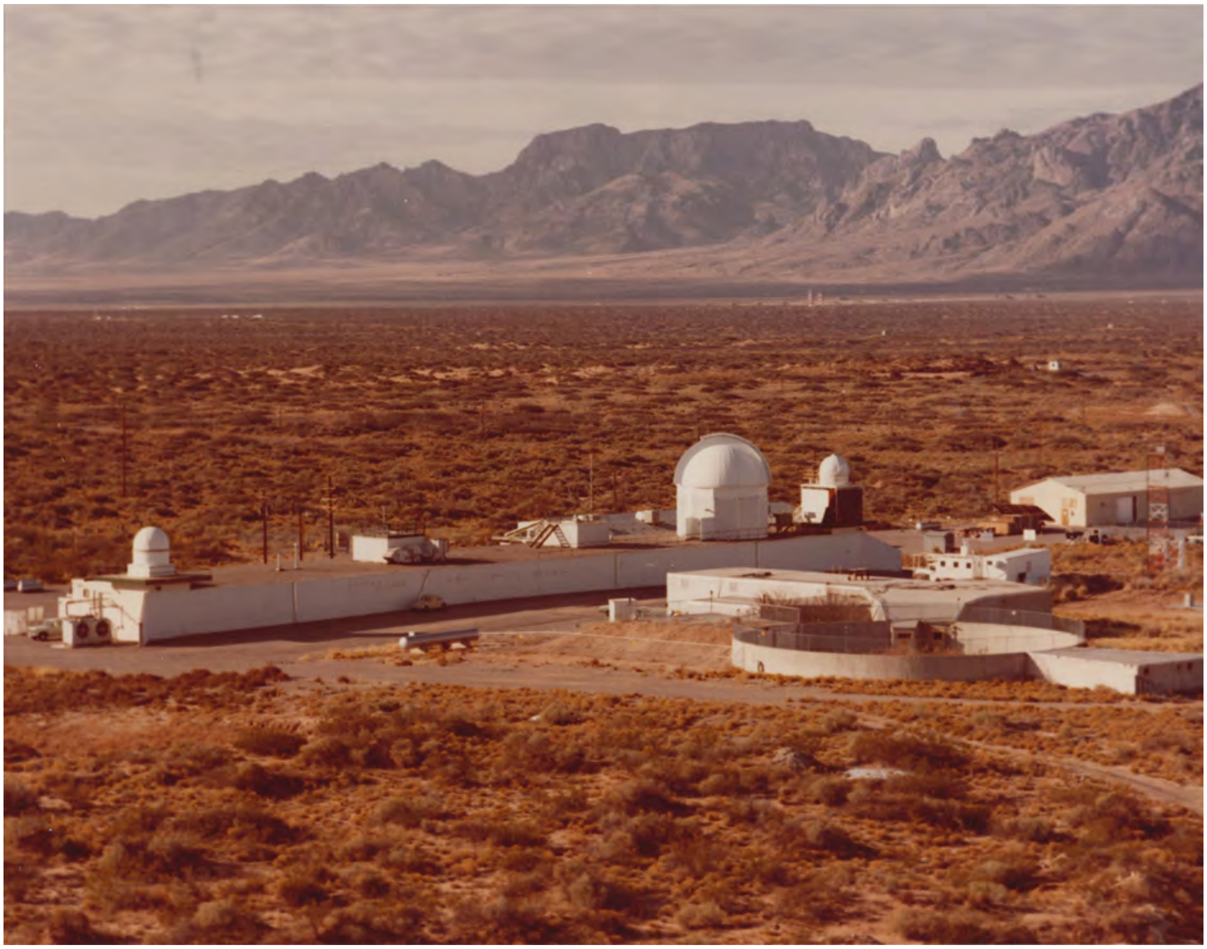

Figure 29. Overview of TDU complex, Properties 23106 and 23108. This photograph is undated but appears to be from the mid-1980s, contemporary with the operation of the APRF (*courtesy WSMR Museum Archives)*.

Hines personal communication 2015). A brochure for the site also notes that a mobile 924 MHz Boundary Layer Wind Profiler and a Sounding Radar (SODAR) unit were located at the site. Several mobile vans housed mass data storage, retrieval, and analysis hardware for processing and storage of the data gathered at the site. The ASL staff members that served at the APRF during its peak believe that it was likely the best instrumented and most advanced atmospheric research site in the world at the time (Scott McLaughlin, Wayne Flowers personal communication 2015).

A system designed by the ASL as part of the research conducted at the APRF was the Atmospheric Turbulence Data Measurement and Observation System (ATMOS), a specialized device designed for the real-time calculation of atmospheric seeing values. The system merged a digital camera and differential motion analysis technique with a telescope for the measurement of atmospheric seeing conditions, which allowed it to operate in both in daylight and at night. ATMOS could provide real-time video, was remotely controlled, and exported the data into software for spreadsheet and graphical analysis. ATMOS was portable, and ASL literature discusses its use for the evaluation of astronomical seeing conditions at Kitt Peak in Arizona. Several of the devices were used at the APRF (John Hines personal communication 2015).

Project leads John Hines and Frank Eaton pioneered many technological firsts in the field of atmospheric turbulence measurement, and the project incorporated some of the first PCs and Apple computers for automation of sensors, data processing, and graphical analysis of atmospheric conditions. During the early 1990s, data from the APRF was also made available to the scientific community via the internet, or the World Wide Web, as it was then known. According to Wayne Flowers, he coded the APRF website around 1992 for the dissemination of upper atmospheric wind speed data gathered from the profilers to the research community. This marked an early use of the web to distribute scientific research, and Flowers recalls that only a few dozen US websites were operational at the time (Wayne Flowers, John Hines personal communication 2015). Data from the APRF site was used not only in support of ASL and HIDL research, but was also relied upon by the Navy and Air Force for laser-based weapon research and development. Data derived from the APRF was also purchased by various customers and in-house research programs conducted by the ASL were ongoing throughout the life of the APRF, resulting in multiple articles published in peer-reviewed journals.

The methods and technologies developed by the ASL APRF for the real-time measurement of atmospheric conditions provided valuable input into beam director systems designed to compensate for the effects of atmospheric distortion on laser beams. By the end of the Cold War, the SDI had developed adaptive mirrors that precisely corrected the beam to compensate for atmospheric distortion, so that the wavefront of the beam arrived at the target accurately and highly focused (Kopp 2008). The adaptive mirrors were made of hundreds or even thousands of independently actuated small mirrors that could precisely control the beam distortion. Developed along with the adaptive mirror were lower powered laser radar (lidar) systems that measured atmospheric distortion along the beam path and provided real-time input to the adaptive mirror for the correction process (Kopp 2008). Thus, the major conceptual and technological hurdles of laser-based weapons systems were overcome by the 1990s. However, the practical limitations of the systems and issues of costs as compared to more conventional weapons have limited their deployment in the post-Cold War years.

The APRF came to an untimely end in 1996 as a result of budget battles both internal and external to the ASL. Over time, the facility had become increasingly oriented towards pure research rather than supporting the development of laser-based weapons systems. After the end of the Cold War and the final dissolution of the Soviet Union in 1991, the SDI effort was halted and funding for laser-based weapon programs dissipated. Some of the APRF researchers believe that the purely scientific role that the APRF had assumed made it a prime target as budgets were cut and facilities reduced under the Base Realignment and Closure Committee (BRAC) of the mid-1990s (Wayne Flowers and Scott McLaughlin personal communications 2015). The Army made plans to relocate the APRF, but these plans failed to account for the cost of moving equipment or the ability of land and frequency bandwidth at proposed locations in the eastern US. Ultimately, the APRF equipment was scattered to various organizations and much of the site disassembled. The 50 MHz profiler equipment was moved to Vandenburg AFB, and the system's ground-based antenna grid at Gregg Site was abandoned in place. The 2.9 GHz FM-CW radar was transferred to Dugway Proving Ground, and the 404 MHz radar was left intact and continued to be operated by NOAA as part of its Wind Profiler network (John Hines, Scott McLaughlin personal communication 2015). The smaller equipment was collected and shipped to Adelphi, Maryland and ultimately was stored at Fort Meade. The final removal of the APRF equipment occurred in April 1996 and any remaining equipment or properties not assigned to an organization at WSMR were abandoned in place (John Hines personal communication 2015).

The NOAA Wind Profiler network into which the 404 MHz radar profiler was incorporated was part of an evaluation effort to verify if a national network of wind profilers could improve weather forecasts (Doug van de Kamp personal communication 2015). Although the effort provided positive results, the network was eventually canceled due to funding issues. The network of 31 sites including the one at WSMR are scheduled to be removed, and the 404 MHz profiler at Gregg Site is currently scheduled to be removed in the spring of 2016 (Doug van de Kamp personal communication 2015).

6.8 Historic Context Summary

The formula of air defense changed drastically at the end of WW II with the introduction of the atomic bomb and jet-powered aircraft that could deliver it at high speeds and altitudes across large distances. The anti-aircraft gun defenses that had been successful in the attritional fight against bombing were outmoded by the prospect that a single plane and a single bomb could destroy a city. New anti-aircraft systems based on missiles were developed by the early 1950s, and by mid-decade the Nike Ajax was deployed nationwide and the follow-on Nike Hercules was under development. The Air Force had developed its own BOMARC system, and aggressively promoted it as alternative or substitute to the Nike Hercules. However, as the BOMARC was still years away from being deployed, the Air Force funded development of an interim system based on the successful Navy Talos missile, which was known as the land-based Talos or the Talos Defense Unit. The TDU was located just northwest of LC-35, where the Navy had been testing the Talos missile for several years.

The TDU was constructed as a next-generation air defense missile system in 1956. RCA was the prime contractor for the development of the system, and worked in cooperation with the Navy. The system incorporated a version of the innovative AN/FPS-16 radar, which was soon recognized as the most accurate tracking radar in the world. The system represented a substantial technological and mechanical advance, and most accounts indicate that it worked remarkably well. George Helfrich, who worked with the Navy at LC-35 as part of the Johns Hopkins APL, recalled that the system had a series of successful intercepts during its testing (George Helfrich personal communication 2015). However, due to a 1956 decision by the Secretary of Defense that defined the roles of the Army and Air Force in missile development, the TDU became an Army project. The Army was already committed to the Nike Hercules and next generation Nike Zeus development, and funding for the TDU was sparse.

Additionally, the development of ICBMs capable of delivering nuclear warheads had rapidly rendered the air defense systems of the 1950s obsolete. These systems were designed to intercept fleets of bombers, but were incapable of intercepting ICBMs approaching at much higher speeds at very steep angles. Funding was diverted from systems like the TDU towards “anti-missile missile” programs such as the Nike Zeus. By the end of 1959, the TDU prototype development was halted and RCA began to remove equipment from the facility. When George Helfrich arrived at LC-35 in 1959, the neighboring TDU was already decommissioned (George Helfrich personal communication 2015).

However, other activities soon took advantage of the new TDU buildings. Property 23108, the former TDU Launcher Complex, eventually became the Nucleonics Counting and Calibration Laboratory. By the early 1970s, Property 23106, the former TDU Operations Building, was home to the HIDL, which supported HELSTF when it was established in 1976 at WSMR. A major portion of the research conducted at the HIDL was understanding and compensating for the effects of the atmosphere on the paths of laser beams. This required a major effort by the WSMR ASL to accurately characterize atmospheric conditions and to develop methods and technologies that could accomplish atmospheric soundings in real-time without the use of instrumented balloons or rockets.

By the 1980s, the ASL effort at HIDL had expanded into a new atmospheric research facility, the APRF. The APRF was located adjacent to the old TDU complex and was referred to as Gregg Site. The APRF involved several radar atmospheric profiling units, optical instruments, data processing and storage infrastructure, and a variety of other instruments. The APRF was one of the best instrumented and most advanced atmospheric research facilities in the world while it was in operation. Unfortunately, defense spending was reduced and interest in laser-based weapons diminished following the end of the Cold War. As part of these spending cuts, the APRF was decommissioned in 1996 and the HIDL was also abandoned by the end of the decade.

The TDU developed out of the Army and Air Force competition in the field of air defense in the 1950s. Its short operational history touches upon several military and Cold War milestones, including nationwide air defense systems, the Missile Gap, the emerging compartmentalization of the Army and Air Force roles, and the Cold War Arms Race. Later activities at the related Gregg Site were involved in the development of laser-based weapons and significant atmospheric research studies, which were tied to the Reagan-era SDI of the 1980s. Though these various activities are somewhat disparate functionally and chronologically, they touch on many significant aspects of the Cold War and thus reveal that the historical story of the TDU/Gregg Site is a complex and intriguing one.

The preceding historic context has provided the story of the TDU and the site's later evolution into the HIDL and Gregg Site; now the specific properties and their roles in this history can hopefully be better appreciated. Therefore, this document now turns to the description of the buildings, structures, objects, and features recorded during the current inventory effort.

7. Description of Resources

Based on guidance provided in *Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties* (Lavin 1998), the activities at TDU and Gregg Site fall into three Cold War sub-themes: Air Defense, Basic Scientific Research, and Material Development. As a prototype air defense facility, the original TDU buildings are attributable to the theme of Air Defense and Material Development. Later activities conducted within these buildings, such as the nucleonics work in Property 23108 and the HIDL in Property 23106, would be classifiable under both Material Development and Basic Scientific Research. The later Gregg Site properties are attributable to the theme of Basic Scientific Research, as this research was conducted by the ASL, one of the seven major Army laboratories Lavin (1998:64) identifies as being active at the end of the Cold War.

The TDU and Gregg Site inventory effort resulted in the recordation of 20 buildings, structures, and objects. As part of the inventory methodology, less significant resources representing remnants of TDU and Gregg Site supporting infrastructure which lacked WSMR property numbers were recorded as features and are described separately. Twenty-one features were recorded in association with the buildings, structures, and objects at TDU and Gregg Site. The recorded WSMR properties were assigned a New Mexico Historic Cultural Property Inventory (HCPI) number and were documented on WSMR-specific HCPI forms, and the inventory was logged as NMCRIS activity number 133164. The HCPI documented properties include buildings, structures, and objects. The recorded resource locations are displayed in Figure 29.

The National Park Service defines buildings as properties that principally provide shelter for any form of human activity. Per New Mexico Historic Preservation Division guidance, only properties that fit the definition of a building in the common sense of having four walls and a roof are referred to as buildings. Structures are constructed properties that fall outside the typical definition of buildings, and during the current inventory were primarily represented by instrumentation sites. Objects are less formal properties that are often of pre-manufactured origin, such as liquid propane tanks.

The following section presents a brief descriptive overview of each property followed by a summary of its use and evolution. For more in-depth, detailed descriptions of the recorded properties, see the HCPI forms included within Appendix A.

7.1 Building Types

All of the recorded properties form a fairly discrete spatial cluster, but are largely split between significantly RDT&E efforts and time periods. The properties at the TDU and Gregg Site represent more of a palimpsest accumulation than a united entity on the landscape, but can nonetheless be grouped into several functional categories whose purposes are reflected architecturally and through physical expression. Four such property categories were identified for the recorded TDU properties: Missile Launch Facilities, Instrumentation Facilities, Maintenance and Storage Facilities, and Miscellaneous Facilities.

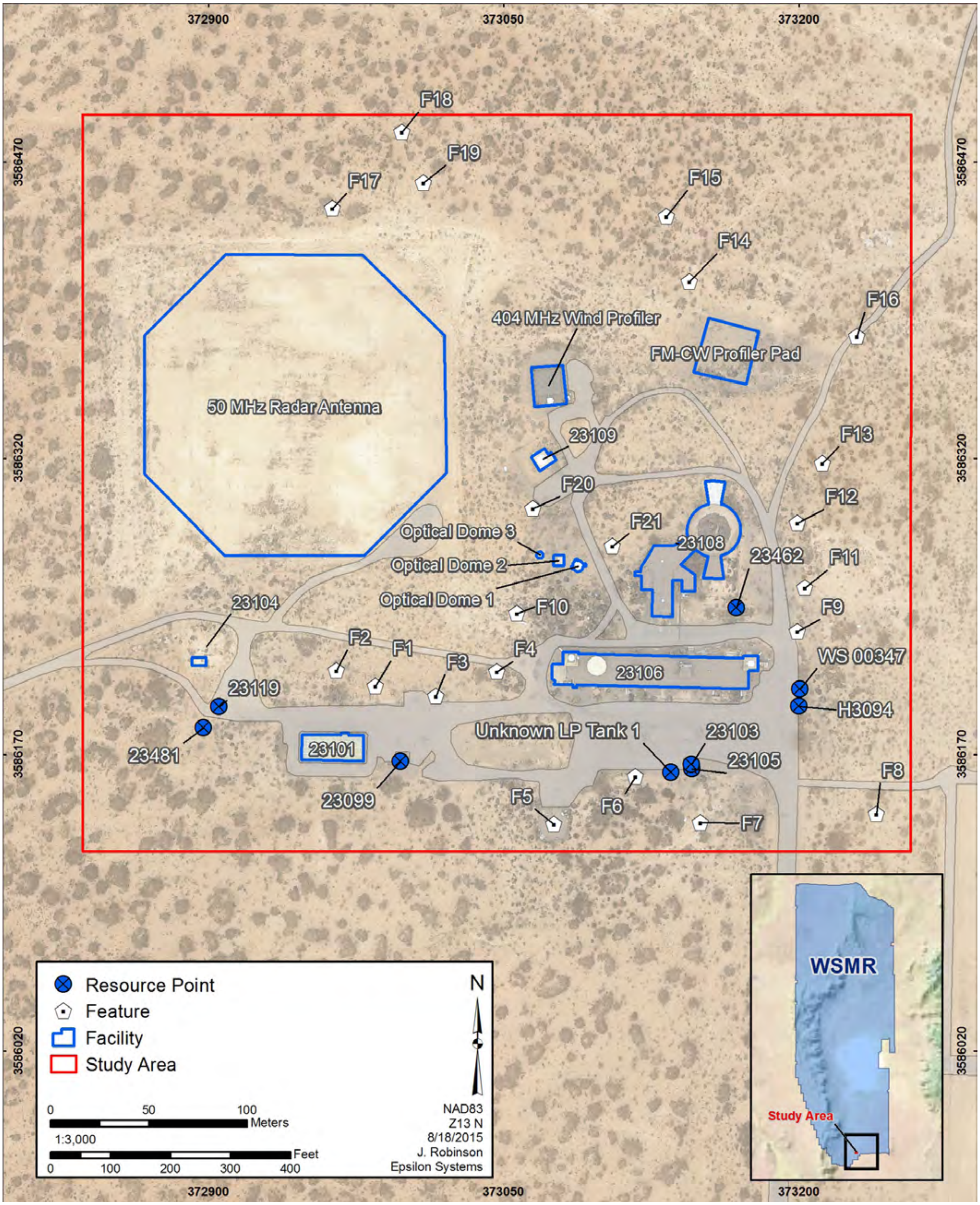

Figure 30. Resources documented during the current inventory.

The establishment of the TDU in 1956 marked the first wave of construction at the site and was responsible for the most substantial buildings at the location, Properties 23106 and 23108. Property 23104 was also constructed during this period, as was a generic steel frame warehouse (Property 23102), but both of these properties have been demolished. Both Properties 23106 and 23108 were built using a mixture of CMU and poured concrete construction, with the more robust poured concrete construction relied on to provide blast resistance walls. No additional substantial CMU or poured concrete buildings were built at the site, with additional buildings consisting of prefabricated steel frame construction, such as Properties 23101, 23109, and H3094. Other structures established at the location were primarily structural components of the APRF instrumentation, such as the various profiler units, or were basic infrastructural structures and objects such as the Property 23119 septic tank and the various LP Tanks found at the site.

