

DEFINING B-29 AIRSCAPES IN THE ARCHAEOLOGICAL RECORD AS A PREDICTIVE MODEL FOR SITE LOCATION

by

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The Boeing B-29 Superfortress made history when it dropped atomic bombs on Hiroshima and Nagasaki, Japan, bringing an end to World War II. Based on a small island in the central Pacific Ocean, this colossal aircraft left a permanent mark on the history of the world. The strategic movements of the United States armed forces in the Pacific Theater were conducted with the capabilities of this aircraft in mind. The islands of Saipan and Tinian in the Commonwealth of the Northern Mariana Islands were ideal locations for a forward operating base for this new aircraft, lying within the aircraft's range of Japan, while safely outside of the range of Japanese aircraft. Visiting sites related to B-29 aircraft, and employing concepts from GIS theory, battlefield archaeology and cultural landscapes, this thesis seeks to construct an aviation landscape or "airscape". This airscape concept will then be applied to an unidentified B-29 aircraft wreck site on Saipan as a model for understanding site formation.

DEFINING B-29 AIRSCAPES IN THE ARCHAEOLOGICAL RECORD AS A PREDICTIVE
MODEL FOR SITE LOCATION

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By

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The 509th Is Winning the War

Into the air the secret rose,
Where they're going, nobody knows.
Tomorrow they'll return again.
But we'll never know where they've been.
Don't ask us about results or such,
Unless you want to get in Dutch.
But take it from one who is sure of the score.
The 509th is winning the war.

When other groups are ready to go,
We have a program for the whole damn show.
And when Halsey's 5th shells Nippon's shore,
Why, shucks, we hear about it the day before.
And MacArthur and Doolittle give out in advance,
But with this new bunch we haven't a chance.
We should have been home a month or more,
For the 509th is winning the war.

-Anonymous, 1945

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List of Abbreviations

ABPP	American Battlefield Protection Program
AFB	Air Force Base
AFRB	Air Force Reserve Base
ASIM	Archaeological Site Information Modelling
BG	Bomb Group
BS	Bomb Squadron
BuNo	Bureau Number
BW	Bomb Wing
CAF	Commemorative Air Force
CNMI	Commonwealth of the Northern Mariana Islands
CRM	Cultural Resource Management
DEM	Digital Elevation Model
DPAA	Defense POW/MIA Accounting Agency
ECU	East Carolina University
FAA	Federal Aviation Administration
FOB	Forward Operating Base
GIS	Geographic Information System
GPS	Global Positioning System
HPO	Historic Preservation Office
IFR	Instrument Flight Rules
MACR	Missing Air Crew Report
NARA	National Archives and Records Administration

NCB	Naval Construction Battalion
NHC	Naval Historical Center
NHHC	Naval History and Heritage Command
NM	New Mexico
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRHP	National Register of Historic Places
POA	Pacific Ocean Area
POW	Prisoner of War
RAF	Royal Air Force (Britain)
RMA	Report of Major Accident
ROV	Remotely Operated Vehicle
SCRU	Submerged Cultural Resources Unit
SEARCH	Southeastern Archaeological Research Inc.
SLOC	Sea Lines of Communication
SWPA	Southwest Pacific Area
TX	Texas
US	United States
USAF	United States Air Force
USAAF	United States Army Air Force
USN	United States Navy
VFR	Visual Flight Rules
WAMM	Western Australia Maritime Museum

WWI

World War I

WWII

World War I

1 Introduction

“Aviation has forever altered the impact of war on both military and civilian targets, projecting force far beyond the grasp of armies and fleets.” (Cooper 1994:136)

On December 17, 1903, when the Wright brothers made the first successful controlled flight lasting only 59 seconds and traveling 852 feet (ft.) (260 meters (m)), they could never have imagined the impact that controlled flight would have on global foreign policy (Kelly 1943:101). Aviation forever changed the nature of warfare and has brought the world together in ways never before imagined.

With the appearance of aircraft in the material record, archaeologists began a discussion around a theoretical construct that would help to contextualize aviation resources within the milieu of the cultures that created them. This discussion served as the impetus for the development of *aviation archaeology* (Spennemann 1998a:2).

Despite its novelty, aviation archaeology is establishing itself as an essential tool for cultural resource managers, archaeologists and government institutions such as the military and the National Park Service (NPS) (Cooper 1994; Coble 2001; Holyoak 2001). Cooper (1994:136) writes, “as a form of technology, aviation must be recognized to be as critically important to the development of the twentieth century world as maritime shipping and navigation was to the development of the industrial and pre-industrial world.” The ease of movement across wide expanses of the globe has been credited with cultural changes towards homogeneity as well as changes in foreign policy (Spennemann 1998b).

The development of this theoretical construct has required a great deal of collaboration. Academic institutions such as East Carolina University (ECU) have paired with the Marine Option Program through the University of Hawaii to study aircraft remains in the Central Pacific, including fieldwork conducted in Kaneohe Bay as well as at Midway Atoll (Rodgers et al. 1998). Government organizations such as the NPS's Submerged Cultural Resources Unit (SCRU) have worked in conjunction with the United States Navy (USN) on various projects around the world focusing on both aircraft as well as aircraft carriers (Delgado et al. 1991). The significance of this work was officially recognized in 1993 when the United States (US) Naval Historical Center (NHC) (now the Naval History and Heritage Command NHHC) began an archaeological management program for the protection and management of shipwreck and aircraft wreck sites (Coble 2002:34). This program has been highly effective and has produced a database that is abreast of all US Naval aircraft losses. The creation of this database containing lost US Naval aircraft begged for their investigation by the archaeological community, a call which has not been ignored.

When considering aircraft in the archaeological record, it was necessary to examine the relationship between the earth's surface and the air above it. The "maritime cultural landscape" is a concept developed by Christer Westerdahl (1992:5) which includes material remains both on land as well as under water. A maritime cultural landscape addresses the relationships of maritime communities to water and spans the liminal zone between these two different regions. The concept of a "scape" is also applicable to aircraft, for they represent one of the greatest achievements of humankind, traversing and exploring the skies, and as such are similar in many ways to seafaring vessels that sailed and explored the seas.

To examine aviation through an archaeological lens, it was useful to view the air as a scape through which aircraft travel (see Figure 1). To define an “airscape”, aspects of battlefield archaeology, aviation archaeology, cultural landscapes and GIS theory were utilized. This methodology took the vacuous airspace that exists between the earth’s surface and the edge of the atmosphere and used the World War II (WWII) B-29 aircraft as a case study in an effort to deconstruct something that seems ubiquitous into a meaningful space through which aircraft moved predictably.



Figure 1: Boeing B-29 “Superfortress” in flight (Moseman 2015)

In the Pacific Theater of WWII, the Boeing B-29 was a decisive asset for the US. This heavy bomber was the first of its kind (Parton 1989:22) and revolutionized triphibious warfare. Triphibious warfare was a term first used by General Douglas MacArthur in reference to a military tactic that used integrated and coordinated air, land, and sea capabilities (Mullis 2013:148). Unlike the invasion tactics that the US was accustomed to employing against large

land masses such as those in Europe, small Pacific Ocean islands and atolls required a combined triphibious assault.

To place a single aircraft wreck within the context of aviation, Spennemann (1998a:2) argues that there are at least four elements to the understanding of any aircraft wreck site: the sites and buildings, aircraft remains, aviation artifacts, and indirect resources, including anti-aircraft batteries, bomb craters and bullet holes (Rodgers et al. 1998:12). Spennemann argues that when considered together, these four components tell the story of the aircraft from its construction to its final resting place and how this journey fits within a larger airtape.

This thesis examined artifacts, aircraft and sites related to the Boeing B-29 Superfortress with a focus on its operations on Saipan, Commonwealth of the Northern Mariana Islands (CNMI). The activities of the B-29 on Saipan served as a case study through which it was possible to explore the usefulness and limitations of a cultural landscape analysis, and then examine an aircraft wreck site within the theoretical framework of an “airtape” in order to generate a Geographic Information System (GIS) model. This model, by indicating patterns in aviation-related activities, would identify regions with an increased likelihood of containing aircraft wreck sites and aid in the search for missing aircraft and their crews from past US engagements.

1.1 Research Questions

How can an analysis of airtapes contribute to our understanding of aircraft wreck sites, and can this analysis aid in the search for other lost aircraft? This thesis aimed to answer this question through a case study of B-29 related activities and sites on Saipan, CNMI.

Before the concept of an airscape could be applied to the interpretation of aircraft wreck sites, it was imperative that significant features of the scape be identified, analyzed and understood. By employing the tools of battlefield archaeology, aviation archaeology, and cultural landscapes in a GIS, it was possible for aircraft wreck sites to be understood beyond the wrecking event. It was hypothesized that an understanding of the ways in which individual aircraft fit into the greater landscape of aviation could have implications for the prediction of aircraft wreck site locations.