The steel frame buildings found at the TDU and Gregg Site are common at most ranges, and are the pre-manufactured, steel-frame type, clad in a variety of panels (mostly metal). Extremely popular for their inexpensive construction, durability, and adaptability, the steel-frame building has its origins in the Quonset hut, the hugely successful WWII-era pre-manufactured building with its characteristic half-round shape. Major manufacturers of these common pre-manufactured buildings were the Butler and Armco companies. These “Butler-type” buildings, which were functionally equivalent to Quonset huts, were capable of being assembled quickly and inexpensively and were adapted for many uses. Property 23101 is a good example of this type of building and its modularity; it was removed from its original location and relocated to the Gregg Site in 1973.

7.2 Building Styles

In terms of “style,” the buildings, structures, and objects recorded at the TDU and Gregg Site are primarily determined by functional aspects and not easily categorized. These facilities were purpose-built for function and lack most attributes typical of defined architectural styles. Pre-manufactured buildings such as common gable-roofed, steel-frame semi-permanent buildings are easily identifiable. However, the DOD recognizes that some utilitarian facilities, such as the TDU Operations Building, derive stylistic cues from the Modern movement. These permanent buildings follow a consistent design of post and lintel concrete structures infilled with concrete masonry unit (CMU) walls, or simply CMU construction. Whether designed “in-house” by the Army Corps or by notable architect-engineer partnerships like Burns and Roe of New York, stylistic cues such as a horizontal emphasis in elevations and windows, flat or very shallow gabled roofs, and a complete lack of decorative elements all point to International Modernism. This loosely Modernistic design style is primarily expressed in the TDU Operations Building, although some elements of the utilitarian TDU Launcher Complex (Property 23108) could be considered as subtle evocations of the Modernistic style.

7.3 Building Integrity

In regard to the NRHP guidance on questions of "integrity," a discussion can be found in *Section 8.5, Integrity of TDU and Gregg Site Resources.* In a more general sense, particularly in terms of the individual resources, some aspects of physical integrity should be noted. The general location is now unoccupied and ground cover is inevitably taking back the areas around these facilities. One significant building at the TDU, Property 23104, was demolished and only an exterior radar platform remains from its installation. For the major buildings at the TDU, constructed to be permanent and long-lasting, their basic physical integrity is relatively high. However, the mechanical and technological elements that defined the significance of these facilities have been removed. This undermines much of the interpretive value at both the individual and district perspective. In a similar fashion, equipment and materials related to the later HIDL and APRF activities have also been removed. The decommissioning of these facilities in the 1990s substantially diminished their integrity and interpretative value. The secondary properties at the location, including pre-manufactured steel-frame buildings, LP tanks, and a septic tank, are all in varying degrees of slow decay from environmental factors but are functionally intact.

In the following analysis, each functional type of building and structure found at the TDU and Gregg Site is discussed separately. The discussion will introduce the attributes or characteristics in terms of that function at the range. It will then briefly discuss the resources that represent that functional type. The building and structure type discussions are followed by detailed descriptions of each individual resource with information regarding the physical changes and/or changes in use over the last six decades. Wherever possible, the interiors of the buildings were examined and none were significant in terms of architecture or engineering, nor did they retain any fixtures that were associated with the identified periods of significance.

As none of the TDU and Gregg Site resources were recommended to be individually NRHP-eligible, no discussion of eligibility was included within the individual resource descriptions and histories. A full discussion of National Register eligibility and historic district considerations can be found in *Section 8, Discussion of National Register Eligibility and Historic District Consideration.*

7.4 Missile Launch Facilities

According to Thompson and Tagg (2007:69), DOD property types associated with the RDT&E of missiles include launch pads, launch ramps, and launch silos. However, the TDU Missile Launch Facilities do not fall into any of these categories. This is partially attributable to the prototype nature of the land-based Talos system; the TDU tested a land-based installation of the already well-tested Talos missile. The TDU testing was more focused on the mechanical and electronic aspects of the prototype installation rather than testing the Talos missile itself, which was already in advanced stages of development. The TDU was an installation prototype, and had the program funding been extended similar facilities would have been constructed across the country, and the WSMR TDU itself might have been incorporated into the nation's air defense network, as suggested by some newspaper articles on the system (Wind and Sand 1956:6). As such, the TDU had more in common with Nike missile battery installations than properties typically associated with missile RDT&E efforts. The TDU prototype primarily consisted of an Operations Building (Property 23106) and a Launcher Complex (Property 23108).

7.4.1 Property 23106, TDU Operations Building

Property 23106 is an expansive one-story, mostly windowless, rectangular-plan building of CMU and cast-in-place, reinforced concrete construction (see Figure 31). The rectangular plan is modified on the east and west elevations by the presence of blocks for the support of AN/FPQ-4 radars, creating a discontinuous step in these elevations. Two entry blocks for double personnel entrances also protrude on the south elevation, which is the primary elevation of the building. The northeast and northwest corners of the building are abutted by diagonally oriented buttresses of reinforced concrete. These buttresses provide additional structural support to the radar towers at the building ends, and also acted as the margins for an earthen revetment that originally surrounded the north elevation. Also along the north elevation, an underground, concrete lined electrical trench (cable run) connects the building to the adjacent Property 23108 (see Figure 32). The flat roof of the building is of built-up construction and sealed with tar and gravel material. The roof incorporates four radar pedestals and a large dome structure.

The east radar platform has had the original AN/FPQ-4 radar removed and the concrete platform now supports an astrodome installation. Other than the removal of the radar and replacement astrodome, the platform remains mostly consistent with its original construction. The astrodome has a steel lower ring and a fiberglass upper dome, and was manufactured by the Coleman Engineering Company. In the central portion of the roof are two square towers of concrete block construction with flat concrete roofs. These towers originally supported two C-band guidance radars for the TDU. The C-band guidance radars have been removed from

Figure 31. Overview of Property 23106 south and east elevations.

both towers, and the towers have been subsequently modified.

Near the AN/FPQ-4 tower at the west end of the building is a sheet metal dome structure constructed atop of the main roof of the building (see Figure 34). The dome is constructed of 12 individual sheet metal wall panels to form a round plan, and the exterior of the building is covered in a heavy coat of tan-painted elastomeric material. A single personnel door is located on the east side of the dome, next to which is an aluminum ladder that provides access to the roof of the dome. The west AN/FPQ-4 radar tower, numbered T-2 in the original as-built drawings, is much more heavily modified than its eastern counterpart. The original radar platform has been modified with the addition of an elevated instrument platform supporting a Houston Fearless astrodome (see Figure 38).* The elevated platform is supported by four corner support posts mounted to the original concrete AN/FPQ-4 platform. A steel frame and sheet metal panels were added between the support posts, creating a mostly enclosed space beneath the upper instrument platform.

Several collections of assorted equipment and concrete barriers are located along the north elevation (see Figure 33). These include two sets of Jersey barriers (modular concrete barrier walls used to control traffic flow), a dump of wood

Figure 32. Cable trench that connects Property 23106 to Property 23108, view north towards south elevation of Property 23108.

Figure 33. Jersey barriers stacked along north elevation. View to the west/southwest.

* The Houston Fearless Company was founded by Hub Houston in 1936 as a spin-off from Hughes Development Company which was owned by famed eccentric tycoon Howard Hughes. The company specialized in the production of film equipment and processing for the motion picture industry. The business was expanded to include color film production and processing for the military in the 1940s, and merged with the Fearless Camera Company in 1950 to become Houston Fearless. The firm provided high-speed film processing equipment for the USAF SR-71 Blackbird program in the 1960s. The company was sold several times and was reformulated as Houston Fearless 76 Incorporated in 1976. Today, Houston Fearless 76 is a military contractor that continues to specialize in camera and film processing equipment, as well as wastewater treatment systems and mobile shelter systems (Houston Fearless 76 2015).

Figure 34. Enclosed sheet metal dome on roof, view to the west/southwest.

packing crates, portable instrument pedestals, a disassembled steel overhead hoist assembly, lattice work radio tower segments, and three steel railings assemblies. Associated with the rails is a damaged portable radiation screen, similar to that used by X-ray technicians.

The building interior was accessed during the recording to document its interior condition and features. According to the original design plans, the building was divided into seven primary rooms, with most of the space for personnel in the western half of the building. The transmitter rooms for the AN/FPQ-4 radar were located at either end of the building. The western portion of the building was occupied by a "Console Room," on either side of which were large "Cubicle Rooms" occupied by electronic cabinets (see Figure 35). The east part of the building was occupied by the "Power Area" and a large "Shop and Training Area." The access main corridor ran along the south side of the building.

The building in its current condition is sub-divided differently, although the power room area with its electrical breaker panels and HVAC equipment remains obvious. The console and cubicle rooms have been split into smaller offices, although a single large room in the northern part of the building appears to have functioned as some kind of control room (see Figure 36). This room and the rooms surrounding it are equipped with raised plenum flooring for the installation of sub-floor wiring. A laboratory space in the south-central portion of the building

Figure 35. The original TDU control console within the "Console Room", long since removed from the building (*photo courtesy of WSMR Museum Archives)*.

once housed a fluorine laser, according to signs in the room, although only some of the plumbing associated with the laser remains. Overall, the building interior is quite empty, with little in the way of equipment or documents left behind.

History of Use

Property 23106 was constructed in 1956 as the Operations Building for the first and only TDU prototype. The original plans for the building were drawn up by the A&E firm of Burns and Roe Incorporated and submitted to RCA, the prime contractor for the TDU. The RCA contract was issued by the Navy Bureau of Yards and Docks, District of Public Works Office. The building was constructed by C.H. Leavell & Company of El Paso, Texas, a sub-contractor to RCA, at a cost of $442,195. Another sub-contractor to RCA, the American Machine and Foundry Company, was responsible for most of the mechanical portions of the TDU (Wind and Sand 1956:1; Wind and Sand 1957a:8). Other contractors that worked on the TDU project were the Reeves Instrument Company of New York, New York; Hycon Manufacturing Company of Pasadena, California; McKiernan Tierney Company of Dover, New Jersey; and ITE Circuit Breaker Company of Philadelphia, Pennsylvania (Las Cruces Sun-News 1958).

The building's tenure as part of the TDU was short-lived. Based on articles in *Wind and Sand,* the last Talos firing from the TDU occurred in either late 1958 or early 1959, and disposition records relate that RCA was in the process of removing equipment from the building by June

Figure 36. View of interior “control room” with raised plenum flooring within Property 23106, view to the east.

1959. This left the large, almost brand-new building open for re-use as part of other programs at WSMR.

A 1963 memorandum from the Director of the Range Operations at WSMR outlines the history of Property 23106 following the end of the TDU program (Beaudry 1963). In the memorandum, it is stated that in June 1959 the Commanding General concurred with the assignment of the TDU facilities for use as a data collection center as part of the Advanced Range Testing, Reporting, and Control (ARTRAC) plan, and RCA began to remove all the equipment associated with the TDU. The WSMR Integrated Range Mission (IRM) planned to use Property 23106 as a “lower range instrumentation control center” as part of the ARTRAC implementation. However, the plans to develop the facility went through a series of debates, changes, and contradictory approvals and disapprovals (Beaudry 1963). Architectural plans were drawn up and contracts issued for the modifications of Property 23106 during 1960 to 1961, but were halted due to concerns over the potential radiation effects to equipment and personnel from the installation of a SPG-56 radar unit at the neighboring Navy Launch Complex (LC-35) (Beaudry 1963). Consultation with the Navy in 1962 showed that these concerns were largely exaggerated, and the adaptation of the TDU facilities began to proceed once again. As of 1963, it was calculated that $370,684 had been spent on the modification of the TDU facilities in anticipation of their adoption by IRM (Beaudry 1963).

Figure 37. East T-2 AN/FPS-16 radar platform with Coleman astrodome, view to the east.

Despite this expenditure, a 1963 memo from Missile Flight Surveillance Command documents that the use of Property 23106 by IRM as a data center for ARTRAC was not approved as it was felt that the location of the TDU among the launch complexes north of Nike Avenue would represent an unnecessary hazard for the type of work being conducted and also require frequent mandatory evacuations of the building personnel during some types of firings. It is also stated that the location was too remote from the primary range control area, and that the use of the building as an ARTRAC control center was not advantageous to the current range missions (Wagner 1963).

Figure 38. Overview of modified west T-2 AN/FPS-16 tower, view to the northwest.

Thus, despite IRM's extensive planning for the adaptation of the building as an ARTRAC control center, it was never used for this purpose. It was, however, utilized for other projects. Disposition data indicates that the facility was used during the mid-1960s as the Orbital Support Computer Center, and the west wing was used in support of the XN-3 AN/FPQ-4 radar and Space Operations Center. Disposition data also relates that Room 112 of the building was utilized for acceptance testing of the Instrument Data Converters (IDC) from 1972 through at least 1974.

The west AN/FPQ-4 radar was removed in 1973, and the same year the building became the HIDL which supported the HEL program as a laser instrumentation development laboratory. The HEL system was a laser-based weapons system whose development was initiated in 1976 and was primarily based at the HELSTF facility on the north side of Highway 70. The HIDL was under the supervision of the Instrumentation Directorate until 1982 when it was transferred to the High Energy Laser Program Office (HP). This included not only Property 23106, but 23102 and S-20496 as well.

The sheet metal dome enclosure on the roof of the building was added in 1980 to house a coelostat, and a 1980s photograph of the building shows that the dome was originally equipped with an upper observatory dome for operation of the coelostat. It is unknown when the dome was removed and replaced with the current enclosed roof.

According to disposition data for the property, the coelostat was used in support of the Navy Automatic Aimpoint Selection and Maintenance (AuASAM) system tests, which was a sub-system developed for use with the Navy Sealite Beam Director test program (Gonzalez 1980). The AuASAM system and the Sealite Beam Director Tracker Imager were tested against stationary targets at the HIDL from mid-March through mid-July 1980, and this activity was primarily located in rooms 101-104, 107, 110, and 111 of the building (Gonzalez 1980; Missile Ranger 1980). Similarly, from 1980 to 1984, Room 112 was used for installation of the High Energy Laser Acquisition and Processing System (HELDAPS). During the 1980s, the HIDL facility was under command of the Directed Energy Directorate (DE).

In 1989, an agreement with the DE allowed for co-use of the HIDL with the Vulnerability Assessment Laboratory (VAL), and the interior of Property 23106 was divided between the two organizations. Memos regarding the property from 1991 indicate that it was still being used in support of directed energy (laser) programs, but the co-use agreement with VAL had been terminated. By 2000, the HIDL program had vacated the building and the property was ready for turn-in (Payen 2000). The building was vacant as of the 2000 recording by HSR.

7.4.2 Property 23108, TDU Launcher Complex

Property 23108 is a launcher complex with a very irregular footprint of cast-in-place, reinforced concrete and CMU construction. The property is composed of four primary parts which are united by a circular, concrete lined and walled launcher cell, labeled as the "pedestal pit" in the original architectural drawings. On the north and south sides of the pedestal pit are trapezoidal shaped magazines or storage cells, each with two interior bays. Attached to the southeastern margin of the pedestal pit is a large block with an irregular footprint that abuts in the same manner as the storage cells, but expands into a larger building in its southern and western extent. This portion of the building is identified as the "checkout and assembly area" in the original architectural plans for the property. The launcher cell itself is uncovered, but the remainder of the building is protected by a built-up flat roof, surfaced with tar and gravel and supported by steel I-beam rafters.

Figure 39. An aerial overview of the complex plan of Property 23108 (*courtesy WSMR)*.

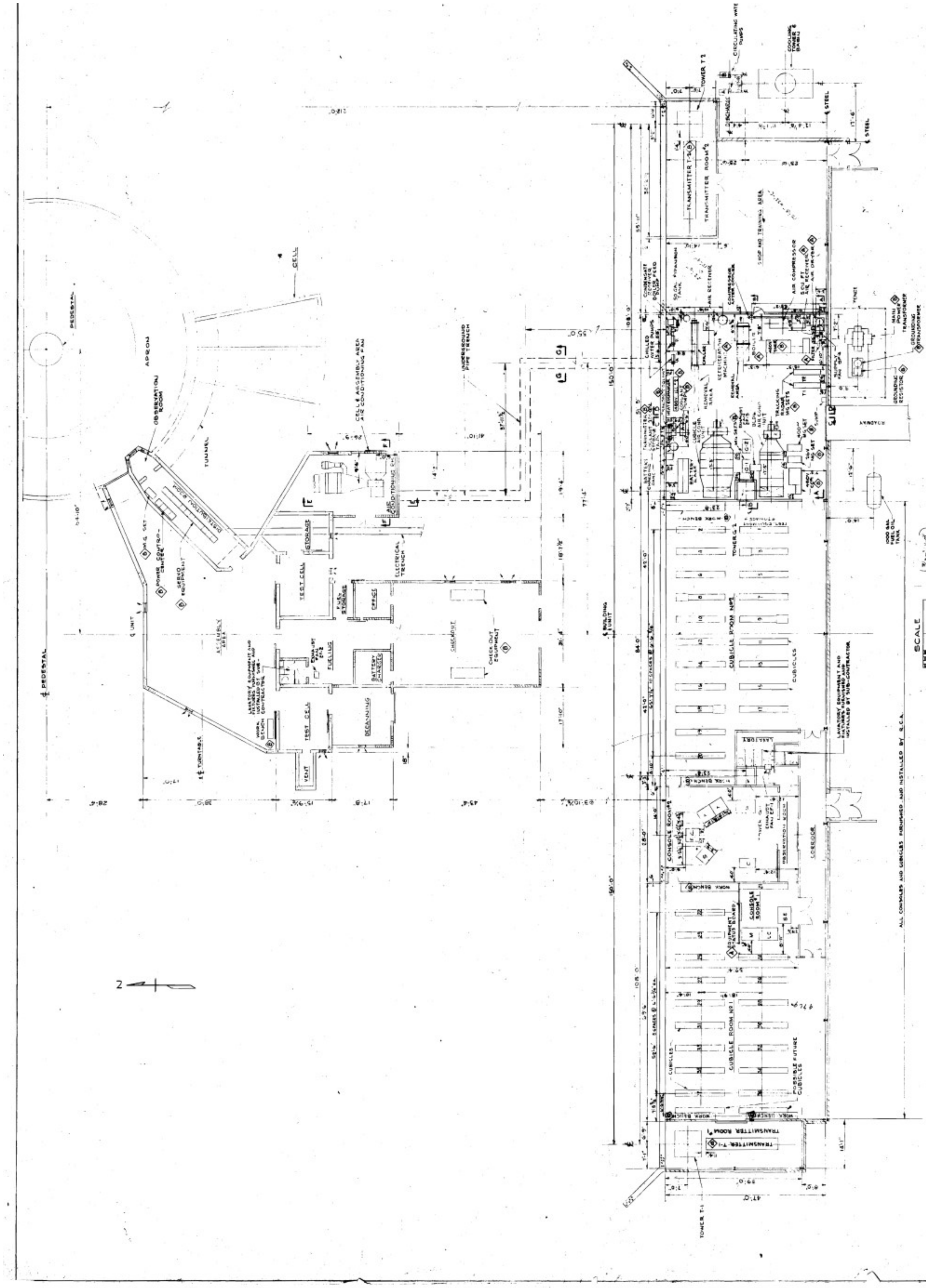

Figure 40. The original architectural overview drawings for Properties 23106 and 23108 (*courtesy WSMR*).

Figure 41. Interior of the launcher cell, infilled launcher pit with vegetation at center, observation booth at upper right, and south storage cell at upper center. View to the south/southeast.

The south elevation of the checkout portion of 23108 has a large, double steel, slab-type door entry with a rectangular concrete entry apron with imbedded steel plates. These plates are the remnants of an overhead crane that traveled into the building via the double doors, as visible in historic photographs of the building soon after its construction. This would have allowed Talos missile components to be unloaded and moved inside the building for the checkout and assembly process. As shown on the original plans for the property, the interior of the checkout/assembly block of the building was dominated by an assembly area that connected to the launcher cell.

The center of the launcher cell, or pedestal pit as it is referred to in the original drawings, was originally a bowl shaped concrete depression. Centrally located in the bottom of the depression was the Talos launcher pedestal. Based on the original as-built plans, the depression was originally 54 feet in diameter measured edge to edge and just over 12 feet deep. According to one source, the depression was originally filled with water and used as a splash pool for absorption and dispersion of the blast effects from the Talos missile launch (Missile Ranger 1970:3). Pairs of steel rails ran from each of the storage cells, and another set ran from the assembly area door. The pedestal rotated to align with these rails, and pulled the Talos missiles onto the launcher rail via a cart assembly. Today, none of the TDU launcher equipment remains inside the launcher cell and the pedestal pit depression has been infilled.

The storage cells flanking the launcher pit were constructed with two interior bays, each of which held a Talos missile in readiness. The walls of the cells are of thick reinforced concrete, while the roofs were constructed of friable material. In the unlikely event that one of the missiles exploded, the blast would be directed up through the roof rather than through the walls, mitigating the chance of igniting the neighboring Talos missile in the opposite bay. All the interior equipment has been stripped from the storage cells, and the steel door frames have been fitted with double, steel-slab personnel door entrances.

The checkout/assembly area connects to the launcher cell in a fashion that is structurally similar to that of the storage cells, but was modified to include an observation area at the far end of the interior distribution room. The observation area is a small booth of reinforced concrete construction that protrudes slightly into the launcher cell area. The observation booth has blast-proof windows set in steel frames in all three sides.

The interior of the building has undergone extensive renovation and the most recent usage of the interior rooms was divergent from their original design. Most of the central rooms have been converted to basic office space complete with dropped tile ceilings and carpeting. All equipment has removed from the building, leaving few indications as to its most recent usage. However, one interior space was signed as the "NUCLEONICS COUNTING LAB".

Figure 42. North storage cell doorways, modified with double personnel doors, view to the northeast.

Figure 43. Observation booth and entry into assembly and checkout area of building, view to the south.

Figure 44. Interior hallway of modified checkout and assembly block, view north.

Figure 45. View of assembly area in the building interior, view to the south/southwest.

History of Use

Property 23108 was constructed in 1956 as the Launcher Complex for the first and only land-based Talos prototype, the TDU. It was the counterpart to the Property 23106 Operations Building; the two buildings were the primary facilities of the TDU. The original plans for the building were drawn up by the A&E firm of Burns and Roe Incorporated and submitted to RCA, the prime contractor for the TDU. The RCA contract was issued by the Navy Bureau of Yards and Docks, District of Public Works Office. The building was constructed by C.H. Leavell & Company of El Paso, Texas, a sub-contractor to RCA. The construction cost was $982,317 according to the WSMR Real Property Record. Another sub-contractor to RCA, the American Machine and Foundry Company, was responsible for most of the mechanical portions of the TDU (Wind and Sand 1957a:8). Other contractors that worked on the TDU project were the Reeves Instrument Company of New York, New York; Hycon Manufacturing Company of Pasadena, California; McKiernan Tierney Company of Dover, New Jersey; and ITE Circuit Breaker Company of Philadelphia, Pennsylvania (Las Cruces Sun-News 1958). Based on articles in *Wind and Sand*, the last Talos firing from the TDU occurred in either late 1958 or early 1959, and disposition records relate that RCA was removing equipment from the TDU by June 1959. The unique property was soon considered for other applications at WSMR.

By early 1960, the building was requested for use by the Aerial Targets Branch for the storage, assembly, and checkout of aerial targets. However, this request was denied in June 1960 by the WSMR Safety Office (Beaudry 1963). The WSMR Integrated Range Mission (IRM) then requested the building for use as an Optical Test Facility (also referred to as a Telescope Test Facility in the same document) in June 1960. This request was denied in November 1961 due to the installation of SPG-56 radar unit at the neighboring Navy LC-35. It was felt that the radiation hazards from the radar operation would be detrimental to both personnel and equipment at Property 23108. The same concern was raised for the re-use of the adjacent Property 23106 (Beaudry 1963).

Meanwhile, full architectural plans for the modification of Property 23108 and Property 23106 were drawn up in 1961 by the Kenneth S. Clark architectural and engineering firm of Santa Fe, New Mexico. These plans called for extensive modifications to the property, included increasing the height of the launcher cell outer wall; the addition of a steel frame, metal clad roof to the launcher cell; and the covering of the launcher pit depression by a level floor across the interior. The plans also indicate “sky domes” in the roof and instrument locations (the type of instruments is not identified in the plans) within the interior of 23108. A portion of the launcher cell outer wall near the south storage cell was to be removed and a door added, providing direct access to the launcher cell. The assembly/checkout area was to be likewise modified extensively, with numerous walls scheduled to be added and portions of existing walls removed. Within the former distribution room, a subterranean stairwell was planned in order to access the south maintenance tunnel. The maintenance tunnel is re-classified as a basement in the modification plans, with notes indicating that the area was to be modified for use as a darkroom. The primary entrance on the south elevation of the building, which entered the former checkout area, was to be completely sealed. However, none of these scheduled modifications were carried out as IRM’s request to use the building as an Optical Test Facility was denied.

Despite this, IRM still wanted to retain Property 23108 for other testing purposes. As outlined in another memo dated July 2, 1962, these scheduled tests involved 100,000 to 250,000 volt high current power supplies, which in their planned application produced hazardous X-ray radiation. The IRM memo related that these tests also could produce high-intensity ultra-violet and laser beam outputs which could be fatal to personnel even from minimal exposure (Maughan 1962). Property 23108 was identified as the only known laboratory facility that met the project needs for isolation and utility (Maughan 1962); however, the same argument was advanced by the SMSA for use of the building for another project (Horne 1962). The same IRM memo also noted that the launcher pit was currently being utilized by NMSU as a water reservoir for use in turbulence reduction studies being conducted in conjunction with a subdivision of IRM (Maughan 1962). A separate memo notes that the blast doors, cable, and hydraulic systems of the TDU launcher had been previously removed in 1960 (Beaudry 1963).

Despite the preliminary work performed by IRM in converting the property, Property 23108 was instead assigned to the Electronics Research and Development Activity (ERDA) in August 1962 (Beaudry 1963). The modifications eventually made to the building were less substantial and more recent than those proposed in the 1961 Kenneth Clark plans. The assignment of the building to IRM was terminated on August 27, 1962 with the exception of the launcher pit area, which apparently remained assigned to IRM for a while longer. The building was then transferred to the ERDA branch at WSMR. According to a letter dated August 21, 1962, the building was to be used by the Signal Missile Support Agency (SMSA) which planned to use 23108 as laboratory space for a laser (referred to as "SPLASER" in the memo) research program. The SMSA laser program was described as very hazardous and classified as secret; it was anticipated to last up to 10 years (Horne 1962).

Around this time, the authority of RCA to act as Post Engineer for the TDU properties was officially revoked in a letter dated January 25, 1963. This authority was established in a letter dated January 13, 1958 in order for RCA to "perform certain activities" at the site, probably the dismantling and removal of equipment from the TDU. This revocation appears to have purely an administrative clarification as the disposition records suggest that RCA had not been active at the site for several years.

By 1965, it appears that the SMSA laser program was complete at 23108, as the property was assigned to the Data Collection Directorate (DCD) and occupied by the ERDA-Optics branch beginning in April 1965. It was assigned to be used for reliability testing of Operation-Status Units (consisting of control consoles, control transmitters, displays, a multi-plexer, switching units, remote control units, and various receivers) related to the ARTRAC improvement project during the summer of 1965. The initial request for the use of Property 23108 for this testing was in December 1964, which specified the need of 2500 to 3000 square feet of warehouse space for the set-up and operation of the units as part of their acceptance and evaluation testing. Related to this request, the property was reassigned from DCD to the Communications Directorate, Engineering and Control Branch (CD-E) in July 1965. The Real Property Record notes that minor alterations were made to the building in 1965, probably related to this testing program.

Property 23108 was assigned for use in support of Nucleonics Calibration in June 1967, and some minor modifications, including the installation of a heating system, were made to the building in 1968 and 1969 to improve it for this use. The Nucleonics Calibration Facility established in Property 23108 was responsible for the calibration and maintenance of the hundreds of nucleonics instruments, such as Geiger counters, used at WSMR (Missile Ranger 1970). A 1969 facilities inventory noted that it remained in use as a nuclear calibration facility under the LG-L organization and that the basement and tunnels around the "fish bowl" would make excellent fallout shelters. The building was noted as being well-suited for its use as a nuclear calibration facility as its "shielded walls were good for x-rays and radiation" (Meade 1969). The facilities inventory report enumerated the rooms in the building as the Control Office (213), Storage (212), Electrical Repair (201 and 202), Standards and Evaluation (206), Hot Storage (207), Utilities (208), Main Radiation Exposure Bay (200), Gamma Calibrator (200-A), and X-ray Cell (200-B). Only four total personnel were listed as working at the facility (Meade 1969). By 1973, the Nucleonics Calibration Laboratory in 23108 was part of the Calibration Division Quality Assurance Office (QA-C), and Mr. Orion T. Linam and Mr. Robert E. Sleever were designated as the building custodians (Harmon 1973). Robert Sleever was the individual primarily responsible for the establishment of the Nucleonics Calibration Facility at Property 23108 in 1967 (Missile Ranger 1970).

The use of the property as the location of the Nucleonics Calibration Laboratory appears to have continued through the remainder of the 1970s and the 1980s. Architectural plans for the relocation of an astrodome shelter from Property 1528 to the roof of the checkout area of

Property 23108 were filed in 1975 (Drawing #PE-GP-075). The astrodome was later removed; a steel frame that supported the astrodome was located just west of the building during the inventory and recorded as Feature 22. According to the building's Real Property Record, additional minor improvements were made in 1986, and a wall modification for the calibration room was undertaken in 1989.

By the 1990s, the laboratory designation had become the Test Measurement and Diagnostic Equipment Support (TMDE) Nucleonics Counting Laboratory. The Nucleonics Counting Laboratory was moved to Building 1512 in 1998. Property 23108 was placed on hold status by the United States Nuclear Regulatory Commission (USNRC) until 2001 while the proposed decommissioning package for the building was approved. The building was approved by the USNRC for unrestricted use in 2001, but does not appear to have been reused since that time. At the time of the current recording, the building was abandoned. No equipment remained within the building interior and the building is in fair condition.

7.5 Instrumentation Facilities

Thompson and Tagg (2007:94) identified several types of tracking and telemetry facilities associated with DOD RDT&E activities, including cinetheodolite stations, camera stations, radar stations, and telemetry stations. A variety of instrumentation facilities were recorded at TDU and Gregg Site, several of which could be classified as camera stations or radar stations. Property 23109 was constructed as an elevated camera platform with an enclosed interior for facility space. A dedicated building for the AN/FPS-8 radar was formerly located at the site, but has been demolished. Only an associated radar support pad remains of this property.

Many instrumentation functions for the original TDU were incorporated into the Property 23106 Operations Building, eliminating the requirement for external instrumentation support facilities, such as the AN/FPS-16 radar buildings that are seen elsewhere at WSMR. Dedicated camera shelter buildings are also commonly encountered at WSMR, but at Gregg Site optical instruments were housed by a variety of astrodomes.

Many of the instrumentation structures at Gregg Site are remnants of the ASL APRF, and include several astrodome locations that are consistent with cinetheodolite or camera stations as summarized by Thompson and Tagg (2007:94), but housed special optical instruments such as the ATMOS. Other ASL instrumentation structures recorded at the site are less substantial, such as the radar profiler installations that consist of fenced enclosures that formerly surrounded radar units. One of these remains at the site today. The large seven acre 50 MHz antenna array was part of an ASL radar profiler, but the physical remains of the antenna consist only of fence posts and wires with no associated buildings or formal structures.

7.5.1 Property 23109 Camera Building

Property 23109 is a steel frame building clad in transite composite panels, built on an at-grade concrete foundation. The building has a simple square footprint that is modified by a partial-length, shed roof addition on its east elevation (see Figure 46). The flat roof of the building supports a large astrodome, which is accessed via a metal staircase attached to the west elevation. Beneath the astrodome, a substantial concrete column provides support of the enclosed instrument. This concrete column is not visible from the exterior of the building, but it is visible in photos of the building's construction. The building is essentially an elevated instrument platform enclosed by walls.

The flat roof of the building is constructed of I-beam rafters and decked with diamond plate steel panels. The roof has been coated with a heavy layer of elastomeric sealant, and a steel post and cable handrail runs along the roof perimeter. The astrodome mounted to the rooftop deck is of Parabam manufacture, with the entry door and drive unit located on its east side. No equipment remains in the astrodome, and it is mostly filled with discarded cardboard boxes.

The main entrance to the building is located on the south elevation, which serves as the primary elevation of the building. This entrance is sheltered by a windbreak constructed of angle-iron framing and green translucent fiberglass panels. A sign mounted to the wall immediately east of the entrance reads "ATMOSPHERIC PROFILER RESEARCH FACILITY (APRF) / US ARMY ATMOSPHERIC SCIENCES LABORATORY / WHITE SANDS MISSILE RANGE NEW MEXICO 88002". To the west of the entry is a steel frame window with four safety-glass lights, identical windows are found on the east, west, and north elevations of the building. All windows in the building are fitted with exterior security grilles welded from rebar and flat steel

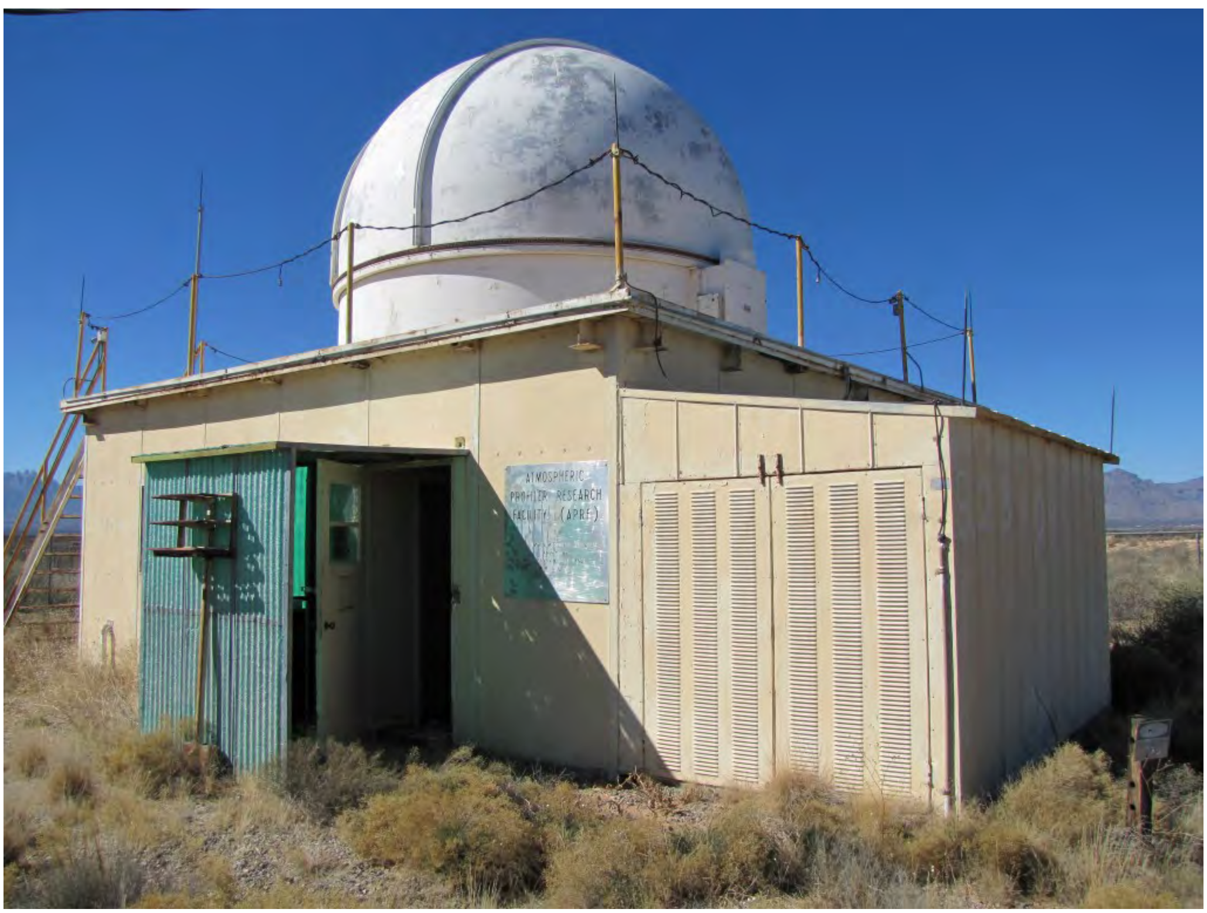

Figure 46. Property 23109, south elevation, view to the northwest.

bars.

History of Use

Property 23109 was constructed in 1961 as an "electrical equipment facility" at a total cost of $28,637. A 1963 WSMR Facilities Inventory identified the property as an Instrument Building, and photographs of the building at the time of its construction refer to it as a "Telescope Radome." The facility was constructed as part of the second generation optical instrumentation effort which supplanted the heavy construction of the first generation buildings with elevated steel frame structures fitted with astrodomes. Some, such as this Type "B" were designed specifically to house tracking telescopes, though details regarding the type of telescope housed in the building are not provided in these records. Type "B" units were enclosed at the base, creating usable interior space. This particular unit was dubbed "Instrumentation Control Center No. 1" and was added in late 1960 (WSMR Drawing Set WS-JR, 1960).

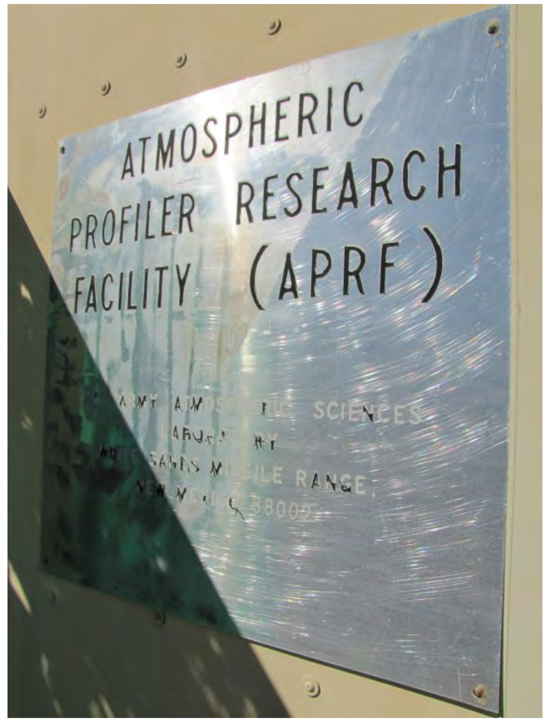

Figure 47. APRF sign on south elevation of Property 23109 near entrance.