In order to establish and define a B-29 airscape, the following questions must be answered:

1. What is the definition of an archaeological airscape?
2. What are the archaeological and historical data to support the development of a B-29 airscape in the Pacific Theater of WWII, and more specifically in the CNMI?
3. Can the definition of an airscape and its exploration through a case study provide an archaeological GIS model for B-29 sites? And if so, can this model be verified with and/or dovetail with historic sources?

1.2 Background

The Boeing B-29 Superfortress was a strategic long-range, high-altitude heavy bomber aircraft introduced in 1943 (Doyle 2011:6; Mann 2004:103). At the time of its debut, the B-29 was touted as having “opened a new chapter in aerial warfare” (Whittaker 1944:8) for it was thought to be the “perfect” bomber, its design “dictated by lessons learned in combat” (Whittaker 1944:12-13). By the time of its official retirement from battle at the end of the Korean War in

1953, the B-29 had changed global politics forever (see Figure 2). At 8.5m (27.8ft) in height, the aircraft ran 30.1m (98.7ft) long with a 43.02m (141.1ft) wingspan (Doyle 2011:6). The massive bomber weighed 31,815 kilograms (kg) (70,140 pounds [lbs.]) empty with a maximum takeoff weight of 61,236kg (135,000lbs) (Doyle 2011:6). The B-29 could reach a maximum speed of 603 kilometers per hour (kmph) (375 miles per hour [mph]), travelling with a maximum tested range of 3,058 km (1,900 miles [mi]) (Mann 2004:103). Its standard armament included 12 electrically-operated 12.7 millimeter (mm) (.50 caliber) Browning M2 machine guns and a 20mm (.50 caliber) M2 cannon (which was removed in later models) on its tail (Mann 2004:103). Furthermore, the Superfortress could carry up to 9,071kg (20,000lbs) of additional internal ordinance above and beyond its standard armament (Mann 2004:103). This highly sophisticated piece of equipment would re-write the capabilities of air warfare, and launch the world into the nuclear age.



Figure 2: B-29 *Enola Gay* on Tinian in 1945 (Lawrence 1945)

The powerful new aircraft's first flight took place at the Boeing factory in Wichita, Kansas on September 21, 1942 which lasted 35 minutes (Whittaker 1944:13). When the

Superfortress was first introduced to the US public, it was advertised as one of the most rigorously tested aircraft in history, with the supercharger for the engines alone undergoing over 5,000 hours of testing (Whittaker 1944:13). The B-29 was initially equipped with 18-cylinder radial engines, however, no single supercharger had sufficient capacity to supply this design and so it was converted to a twin supercharger installation (Whittaker 1944:13). This new configuration required the development of the first dual nose wheel for a tricycle landing gear to support the incredible weight added by the use of twin superchargers (Whittaker 1944:13).

The US military well understood the extraordinary power of this new bomber technology and kept the specifics of its abilities a secret. At the time of its development, only “some conception of the plane’s capabilities may be gleaned from the announced fact that it will fly higher, farther and with greater bomb load than any other bomber” (Whittaker 1944:13). Even after its debut in the Pacific Theater, the technology that went into the construction of the B-29 remained a secret coveted by the Soviet Union who impounded all B-29s which landed there and conducted “one of the most unusual and ambitious projects ever conceived in aviation history: the copying and production of the most sophisticated airplane in the world, by an industry that then could not have begun the design of such an advanced bomber” (Birdsall 1980a:77). Ultimately, the Soviet Union would produce several hundred production examples of a replica B-29 called the Tu-4 (see Figure 3) which was externally indistinguishable from the US aircraft (Birdsall 1980a:77).

During WWII, there were three companies building Superfortresses for military use. Boeing built 2,766 planes between its Renton, Washington factory (abbreviated BN) and its Wichita, Kansas plant (BW); Bell Aircraft constructed 668 aircraft in Atlanta, Georgia (BA); and the Glenn L. Martin Co. produced 536 units in Omaha, Nebraska (MO) (Veronico 2013:201).



Figure 3: Russian Tu-4 Bull on the tarmac (Military Factory 2017)

The B-29 became indelibly etched into global recognition when at 8:15am local time (9:15am Tokyo time) on August 6, 1945, Colonel Paul Tibbets, piloting a special “Silverplate” edition of the Superfortress, the *Enola Gay*, dropped the first atomic bomb on the Japanese city of Hiroshima (Birdsall 1980b:296). The Superfortress was used again three days later to drop another atomic bomb on the Japanese city of Nagasaki on August 9, 1945 (Birdsall 1980b:302). To this day, the B-29 serves as an example of superior technology contributing to global affairs because the Japanese delivered an announcement of surrender on August 15, and signed the instrument of surrender on September 2, 1945 (Howlett 2015:66).

As with any technology, the B-29 was eventually overshadowed by a larger bomber plane, and was replaced in its primary role during the early 1950s by the Boeing B-47 Stratojet (Veronico 2013:202) (see Figure 5). With the introduction of larger and more powerful bombers, the B-29’s classification was reduced from being a heavy bomber to a medium bomber (Veronico 2013:202). In 1948 many B-29s were removed from service and strategically set aside, though they remained the main nuclear-capable bomber through the end of the 1940s

(Veronico 2013:202). The Korean War in the 1950s marked the beginning of the process of phasing out this technology in response to technological advances by enemies of the US (Veronico 2013:202). During the Korean War, the B-29 encountered and was made obsolete by the Soviet Union's MiG-15 jet fighter whose speed approached that of sound (Veronico 2013:202). On November 4, 1954 the Strategic Air Command flew its last B-29 bomber flight, over 12 years after the first Superfortress left the tarmac in Wichita (Veronico 2013:203). Despite their phasing out, the military retained possession of the remaining B-29 aircraft and used them for training purposes as targets for new anti-aircraft weapons (Veronico 2013:203).

1.3 Project Location

During WWII, the Mariana Islands acted as strategic military stepping stones, providing an unbroken chain of protected lines of air and sea communications from the home islands of the Japanese Empire to their island fortifications throughout the Central Pacific (Hoffman 2000:3). The Mariana chain consists of 15 islands that run north to south for 684km (403mi) and are a mere 805km (500mi) southeast of Iwo Jima (see Figure 4), a central part of the Japanese empire (Rottman 2004:9). The Mariana island of Saipan is closer to the Japanese Empire than any other large island in the Japanese Mandate and of sufficient size to construct infrastructure large enough to support substantial military operations (Hoffman 2000:3). In conjunction with the neighboring island of Tinian, Saipan acted as an important supply base and communication center for the entire Central Pacific, forming a key part of the Marianas defense strategy (Hoffman 2000:3).

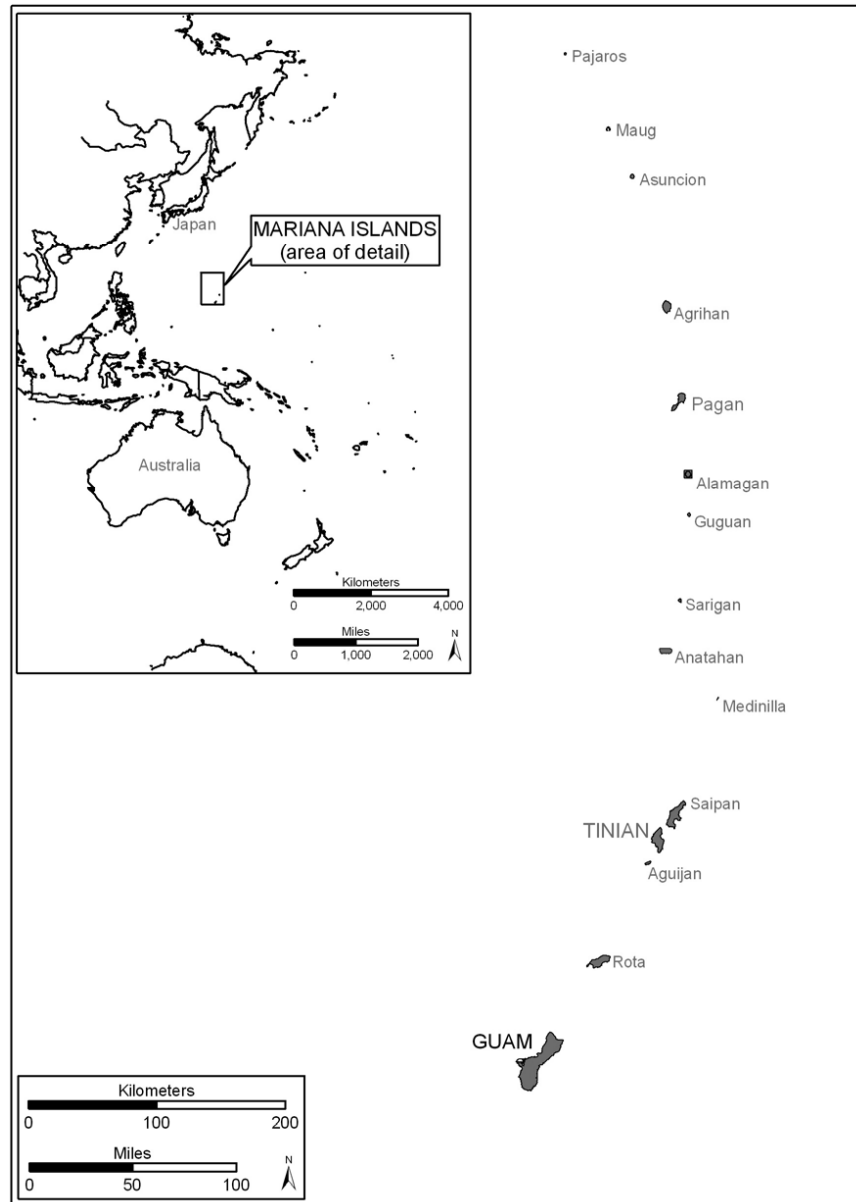


Figure 4: Location of Saipan and Tinian (Burns 2008a)