A memo relates that the property was transferred from the Instrumentation Directorate to the High Energy Laser (HEL) Program in 1983. By 1987, the property was under the direction of the ASL Directed Energy and Instrumentation Branch, and was used for specialized meteorological instrumentation development and validation activities in support of the HEL Program in cooperation with the HIDL. The building was the base of operations for the ASL APRF research, and is identified by retired ASL engineer John Hines as "Gregg Site." The astrodome was the location of several optical sensors early in the program, but was later used just for dry storage (John Hines personal communication 2015). In 1996, the APRF program was defunded and most of the profiler units and related equipment were removed. This included the equipment in Property 23109. At the time of the current inventory the building was no longer in use, but materials related to the ASL atmospheric profiler research remained in the building.

7.5.2. Optical Dome 1

Optical Dome 1 (OD 1) is a Parabam instrument shelter installed on an at-grade concrete pad (see Figure 48). It is the largest and easternmost in a line of similar structures located west of Property 23108. The astrodome lacks a WSMR property number; hence, it was recorded as Optical Dome 1 during the current inventory. This astrodome is of fiberglass construction molded to a steel anchoring rail along its base. This model has four rectangular blocks located at equal intervals along its base, each with a removable access panel. The northernmost of these blocks contains the gear drive unit for the astrodome, and electrical conduits run between the north

Figure 48. Optical Dome 1 exterior, view to the southeast.

Figure 49. Optical Dome 1 interior and instrument pedestal, view to the west.

and west blocks. Inside the astrodome is a square concrete instrument pedestal, but the instrument has long since been removed. Two wood pallets and two sheets of plywood are stacked near the pedestal, and two footstools and an office chair also remain inside the shelter (see Figure 49). The presence of the fixed instrument pedestal suggests that this astrodome may have been used with the upper dome opening in a fixed position rather than tracking with the instrument.

History of Use

OD 1 housed optical instrumentation for the monitoring of atmospheric turbulence as part of the APRF, which was part of the ASL Directed Energy and Instrumentation Branch. Along with OD 2 and OD 3, this structure was part of the APRF that was active at Gregg Site from the 1980s through the mid-1990s. In promotional brochure for the ASL program, these astrodomes are described as "Optical Domes – Three separate optical turbulence devices provide integrated path turbulence". Specifically, the dome housed an ATMOS device, which was a device that provided real-time characterization of atmospheric turbulence or seeing values (John Hines personal communication 2015). In fact, OD 1 is featured on the cover of a promotional brochure for the ATMOS system. The specific construction date of OD 1 is unknown, but the structure is visible in a 1986 aerial photo of the ASL APRF. Although the dome remains on the site, the ATMOS unit was removed along with most of the APRF equipment when the site was decommissioned in 1996 due to funding cuts.

7.5.3 Optical Dome 2

Optical Dome 2 (OD 2) is the location of a removed astrodome instrument shelter; only the concrete slab foundation and square concrete instrument pedestal remain (see Figure 50). No WSMR property was found to be associated with the property in the realty records. The circular imprint on the concrete and the size and position of the instrument pedestal suggest that the astrodome formerly installed at this location was similar to that of OD 1. No anchor bolts are visible in the concrete slab, only a ring of sealant or epoxy remains. A pallet and a plywood sheet remain on the pad near the square concrete instrument pedestal. Similar items are found in association with instrument pedestal within the interior of OD 1.

Figure 50. Optical Dome 2 concrete foundation and instrument pedestal, view to the west.

Figure 51. Optical Dome 2 instrument pedestal detail, view to the south.

History of Use

OD 2 housed optical instrumentation for the monitoring of atmospheric turbulence as part of the APRF, which was part of the ASL Directed Energy and Instrumentation Branch. Along with OD 1 and OD 3, this structure was part of the APRF that was active at Gregg Site during the 1980s and 1990s. In a brochure for the APRF program, these astrodomes are described as "Optical Domes – Three separate optical turbulence devices provide integrated path turbulence". Specifically, this astrodome housed a Celestron 14-inch telescope mounted on an adjustable azimuth/elevation mount, and was equipped with either a stellar scintillometer or a photomultiplier sensor. This telescope tracked the same star as the neighboring ATMOS instrument in order to provide measurements of atmospheric turbulence or seeing values (John Hines personal communication 2015). The specific construction date of the OD 2 pad is unknown, but the astrodome formerly located on the concrete pad is visible in a 1986 aerial photo of the ASL APRF. A smaller astrodome is located immediately south of the OD 2 location in this image, but no indications of this astrodome were identified during the current inventory. The APRF was decommissioned in 1996, and much of the equipment removed from the site. It is not known whether the astrodome was removed from OD 2 during the 1996 decommissioning or at a later date.

7.2.4 Optical Dome 3

Optical Dome 3 (OD 3) is a Parabam astrodome instrument shelter set on an at-grade concrete pad (see Figure 52). It is the westernmost in a line of similar structures located to the west of Property 23108. The astrodome lacks a WSMR property number; hence, it was recorded as OD 3 during the current inventory. It is of composite construction, with the lower wall of the shelter formed from sheetmetal and the upper dome constructed of fiberglass. No anchor attachments are visible along the base of the dome, and it appears to be affixed to the concrete foundation with epoxy. No gear box is visible on the exterior of the dome and only a wiring conduit and PVC pipe enter through the north side of the dome. The instrument sheltered by the astrodome has been removed and the interior of the astrodome is vacant.

Figure 52. Optical Dome 3, view to the south.

Figure 53. Parabam manufacturer's tag on OD 3.

History of Use

OD 3 housed optical instrumentation for the monitoring of atmospheric turbulence as part of the APRF, which was part of the ASL Directed Energy and Instrumentation Branch. Along with OD 1 and OD 2, this structure was part of the APRF that was active at Gregg Site during the 1980s and 1990s. In a brochure for the APRF program, these astrodomes are described as "Optical Domes – Three separate optical turbulence devices provide integrated path turbulence". Specifically, this astrodome housed a Celestron 14-inch telescope mounted on an adjustable azimuth/elevation mount, and was equipped with either a stellar scintillometer or a photomultiplier sensor. This telescope tracked the same star as the ATMOS instrument in OD 1 to provide measurements of atmospheric turbulence or seeing values (John Hines personal communication 2015). The specific construction date of OD 3 is unknown, but it is visible in a 1986 aerial photo of the ASL APRF. Although the dome remains on the site, the optical instrument was removed along with most of the APRF equipment when the site was decommissioned in 1996 due to funding cuts.

7.5.5 50 MHz Radar Antenna Array

This property is a ground based, radar antenna array that is constructed of hundreds of four-inch square chemically-treated wood posts, averaging five feet nine inches in height, laid out in a hexagonal pattern within an enclosure surrounded by a chain link fence (see Figure 54). The entire antenna grid covers an area of approximately seven acres. The area occupied by the antenna array has been cleared and leveled, although vegetation has begun to reclaim the interior of the array. The network of posts support a suspended wire grid via eye bolts attached to the top of each post. Associated with the posts is a ground-based grid of wiring stretched between steel rebar anchors. The ground-based grid appears to be oriented north to south, with the wire spacing averaging 12 inches. An open space in the chain link fence that surrounds the radar antenna array was formerly occupied by a modular building, and the concrete footers that supported the building remain in place. Nearby are wood steps and wood cross brace that were related to the modular building installation. Several electrical boxes are located in the same area and likely controlled the power supply to the modular building and the radar array.

Figure 54. An aerial overview of the 50 MHz Radar Antenna Array (*courtesy WSMR)*.

Figure 55. The support posts and wire grid that make up the antenna array.

History of Use

This radar antenna array was part of the APRF, which was part of the ASL Directed Energy and Instrumentation Branch. The radar antenna array acted as an atmospheric profiler system at Gregg Site during the 1980s and 1990s. The radar is visible in an aerial photograph of the APRF taken in 1986, although other sources indicate that the APRF was constructed between 1988 and 1990 (Hines et al. 1993). A promotional brochure for the facility identifies the radar unit as the High Performance Phased Array Radar (50 MHz), which generated profiles of wind, turbulence, and temperature every three minutes. The radar was a significant part of the ASL facility, which focused on high accuracy, real-time atmospheric characterization studies. The atmospheric monitoring and characterization was part of the development of sophisticated systems that could be used to correct for the effects of atmospheric turbulence in the direction of laser-based weapons systems. In addition to its contributions to the development of laser beam director systems, the APRF would later become recognized for its contributions to the general scientific study of the atmospheric boundary layer. The APRF was shut down in 1996 due to funding cuts, and the significant equipment of the 50 MHz radar was relocated to Vandenberg Air Force Base in California (Scott McLaughlin personal communication 2015). The radar antenna grid was abandoned in place at Gregg Site and has not been re-used since.

7.5.6 404 MHz Wind Profiler/ NOAA Wind Profiler

The 404 MHz Wind Profiler consists of a fenced paddock and associated instrumentation used for meteorological study (see Figure 56). The complex includes five elements: an equipment shelter, a wind profiler radar antenna, a Radio Acoustic Sounding System (RASS) temperature sounder, the fenced enclosure, and a surface wind observation system.

The equipment shelter is a rectangular, pre-manufactured fiberglass building located on the

Figure 56. Overview of the 404 MHz Wind Profiler, view to the northeast.

Figure 57. Interior of the 404 MHz Wind Profiler equipment shelter, view to the north.

south side of the complex and is the only means of access into the fenced enclosure. The wind profiler radio antenna itself is constructed of a grid of fiberglass pipes mounted on a series of milled lumber supports. The antenna is supported by a raised, rectangular I-beam framework that is set atop six cylindrical concrete footers. The radar antenna covers the bulk of the area within the fenced enclosure. The RASS temperature sounder consists of four metal vertically positioned cylinders, located at the corners within the fenced paddock. The rectangular fenced enclosure encircles the aforementioned elements and is supported by treated timber poles. A small rectangular fenced storage enclosure extends from the east side of the paddock and houses a radio antenna, three segments of metal ductwork, and a vertical post with mounted electrical cabling. The surface wind observation system is located outside the fenced paddock and consists of two anemometers and other instrumentation mounted on a 25 foot aluminum pole set in concrete.

History of Use

This wind profiler radar array was established as part of the APRF, which was part of the ASL Directed Energy and Instrumentation Branch. Although recognized as part of the NOAA Wind Profiler Network, the profiler was originally purchased and built by the ASL (John Hines personal communication 2015). The radar antenna array acted as an atmospheric profiler system at Gregg Site during the 1980s and 1990s. The radar is visible in an aerial photograph of the APRF taken in 1986, although other sources indicate that the APRF overall was constructed between 1988 and 1990 (Hines et al. 1993). A promotional brochure for the facility identifies the radar unit as the 404 MHz Wind Profiler, which generated profiles of wind, turbulence, and temperature every six minutes, similar to the larger 50 MHz profiler. The radar was a significant part of the ASL facility, which focused on high accuracy, real-time atmospheric characterization studies. The atmospheric monitoring and characterization was part of the development of sophisticated systems that could be used to correct for the effects of atmospheric turbulence in the direction of laser-based weapons systems. In addition to its contributions to the development of laser beam director systems, the APRF would later become recognized for its contributions to the general scientific study of the atmospheric boundary layer.

The data from the 404 MHz Wind Profiler was shared with NOAA as part of the national NOAA Wind Profiler Network evaluation. The NOAA Wind Profiler Program commenced in 1986 with a congressional initiative for the Wind Profiler Demonstration Network, reaching operational capability in 1992 as an integrated network of 30 profiler sites, including White Sands (Ackley et al. 2002).

The APRF was shut down in 1996 due to funding cuts, but 404 MHz Profiler remained active as part of the NOAA Wind Profiler Network (Doug van de Kamp and Scott McLaughlin personal communication 2015). The NOAA Wind Profiler Network has since been defunded and the 404 MHz Profiler is scheduled to be removed from Gregg Site sometime in 2016 (Doug van de Kamp personal communication 2015).

7.2.7 2.9 GHz FM-CW Profiler Pad

This property consists of a cleared and leveled gravel lot surrounded by a chain link fence with radiation signage posted on all four sides (see Figure 58). The interior of the enclosure is empty except for assorted discarded materials, including wiring, milled lumber, a small hairpin-leg table, and an electrical switch panel made of an old metal sign. A sign on the west side of the enclosure identifies it as the "FM-CW ATMOSPHERIC DOPPLER RADAR SYSTEMS (FADRS) / U.S. ARMY ATMOSPHERIC SCIENCES LABORATORY / WHITE SANDS MISSILE RANGE NEW MEXICO 88002". An electrical terminal box on a conduit riser is located just to the east of the fenced enclosure.

History of Use

As the sign on the fence indicates, the fenced pad was the former location of the 2.9 GHz FM-CW Radar. This radar served as an atmospheric profiler system for the APRF, which was part of the ASL Directed Energy and Instrumentation Branch. The radar is identified in promotional literature for the APRF and is visible in an aerial photo of the site dated 1986. However, other sources indicate that the APRF was constructed between 1988 and 1990 (Hines et al. 1993).

Figure 58. Overview of the FM-CW Profiler Pad, view to the northeast.

Figure 59. Sign attached to the chain link fence surrounding the FM-CW Profiler Pad, view to the east.

The aerial photograph shows two equipment trailers and a truck-mounted equipment shelter were co-located with the radar. According to a promotional brochure for the facility, the FM-CW radar unit generated high resolution radar turbulence profiles. It was one of several radar profiler units used at the APRF, which focused on high accuracy, real-time atmospheric characterization studies. The atmospheric monitoring and characterization was part of the development of sophisticated systems that could be used to correct for the effects of atmospheric turbulence in the direction of laser-based weapons systems. In addition to its contributions to the development of laser beam director systems, the APRF would later become recognized for its contributions to the general scientific study of the atmospheric boundary layer. The APRF was shut down in 1996 due to funding cuts, and the FM-CW radar unit and its supporting equipment were relocated to Dugway Proving Ground in Utah (Scott McLaughlin personal communication 2015). The fenced enclosure, some associated electrical hardware, and miscellaneous debris are all that remains of the radar installation.

7.5.8 Property 23104 AN/FPS-8 Radar Pad


Figure 60. Overview of Property 23104 Radar Pad, view to the southeast.

Property 23104 is a board-formed, concrete instrumentation pad constructed atop an earthen mound (see Figure 60). The pad is 15 feet square and includes a centered ring of four paired mounting bolts. Three 11½-inch tall, board form, concrete footers are located to the south of the mounting bolts. Cinder block debris and other structural material are present on top of the mound and around its base. Some of the fragments are painted a tan color on the exterior surface. This material is likely the remains of superstructure related to the instrumentation pad, or perhaps the associated building (Property 23104) that has been demolished.

History of Use

Figure 61. Overview of the Property 23104 mound, view to the north.

Realty records identify the pad as the site of the AN/FPS-8 Radar Building, Property 23104. Property 23104 was constructed as the AN/FPS-8 Radar Building at an unknown date. Architectural plans entitled "U.S. Naval Ordnance Missile Test Facility, White Sands Proving Grounds, New Mexico F.P.S.-8 Building," are dated 28 January 1957. The plans indicate the AN/FPS-8 Radar Building as a contemporary facility associated with the TDU. The AN/FPS-8 was a medium-range search radar manufactured by General Electric from 1954 to 1958 and used by the Air Force. Improved versions of the radar were incorporated into the early warning SAGE system (Winkler and Webster 1997:76, 81). It therefore seems likely that the radar may have functioned in a general surveillance role for the TDU, providing the tracking and targeting radars of the system with initial target locations.

The building was inventoried by HSR in 1998, at which time the radar had long been removed and the building left vacant. HSR noted that the building had been used as a radar facility for the Redeye/Mauler testing, a maintenance shop, and for storage. Since that time, the building has been removed and the only remains are of the associated radar support platform as described above.

7.6 Maintenance and Storage Facilities

Thompson and Tagg (2007) do not identify a separate RDT&E property category for maintenance and storage facilities, although they do identify a similar category of Assembly Buildings. However, the maintenance and storage buildings at TDU and Gregg Site are not known to have served specifically as locations for assembly and the buildings appear to have served as non-specific enclosed space for equipment storage and maintenance activities. Two such facilities were identified during the current inventory: Properties 23101 and H3094. Both of these are steel-frame pre-manufactured buildings that are a staple for general purpose range use.

7.6.1 Property 23101

Property 23101 is a pre-manufactured steel Butler-type building with a rectangular floor plan oriented on an east-west axis and set on a raised concrete slab foundation (see Figure 62). The galvanized metal superstructure includes 12-inch wide panels and a medium pitch, gabled roof clad with pre-manufactured metal panels with a short eave projecting over the north and south elevations. Fenestration of the north and south elevations includes two full-height bay doors.

However, these doors are sealed with the exception of a replacement metal roll-up door on the north elevation. A single personnel door is also located on the north elevation.

Figure 62. Overview of Property 23101 north and east elevations, view to the southwest.

The fenestration of the east elevation consist of one metal panel door and two pairs of wood windows with green trim and 12 lights each. The two sets of paired windows are sealed with plywood paneling. The west elevation has two identical pairs of windows which are also sealed with plywood. An HVAC support structure and associated duct work are also found on the west elevation, but the HVAC unit has been removed. The building appears to be abandoned and has been left open to the elements.

Figure 63. Interior of Property 23101, view to the southwest.

History of Use

Property 23101 was constructed in 1946 as a General Warehouse. According to WSMR disposition data, the building was relocated to Gregg Site in 1973, at which time the building was reassigned from property number S-1522 to 23101. The building was documented as HCPI Number 34015 by HSR in 2001 (NMCRIS Number 131254). Though presently vacant, Property 23101 has consistently served as a storage warehouse throughout its use history. It is currently listed as "Navy Warehouse HIDL" in the WSMR realty data, suggesting that it formerly supported the HIDL.

7.3.2 Property H3094

Property H3094 is a single room, pre-manufactured steel-frame Butler building with a rectangular floor plan and is located to the east of Property 23106 (see Figure 64). The galvanized metal superstructure includes a medium pitch, gabled roof covered in metal panels with a short eave over the north and south elevations. Many buildings of this type were installed on skids for easy transportability, but H3094 is installed on a concrete slab foundation. The entryway is located on the west elevation, consisting of a rusted single panel steel personnel door with an embossed "BUTLER" manufacturer's plate at the gable end. Additional signage is mounted to the side of the entryway and reads, "HALLIBURTON CALL 21236".

Figure 64. Property H3094 north and east elevations, view to the southeast.

Figure 65. Property H3094, south and east elevations, view to the northwest.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building's history could be located among the various archival sources available at the range. It is not present in aerial views of the TDU complex circa the late 1950s, and was therefore likely added to the location at a later date.