Saipan itself is 20.9km (13mi) in length aligned on a northeast to southwest axis and 8.9km (5.5mi) at its widest point, covering an area of 183.8km² (71mi²) (Rottman 2004:9; United States Navy Department 1944:12). Although the majority of the island's 87km (54mi) coastline is comprised of sheer cliff faces, it includes 22.5km (14mi) of beaches, which make it highly defensible (Rottman 2004:10). Located on a plain at the southern end of the island, Aslito Naval Air Field was easily identified as a significant objective in the invasion of Saipan (Denfeld and

Russell 1984:7). Aslito airfield was built in 1934 and acted as the chief Japanese airbase in the Mariana Islands until the US invaded Saipan (Denfeld and Russell 1984:7). The Japanese military used the airfield as both a fighting field and a forward maintenance and rebuilding resource to support their activities leading up to and during WWII (Denfeld and Russell 1984:7).

The center of the island of Saipan is dominated by Mount Tapochau which rises to a maximum elevation of 474m (1,554ft) (Rottman 2004:10). On the western face of Mount Tapochau, between 262m (860ft) and 336m (1,102ft) elevation, and located on the property of Dr. Daniel Lamar are the remains of a potential B-29 aircraft (pers. Comm. Genevieve Cabrera). This aircraft wreck site is widely known to both tourists and local inhabitants of Saipan, making it a well visited site (pers. Comm. Genevieve Cabrera). This potential B-29 site was chosen as a case study for the construction of an archaeological airscape due to its local cultural significance.

Located 3.2km (2mi) south of Saipan, across the Saipan Straits, the island of Tinian extends approximately 16.5km (10.2mi) in length and 8km (5mi) at its widest (Rottman 2004:11). Together, Saipan and Tinian constituted the key point of the Japanese Mariana's defense and as such, were viewed as a single tactical locality for both the US invasion strategists and the Japanese outer ring of defense (Hoffman 1988:3). Tinian's flat, open terrain was perfectly suited to the construction of airfields, leading to the creation of one major airfield at Ushi Point and two smaller airfields on the southern half of the island (Hoffman 1988:4–5).

The proximity of Saipan and Tinian to the industrial center of the Japanese homeland was within the range of the B-29, making it a major objective in the US campaign within the Central Pacific (Birdsall 1980b:102). Due to their location and geography, these islands were chosen as ideal operating bases for US strategic bombing missions to the Japanese mainland, and required an invasion by US forces (Carrell 1991:245).

1.4 Justification

The study of aircraft and flight in the material record has been woefully underemphasized by the archaeological community. Since the first use of the title “aviation archaeology”, archaeologists have argued over its validity (McCarthy 2004:82) because the archaeological community has been in dispute over whether aircraft are too recent to be historical (McCarthy 2004:82; Fix 2011:1002; Dagneau 2014:292; Lyon 1974:3; Gould 2000; McCarthy 1998; Rodgers et al. 1998). One argument against aviation archaeology suggests that by the time aviation resources began entering the material record, “documentary evidence [had become] increasingly accurate and complete, and all the archaeologist [could] do is add peripheral details to the historian’s knowledge” (Lyon 1974:3). This argument has been refuted (Gould 2000; McCarthy 1998) with the contention that “the archaeological record [is] a primary and legitimate source of information...[even when] written documents are available” (Gould 2000:8; Rodgers et al. 1998:8). This counterargument has been supported by archaeological reports wherein the aircraft could not be identified from the historical record alone, and required an investigation of the site to determine the identity of the aircraft (Jung 1996; Jung 2001; Jung 2007a; Jeffery 2004; Brown 2014).

Associated with spatial aspects of aviation archaeology is battlefield archaeology. The study of battlefield archaeology attempts to understand the actions of military forces and the ways in which campaigns or engagements unfolded in order to draw inferences about archaeological assemblages (Babits et al. 2011:3). By identifying the battlefield and critically analyzing it, information can be extracted that contributes to an understanding of the memory that persists into the present through the material record, historical record, and oral record (Tarlow and West 1999:233).

This thesis contributed to the knowledge base of cultural heritage in the CNMI, and added to the historical knowledge of wrecked Superfortresses. By applying known information about routes, targets and strategy to a GIS model, it was possible to observe flight patterns of WWII aircraft and generate an aircscape for their activities. There has been a great deal of research into the cultural heritage of the CNMI and its role in WWII (Thomas and Price 1980; Lord and Plank 2003; Burns 2008a; Burns 2008b; Bell 2010; McKinnon and Carrell 2011; McKinnon and Carrell 2014; Raupp et al. 2015; McKinnon and Carrell 2016; McKinnon 2015); however, little of this research has focused on cultural landscapes of the air and viewing aviation resources in the context of a larger “airscape”.

1.5 Methods

This thesis explored several sites in the CNMI as they relate to spatial relationships of US B-29 activities. The project included visits to and recording airbase-related sites on Saipan and Tinian, in addition to a potential B-29 aircraft wreck site.

Prior to conducting fieldwork, research concerning the B-29 and the significance of Saipan in WWII was conducted. Primary historical documents and US Army Air Force (USAAF) records located at the National Archives and Records Administration (NARA) in College Park, MD were reviewed, as well as unit histories (especially those of the 20th and 21st Bomber Commands), crash cards and accident reports on file with the Aviation History Branch of the NHC. Additionally, a visit to the Saipan Historic Preservation Office (HPO) was made to collect information related to the B-29 and its activities on Saipan. This information served as a backdrop against which to cast the archaeological data.

Using methods borrowed from battlefield archaeology and cultural landscape studies, a non-disturbance survey of aviation-related sites on Saipan and Tinian was conducted. This survey employed a cultural landscape approach to examine the topographical landscape, the transport and communication landscape, the outer resource landscape, and the toponymical landscape (Westerdahl 2005a:17). The topographical landscape included terrain features such as mountains and plains. The transport and communication landscape captured the way in which a given culture moved through the landscape, and how information travelled between places (Westerdahl 2005b:21). The outer resource landscape included the movement of resources that were used by the culture (Westerdahl 2011:746). Finally, the toponymical landscape consisted of the cognitive landscape that could be understood through the traditions, place names, and ritual or symbolic landscape of the culture (Westerdahl 2011:746).

Geographical data relating to this cultural landscape was collected from field research activities and placed on a map in an effort to create a visual representation of the airspace. The cultural landscape analysis was further developed using ArcGIS and utilized to render a digitized projection of the airspace and battlefield as it related to aircraft. ArcGIS is a useful tool for visualizing spatial relationships between seemingly disparate events and features. Individual events and characteristics of the battlefield were assigned a shapefile (Wagner 2010), and then overlaid upon each other and a map of the region to create a georectified “airscape” for Saipan in the Pacific Theater. This airspace was then subjected to a spatial analysis to identify trends which may have influenced aircraft flight patterns.

This research added to the collective understanding of historic aircraft wrecks on Saipan. Additionally, it proposed a methodology for understanding the ways in which airspaces affect aircraft wrecking events, and wrecking events effect aircraft airspaces. Finally, the use of GIS

allowed the dynamic interactions of aircsapes and aircraft wrecking events to be visualized and understood within the greater context of the Pacific Theater of WWII.

1.6 Previous Research

Since the events of WWII left their mark on the CNMI, a number of submerged cultural resource and maritime heritage surveys have been conducted around the islands of Saipan and Tinian (Thomas and Price 1980; Pacific Basin Enviromental Consultants 1985; Carrell 1991; Carrell 2009; Lord and Plank 2003; Burns 2008a; Burns 2008b). These reports have ranged from basic site identification projects to more involved remote sensing survey projects, all of which have furthered the archaeological community's knowledge of underwater sites in Saipan (Raupp et al. 2015:40). Publications generated by organizations such as Southeastern Archaeological Research Inc. (SEARCH) (Burns 2008a; 2008b), the National Park Service (Carrell 1991), and Ships of Exploration and Discovery Research, Inc. (Ships of Discovery) (Carrell 2009) have laid the foundation for a comprehensive survey of all WWII sites in the lagoons and surrounding waters of Saipan (Raupp et al. 2015:40).

Previous work pertaining to the study of aviation resources in the material record has been conducted largely in Australia and the Central Pacific. Silvano Jung (2001; 2007b; 2007a) has conducted extensive research on flying boats lost in Roebuck Bay, Broome, Western Australia during a Japanese air attack in March 1942 and has developed an invaluable understanding of site formation processes for downed aircraft in an underwater environment. Similarly, Michael McCarthy of the Western Australia Maritime Museum (WAMM) studied PBY "Catalina" flying boats that were intentionally sunk off Rottnest Island in Western Australia following WWII and was able to establish a hierarchical system for quantifying

potential site significance for various purposes (McCarthy 1997). Rodgers, Coble and Van Tilberg (1998) studied the wreck site of a flying boat in Hawaii's Kaneohe Bay, which was lost during the Japanese assault on Pearl Harbor; they were able to tell the story of a historical aircraft that may not otherwise have been heard (Rodgers et al. 1998). Within the CNMI, Jennifer McKinnon and Toni Carrell (McKinnon and Carrell 2014; 2016) have conducted extensive research on the Battle of Saipan and various underwater cultural heritage sites related to it. McKinnon and Carrell have also worked with local cultural resource managers to create an underwater heritage trail for WWII wrecks in Saipan's lagoons (McKinnon and Carrell 2011).

1.7 Limitations

Limitations in this project included archaeological integrity, time constraints and scope. In the case of conspicuous land sites, issues of archaeological integrity and site disturbance became important. Many individuals do not recognize aircraft crash sites as archaeological and thus do not consider them worthy of preservation. Additionally, the passage of time has undoubtedly led to the disintegration of some battle-related structures and artifacts which may no longer be visible or even still extant. If structures and features had been removed or were inaccessible due to overgrowth, then they could not be included in the results of this project.

Survey-related limitations included time constraints and scope. During the course of the project, survey work was divided into two groups: island survey and archaeological site survey. The island survey work was conducted over two weeks by two to three individuals who visited sites open to the public, while the archaeological site survey work occurred over two site visits on the private property of Dr. Daniel Lamar with six to eight team members. The small team size for the island survey dictated that a strict schedule be adhered to, and an alternate schedule

devised for inclement weather. The limitation of time at the aircraft crash site mandated clear and specific goals for the identification and recording of significant site features.

Finally, this project was limited in its scope because it explored only two islands that were involved in a war that truly spanned the globe. If there were time to examine all known aircraft wrecks and related attributes to the B-29 airspace, the airspace model would include factories in the US, storage facilities and transport facilities, as well as flight-paths. A project of that size, however, is beyond the scope of this thesis. Despite limitations in scope, any research or information that can be extracted from this project contributes to a better understanding of WWII B-29 aircraft wreck sites in and around the Mariana Islands.

2 History

2.1 Saipan

2.1.1 Location

The archipelago known today as the Commonwealth of the Northern Mariana Islands (CNMI) consists of 15 islands running north to south along a slight curve about 684km (425mi) in length (Rottman 2004:9). The Mariana Islands are approximately 483km (300mi) north of the West Caroline Islands, 5,471km (3,399.5mi) west of Pearl Harbor, 2,028km (1,260mi) south-southeast of Tokyo, 2,414km (1500mi) east of Manila, and 805km (500mi) southeast of Iwo Jima (see Figure 5) and serve as a significant waypoint on the path to Tokyo (Rottman 2004:9). Saipan is the second largest island in the chain with a land area of 124.3 square km (km²) (48 square miles [mi²]), and is situated around 15° north of the equator and 146° east of the prime meridian (Cloud Jr. et al. 1956:1). Geologically, Saipan has a volcanic core enveloped by younger limestone that steps down from Mount Tapochau to the ocean in successive erosional terraces (Cloud Jr. et al. 1956:1). The dominant topographical feature of Saipan is an upland terrace running through the northern three quarters of the island (Carrell 1991:39). The northern, eastern and southern coastlines are formed of cliffs and moderate to steep slopes, while the western coastline is protected by the barrier reef that runs along nearly 90 percent of the western coast forming the Saipan Lagoon (Carrell 1991:39). This volcanic core wrapped in limestone has created terrain that is characterized by cliffs and crags both inland and at the coastline (Carrell 1991:39). With a large number of caves, nooks and crannies, the defenders of this island have a distinct terrain advantage (Carrell 1991:39).

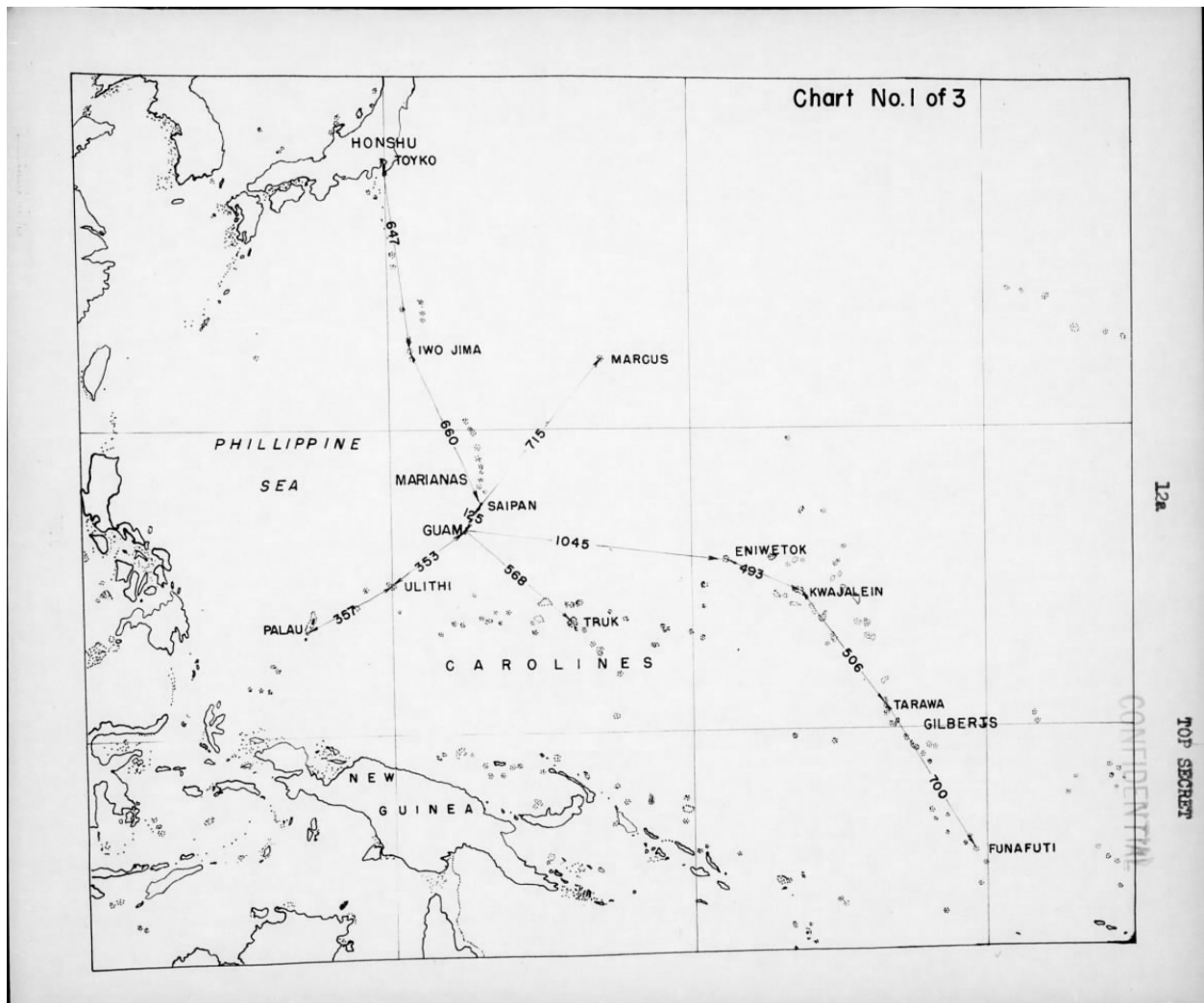


Figure 5: Distance chart of the Pacific Theater (NM) (NARA RG 38 Reel A2034 MicroSN 15'6316 1945)

2.1.2 Island History with Europe

Prior to European arrival, the entire Mariana Islands chain was inhabited by the Chamorro, a single people with a single language, and a homogenous culture (Spoehr 2000:3; Cabrera 2015:18). On March 6, 1521 Fernan de Magalhaes, commonly known as Magellan, sighted the Marianas as he sailed along the 13th parallel westward across the Pacific Ocean (Spoehr 2000:5). While a couple of sightings of the Mariana Islands by European explorers were reported after Magellan's recording, the next major event in the post-contact written history of the islands

occurred in 1565 when Legazpi provisioned an expedition from Guam and proclaimed the Marianas to be Spanish territory before sailing west to establish claims in the name of Spain in the Philippines (Spoehr 2000:6). The growth of a Spanish colony in the Philippines made the Marianas an important way stop for water and provisions on the westward journey from Spain, increasing the amount of contact between the Chamorros and Europeans (Spoehr 2000:6). From this time of first contact with the Mariana Islands, European interaction with Saipan in particular was most likely incidental, for most Spanish ships in the trickle of trade with passing ships en route to Manila provisioned themselves from Guam, being the largest in the island chain (Spoehr 2000:8).