7.7 Miscellaneous Facilities

Not all facilities fit neatly into categories and depending on the type of site, the function of support facilities can vary greatly. Although Thompson and Tagg (2007) do not identify a separate category for these types of properties, they are common components at most RDT&E locations. However, they are often ignored as they do not perform any specialized or technical function. Several properties recorded during the current inventory fall into the general category of infrastructure and general support buildings. Examples include portable buildings, several Liquid Propane (LP) gas tanks, and an abandoned septic tank. Construction types include simple, reinforced concrete structures and steel-frame pre-manufactured buildings. Although not as prominent as major buildings and structures, many of these facilities were assigned individual WSMR property numbers. None of these miscellaneous facilities are notable for design or construction.

7.7.1 LP Tanks

Properties 23099, 23103, 23105, 23462, and 23481 are cylindrical steel liquid propane (LP) storage tanks (see Figure 66). One additional LP tank lacked a WSMR property number was therefore as recorded Unidentified LP Tank 1 (LPT 1). Given their generally uniformity and lack of historic significance, they are best considered as a group. These six LP tanks are all generally similar objects and consist of pre-manufactured steel tank installed on concrete or steel supports. Most feature various plumbing accoutrements and a few retain variations of "NO SMOKING" signage. These tanks supplied nearby buildings with propane fuel. Though they mostly retain the gas plumbing to their associated buildings and appear useable, they have fallen out of use along with the buildings they once served.

Figure 66. Property 23099 LP Tank, a typical example of the LP tanks at the TDU. View to the northeast.

History of Use

Properties 23103, 23105, and 23462 were installed in the mid to late 1950s at the TDU. Properties 23103 are plumbed together and were probably originally installed to supply Property 23102, a relocated warehouse building, with propane. Property 23462 was installed to supply Property 23108, the TDU Launch Complex, with propane.

Properties 23099 and 23481 were installed slightly later. Property 23481 was installed in 1963, while Property 23099 was installed in 1974 to supply the recently relocated Property 23101 storage building with propane.

Due to the lack of WSMR property number, no historical information regarding LPT 1 could be located. Given its location, it may also have been installed in support of Property 23102.

7.7.4 Property 23119

Property 23119 is a buried concrete septic tank located to the south of Property 23104 and to the west of Property 23101. The rectangular object is oriented north-south and is partially exposed in a two-track road. The concrete walls of the tank are approximately 5¾ inches thick with a 21-inch square concrete lid (see Figure 67). The interior of the tank appears to be partially filled with rain water with one four-inch diameter corroded inlet pipe visible above the water level on the north side of the tank.

Figure 67. Property 23119 buried septic tank, plan view.

History of Use

Property 23119 was constructed in 1956 and likely served as the septic reservoir for Property 23104 prior to demolition of the building. At the time of the current inventory, the septic tank appeared to have been abandoned in-place and no longer operational.

7.7.6 Property WS00347

Property WS00347 is a one-story portable shed clad in horizontal, sheet metal paneling; it is located to the east of Property 23106 (see Figure 68). The one room building maintains a rectangular footprint resting on three parallel wooden skids, with a shallow pitched shed roof. The white painted exterior of the building remains unmodified. The west elevation serves as the entryway, with a two-panel steel personnel door stenciled “SHED” in black paint. Signage mounted above and to the right of the door identifies the structure as “WS00347”. The building is presently empty.

Figure 68. Property WS00347, overview to the northeast.

History of Use

Due to the lack of a formal WSMR property number, no information regarding the building’s history could be located among the various archival sources available at the range. It is not present in aerial views of the TDU complex circa the late-1950s, and was therefore likely added to the location at a later date.

7.8 Isolated Features

While buildings, structures, and objects serve as the most prominent exemplars of the built environment, supporting aspects, such as infrastructural components, are no less important. For the purpose of the property inventory at TDU and Gregg Site, these elements were captured as features. This broad classification is inclusive of architectural and historic archaeological manifestations that are spatially or functionally associated with activities at the site, but not readily identifiable as a building, structure, or object. In most cases these are isolated elements, although some features might be composed of several sub-elements. None of these resources are recognized as properties by WSMR, and as such are not assigned WSMR property numbers.

Twenty-one features were documented during the current inventory and were categorized under five different types. These types were defined primarily based on functional characteristics, although in some cases the function was not apparent. The five feature types include Electrical, Instrumentation, Infrastructural, Structural Remnants, and Miscellaneous. The individual features are described within each of these categories. As these features are by definition insubstantial manifestations that cannot be categorized as buildings, structures, or objects, they are by default not considered as eligible to the NRHP. Therefore, a discussion of their eligibility is not warranted.

7.8.1 Feature 1

Feature 1 consists of a converted semi trailer located to the north of Property 23101 (see Figure 69). The trailer is on blocks and listing slightly with degraded and deflated tires. The trailer was repainted white; however, the original "army green" paint and US Army star remain visible on the sides and rear panel doors. The metal clad trailer is of metal frame construction and is insulated. Access to the trailer is provided via a metal four-step portable stairway at the rear panel doors, as well as by a single panel door that has been added to the west-facing side of the trailer. The rear door is stenciled "U.S. Army" and includes an aluminum tag that is riveted to the door reading "TD-60". Stenciled labeling on the side panels of the trailer reads, "TD 60 USNOMTF WSMR 670 4122". The north side of the trailer is unadorned with exception of a mounted angle iron frame that appears to have supported a power supply, such as a large car battery.

Figure 69. Feature 1 equipment trailer, view to the northwest.

7.8.2 Feature 2

Feature 2 consists of a below grade, concrete electrical pull box located to the north of Property 23101 and northwest of Feature 1 (see Figure 70). Access to the vault is provided by an at-grade plate steel cover with an inset steel lip measuring 31½ by 49½ inches. At ground level the concrete pour is irregular and sloppy; however, the interior of the vault is board formed. The interior of the vault includes mounted brackets on the north and south walls with some remaining conduit, as well as 3 to 4-inch diameter ports at the base of the east and west walls. Discarded debris is scattered to the east and south of the pull box. Items include plywood panels, milled lumber, a 9 by 6 foot metal panel constructed on two posts with 18 horizontally mounted panels, an angle iron box framework (2 feet by 4 inches by 57 inches) with a mounted sheet of galvanized metal and four torch cut legs, and a metal ceiling mounted cable carrier or tray (10 feet by 9¾ inches by 6½ inches) similar to those in place in Property 23106.

Figure 70. Feature 2 electrical pull box, plan view.

Figure 71. Feature 3 electrical riser with box and outlet, view to the southwest.

7.8.3 Feature 3

Feature 3 consists of an electrical conduit riser with a mounted electrical box and outlet (see Figure 71). The riser and attachments are painted yellow.

7.8.4 Feature 4

Feature 4 consists of a metal pole with mounted weather instrumentation, conduit, and an electrical box (see Figure 72). The housing for the instrumentation has been removed, but it appears to be an anemometer. The feature is located to the west of Property 23106.

7.8.5 Feature 5

Feature 5 consists of a fenced paddock (see Figure 73). The interior of the enclosure is graded and graveled with access provided through a gate located on the north side of the paddock. A WSMR building placard is affixed to the gate, but does include any legible information. Additional illegible, diamond-shaped signage is mounted on the fencing offset from the southeast corner of the paddock. Similar signage is present elsewhere at Gregg Site and include RF warnings. The enclosure is located to the south of Property 23106. The interior of the paddock includes various piles of discarded refuse (e.g., wooden pallets, lumber, plywood paneling, electrical paneling, and cables). A collection of approximately 10 discarded concrete fence plugs are located outside of the enclosure, offset from the northwest corner. The plugs are adjacent to a collapsed lumber crate of platform that is painted red and partially obscured by dense vegetation.

Figure 72. Feature 4, pole with instrumentation, view to the north.

Figure 73. Feature 5 fenced paddock, view to the southwest.

7.8.6 Feature 6

Feature 6 consists of a fire hydrant. The fire hydrant is painted yellow and orange and reads, “MUELLER 514 1973 CHATTA TENN”.

7.8.7 Feature 7

Feature 7 consists of concrete barrier (with wing walls) associated with a trench and is a possible erosion control feature. The shallow trench is oriented southwest-northeast with excavated material mounded along the east side, and measures approximately 80 feet in length by 4 feet wide. The concrete barrier is of board formed construction and measures 7½ inches thick by 18 inches above ground level, with a central section measuring 18 inches in length, and wing walls each measuring 22 inches in length.

A discarded 35 foot length of 1-inch diameter gas pipe parallels the west side of the trench in addition to discarded, illegible signage that is mounted on two posts.

Figure 74. Feature 8 instrument pedestal, view to the north.

7.8.8 Feature 8

Feature 8 consists of a square, concrete, portable instrumentation pedestal (see Figure 74). The cast foundation includes a centered cylindrical pedestal topped with a steel disc and three inset mounting bolts, in addition to three steel rings placed set in the deck of the base within shallow depressions. The pedestal base measures 36 by 36 by 13 inches.

Figure 75. Feature 9, faded TMDE facility sign, view to the north.

7.8.9 Feature 9

Feature 9 consists of standing facility signage (see Figure 75). The signage reads, “US ARMY TMDE SUPPORT GROUP US ARMY TMDF SUPPORT ACTIVITY – CONUS NUCLEONICS/SOLAR RADIOMETRY PHOTOMETRY TMDE SUPPRT CENTER BLDG 23108.” The signage is located to the east of Property 23106.

7.8.10 Feature 10

Feature 10 consists of two electrical conduit risers, a stainless steel cylinder and two discarded concrete footers located to the northwest of Property 23106 (see Figure 76). Both of the metal risers stand approximately 3½ feet tall, and one includes a mounted rectangular aluminum panel with an outlet and fuse box. The stainless steel cylinder measures 24 by 146 inches and appears to have served as a vertical support structure. The exterior of the cylinder is painted white with three vertical ribs terminating in large semi-circular anchors at the distal terminus of the cylinder. A guy wire remains attached to one of the anchors. The interior of the cylinder is asbestos lined at the distal portion. The cylinder is capped with a welded mounting fixture that appears to be sheared. The base of the cylinder is robust, with a 32-inch diameter and measuring 1⅞-inches in thickness. The base is unpainted stainless steel and includes a 20 bolt mounting pattern. Two discarded, rectangular concrete footers are present to the south of the cylinder. The footers measure 18 by 42½ inches and 32 by 42 inches, respectively. Two bent lengths of 2-inch diameter stainless steel pipe are in association with the concrete footers.

Figure 76. Feature 10, stainless steel cylinder, view to the east.

7.8.11 Feature 11

Feature 11 is a dump of steel material located just east of a two-track road (see Figure 77). The dump includes rebar, torch-cut fasteners, torch-cut steel plates, steel panels, and beams. Prominent pieces in the dump are two large angled brackets or mounts, a square panel, a round panel, and two 6 by 6 inch by 5 foot long angle iron segments. These materials were likely removed from 23108 during one of its intervals of modification.

Figure 77. Feature 11, steel material dump, view to the northeast.

7.8.12 Feature 12

Feature 12 is a dump of milled lumber and one 50 gallon drum located east of a two-track road (see Figure 78). The majority of the material appears to have been derived from a degraded catwalk or scaffold deck located at the center of the scatter. This dump may represent the remnants of forms and scaffolding used in the original construction of Property 23108, which is located to the west.

Figure 78. Feature 12, milled lumber dump, plan view.

7.8.13 Feature 13

Feature 13 is a dump of concrete debris located along the east side of a two-track road (see Figure 79). The concrete debris appears to be a dump of unused mixed concrete and various pieces of form overflow and spill. The dump appears to be purely waste, possibly from the original construction of Property 23108, and is not actual structural debris.

Figure 79. Feature 13, dump of mixed concrete and concrete debris, view to the southeast.

7.8.14 Feature 14

Feature 14 is a dump of square concrete columns that were originally vent extensions attached to the rear walls of the Property 23108 magazine cells (see Figure 80). Two of these extensions still have a louvered vent panel attached at one end. Each is approximately two feet square and five feet in length. Three are located in a group with the fourth approximately seven meters to the north. Associated with the vent extensions are fragments of concrete debris and pieces of transite conduit, a segment of which is embedded in the northernmost vent extensions.

Figure 80. Feature 14, dump of concrete vents from Property 23108, plan view.

7.8.15 Feature 15

Feature 15 is a square "bullseye" style calibration target mounted in a steel frame atop a 2 ½ inch diameter steel pole that is stabilized by four guy lines (see Figure 81). The target is approximately 15 feet in height and faces west towards a camera shelter.

Figure 81. Feature 15 instrument calibration target, view to the north.

7.8.16 Feature 16

Feature 16 is a rectangular concrete pull-box, approximately 15 feet in length, covered by four individual panels of reinforced concrete construction (see Figure 82). Each of the panels measures four feet by three ft, and three are equipped with a central lift point.

Figure 82. Feature 16, concrete electrical pull box, view to the south.

7.8.17 Feature 17

Feature 17 consists of large guy line anchors and associated concrete plugs that have been dumped north of the ASL 50 MHz Phased Array Radar site (see Figure 83). The anchors are constructed of welded six inch wide steel channel beams with a bracket supporting six one-inch diameter turnbuckles attached to the ends. One anchor remains embedded in a large concrete plug, while a second a second guy line anchor beam, detached from the concrete plug, is located nearby. The anchor beams are damaged and twisted but were probably originally 12 to 14 feet in length. These robust anchors obviously guyed a substantial tower, which may have been one of the boresight towers required for the calibration of the AN/FPQ-4 radar units mounted on Property 23106. It appears that these anchors were removed from the area now occupied by the ASL 50 MHz Phased Array Radar and dumped in this location.

Figure 83. Feature 17, tower guy line anchor and concrete plug dump, view to the north.

7.8.18 Feature 18

Feature 18 is a guy line anchor identical to those of Feature 17, but remains in-situ and in good condition (see Figure 84). The anchor is constructed of welded six inch wide steel channel beams with a bracket supporting six one-inch diameter turnbuckles attached to its end. The anchor beam is anchored in concrete. The anchor beam is approximately six feet in length, and its end is elevated about four feet above the ground. Like Feature 8B, this anchor was likely part of a former boresight tower installation in support of the Property 23106 AN/FPQ-4 radars.

7.8.19 Feature 19

Feature 19 is a concrete pad with an associated scatter of various building materials (see Figure 85). The small, square concrete pad measures 22½ inches per side, and is approximately five inches above ground level. An outlet and electrical conduit are located at its southwest corner, and two half-inch diameter anchor studs are imbedded in the surface of the pad. The scatter of materials associated with the pad includes electrical wiring racks (similar to those seen within Properties 23106 and 23109), steel cable, torch-cut steel fragments, and milled lumber fragments. The concrete might be associated with the tower that was guyed by the nearby guy line feature.

Figure 84. Feature 18, intact tower guy line anchor, view to the north.

7.8.20 Feature 20

Feature 20 is a wood utility pole with a wooden pulley mounted in a steel frame attached to the top of the pole (see Figure 86). The utility pole is approximately 20 feet in height and has climbing stirrups running its entire length. An electrical terminal box and associated conduits are located at the base of the pole. This feature is located approximately 10 meters south of the Property 23109 fence.

Figure 85. Feature 19, concrete pad foundation and scatter of assorted debris, view to the east.

7.8.21 Feature 21

Feature 21 is a rectangular steel framework resting upside down near the west elevation of Property 23108 (see Figure 87). The mounting pads of the frame are caked in tar roofing material, indicating that it was once mounted on the roof of the nearby building. The frame is welded from 2½ inch angle iron, and measures seven feet by six feet, with the legs four feet in height; one leg is broken. Each of the legs was lengthened by welding another length of angle iron to the original portion of the leg. Based on review of architectural drawings (Drawing #PE-GP-075), the angle iron frame once supported a small astrodome that was moved from Property 1528 to the roof of the checkout area of Property 23108 in 1975. The astrodome was accessed via the west elevation exterior staircase that remains attached to the building. The astrodome was later removed at an unknown date and the supporting frame was apparently also removed and deposited in its current location.

Figure 86. Feature 20, pulley mounted atop a wood utility pole, view to the northeast.

Figure 87. Feature 21, Rectangular steel frame, view to the southeast.

8. NRHP Eligibility Recommendations

In evaluating the recorded properties for individual eligibility, the TDU and Gregg Site resources were assessed in terms of the applicable National Register Criteria. The four eligibility criteria are:

> (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (b) that are associated with the lives of persons significant in our past; or
>
> (c) that embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) that have yielded, or may be likely to yield, information important in prehistory or history.

Special Criteria Considerations are also applied in specific circumstances. One of these criteria considerations is applicable to the TDU and Gregg Site resources: Criterion Consideration G. This consideration allows the NRHP nomination of properties that are younger than 50 years old, provided that they are of exceptional importance. Criterion Consideration G and how it applies to the recorded resources is discussed in further detail in the Period of Significance section below.

Throughout the resource evaluation process, the historic context of TDU and Gregg Site was consulted in order to determine events that might constitute significance, facts about the people who were important to the history of the range, and attributes of design in the various periods of construction. Of the evaluation criteria, Criterion B appears to be the least applicable to the buildings, structures, objects at the site. Generally, any such associations are taken into account under the historical trends treated under Criterion A. Criterion D is not particularly applicable in this case as additional information about the resources would be garnered from archival resources rather than from the study of the resources themselves. Criteria B and D were considered in evaluation of the TDU and Gregg Site resources wherever possible; however, the more systematic application was made with respect to Criteria A and C.

During the current inventory, a total of 20 resources were recorded, which were grouped into four different property types. The property types are Missile Launch Facilities, Instrumentation Facilities, Maintenance and Storage Facilities, and Miscellaneous Facilities. The NRHP eligibility of the individual TDU and Gregg Site properties is discussed in detail within the HCPI forms included in Appendix A. The property eligibility is also summarized in Table 1 below. As individual resources, none of the inventoried properties at TDU and Gregg Site were recommended for individually eligibility to the NRHP for the reasons summarized below.

In addition to 20 recorded properties, 21 features were also recorded at the TDU and Gregg Site. As these features are by definition insubstantial manifestations that cannot be categorized

Table 1. Summary of Recorded Properties and NRHP Eligibility.

Property	Property Function	Build Date	HCPI #	Eligible?
23099	LP Tank	1974	38462	No
23101	Warehouse	1946	34015	No
23103	LP Tank	1952	38463	No
23104	AN/FPS-8 Radar Bldg.	1956	34017	No
23105	LP Tank	1958	38464	No
23106	TDU Operations Bldg.	1956	34018	No
23108	TDU Launcher Complex	1956	34019	No
23109	Camera Building	1961	38465	No
23119	Septic Tank	1956	38532	No
23462	LP Tank	1959	38466	No
23481	LP Tank	1963	38467	No
H3094	Storage Building	Unknown	38468	No
WS00347	Portable Building	Unknown	38470	No
FM-CW Radar Pad	APRF Profiler	ca. 1980s	38469	No
50 MHz Radar Antenna Array	APRF Profiler	ca. 1980s	38472	No
404 MHz Wind Profiler	APRF Profiler	ca. 1980s	38471	No
Optical Dome 1	APRF Instrumentation	ca. 1980s	38473	No
Optical Dome 2	APRF Instrumentation	ca. 1980s	38474	No
Optical Dome 3	APRF Instrumentation	ca. 1980s	38475	No
Unknown LP Tank 1	LP Tank	Unknown	38533	No

as buildings, structures, or objects, they do not possess any significant associations with historic events or people, lack any distinction of architectural form or method of construction, and do not possess any data potential for additional information relevant to the TDU or Gregg Site. As such, they cannot be recommended for eligibility to the NRHP, either individually or as contributing elements to any possible district.

8.1 Eligibility Criterion A

Under Criterion A, the historic association of the two primary TDU properties with the theme of Air Defense, Ballistic Missile Defense, and Army Missiles is compelling. Later activities and properties at the site are associated with the themes of Basic Scientific Research and Materiel Development (per Lavin 1998). However, the properties do not retain sufficient integrity to be recommended for eligibility under Criterion A. This discussion will first explore the relevant historic themes under which the resources were evaluated. This is followed by a detailed discussion on the integrity issues that have compromised the ability of the resources to sufficiently convey their historic significance.

8.1.1 Historic Themes

Specific guidance for the evaluation of US Army Cold War era military-industrial properties is provided by the Army (Lavin 1998). This guidance is relevant to the evaluation of the TDU, as it was an outgrowth of the military-industrial complex during the Cold War. As an Air Force funded collaborative effort between the Navy and primary contractor RCA, the TDU is an excellent example of a military-industrial property. Later efforts at the site related to atmospheric research and the development of laser-based weapons also involved a collaborative effort between the military and various contractors, such as MIT.

Based on the guidance provided by the US Army (Lavin 1998), Cold War era properties considered as eligible under the four NRHP criteria must be connected to a specific historic theme related to the Cold War. Lavin (1998) defines nine such Cold War themes, some with specific sub-themes or facilities, for Army military-industrial properties. Three specific themes are applicable to TDU and Gregg Site: Air Defense, Ballistic Missile Defense, and Army Missiles; Basic Scientific Research; and Materiel Development.

The theme of Air Defense, Ballistic Missile Defense, and Army Missiles is applicable to the primary TDU properties (Property 23106 and Property 23108) as they are the only existing prototype of the land-based Talos air defense system. These properties have significant associations with the Cold War, particularly the theme of Cold War Air Defense (per Lavin 1998). The property is associated with the 1950s period of competition between the Air Force and Army for primacy in the nationwide air defense system, and was initially conceived as a competitor to the Nike Hercules by the Air Force in cooperation with the Navy. The effectiveness of these air defense systems was a factor calculated into the larger nuclear arms race between the US and the Soviet Union, a race with national and global consequences.

While the TDU was considered a significant technological achievement at the time of its construction, it was a spin-off of the Navy ship-based Talos missile system that was in service in the fleet from 1958 to 1979. There is no indication that TDU made any significant technological contributions to the ship-based Talos system, which was already in the late stages of development by the time the TDU was operational. Neither did the TDU make any lasting contributions to the state of the art in Air Defense systems; the existing Army Nike Ajax system was already installed nationwide by 1958, and the successor Nike Hercules was designed around the existing Nike Ajax guidance systems and radar to economize the upgrade to the more powerful missile. The TDU is therefore not significant as a technological “event” in itself, but rather due to its association with “a pattern of events or a historic trend that made a significant contribution to the development of a community, a State, or the nation” (NPS 1995:12). The specific “pattern of events or historic trend” in this case included the competition between the Army and Air Force for dominance in the arena of nationwide air defense systems, technological paradigm shifts such as the Bomber and Missile Gaps, and changes in DOD policy and military politics that shaped the roles of the three service branches with regard to missile development. Nationwide air defense installations, of which the TDU was a short-lived prototype, were one of the most visible manifestations of the Cold War in the continental US.

The themes of Basic Scientific Research and Material Development are applicable to the later activities at the site. Property 23106 housed the HIDL from the 1970s to the early 1990s, and Gregg Site was the location of the ASL APRF during the 1980s and 1990s. Additional scientific research was conducted at Property 23108, which housed the Nucleonics Calibration Laboratory from the late 1960s through the 1990s. This facility, later known as the Nucleonics Counting Laboratory, was responsible for the calibration of radiation measuring instruments and dosimetry research. Research conducted on the effects of atmospheric distortion at the HIDL contributed to the efforts to develop operational laser systems at HELSTF, and this research was later expanded into the APRF. The APRF was a world class atmospheric research facility with research related to the development of laser-based weapons at WSMR and other DOD laser research programs, a major material development effort that was part of the 1980s SDI. In relation to basic scientific research, the ASL APRF contributed to scientific atmospheric research beyond the realm of DOD projects, and shared data with NOAA and other organizations through the nascent Internet. The primary scientists and engineers of the program published many articles in peer-reviewed journals based on research and data conducted at the site.

8.1.2 Issues of Integrity

Despite the relevant historic themes, both the primary TDU properties (Properties 23106 and 23108) have been extensively modified and the mechanical and electrical systems that defined the properties operation as an Air Defense System have long been removed and both properties modified for a variety of later activities. This has substantially diminished the integrity of the property's association with the primary historic theme of Cold War Air Defense (see discussion below). NRHP guidance is clear that not only a property "must have an important association with the event or historic trends" but also "must retain historic integrity" (NPS 1995:12). The details of the TDU integrity are discussed separately, but specifics important to the consideration of Criterion A are that a property must retain "the essential physical features that enable it to convey its historic identity" (NPS 1995:46). Further reiterating this concept in regards to Criterion A and B, NPS guidance states that "A property that is significant for its historic association is eligible if it retains the essential physical features that made up its character or appearance during the period of its association with the important event, historical pattern, or persons(s)" (NPS 1995:46).

The character defining, essential physical features of the TDU during its period of association with Cold War Air Defense would include the guidance and radar systems, missile handling equipment, launcher equipment, and Talos Missiles that defined the system. All of these features have either been removed entirely or extensively modified, substantially altering the installation's character and appearance from that of its primary period of association.

Specific to Property 23106, the TDU Operations Building, the original installation included two AN/FPQ-4 radars and two C-band guidance radars installed on the roof of the building (see Figure 19). Part of the AN/FPQ-4 radar installations, which were cutting-edge technology as of the late-1950s, were two offset boresight towers that were required for the alignment and calibration of the radars (see Figure 18). All the radars have been removed from Property 23106, as well as the critical AN/FPQ-4 boresight towers that were located north of the building. The substantial earthen revetment located along the north elevation of the building, originally mandated for protection against an explosive mishap in the neighboring Property 23108 launch complex, has also been removed from the building. The prominent AN/FPQ-4 towers on the east and west ends of the building now support astrodome installations from the building's tenure as the HIDL, which further obfuscates the building's original identity and purpose (see Figure 29). The interior equipment and layout has also been heavily modified and re-purposed; the TDU control console, the nerve center of the complex, has been removed for over a half-century and the location of the control room itself is no longer apparent due to extensive interior remodeling. The expansive banks of vacuum tubes and electrical cabinets that were an essential part of the 1950s TDU installation are also long gone from the building interior. The extant physical features of Property 23106 communicate very little about the TDU installation and its historic associations. The building itself, a large, rectangular edifice of concrete and CMU construction, is fairly typical of DOD architecture and does not evoke the historic character and associations of the TDU.

A similar situation exists for Property 23108, the TDU Launcher Complex, where the defining physical features including the launcher pedestal, launcher bay rail systems, assembly area equipment, and launcher cell depression. Most prominent to the exterior of the property were the launcher pedestal and depression, from which the Talos missiles were launched. The launcher pedestal included a retractable rail and cart assembly that connected to the Talos missile bays and loaded the missile onto the launcher for firing. The launcher pedestal has been entirely removed, as have the rails that connected to the individual missile bays. The deep concrete bowl of the launcher depression was later used as an irradiation pool during the facility's tenure as the Nucleonics Calibration Laboratory (Missile Ranger 1970:3). The launcher pedestal and depression were the most visible and evocative components of the TDU launcher complex and as the epicenter of the actual Talos missile launch, arguably the most important physical features of the complex. In its current condition, the pit is filled with earth and supports a substantial growth of desert vegetation (see Figure 88). The removal of the TDU launcher equipment and infilling of the launcher depression has significantly diminished the ability of the property to convey its original role and its historic associations. The building interior was also extensively remodeled as part of the Nucleonics Calibration Facility installation in 1967, and only very limited elements of the original TDU installation remain within the building. The footprint of the building is more specific and evocative of the original installation than that of the neighboring Property 23106, however; by itself the extant physical building conveys very little of its original character and appearance during the period of significance.

The other historic properties recorded at the TDU and Gregg Site lack significant associations or lack integrity. Property 23109 post-dates the period of operation of the TDU and is therefore not associated with the theme of Cold War Air Defense. Property 23104 is contemporary with the operation of the TDU, and as an early-warning surveillance radar system employed by the Air Force and possibly used in conjunction with the TDU, it can be linked to the theme of Cold War Air Defense. However, as the majority of the property has been demolished and has suffered a near complete loss of integrity, it is not able to convey this historic association.

Property 23101 was not relocated to Gregg Site until 1973, and therefore also lacks any significant historic associations. Other minor properties at the site, including storage buildings, portable buildings, and LP Tanks are simple infrastructural and support properties that do not possess any significant historic associations with the Cold War period.

Other recorded properties at the site post-date the operation of the TDU and are associated with later Cold War activities. As these associations are less than 50 years old, they are discussed within the section on Criterion Consideration G. The late Cold War and post-Cold War reuse of

Figure 88. The TDU launcher at Property 23108 as it appeared circa 1957 (*top)* and how the launcher area appears today (*bottom)*.

Properties 23106, 23108, and 23109 are also considered within this section.

Although the primary TDU properties possess significant associations with Cold War Air Defense, this is only part of the equation required for eligibility under Criterion A. The properties must also retain essential physical features in order to convey their historic character and associations; it is the recommendation of ESS that Properties 23106 and 23108 do not retain sufficient physical traits from the period of significance to be eligible under Criterion A. The remaining properties on the site either post-date the primary period of significance or lack significant historic associations. Therefore, none of the recorded TDU and Gregg Site properties are recommended for eligibility under Criterion A.

8.2 Eligibility Criterion B

In regards to Criterion B, none of the recorded properties were found to be associated with specific individuals important to local, state, or national history or the history of WSMR. The historic associations of the properties are generally more appropriate under the broader scope of Criterion A.

8.3 Eligibility Criterion C

As it was originally built, the TDU represented a significant technological achievement among Cold War Air Defense systems. The two primary buildings at the site, Properties 23106 and 23108, comprised one of the most state-of-the art air defense systems in existence at the time. However, most of this technological innovation was found in the equipment and systems housed by the buildings rather than in the buildings themselves. In regards to Property 23106, the AN/FPQ-4 radars, the most accurate in existence at the time of the building's construction, have long since been removed, as have the control consoles, computers, and electrical cabinets that were part of the original installation. The same is true of Property 23108, where the primary launcher components of the TDU, including the launcher pedestal, storage cell rails, and checkout/assembly equipment, were removed from the property as early as 1959.

In addition to the integrity problems of these properties, neither represents any particular technological advances or innovations in its actual construction. The buildings' construction includes CMU walls, reinforced concrete, and steel roof frameworks that were used across WSMR and other military installations nationwide during the Cold War and beyond. Overall, Properties 23106 and 23108 are utilitarian buildings driven by function rather than form. As such, the buildings lack distinction in their type, period, or method of construction. Nor do they represent the work of a master or possess high artistic values. For these reasons, these resources are not considered to be individually eligible under Criterion C.

The other recorded properties at the TDU and Gregg Site are of lesser scale and complexity than the primary TDU buildings. The other buildings at the site are pre-manufactured installations that are common at DOD locations across the country and lack any architectural distinction. Property 23101, a storage warehouse, is a simple and very common type of pre-manufactured steel building. As such, it lacks any architectural distinction or recognizable style, and does not possess any artistic value or high degree of craftsmanship.

Likewise, Property 23109 is essentially an elevated instrument platform that has been enclosed with walls to form a useable interior space under the instrument platform. It is a simple utilitarian structure supporting a pre-manufactured Parabam astrodome, which are common across WSMR. Other astrodome installations include Optical Domes 1 and 3 (the astrodome of Optical Dome 2 has been removed). Astrodomes were designed specifically for missile test ranges to protect optical instrumentation and operators from the elements. Hundreds were placed on ranges throughout the country during the Cold War era. While distinctive as a type, they were pre-manufactured in a variety of configurations by multiple manufacturers. Astrodomes are considered equipment and as such, lack architectural distinction per se and do not fall under a recognizable "style." Neither do these simple astrodome installations possess artistic value or "represent the work of a master." If considered historically significant, that distinction would be with associations better considered under Criterion A.

In a similar vein, the various profilers of the APRF are assorted ground based antenna arrays surrounded by chainlink fences and lack any architectural distinction. Neither do they necessarily represent any significant technological achievement, as they are based on well-established and common principles of antenna design. Like the various astrodomes, most of the profilers have been decommissioned and the primary equipment removed, which has further diminished the technological significance of these structures.

The remaining properties at the TDU and Gregg Site include small pre-manufactured buildings, a septic tank, and six LP Tanks. These properties represent simple, highly common infrastructural structures and objects that also lack any architectural distinction or other qualities that would make them candidates for eligibility under Criterion C.

For these reasons, none of the recorded TDU and Gregg Site properties are recommended for individual eligibility under Criterion C. The final clause of Criterion C, "…a significant and distinguishable entity whose components may lack individual distinction" (NPS 1996:2), refers to districts. The district considerations for the TDU properties are discussed in a separate section below.

8.4 Eligibility Criterion D

Per NRHP guidance, Criterion D is most often applied to archeological districts and sites, but can be applied to buildings, structures, and objects (NPS 1995:21). However, for buildings, structures, and objects to be eligible under Criterion D, the properties themselves must be the principal source of important information, which is usually related to design and construction details (NPS 1995:21). This is not the case with the TDU resources, as the design and construction details of most of the properties are well documented in archival materials that are separate from the physical resources themselves. As such, any additional information regarding the recorded properties would be found within period architectural drawings, industry publications, military manuals, or other publications; the actual physical resources do not possess potential for additional information regarding their design and construction. Therefore, none of the properties are recommended as eligible under Criterion D.

For these reasons, the current inventory did not recommend any of the TDU or Gregg Site properties to be eligible either individually or as contributing elements to any possible districts under the four primary NRHP eligibility criteria.

8.5 Previous NRHP Evaluations

HSR conducted an inventory and evaluation of four properties at the site between 1998 and 2001. The previously documented resources are Property 23101 (recorded in 2001), Property 23104 (recorded in 1998), Property 23106 (recorded in 2000), and Property 23108 (recorded in 2001). These previous recordings focused on the primary buildings at the site, and did not consider the associated ASL APRF properties, which at that time had only been recently decommissioned. Of the four buildings documented by HSR, three were recommended as ineligible to the NRHP (Properties 23101, 23104, and 23106). However, HPD did not concur with the recommendation of ineligibility for Property 23106. In a letter dated April 13, 2001, Nancy Hanks of HPD stated that Property 23106 "appears to be eligible due to its Cold War association with the Talos Defense Unit and the AN/FPS-16 Radar." Property 23108 was only recommended as "potentially" eligible under Criteria C and D as it was under 50 years of age at the time of the recording, but this recommendation did not receive concurrence from SHPO.

Although the previous inventory efforts made valuable contributions to the documentation of the TDU and Gregg Site resources, none were large enough in scope to encompass all the properties present at the site. Many of the properties were not yet 50 years old at the time of these inventories, which limited the discussion of the property's eligibility. Additionally, these previous efforts did not identify, via a detailed historic context, the historic themes relevant to addressing the historic significance of the TDU and Gregg Site properties. The current inventory and evaluation discusses the properties within the framework of an appropriate historic context, and also considers how the current condition of the resources reflects the identified periods of significance in order to properly assess the eligibility of the recorded resources.

8.6 Period of Significance and Criterion Consideration G

Two periods of significance are identifiable for the properties record at TDU and Gregg Site. The earlier and primary period of significance is associated with the construction and operation of the TDU proper, the project that established the site at WSMR. This period is short-lived and neatly bounded; the primary facilities were completed in 1957, were operational between 1957 and 1959, and the program was halted by the end of 1959. The TDU was a product of the heyday of national anti-aircraft systems, and was initiated by the Air Force as part of the aggressive inter-service rivalry with the Army that existed in the 1950s. Although the TDU showed promising results and was an advanced system for the time, it suffered from being an Air Force initiative that was passed to the Army as a result of a 1956 decision by the Secretary of Defense. The Army was committed to funding its own Nike Hercules and next generation Nike Zeus system in this period, and funding to maintain the TDU effort was scarce. Looming even larger at the time was the appearance of ICBMs as nuclear delivery vehicles, which had largely rendered anti-aircraft systems such as the TDU obsolete. This limited political support for further funding for anti-aircraft systems, with the emphasis shifting to the development of anti-missile systems such as the Nike Zeus.

The secondary period of significance definable for TDU and Gregg Site is the period of atmospheric research related to the development of laser-based weapons systems during the 1970s to the 1990s. The TDU buildings were re-used for a variety of purposes during the 1960s, with

Property 23108 eventually becoming the Nucleonics and Counting Laboratory by the 1970s, a function that was apparently unrelated to the HIDL or APRF. Property 23106 became the HIDL in 1973 as part of the effort to develop laser-based weapons systems. Efforts to understand the effects of atmospheric distortion on targeting and directing these beams were conducted at the HIDL, and this research eventually expanded into the ASL APRF site. ASL research in support of the HIDL was initiated around 1977, according to former APRF senior scientist Wayne Flowers (personal communication 2015). The APRF was an outgrowth of this work and was established by the mid-to-late 1980s. The APRF was defunded and the site decommissioned in 1996, providing a fixed end date for the work at the site. The HIDL was no longer present at Property 23106 by 2000, when the building was turned in for reassignment.

As this latter period of significance, from 1973 to 2000 as suggested by the tenure of the HIDL, is less than 50 years of age, it is considered within the framework of Criterion Consideration G. This consideration applies to both properties and events that are less than 50 years old. Additionally, per guidance in the *National Register Bulletin*, properties that are more than 50 years old but possess significant associations with events less than 50 years old must be evaluated under Criterion G (NPS 1995:43). Criterion Consideration G therefore applies to the research conducted at the HIDL in support of HELSTF and the development of the MIRACL, and the related ASL APRF research. In the broader historical perspective of the Cold War, the HIDL and the APRF were part of the 1980s SDI initiative to develop advanced defense technologies. The SDI is often attributed with accelerating the fall of the Soviet Union, whose economy faltered as it attempted to fund the technological advances needed to keep pace with the promised developments of the SDI. However, the ability of Property 23106 and the various APRF properties to convey this historic association is limited, as the association is technical and abstract and not readily conveyed by the current physical qualities of the property. Due to the recent nature of this period of significance, insufficient historical perspective exists to properly evaluate the role and impact of the HIDL and APRF research in the context of local, regional, or national history. No published guidance currently exists that would inform on the wider significance of these programs in lieu of this historical perspective.

For these reasons, none of the TDU and Gregg Site properties are recommended for eligibility, either individually or as a district, based on their associations with activities or events that have occurred within the last 50 years. Per Criterion Consideration G, neither the properties themselves nor their associations can be demonstrated to meet the rigorous standard of exceptional importance required for eligibility under Criterion Consideration G.