In 1668, the Spanish officially sponsored a mission to Guam for the purpose of religious conquest, marking the beginning of a period that was characterized by subjugation of the Chamorro by Spanish missionaries, and which left the Chamorro decimated and subdued by years of violence and oppression (Spoehr 2000:9). At the time of the Spanish mission, the indigenous population of the Marianas was between 35,000-50,000 although it was hypothesized to be around 40,000 (Hezel 1982:133). An indigenous population of 40,000 corresponds to conservative population estimates made by visitors in the eighteenth century as well as estimates for pre-contact population numbers for other island groups in Micronesia (Hezel 1982:133). By 1698, the Chamorros that had inhabited Saipan and the other Mariana Islands were forced to move to Guam (Spoehr 2000:23). In 1710, the Spanish governor took the first census of the Marianas, documenting a Chamorro population of only 3,539 (Hezel 1982:133).

The Spanish continued their expansion into other island groups in the Pacific Ocean including the Caroline Islands and the Marshall Islands (Cabrera 2015:15). In 1885, German expansionist ideology led to the acquisition of territory in the Pacific Ocean when they received

control of the Marshall Islands through concession by Spain (Cabrera 2015:15). France and Great Britain also acquired territory in the South Pacific as part of an influx of western European interest in these small island clusters supporting trade routes with East Asia (Cabrera 2015:16).

This western presence in its surrounding waters spurred Japan towards action through exploration and national expansion (Cabrera 2015:16). In the 20 years after 1887 when Japanese explorers discovered and claimed the Volcano Islands, Japan established itself as a major political power in the Pacific Ocean territories by developing lucrative commercial ventures in and around Micronesia (Cabrera 2015:16). Germany rose to prominence in the Pacific Ocean by controlling the Northern Mariana Islands, the Caroline Islands, and the Marshall Islands, along with the atolls of Kapingamarangi and Nukuoro from 1899 to 1914 (Cabrera 2015:16). The European power proceeded to monitor and control the commercial activities of Japan until the outbreak of WWI directed Germany's attention to the homeland, and Japan was able to weigh anchor outside the village of Garapan, Saipan, and raise the Japanese flag, claiming the territory on October 14, 1914 without firing a single shot (Cabrera 2015:16). This claim became official in 1921 when the newly established League of Nations granted Japan a Class C mandate over the territories in the Pacific that were seized from Germany (Cabrera 2015:16).

Under the Japanese mandate, the Northern Mariana Islands enjoyed tremendous economic activity in the production of sugar cane as the main cash crop (Cabrera 2015:17). The economic opportunities in the Mariana Islands led to an influx of immigration by Japanese and Okinawan farming families, and a corresponding shift in the social hierarchy where the indigenous Chamorro and Carolinians were forcibly relocated away from their familial lands and deprived of civil liberties (Cabrera 2015:17). In the decade leading up to the assault on Pearl Harbor, Japan maintained a veil of secrecy around fortification activities on its mandated islands,

withdrawing from the League of Nations in 1935, and closing extraneous access to Saipan and the rest of the Northern Mariana Islands in 1938 (Cabrera 2015:18). Japanese fortifications continued in secrecy, often employing Chamorro and Carolinian natives as slaves forced to build these military installations (Cabrera 2015:18).

2.2 The Pacific Theater

The events that unfolded between the US and Japan in the Pacific Theater during WWII were set in motion long before the Japanese bombed Pearl Harbor. At the conclusion of World War I (WWI), Japan was awarded territory in the western Pacific and the Far East, initiating an aggressive expansion movement (Crowl 1993:2). In response to this Japanese accumulation of territory, from 1924 through 1938, a joint US Army and USN board generated a series of plans entitled the “Orange” plans (Crowl 1993:2). The “Orange” plans centered on the assumption that any war would be “primarily naval in character throughout, unless large Army forces are employed in major land operations in the Western Pacific, directed toward the isolation and exhaustion of Japan, through control of her vital sea communications and through aggressive operations against her armed forces and her economic life” (Crowl 1993:2). This plan dictated that the US Naval Fleet establish a forward naval base in the Philippines – a move that would require a “leap-frog” process of seizure and occupation of significant Japanese Mandated Islands, especially in the Marshall and Caroline Islands (Crowl 1993:2). A naval base in the Philippines would enable the US to sever Japanese trade routes through the South China Sea, and thus economically isolate the Japanese mainland, while threatening the surrounding waters with naval might (Crowl 1993:2). This plan relied heavily on subsidiary US bases in the Japanese

Mandated Islands as a way to protect the line of communications between the forward naval base in the Philippines and the continental US (Crowl 1993:3).

During the planning process, admiral Harold Stark proposed four alternatives for confrontation with Japan in the Pacific (Spector 1985:65). He laid them out in a memorandum, and recommended plan “D” which called for an offensive posture in the European theater and a defensive posture in the Pacific theater (Spector 1985:65). Operations conducted in the Pacific theater would come to be referred to as “DOG” plans due to the phonetic association with the letter D in the Joint Army/Navy Phonetic Alphabet at the time (Spector 1985:66).

Before entering WWII in the Pacific Theater, strategic specialists knew that obtaining the islands from Hawaii through the Marshall, Caroline, and Mariana Island chains would be necessary in order to relieve or support potentially beleaguered US forces in Guam and the Philippines, or in the worst case scenario, to recapture those island territories (Marston 2010:159) (see Figure 6). These strategic plans were predicated on the assumption that the US alone would be engaging with the Japanese military; however, the initiation of hostilities in Europe, and the growing alignment between European anti-Axis nations and the US, especially Great Britain, meant that the US had to agree to strategic measures that incorporated a combined approach (Crowl 1993:3). The introduction of Allied powers into the US strategy led to a Euro-centric policy, meaning that there was less expenditure of effort on the Pacific theater (Crowl 1993:3). The inclusion of Allied powers led to a modified strategic plan that incorporated various other color-named war plans, the collective being called “Rainbow 5” which provided more specific assignments to the US forces, and cemented the role of the Central Pacific in the inevitable war against Japan (Crowl 1993:3). Despite the inclusion of Allied forces and the

Rainbow 5 plans, the Orange Plan held: hold the Philippines and control the Central Pacific west of Hawaii (Crowl 1993:3).