8.7 Integrity of the TDU and Gregg Site Resources

In general, the integrity of the resources recorded at TDU and Gregg Site has been substantially diminished by extensive reuse and modifications. Both of the primary TDU buildings had the actual TDU equipment removed soon after the program was halted in 1959. One of the AN/FPQ-4 radars remained installed at Property 23106 through the 1960s, and was used as a sort of test bed for radar improvements. This radar was also removed from the building by the early 1970s (George Helfrich personal communication 2015). All the mechanical and electrical equipment was stripped from the Property 23108 Launcher Complex as well, and the building was assigned for other purposes by the early 1960s. Various external and internal modifications have been made to both properties for their use as the HIDL (Property 23106) and the Nucleonics Counting Laboratory (Property 23108). Both of these operations have also vacated the site, removing most of the equipment associated with this late period of use.

Other properties at the site have been removed and modified. A warehouse that was installed contemporaneous to the operation of the TDU (Property 23102) was removed from the site and another similar building (Property 23101) installed at the site in 1973. An AN/FPS-8 Radar Building (Property 23104) was demolished sometime after it was recorded by HSR in 1998. Property 23109, an elevated camera shelter, had long had its namesake camera removed when it was repurposed by the ASL as part of the APRF during the 1980s and 1990s. The astrodome on top of the building was used for optical instruments early in the program, but later was used for storage space (John Hines personal communication 2015).

The various radar profilers and optical dome installations that formed the APRF were likewise mostly removed during the 1996 decommissioning. The large seven acre 50 MHz radar antenna remains at the site, but all the actual radar equipment that powered the antenna array has been removed. The FM-CW radar profiler was also removed and only the fenced enclosure remains. The optical equipment has been removed from the astrodomes, and one of the astrodomes also removed. The APRF, mostly of interest from a technical standpoint, has been stripped of this technical equipment leaving only the insubstantial remains of the profilers and optical instrument locations. Today, the most intact component of the former APRF installation is the Property 23109 Camera Building. The 404 MHz Wind Profiler, present during the 2015 inventory, was removed by NOAA as of 2016.

The extensive removal of equipment from most of the recorded properties and their extensive reuse and modification has substantially reduced the integrity of the individual resources design, materials, and workmanship. The removal of the mechanical and electrical equipment from both the TDU buildings and the APRF installation has also diminished the integrity of the association of these properties with their respective programs. Only the more general aspects of integrity, location and setting, remain fairly intact at TDU and Gregg Site, although it is also evident that the later additions of the APRF have altered the setting of the original TDU installation. The problematic integrity of the resources was the main reason why the primary TDU buildings (Properties and 23106 and 23108) were not recommended as eligible to the NRHP. The integrity of the documented resources is discussed in detail in the individual property descriptions.

8.8 The TDU as a Military Landscape and District

The wider perspective of a historic military landscape was considered as part of the TDU inventory. Military landscapes are those that have been uniquely shaped in support of military missions, and historic military landscapes are those that have significant associations with historically important persons, events, or patterns or represent significant examples of design or construction (Loechl et al. 1994:9). Per the guidance, an identified historic military landscape is typically recorded as a historic district or site. Historic military landscapes are evaluated within the framework of an appropriate historic context that allows for the associated military mission, chronological period, geographic context, and historic themes of a military landscape to be identified and understood (Loechl et al. 1994:19-20). For the purpose of the present undertaking, this historic context is provided within Chapter 6 of this report.

In addition to the historic context of a military landscape, the physical characteristics of the landscape must also be considered. Landscape characteristics are “the tangible evidence of the activities and habits of the people who occupied, developed, used, and shaped the land to serve human needs; they may reflect the beliefs, attitudes, traditions, and values of these people” (Loechl et al. 1994:36). Specific to the evaluation of historic military landscapes, nine such characteristics are identified. These characteristics are Spatial Organization and Land Use; Response to Natural Environment; Expression of Military Cultural Values; Circulation Networks; Boundary Demarcations; Vegetation; Buildings, Structures, and Objects; Clusters of Buildings, Structures, and Objects; and Archaeological Sites (Loechl et al. 1994:36-40). Each of these characteristics is discussed in relation to TDU and Gregg Site below.

8.8.1 Spatial Organization and Land Use

The implementation of military missions directs the way the land of a military installation is utilized and how it is spatially organized (Loechl et al. 1994:36). Most of the WSPG launch complexes are aligned along the north side of Nike Avenue in the southern portion of the Range, with firing lines and impact areas located in open areas of the Basin floor further to the north. The TDU installation is located adjacent to, but independent of, the other WSMR launch complexes along Nike Avenue. The facility is located near the boundary of LC-34 and LC-35, just north of LC-35. Despite its proximity to the main launch area at LC-35, the TDU launch complex occupied a separate discrete area. This reflects the facility’s distinction as a unique prototype installation that was constructed and operated independently from the neighboring launch complexes along Nike Avenue.

The TDU installation originally consisted of two primary buildings; the control or operations building (Property 23106) and the combination launcher cell and assembly/checkout building (Property 23108). Other associated properties included a storage warehouse south of the control building, two boresight towers for calibrating radars, a sentry house, and several small buildings that were used for supplemental shop space or storage. These support buildings have been removed from the site since the termination of the TDU testing in 1959.

The TDU launcher building (Property 23108) consisted of a launcher in a circular pit with three attached two-cell missile storage cells or magazines, one of which was combined with the missile checkout/assembly portion of the building. A 1950s promotional film on the TDU shows that the original concept was much larger and more elaborate, with a pair of launchers each surrounded by 30 Talos missile cells. This conceptual model was substantially scaled back for the prototype at WSMR, which was based on a single launcher cell and three storage cells each containing two internal bays.

The separate, windowless control building (Property 23106) held the computers and support systems for two C-band, monopulse AN/FPQ-4 radar units mounted on the roof of the building. Two additional C-band guidance radars were also centrally located on the roof of the control building. The RCA conceptual scale model of the TDU incorporated four of these radars to accommodate the two Talos launchers, but was otherwise consistent with the actual constructed building. The AN/FPQ-4 radar units were essentially identical to the RCA AN/

FPS-16 monopulse radar, which was a major advance in radar systems and was the first radar designed expressly for use at missile test ranges. At the time of its introduction, it was the most accurate radar system in the world (Barton 2011; 2014). The TDU AN/FPQ-4 versions of the AN/FPS-16 radars were likely among the very first installations of the new radar in the nation.

Two boresight towers, one per AN/FPQ-4 radar, were originally part of the TDU installation. The towers are indicated on the original architectural plans for the facility and are also visible in period photographs of the TDU. The towers were located to the northeast and northwest of the building; based on the architectural drawings, the towers were located approximately 750 feet to the north of Property 23106, and offset to the east and west by approximately 450 feet from the building centerline. Each had an associated small equipment shed. Neither the boresight towers nor associated equipment sheds remain in place today.

The spatial organization of the original TDU installation was largely determined by the technical requirements of the system and its supporting equipment. The location of the TDU installation within the larger landscape of WSPG and the internal spatial relationships of the TDU properties were not very evocative of the facility's Cold War mission, which was reflected only in the most general sense. The continual modification of the location and addition of more recent properties has further muddied the spatial relationships of the original TDU complex, so that little meaning is conveyed to the contemporary viewer.

8.8.2 Response to Natural Environment

Significant natural features often influence the location and organization of military installations, and climatic factors can influence the types of facilities constructed at these installations (Loechl et al. 1994:37). The natural environment was a critical factor in the selection of the Tularosa Basin as the location of WSPG in 1945. The proposed proving ground required attributes of flat and open ground, a sparse population, and predominantly clear weather. Other preferred characteristics included surrounding hills or mountains for observation sites and natural barriers, access to railroad lines and utilities, and proximity to an established military post for support. The Tularosa Basin was identified as the best choice by the Army, possessing nearly all of the desired characteristics.

More specific to the TDU and its response to the natural environment, the location of the facility on the valley floor provided a flat, open expanse of ground with uninterrupted flight paths into the range interior to the north. However, the natural environment was likely not the most important consideration in the location selection for the TDU. Due to the open expanses of the Tularosa Basin, there were few natural barriers or environmental constraints on the siting of the TDU and the desired characteristics likely could have been found at alternative areas within the abundant acreage of WSPG. More likely, the TDU was situated near the Navy launch complex of LC-35 to facilitate technical support for the Talos missile, which had been tested extensively at LC-35. The real estate of the facility was also likely under Navy administration (but owned by the Army), which facilitated the construction of the facility. The positioning of the TDU along the Nike Avenue launch complexes also allowed the complex to take advantage of existing flight corridors, impact areas, and instrumentation sites that were already established. Additionally, the location of the TDU met logistical needs of easy highway access and proximity to the main cantonment.

8.8.3 Expression of Military Cultural Traditions

According to Loechl et al. (1994) military cultural traditions are expressed at military installations in both organizational and aesthetic senses. These military values include hierarchy, uniformity, discipline, utility, and patriotism (Loechl et al 1994:38). However, these values are more specific to personnel and administrative areas of military installations, while the TDU was a technically driven facility. As such, the original layout of the TDU installation expressed the technical requirements of the facility rather than the hierarchical or patriotic values that would be displayed at military barracks or housing areas.

While most of the military values discussed by Loechl et al. (1994:38) are not applicable to the TDU properties, the value of "utility" is visible in the utilitarian nature of the TDU buildings. The massive concrete construction and unadorned exteriors of Properties 23106 and 23108 reflect the pragmatic nature of the Army testing mission, which emphasizes function rather than form in order to meet the requirements of the RDT&E process.

8.8.4 Circulation Networks

Loechl et al. (1994) defines circulation networks as roads and transportation routes that facilitate the movement of troops and supplies across military installations. These networks can include major primary and secondary roads as well as smaller local roads and access routes to specific areas (Loechl et al. 1994:38). Circulation networks at the TDU were a minor component of the layout due to the small footprint and discrete layout of the site. Movement of personnel and materials was not a primary consideration for the TDU due to the nature of the facility's RDT&E mission. The TDU road network consisted of a primary access road that ran north from Nike Avenue which also provided access to the west side of LC-35. This access road terminated at a large parking lot on the south side of Property 23106. In period photographs, a chain link fence and gate controlled access into the TDU parking area, and a small guard shack (long since removed) was positioned at the gate. Additional access roads looped around the rear of Property 23106 to provide vehicle access to Property 23108. Period photographs also show that the two AN/FPQ-4 boresight towers were accessed via dedicated dirt roads. The TDU road network was therefore rather limited and was not a defining characteristic of the facility on the landscape. The original TDU road network has been modified by the later re-use of the location. The minor access roads that connected to the boresight towers have been destroyed by the establishment of the later APRF facilities or reclaimed by vegetation. The addition of new road alignments to access the various APRF radar profilers served to obfuscate the original TDU road network, and these additional road segments do not contribute to the delineation of the Gregg Site area on the landscape.

8.8.5 Boundary Demarcations

Boundary demarcations on military installations define the limits of the overall installation as well as specific areas of land use within the larger installation, and unlike city limits, are often quite visible (Loechl et al 1994:39). This is partially true of the original TDU installation as a chain link fence demarcated the south edge of the complex when approached from Nike Avenue. However, period photographs show the north, east, and west margins of the complex were not fenced or otherwise visibly demarcated. This lack of demarcation is typical of many areas at WSMR and reflects the notion that these sub-areas are part of the larger range at WSMR and specific demarcation is not necessary unless required by specific security or safety concerns.

As the TDU was later reused and expanded into the area known as Gregg Site, most of the radar and instrumentation units of the APRF were fenced and signed as they emitted potentially hazardous high frequencies. These additional fenced areas were not part of the historic layout of the TDU and do not clearly delineate the limits of Gregg Site, the boundaries of which are only hinted at by the distribution of the old APRF structures and buildings.

As indicated by Loechl et al. (1994:39), other delineations, such as roads and paths, can serve in place of fences or other formal boundary markers. However, TDU also lacks a well-defined road network, with most roads consisting of relatively informal access roads. In lieu of more formal boundaries, the built environment of TDU and Gregg Site were used to define the current inventory area.

8.8.6 Vegetation

Vegetation can be important to the definition of landscapes as it bears a direct relationship to long-established patterns of land use. Landscaped residential areas or intentionally cleared areas both communicate different aspects of the military mission on the land. Forests or groves of trees can be used as boundary markers or buffers against surrounding communities (Loechl et al. 1994:39). However, as a RDT&E facility situated within a larger range, TDU is somewhat of an exception to the patterns suggested by Loechl et al. (1994).

Vegetation typical of the TDU area is Plains Mesa Sand Scrub (Dick-Peddie 1993). It is likely that the current vegetation community in the Tularosa Basin developed from disturbances introduced by human agency during the 19th century, allowing for the development of shrubland in lieu of established grasslands (Muldavin et al. 2000a:80). The flora within the TDU were observed to be variable, defined by co-dominance of four-wing saltbush (*Atriplex canescens*), and honey mesquite (*Prosopis glandulosa*) with an understory of forbes and grasses including broom snakeweed (*Gutierrezia sarothrae*), soaptree yucca (*Yucca elata*), and mesa dropseed (*Sporobolus flexuosus*).

This desert scrub vegetation was extensive enough that much of it was cleared from the interior of the TDU area when the site was originally constructed. Period photography shows that the area south of the Property 23106 Operations Building was completed cleared, graded, and graveled for use as a large parking lot. The area surrounding Property 23108 was also completely cleared of vegetation and graded. A lot west of Property 23108 appears to be completely cleared in a 1957 photograph and used as a storage yard. Cleared areas east of the two primary TDU buildings appeared to have served as staging areas for equipment and materials during the original construction of the facility. A 1963 aerial photograph shows another extensive cleared area surrounding Property 23109, and another bladed area southwest of Property 23106. Additional clearing was undertaken during the tenure of the APRF, with graded and graveled lots established for the radar profiler installations. The installation of the large 50 MHz radar along the west side of Gregg Site required the clearing and grading of a large seven acre site, a substantial alteration to the setting of the original TDU installation.

While other areas within WSMR have been planted with landscaping plants, particularly within the main cantonment, no such landscaping efforts were made at TDU. The clearing of the vegetation was in keeping with the RDT&E mission of the facility, which was expressed in a utilitarian landscape shaped by technical requirements. One later exception was two apricot trees planted in a sheltered outdoor area of Property 23106. This location was used as a picnic area during the tenure of the Nucleonics Counting Laboratory within the building. The apricot trees have withered and died due to lack of care, but still serve as a reminder of the people who worked at the facility, adding a human touch to the otherwise utilitarian setting of the building. Today, most of the cleared areas are gradually being reclaimed by desert scrub, demonstrating the dynamic role that vegetation plays in characterizing the landscape.

8.8.7 Buildings, Structures, and Objects

Buildings, Structures, and Objects are often the most prominent features on the landscape and traditionally the focus of the NHPA compliance process. As defined by the NPS, buildings are designed to shelter some sort of human activity, while structures are designed for functions other than sheltering people and their works (NPS 1995). Objects are generally smaller and can be moveable, and are often commemorative or artistic in nature such as water fountains or statues (Loechl et al. 1994:40). The buildings, structures, and objects at TDU and Gregg Site are the primary expression of the military mission on the landscape and define the complex, which largely lacks other demarcations on the landscape. Many of the TDU and Gregg Site resources are structures and objects. Many of the recorded structures were instrumentation installations established by the APRF program and the majority of the recorded objects were liquid propane tanks.

The TDU and Gregg Site inventory effort resulted in the recordation of 20 buildings, structures, and objects. As part of the inventory methodology, less significant resources representing remnants of TDU and Gregg Site supporting infrastructure which lacked WSMR property numbers were recorded as features and are described separately. Most of these properties were located in definable clusters which were an expression of the functional activities they supported. This is particularly visible in the clustering of the two original TDU buildings and the later APRF facilities.

8.8.8 Clusters of Buildings, Structures, and Objects

According to Loechl et al. (1994:40), the organizational and spatial relationships among buildings, structures, and objects at military installations is one of the most important characteristics of military landscapes. Organizational clusters at the TDU define two functional areas; the original TDU installation (Properties 23106 and 23108) and the later APRF installation that was arrayed around Property 23109. These property clusters spatially overlap but do not represent a unified plan or development. Rather, the TDU and Gregg Site properties are more of a palimpsest accumulation of properties derived from two periods of significance that are essentially unrelated, reuse and adaptation aside. The two TDU buildings, the principal buildings at the site, are the remains of a 1950s air defense prototype. The other buildings, structures, and objects post-date the primary TDU properties and are mostly related to the 1970s and 1980s ASL atmospheric research in support of laser-based weapon developments. Considered in isolation from the neighboring Gregg Site properties, it is difficult to consider the remaining original two TDU buildings (Property 23106 and 23108) as a "cluster." Per the examples provided by Loechl et al. (1994:40), clusters of military buildings, structures, and objects usually involve larger numbers of properties arranged in an organizational theme that reflects the larger military structure and mission.

8.8.9 Archaeological Sites

Military installations often include prehistoric and historic archaeological sites, but most predate the military use of the land and are unrelated to the military mission of the installation (Loechl et al. 1994:40). Accordingly, the current inventory was thematically oriented towards extant Cold War buildings, structures, and objects at TDU and Gregg Site. Archaeological manifestations related to this thematic approach were captured as features, which were generally associated with buildings, structures, and objects.

The perspective of historic military landscapes is thematically limited to military use of the landscape, but archaeological sites can nonetheless inform on past military missions of the installation (Loechl et al. 1994:40). Some military forts and training areas in the Southwest have long histories that began with the concession of the region to the United States by Mexico as part of the Treaty of Guadalupe Hidalgo in 1848. Fort Bliss is an excellent example, which was first established in 1849 and has steadily transitioned from a small isolated frontier outpost to a major center for Army training and maneuvers. WSMR is a different case, as the earliest significant military use of the Tularosa Basin occurred during WWII, predating the establishment of WSPG by only a few years. Due to its proximity to LC-35, one of the oldest launch complexes at WSPG, the area later occupied by TDU might have been used for testing prior to the mid-1950s during the early days of the proving ground. However, no historic archaeological sites related to the military use of the area prior to the establishment of the TDU were encountered during the inventory. No prehistoric sites have been previously documented in the area of TDU and Gregg Site and none were identified during the current inventory.

8.8.10 TDU as a Historic District

Per the guidance offered in Loechl et al. (1994), historic military landscapes are nominated as historic sites or districts. The language specific to historic districts is contained within the understated but very important final clause of eligibility Criterion C, which allows for properties "that represent a significant and distinguishable entity whose components may lack individual distinction" (NPS 1995:2), to be nominated to the NRHP. In essence, the district clause of Criterion C allows recognition of groups of properties whose whole is greater than the sum of their parts (King 2004:113).

Consideration of the TDU and Gregg Site within an appropriate historic context and analysis of its physical landscape characteristics show that it generally does not meet the definition of a historic military landscape as presented by Loechl et al. (1994). Excluding the divergent APRF resources that are historically unrelated to the original TDU facilities, the original TDU installation lacks most of the characteristics of a historic military landscape. As evidenced by historic photographs, the original TDU facility did not possess many of the physical attributes of historic military landscapes as discussed in this section. The spatial organization of the TDU installation did not express its military mission in any but the most general sense. The TDU facility did not represent a special adaptation to the natural landscape, nor did it express traditional military values. The location of the TDU (and later Gregg Site facilities) were not specifically indicated on the landscape by boundary demarcations, circulation networks, or specific types of landscaping or vegetation. The buildings, structures, and objects recorded during the current inventory are the primary expression of the TDU and Gregg Site on the landscape, but the clustering of these properties reflect a disparate collection of resources constructed several decades apart for divergent purposes.