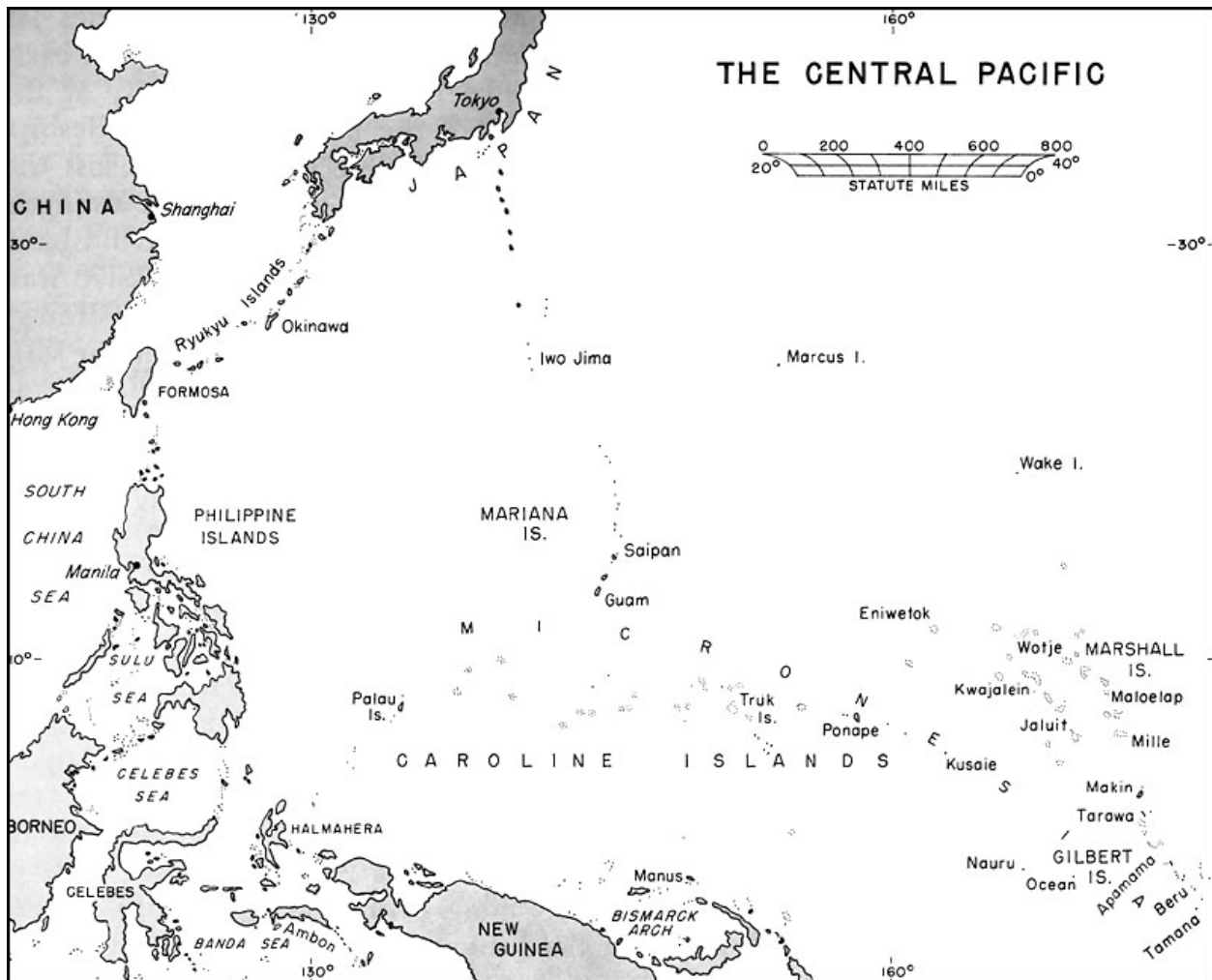


Figure 6: The Central Pacific Theater (Morton 1962:435)

Anticipating US advances towards the main island of Japan, Imperial Japanese Navy planners developed a plan of “gradual attrition” (Marston 2010:160). The strategy behind “gradual attrition” involved the use of submarines, land-based bombers, and light surface forces to slowly erode the significantly larger USN down to a size that provided relative parity for the smaller Japanese Naval fleet (Marston 2010:160). It was discovered that the assault on the US naval base at Pearl Harbor rendered the USN unable to aid either Guam or the Philippines against Japanese military invasion (Marston 2010:160).

Initial Japanese successes in the Pacific Theater during the first year of the war threatened the sea lines of communication (SLOCs) between the US and Australia, and threatened the Australian continent itself (Marston 2010:160). The Japanese took Guam, Hong Kong, Singapore, Manila, and the Philippine Islands during this early streak of success; this in turn required additional expenditure of resources by the Allied powers to re-take these island territories before implementing “Rainbow 5” (Crowl 1993:4). Their control of the Western Pacific, which the Japanese military achieved during the first year of the war, made the naval war against Japan more difficult for the US than that being fought in Europe (United States 1947:1).

Japan continued to aggressively expand, achieving a tenuous foothold in the Aleutians before encountering resistance by the US Pacific Fleet. The Japanese failure to extend their control southward at the Battle of the Coral Sea, and failure to extend their control into the Eastern Pacific at the Battle of Midway, arguably marked a turning point in the war (United States 1947:1). After the battle at Midway, the US took primary responsibility for the war in the Pacific from England, the Soviet Union, and France (Crowl 1993:4). The US strategic planners then divided the Pacific Theater into the Southwest Pacific Area (SWPA) under the command of General Douglas MacArthur, and the Pacific Ocean Areas (POA) under the command of US Commander in Chief of the POA, Admiral Chester Nimitz (Crowl 1993:4).

In January of 1943 at the Casablanca Conference between President Roosevelt and the US Joint Chiefs of Staff, as well as British Prime Minister Winston Churchill and the British Chiefs of Staff, US Admiral Ernest King led the charge for a greater effort in the Central Pacific as part of a thrust against the Japanese (Crowl 1993:6). With this push, Admiral King advocated for a drive to the Philippines, cutting communications between relatively resource-poor Japan, and the

oil-rich East Indies (Crowl 1993:6). In order to achieve this goal, bases would have to be established first in the Marshall Islands, then Truk Atoll and the Mariana Islands (Crowl 1993:6).

The final phase of the operational push to the Japanese homeland was to be Operation FORAGER, a proposal that brought the Marianas into the fold as a major objective (Crowl 1993:39). During the entire planning phase of the assault on the Central Pacific, Admiral King had maintained the opinion that the Mariana Islands were the key to the Western Pacific (Dyer 1972:855). He believed that from bases on the Mariana Islands, the US could easily cut the Japanese lines of communications to the Netherlands East Indies and Malaysia, two significant sources of natural resources for the Japanese homeland (Dyer 1972:855).

The US assault in the Pacific Ocean was carried out with great success, and within the first seven weeks of 1944, the Japanese Combined Fleet was forced to retreat from Truk Atoll (or Chuuk) to the islands of Palau in the Western Carolines (Dyer 1972:855). The success continued and Eniwetok fell in late February, two and a half months before its expected acquisition in early May (Dyer 1972:855). The success of the drive, and subsequent retreat by the Japanese fleet from Chuuk Atoll and Eniwetok so early in 1944, allowed Admiral Nimitz to propose two schedules of future operations: one in which a terrestrial invasion of Chuuk would occur on June 15, 1944, and the Southern Marianas would be assaulted on September 1, 1944; and another in which Chuuk would be neutralized and by-passed altogether, while the Southern Marianas would be invaded on June 15, 1944 (Dyer 1972:856). By advancing the scheduled assault of the Marianas, Admiral Nimitz believed that his forces in the POA would be ready to launch a major attack on the Formosa-Luzon-China area in the spring of 1945 (Dyer 1972:856). It was believed that success in the Marianas would largely neutralize Chuuk and isolate the Central Caroline Islands because control of the Marianas would sever the main Japanese aircraft pipeline down

from Japan to the Carolines (Dyer 1972:857). On September 15, 1944, the Palau islands in the far western Carolines would be assaulted to establish a fleet base there, and those islands would serve as a forward staging area for later operations against Mindanao, Formosa, and the China coast (Dyer 1972:857).

2.3 The Marianas as Strategic Targets

The three objectives of Operation FORAGER: Saipan, Tinian and Guam, lay directly across the path of the Central Pacific forces as they advanced from their westernmost base on Eniwetok, towards the Japanese home islands which included the Philippines, Formosa, the Ryukyus and Japan itself (Crowl 1993:26). The US invasion of the Mariana Islands was a crucial part of opening up the western Pacific to further attack, which would deprive Japan of position, access to resources, and time that it could not afford to lose (Graham 1994:18).

The battle for the Mariana Islands was a part of a movement that set a new standard of warfare in the Pacific (Carrell 1991:245). Historically, small carrier groups conducted fast, isolated raids on enemy targets (Carrell 1991:245). During the Mariana Islands campaign a new strategy was developed: massive, long-range strikes sustained for days at a time (Carrell 1991:245). Air operations combined with submarine assaults would slowly strangle the Japanese empire, cutting off its access to resources (Carrell 1991:245). In order to launch effective air operations, a forward operating base (FOB) would have to be established to ensure that the assault on Japan could not be outflanked (Carrell 1991:245). The Mariana Islands were an ideal FOB, placing US forces within striking range of the Japanese mainland with the new B-29 long-range heavy bomber (Carrell 1991:245).

2.4 Operation FORAGER

As the Allied forces invaded Normandy in June 1944, half way around the world, US forces were embroiled in equally pivotal battles in the Pacific Theater that would make defeat of the Japanese empire almost certain (Graham 1994:18). The invasion of the Mariana Islands by US forces became the lynchpin that promised to open the entire western Pacific to further attack (Graham 1994:18). US occupation of the Mariana Islands would also isolate Japan from trade for key resources that drove its war effort (Graham 1994:18). It soon became clear that defeating the US initiative Operation FORAGER was the last chance for Japan to avoid defeat (Graham 1994:18). By invading the Mariana Islands, the US would recapture Guam, continue the advance towards the Japanese home islands, and secure air bases from which the USAAF could attack the Japanese mainland (Graham 1994:18).

The code name FORAGER was assigned to the operation that was aimed at the capture, occupation and defense of Saipan, Tinian and Guam (Dyer 1972:859). When Operation FORAGER was launched in June 1944, Admiral Nimitz had four principal purposes: to obtain an island base from which to bomb the Japanese homeland; to obtain a base which would permit the isolation and neutralization of the Central and Western Carolines, thus supporting General MacArthur's movement to the Philippines; to establish effective command of the sea in the Marianas area, creating a forward position on the flank of the Japanese communication lines to the Philippines and Southeast Asia; and finally, to secure a large base from which amphibious assaults could be launched against the Ryukyus, the Bonins, or the Japanese homeland (Dyer 1972:859).

For sheer size, Operation FORAGER was unprecedented among amphibious operations in the Pacific and involved a prominent display of US might (Graham 1994:18). This operation was

specifically aimed at controlling the islands of Guam and Tinian (Graham 1994:18). Guam was a former US territory with known extant infrastructure, good airfields and a good harbor for moving resources into the western Pacific (Graham 1994:18). Tinian was chosen for its flat geography which was excellent for airfields, and its location: the Japanese mainland could be reached by the powerful new B-29 bomber, if launched from Tinian (Graham 1994:18). The only problem with Tinian was its proximity to Saipan (Graham 1994:18). Operations on Tinian would be within range of Japanese artillery from the more heavily developed and fortified Saipan, and so, Saipan necessarily had to fall before an assault on Tinian could be attempted (Graham 1994:18).

During the early stages of planning Operation FORAGER, Saipan was selected as the first invasion target because without it, Japanese reinforcement aircraft flying out of its homeland or Iwo Jima to the Mariana Islands would not be able to land and refuel at nearby air bases before or after engaging the US protective air cover (Dyer 1972:930). By taking Saipan, the US forces prevented the Japanese military from using the airstrips on Saipan as support to interfere with the large task force that would be necessary to capture the island of Guam (Dyer 1972:931).

In planning the practical nature of the invasion, Admiral Nimitz's planners were forced to adapt their strategy from previous successful assaults in the Gilbert and Marshall Islands (Marston 2010:166). The Gilbert and Marshall Islands were small, low-lying coral atolls, while the Mariana Islands were large, volcanic islands with rugged terrain and dense jungle vegetation (Marston 2010:166). The enemy was also different: for the first time in the Central Pacific, the Japanese Army moved divisions from China to help defend the Marianas (Marston 2010:166). A larger army force enabled the Japanese to shift their tactics from holding at the water's edge, to a more dynamic operation that involved tank attacks and the ability to fall back to inland positions

that had been prepared for a prolonged defense (Marston 2010:166).

2.5 Invasion of Saipan: DOG Day

During the three days before the US Marines set foot on the island of Saipan, Task Force 58 (TF 58), the long-range naval striking arm of the US Pacific Fleet, conducted highly successful air raids against Japanese aircraft, securing the airspace in preparation for the amphibious assault (Cabrera 2015:19). While TF 58 secured the airspace, US battleships and cruisers conducted strafing activities along Saipan's southwestern shoreline (Cabrera 2015:19). TF 58 bombarded selected targets on Saipan and Tinian, while minesweepers covered the offshore areas to the west of Saipan (Dyer 1972:901). Expecting a US landing on the beaches between Agingan Point and Cape Obian, due to the high quality of those beaches as landing sites, and their proximity to Aslito Airfield, the Japanese military forces focused their mining and preparatory activities on this stretch of the island, leaving the beaches that were actually utilized by the invading forces relatively free of mines (Dyer 1972:902).

On June 15, DOG Day, Vice Admiral Turner described the weather as "partly cloudy - a few scattered squalls around midday, winds southeasterly 10 to 15 knots. Light to moderate southeast swells" (Dyer 1972:902). Spanning a linear distance of approximately 4.15 mi. (6.68km), the US invasion beaches stretched from the area just to the north of Agingan Point to the modern-day Chalan Kanoa area (Cabrera 2015:19). This extended beach area was divided into four separate beaches identified by color which were subsequently divided into sectors identified by numbers from 1-3 (Dyer 1972:904; Cabrera 2015:19). From north to south these identified sectors were: Red (1, 2 and 3), Green (1 and 2), Blue (1 and 2) and Yellow (1, 2 and 3) (Dyer 1972:904; Cabrera 2015:19). US Marines began to approach the island at 0840 and were faced with

opposition by “artillery and mortar fire from weapons placed in well-deployed positions and previously registered to cover the beach areas, as well as fire from small arms, automatic weapons, and anti-boat guns sited to cover the approaches to and the immediate landing beaches” (Chapin 1994:1) (see Figure 7). By the end of the first day of the assault, the US forces had secured an area approximately 10,000 yards by 1,000 yards at the cost of over 2,000 casualties (Cabrera 2015:20). The Battle for Saipan marked the first Central Pacific landing against a heavily defended island, and necessitated the coordination of assault craft, logistic support craft and marine divisions (Dyer 1972:903).



Figure 7: First assault wave of landing craft at Saipan (World War Photos 2017)

Once the beaches had been secured, the next objectives for the US forces were to capture

Aslito Airfield, hold Mount Tapochau, and push the remaining Japanese militants north towards Marpi Point, securing the island (Cabrera 2015:20). As the US forces advanced across the island, the commander of Japan's Imperial Army on Saipan came to view the Battle for Saipan as one of attrition for Japan, mandating an honorable last stand and a counterattack that would inevitably end in death for himself and his men (Cabrera 2015:22). On July 7, 1944 the final counterattack by 3,000 members of the Japanese Imperial Army was able to push the front line of US forces back from Mount Petosukara to Tanapag Village before aid was provided to the US forces and they were able to regain lost ground and quash the counterattack (Cabrera 2015:23). After mopping up activities by the 2nd Marine Division, the island of Saipan was declared "secured" by Admiral Richmond Kelly Turner on July 9, 1944 (Cabrera 2015:23).

The next day, Vice Admiral Turner logged an estimate of US casualties, "Total casualties 15,053. Of this number 2,359 were killed, 11,481 wounded and 1,213 are missing. Enemy dead buried by our troops number 11,948. There are 9,006 civilians interned and 736 prisoners of war" (Commander, Fifth Amphibious Forces 1944). The low number of Japanese prisoners of war was due to an order issued by Vice Admiral Nagumo, commanding "all civilian and military personnel remaining on the north end of Saipan to commit suicide on 7 July" (Headquarters Expeditionary Troops Task Force 56 1944:3). The securing of Saipan was a major achievement for the US initiatives in the Pacific, and provided a base of operations for the B-29.

3 The Boeing B-29 Superfortress

3.1 Previous Aircraft

After the conclusion of WWI, several influential proponents of military aviation argued that aircraft would be decisive in winning future wars due to their ability to bombard an enemy's homeland (Polmar 2004:1). These proponents included Italian theorist Giulio Douhet, British Royal Air Force (RAF) officer Hugh Trenchard, and WWI US Army aviation commander in Europe William "Billy" Mitchell (Polmar 2004:1). They believed that strategic bombing could force an enemy to surrender without the costly ground and naval campaigns that had been waged across Europe in WWI (Polmar 2004:1). This precept spurred the air services of several countries to begin developing long-range bombers (Polmar 2004:1).

3.2 Specifications

The Boeing B-29 Superfortress is a four-engine mid-wing monoplane that was based on a Boeing plan called Model 345 (Mann 2004:103). The fuselage of the B-29 is arranged in the order of: a forward pressurized compartment, a fore and aft bomb bay section, an aft pressurized compartment, and the tail section with a pressurized tail gunner position (Doyle 2011:17). The forward and aft pressurized compartments are connected by a pressurized tunnel that runs above the bomb bays, facilitating communication between crew members (Doyle 2011:17). While traveling to combat zones, the cabins were pressurized above 2,438.4m (8,000 ft.); however, when the aircraft neared and entered the combat zone, the crew used oxygen masks, and the cabin was depressurized to prevent rapid depressurization if damage during combat should occur (Doyle 2011:17).

The Superfortress required a crew of eleven for bombing missions (Birdsall 1980a:17). Despite being the largest production airplane built up to that time, there was a limited amount of space for the crew by the time the aircraft was equipped for war (Birdsall 1980a:17). Within the forward pressurized section of the aircraft, the bombardier, the two pilots, the flight engineer, the radio operator, and the navigator were all contained (Birdsall 1980a:17). The bombardier sat with a bombsight, gunsight, table and control panel, forward in the nose of the aircraft while the two pilots sat behind him with their controls and instrument panels (Birdsall 1980a:17). The bombardier used a Norden M-9 bombsight which was a computing-type sight enabling highly accurate bombing from high altitudes (Doyle 2011:17). On the right side of the fuselage, behind the pilots and facing aft, sat the flight engineer, and slightly farther aft on the same side, the radio operator with the radio operating equipment (Birdsall 1980a:17). The flight engineer controlled the mechanical systems of the aircraft and had complete knowledge of all systems used, for it was he who was expected to complete in-flight repairs when necessary (Doyle 2011:17). On the left of the radio operator sat the navigator, with a hinged table that could fold up to allow people to move around the well of the upper forward turret while avoiding a maze of cables, oxygen lines and other hydraulic and vacuum equipment (Birdsall 1980a:17).