This makes it unlikely that the TDU properties can be considered as a historic district. According to NPS guidance, “A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development” (NPS 1995:5). Although the TDU and Gregg Site properties represent a definable concentration of resources, they are united neither historically nor aesthetically, nor are they the product of a single development or historical trend.

Rather, the TDU and Gregg Site properties are more of a palimpsest accumulation of properties derived from two periods of significance that are essentially unrelated, reuse and adaptation aside. The two TDU buildings, the principal buildings at the site, are the remains of a 1950s air defense prototype. The other buildings, structures, and objects post-date the primary TDU properties and are mostly related to the 1970s and 1980s ASL atmospheric research in support of laser-based weapon developments. The aesthetics of the properties are widely divergent, with the later ASL properties consisting of insubstantial remains of atmospheric radar profilers and related instrumentation as opposed to the massive concrete, blast-proof buildings of the TDU.

The modification of the original TDU buildings for later purposes also creates problems of integrity for identifying a possible district. Essentially all the hardware at the core of the TDU system has long been removed from the buildings. The buildings themselves have undergone many alterations and modifications to interiors and exteriors, and essentially remain only as concrete shells of the original TDU system. Unlike properties that are significant for their architectural style or design, the TDU buildings were defined by their technical and mechanical functionality and much of their significance was lost with the removal of these components. The issue of integrity is also problematic for the later ASL properties, as these installations were also modified, removed, and otherwise diminished during the decommissioning of the program in 1996. Due to these issues of chronological and functional coherency, coupled with the diminished integrity of the properties from both periods of significance, no districts encompassing the TDU and Gregg Site properties can be recommended.

8.9 Summary

Although the previous inventory efforts made valuable contributions to the documentation of the TDU and Gregg Site resources, these efforts did not include all the properties or address their significance within a detailed historic context. Several Cold War Historic Themes as defined by Lavin (1998) are applicable to TDU and Gregg Site, which was established as a short-lived air defense system prototype in the 1950s and the properties modified for a variety of purposes through the remainder of the Cold War. In the final decades of the Cold War, atmospheric research in support of the development of laser-based weapons systems was conducted at the HIDL within Property 23106 and later expanded into the ASL APRF at Gregg Site. Unfortunately, the majority of the resources retain minimal integrity, and the site overall is not united historically or functionally due to its disparate uses. As a result, none of the documented resources can be recommended for individual eligibility or as contributing elements to a historic district.

References Cited

Ackley, M.H., M.K. Shanahan, and D. Smith

2002 *History of NOAA's Wind Profiler Program: From WPDN to NPN*. Paper presented at the 27th Annual Meeting of the National Weather Association, Ft. Worth, Texas.

Barton, D.K.

2011 Development of the AN/FPS-16 Instrumentation Radar. *IEEE Aerospace & Electronic Systems Magazine*, April 2011 Insert: B1-B16.

2014 *Early Radar Activity at WSPG*. Manuscript on file, Environmental Division, White Sands Missile Range, New Mexico.

Bauer, Louis

1953 New Laboratory for Three-Dimensional Guided Missile Simulation. In *Proceedings of the February 4-6, 1953, Western Computer Conference:* 187-195. Association for Computing Machinery, New York.

Bender, Donald E.

2004 The Nike Missile System: A Concise Historical Overview. Electronic document, http://alpha.fdu.edu/~bender/N-view.html, accessed March 18, 2014.

Berhow, Mark

2005 *US Strategic and Defensive Missile Systems: 1950 to 2004*. Osprey Publishing, Oxford.

Beaudry, Charles L.

1963 History of TDU Facilities, Buildings Number 23102, 23106, and 23108. Manuscript on file, Public Works Department, White Sands Missile Range, New Mexico.

Bingham, Debbie

1980 The Shape of Things to Come. *Missile Ranger* 4 July: 14. White Sands Missile Range, New Mexico.

1985 Media Representatives See HEL: First High Energy Laser Orientation Visit Conducted. *Missile Ranger* 8 November: 10. White Sands Missile Range, New Mexico.

Brown, Charles R. and Charles F. Meyer

1982 Talos Flight Test Facilities. *Johns Hopkins APL Technical Digest* (3)2:160.

1982 The Talos Land System. *Johns Hopkins APL Technical Digest* (3)2:161.

Cagle, Mary

1968 *History of the Mauler Weapon System*. US Army Missile Command Historical Division, Redstone Arsenal, Alabama.

Cinerama

2015 Hazard Reeves: Oh What He Could Do with Some Plastic and Bucket of Rust. Electronic document, http://www.cineramaadventure.com/reeves.htm, accessed March 11, 2015.

Computer History Museum

2015 Analog Goes Electronic. Electronic document, http://www.computerhistory.org/revolution/analog-computers/3/150, accessed March 11, 2015.

Corliss, William R.

1974 *Histories of the Space Tracking and Data Acquisition Network (STADAN), The Manned Space Flight Network (MSFN), and the NASA Communications Network (NASCOM)*. NASA, Washington D.C.

Delgado, Raymond F.

1981 Photo-optical Range Instrumentation: An Overview. *Optical Engineering* 20(5):701-711.

Dick-Peddie, H. W.

1993 *New Mexico Vegetation: Past, Present, and Future*. University of New Mexico Press, Albuquerque

Eckles, Jim

2013 *Pocketful of Rockets: History and Stories Behind White Sands Missile Range*. Fiddlebike Partnership, Las Cruces, New Mexico.

Eidenbach, Peter L., Richard L. Wessel, Lisa M. Meyer, and Gail C. Wimberly

1996 *Star Throwers of the Tularosa: The Early Cold War Legacy of White Sands Missile Range*. Human Systems Research Report 9422. Human Systems Research, Tularosa, New Mexico.

Federation of American Scientists

2015 Mid-Infrared Advanced Chemical Laser (MIRACL). Electronic document, http://fas.org/spp/military/program/asat/miracl.htm, accessed March 6, 2015.

Feit, Rachel, Julian A. Sitters, Heather Barrett, and Kurt Korfmacher

2014 *Cultural Resource Assessment of the Green River Launch Complex, Utah*. Submitted to White Sands Missile Range, New Mexico, as Amaterra Environmental Technical Report No. 71.

Garten, William, Jr., and Frank A. Dean

1982 Evolution of the Talos Missile. *Johns Hopkins APL Technical Digest* (3)2:117-122.

Gonzalez, Alberto D.

1980 Interim Physical Security for Building 23106. Manuscript on file, Public Works Department,White Sands Missile Range, New Mexico.

Harmon, James A.

1973 Appointment of Building Custodians. Manuscript on file, Public Works Department, White Sands Missile Range, New Mexico.

Harvard Business College

2015 Electronic document, http://www.library.hbs.edu/hc/lehman/company.html?company=american_machine_foundry_co mpany, accessed March 11, 2015.

Hays, Phillip R.

2014 *History of the Talos Missile*. Electronic document, http://www.okieboat.com/Talos%20history.html , accessed January 5th, 2015.

Hines, John R., Scott A. Mc Laughlin, Frank D. Eaton, William H. Hatch

1993 The US Army Atmospheric Profiler Research Facility: Introduction and Capabilities. In *Proceedings of the Eighth Symposium on Meteorological Observations and Instrumentation, January 17-22, 1993:*237-242. American Meteorological Society, Boston.

Horne, William V.

1962 Building Assignments (23108). Manuscript on file, Public Works Department, White Sands Missile Range, New Mexico.

Kennedy, Gregory P.

2009 *The Rockets and Missiles of White Sands Proving Ground 1945-1958*. Schiffer Military History, Atglen, Pennsylvania.

Kopp, Carlo

2008 High Energy Directed Laser Weapons. Electronic document, http://www.ausairpower.net/APA-DEW-HEL-Analysis.html, accessed March 6, 2015.

Las Cruces Sun-News

1958 *Brains of Industry, Science, Military go into the Talos Defense Unit*. 6 July: 35. Las Cruces, New Mexico.

Lavin, Mary

1998 Thematic Study and Guidelines: Identification and Evaluation of the US Army Cold War Era Military-Industrial Historic Properties. US Army Environmental Center, Aberdeen Proving Ground, Maryland.

Loechl, Suzanne Keith, Samuel A. Batzli, and Susan I. Enscore

1994 *Guidelines for Documenting and Evaluating Historic Military Landscapes: An Integrated Landscape Approach*. AEC Technical Guideline Prepared by the United States Construction and Engineering Laboratory, Champaign Illinois. Copies available electronically.

Lonnquest, John C., and David F. Winkler

1996 *To Defend and Deter: The Legacy of the United States Cold War Missile Program*. Department of Defense Legacy Resource Management Program, USACERL Special Report 97/01.

Mabe, Ruth

1958 Thousands of Eyes Keep Watch Over Range: Six Organizations Use Millions in Equipment. *Wind and Sand* 5 September: 2-3. White Sands Missile Range, New Mexico.

Maughan, A. Muray

1962 Technical Approval - Modification to Building 23106. Manuscript on file, Public Works Department, White Sands Missile Range, New Mexico.

McMullen, Richard F.

1962 *History of Air Defense Weapons: 1946 to 1962*. ADC Historical Study Number 14, Historical Division, Office of Information, Headquarters of Air Defense Command.

Meade, W.C

1969 Facilities Survey Form, Building 23108. Manuscript on file, Public Works Department, White Sands Missile Range, New Mexico.

Mesothelioma Cancer Alliance

2015 Electronic document, http://www.mesothelioma.com/asbestos-exposure/companies/burns-and-roe.htm, accessed March 11, 2015.

Miles, Richard C. (editor)

1961 Initiation of the Jet Propulsion Laboratory. In *Development of the Corporal: The Embryo of the Army Missile Program.* Historical Monograph No. 4, pp. 1-10. Army Missile Command, Hunstville, Alabama.

Mills, Arthur J. (editor)

1959 *Final Report: Instrumentation Radar AN/FPS-16 (XN-2)*. Prepared for the Department of the Navy Bureau of Aeronautics under Contract BuAer NCas 55-869c. Radio Corporation of America, Defense Electronic Products, Missile and Surface Radar Division, Moorestown, New Jersey.

Missile Defense Agency

2009 *Nike Zeus: The US Army's First Antiballistic Missile*. Missile Defense Agency, Department of Defense, Washington D.C.

Missile Ranger

1970 *Nucleonics Calibration Facility Filling Vital Need*. 20(47), 20 February: 1, 3. White Sands Missile Range, New Mexico.

1980 *Washington Sends Thanks for Job Well Done at WSMR*. 32(34), 29 April: 3. White Sands Missile Range, New Mexico.

Muldavin, E., Y. Chauvin, and G. Harper

2000a The Vegetation of White Sands Missile Range, New Mexico, Volume I: Handbook of Vegetation Communities. Prepared under Cooperative Agreement No. 14-16-002-91-233 White Sands Missile Range, US Fish and Wildlife Service, The Nature Conservancy, and the University of New Mexico. Albuquerque.

Muldavin, E., G. Harper, P. Neville, and Y. Chauvin

2000b The Vegetation of White Sands Missile Range, New Mexico, Volume II: Vegetation Map. Prepared under Cooperative Agreement No. 14-16-002-91-233 White Sands Missile Range, US Fish and Wildlife Service, The Nature Conservancy, and the University of New Mexico. Albuquerque.

Narvaez, Alphonso A.

1991 Kenneth A. Roe, 75, Engineer and Chief of Consulting Firm. *New York Times*, 5 June. New York.

National Park Service (NPS)

1995 *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation*. US Department of the Interior, National Park Service, Cultural Resources Division, Washington D.C. Copies available electronically.

Redmond, Kent C.

1957 *Integration of the Holloman-White Sands Ranges, 1947-1952*. Report by the Historical Branch, Office of Information Services, Air Research and Development Command, United States Air Force, Holloman Air Development Center, Alamogordo. Copies available electronically.

Rogers, Steven C.

1993 US Army Primary Radiation Standards Complex. In *Proceedings of the Workshop on Measurement Quality Assurance for Ionizing Radiation*: 407-416. US Department of Energy, Washington DC.

Payen, Oscar

2000 *HIDL Turn-in*. E-mail transcript on file, Public Works Department, White Sands Missile Range, New Mexico.

Piland, Doyle

2006 Way Back When: Nike Testing Once Buzzed on Nike Avenue. *Hands Across History* 2(2):4-5.

Phillips, Henry W.

1958 Talos Defense Unit – An Advanced Surface-to-Air Guided Missile System. *Journal for the American Society for Naval Engineers* (70)1:133-136.

Salmon, John S.

2011 *Protecting America: Cold War Defensive Sites, a National Historic Landmark Theme Study*. The National Historic Landmarks Program, National Park Service, Washington DC.

Schaffel, Kenneth

1991 The Emerging Shield: The Air Force and the Evolution of Continental Air Defense, 1945-1960. Office of Air Force History, United States Air Force, Washington DC.

Smith, John Q. and David A. Byrd

1991 *Forty Years of Research and Development at Griffiss Air Force Base*. Rome Laboratory, Griffiss Air Force Base, New York.

Sonnichsen, C.L.

1960 *Tularosa: Last of the Frontier West*. University of New Mexico Press, Albuquerque.

Thompson, Scott and Martyn D.Tagg

2007 *Identification and Categorization of Cold War-Era Research, Development, Testing, and Evaluation Property Types*. Statistical Research Inc. Technical Report 07-39. Submitted to Headquarters Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio. Copies available electronically.

Tsiao, Sunny

2008 *"Read You Loud and Clear!": The Story of NASA's Spaceflight Tracking and Data Network*. NASA History Series, NASA, Washington D.C.

US Army Center of Military History

2009 *History of Strategic Air and Ballistic Missile Defense: 1956 to 1972*. Vol. 2. Special Studies Series, Publication 40-5-1, Washington D.C.

Wagner, Nathan

1963 Disposition Form: MFS Non-Concurrence on Justification for Construction Bldg 23106. Manuscript on file, Public Works Department, White Sands Missile Range, New Mexico.

Walker, James, Lewis Bernstein, and Sharon Lang

2003 *Seize the High Ground: The Army in Space and Missile Defense*. Historical Office, US Army Space and Missile Defense Command, Huntsville, Alabama.

Wallace, Laurel

2004 *Historic Highways in the NMDOT System*. New Mexico Department of Transportation Technical Series 2004-1, Santa Fe.

Werrell, Kenneth P.

2005 *Archie to SAM: A Short Operational History of Ground-Based Air Defense*. Air University Press, Maxwell Air Force Base, Alabama.

Western Regional Climate Center (WRCC)

2015 White Sands National Monument, New Mexico, Period of Record Monthly Climate Summary. Electronic document, http://www.wrcc.dri.edu , accessed March 18th, 2015.

Wind and Sand

1956 *Ceremonies Open Huge Building Here for Land-Based Talos Defense Unit*. 7(38), 21 December:1. White Sands Missile Range, New Mexico.

1957a *Talos Joins the Army- Officials, Press See Ceremonies*. 8(29), 18 October: 1, 8. White Sands Missile Range, New Mexico.

1957b *Hammond Leaving Talos Missile Project*. 7(47), 1 March: 1. White Sands Missile Range, New Mexico.

1957c *Navy Spurs Output of Talos*. 7(41), 18 January: 1, 8. White Sands Missile Range, New Mexico.

1957d *Talos Begins Basic Training With Army*. 8(30), 25 October: 1, 8. White Sands Missile Range, New Mexico.

1957e *Talos Firings Termed Successful by Navy*. 8(38), 8 November: 1, 4. White Sands Missile Range, New Mexico.

1958a *Engineer Turns Babysitter: Launcher Isn't for the Birds but Mom Meadowlark Thinks So*. 9(3), 18 April: 1. White Sands Missile Range, New Mexico.

1958b *Ammo Audience Sees Power Parade: 500 Guests Visit WSMR for Spectacle*. 9(14), 4 July: 1, 6. White Sands Missile Range, New Mexico.

1959 *Mighty Missiles Outmatch 1600-MPH Target*. 9(40), 9 January: 1. White Sands Missile Range, New Mexico.

1965 *Multi-Million Dollar Contract Awarded*. 13(17), 29 October: 5. White Sands Missile Range, New Mexico.

Winkler, David F. and Julie L. Webster

1997 *Searching the Skies: The Legacy of the United States Cold War Defense Radar Program*. Report submitted to the United States Construction and Engineering Laboratory, Champaign Illinois. Copies available electronically.

White Sands Missile Range (WSMR)

1968 The Athena Story. Manuscript on file, Environmental Division, White Sands Missile Range, New Mexico.

Preparers' Qualifications

Nathaniel Myers, M.A. (Anthropology, Eastern New Mexico University) is a professional archaeologist with more than seven years of experience. He has performed prehistoric and historic archaeological studies throughout New Mexico and meets the SOI's Professional Qualification Standards (36 CFR Part 61) for Archaeology. Mr. Myers has worked on a broad range of Section 106 and 110 compliance projects for federal, state, municipal, and private clients. As an archaeologist, Mr. Myers has dealt with a wide range of temporal and cultural manifestations across the Southwest. He has also worked on a variety of historic preservation projects, including historic building inventories, archival research, artifact analysis, and individual and district nominations for the NRHP. Mr. Myers also has significant experience with late-nineteenth-century homestead and mining sites and Cold War-era military programs and related facilities. For the current inventory, Mr. Myers served as the primary report author, conducted fieldwork and in-field resource documentation, performed archival research, assisted with oral history interviews, and completed HCPI forms.

Brad Beacham, M.A. (Anthropology, Eastern New Mexico University) has worked as a professional archaeologist for over 12 years in the Great Basin, Southwest, and Mid-Atlantic, the last eight of which have been specific to New Mexico and Texas. He has broad experience in all phases of cultural resources management (CRM) for a wide variety of federal, state, municipal, and private clients. Mr. Beacham has managed Section 106, National Environmental Policy Act (NEPA), NEPA, and Tribal coordination projects, including the direction of fieldwork, the preparation of compliance documents, and client consultation. As an archaeologist, Mr. Beacham has dealt with a wide range of temporal and cultural manifestations across the Southwest. His demonstrated prehistoric expertise includes Ancestral Puebloan, Jornada Mogollon, Mimbres, and Apache sites. His demonstrated historic expertise includes urban landscapes, late-nineteenth-century mining, railroad and irrigation sites and districts, as well as Cold War-era military programs and related facilities. In addition to serving as co-author for the current inventory, Mr. Beacham conducted fieldwork and in-field resource documentation, compiled GPS and GIS data for the resource mapping, completed HCPI forms, and provided valuable assistance in conducting oral history interviews.

Phillip Esser, B.S. (Historic Preservation, Roger Williams University), is an architectural historian with more than 15 years of experience who meets the U.S. Secretary of the Interior's Professional Qualification Standards (as defined in 36 CFR Part 61) for architectural history and history. Mr. Esser has a wide range of historic preservation expertise, particularly historic building documentation ranging from individual buildings to large building surveys for state and National Register landmarking as well as Federal Tax Rehabilitation projects. Mr. Esser has extensive experience with Section 110 and 106 evaluations, preparation of National Register of Historic Places Determinations of Eligibility studies and preparation of nominations as well as historic building surveys. Mr. Esser acted as project manager and contributing author for the current inventory, in addition to conducting archival research and conducting oral history interviews.