Across the bomb bays and farther aft, accessed through a narrow, pressurized tunnel, the gunners sat in the central pressurized section (Birdsall 1980a:17). A right and left blister gunner manned pedestal sights on each side of the aircraft while the central fire control gunner sat in a swiveling stool beneath the top sighting blister (Birdsall 1980a:17). The central fire control gunner used a retiflector sight routed through General Electric manufactured fire-control computers, providing primary control of the master gunnery panel of the central fire control system and the top aft turret as well as secondary control of the forward top turret (Doyle

2011:18). The waist gunners shared primary control of the lower aft turret and secondary control of the lower forward turret (Doyle 2011:18). The remote control guns meant that the gunners were in the ideal positions to observe enemy aircraft and could control various combinations of guns to defend their own aircraft (Polmar 2004:5). Aft of these three central gunners, on radar equipped B-29s, a small windowless compartment contained the radar section and the radar operator (Birdsall 1980a:18). At the extreme rear of the aircraft, the tail turret area consisted of a pressurized section only large enough to accommodate one man to operate the tail gun (Birdsall 1980a:17).

The B-29 stood at 8.45m (27ft 9in) tall, had a 43.02m (141ft 2in) wingspan and ran 30.1m (99ft) in length (Doyle 2011:6) (see Figure 8). Empty, it weighed 31,815kg (70,140lbs), and could carry up to 61,236kg (135,000lbs), of equipment, personnel, bombs and cargo (Doyle 2011:6). This carrying capacity was made possible by four 2,200 horse power Wright R-3350-23 Cyclone 18 cylinder air-cooled engines, each equipped with a pair of General Electric B-11 Superchargers (Doyle 2011:6). These engines enabled the Superfortress to cruise at 320-400kmph (200-250mph) and achieve a maximum speed of 603kmph (375mph) (Doyle 2011:6; Mann 2004:103). It had an operational radius of 3,058km (1,900mi) with a 4,536kg (10,000lbs) bomb load, or 2,494km (1,550mi) with a 9,072kg (20,000lbs) bomb load, and flew at a 9,708m (31,850ft) ceiling (Mann 2004:103). Bristling with armament, the B-29 carried ten .50-caliber machine guns and one 20mm cannon which was later removed due to sighting problems and inaccuracy of fire (Doyle 2011:6; Mann 2004:103). In total, Boeing built 3,960 B-29 Superfortresses between 1943 and 1946 (Mann 2004:103).

In addition to the armament of its bomb load carrying capacity, the B-29 carried a myriad of defensive weapons (Doyle 2011:19). As a bomber, the B-29 was typically vulnerable to rear attack, and so, it was initially armed with two .50-caliber machine guns (Doyle 2011:19).

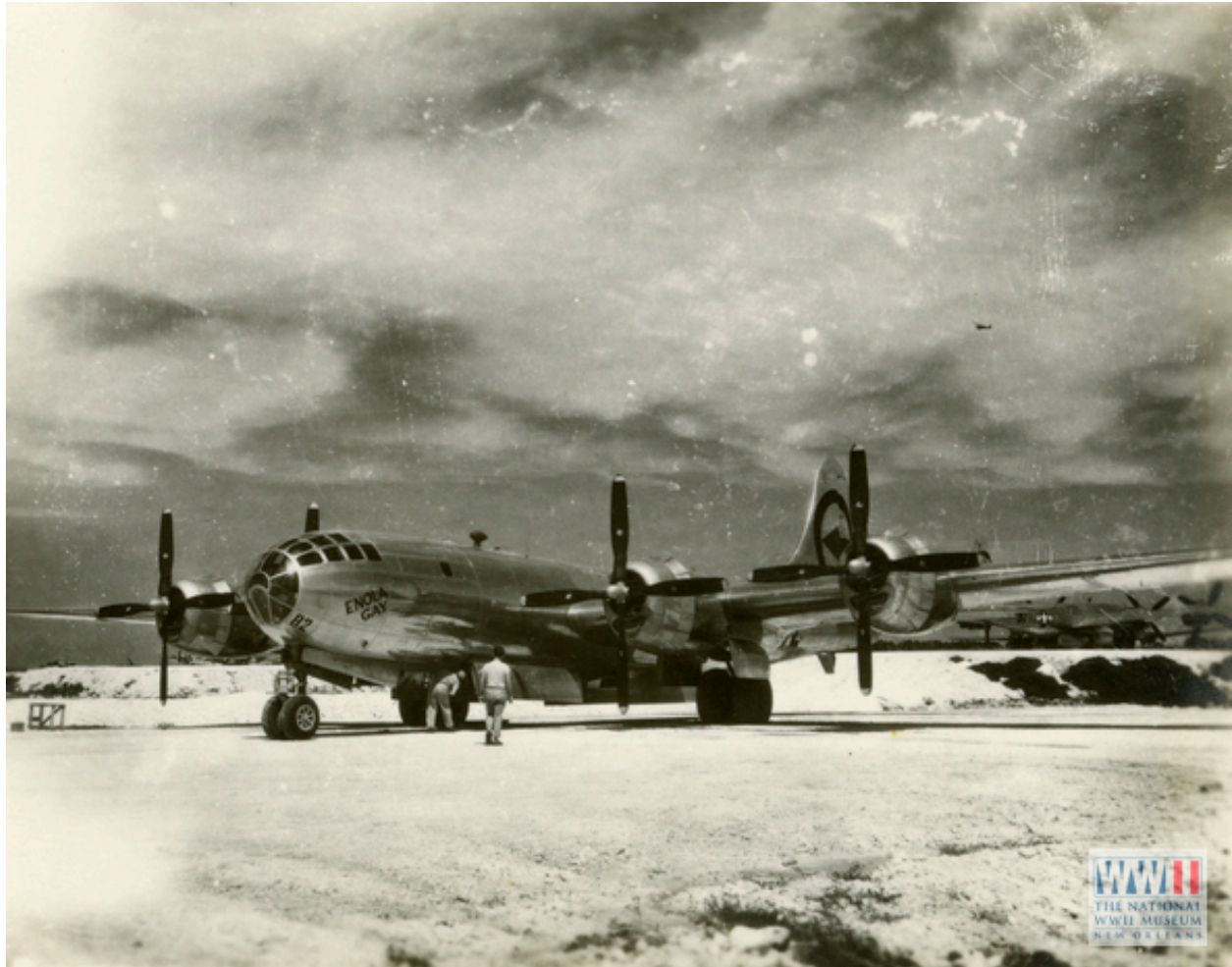


Figure 8: B-29 Superfortress *Enola Gay* on Tinian in late 1945 (509th Composite Group 1945)

The B-29 was the most advanced aircraft in the world produced during WWII (Polmar 2004:1). It was developed as a strategic bomber to carry out long-range, high altitude, daylight bombing attacks (Polmar 2004:1). This powerful piece of equipment was versatile enough for use in conventional as well as incendiary bombing raids, and was strong enough to carry the world into the nuclear age (Doyle 2011:3). As a testament to its success, the B-29 is unique

among WWII bombers in that it is the only type that remained operational into the next US war (Doyle 2011:3).

3.3 Development process

The B-29 was conceived through an informal design request by the USAAF Chief of Staff, Oscar Westover in October 1937 (Doyle 2011:3). In 1938 the Army Air Corps asked Boeing to undertake a design study for an improved B-17 with pressurized crew compartments for high-altitude flight and a tricycle landing gear (Polmar 2004:3). A pressurized aircraft would enable the plane to operate at higher altitudes where it was less vulnerable to enemy fighters and anti-aircraft fire, while simultaneously creating a more comfortable environment for the crew during long-distance mission flights (Polmar 2004:3).

Westover requested an extremely long-range heavy bomber and on August 24, 1940, signed a contract for two experimental B-29s (XB-29) (Doyle 2011:5). This contract would later be expanded to include three experimental aircraft and one static load test airframe (Doyle 2011:5). The first B-29 was constructed at the Boeing Airplane Company's Seattle factory (Doyle 2011:3). Production would later move to Boeing factories in Wichita, Kansas (see Figure 9), and Renton, Washington and include the Bell Aircraft Corporation's factory in Marietta, Georgia, and the Glenn L. Martin Company's factory in Omaha, Nebraska (Doyle 2011:3). In contrast to other WWII aircraft which might have up to 15 distinct versions, the B-29 was only ever factory-made in three production models which were nearly identical in appearance: the B-29, B-29A, and B-29B (the B-29B looked slightly different due to a lack of armament) (Doyle 2011:3).

The B-29 project was not without difficulties. Production delays and bottlenecks, in addition to unexpected problems cost time and amplified the constant pressure, both political and

military, to get the B-29 into the war (Birdsall 1980:4). The first of three Boeing experimental B-29s (XB-29) took its maiden voyage on September 21, 1942, a test flight that was over six months behind schedule (Doyle 2011:5). Problems emerged during testing, especially with the Wright R-3350 engine, most likely due to its hurried development in the face of war (Doyle 2011:5). USAAF commander, General “Hap” Arnold, lobbied for the project’s survival and brought it under the control of the USAAF in what came to be called the “billion dollar gamble” (Birdsall 1980:4). Despite setbacks during testing the USAAF ordered 1,665 aircraft into production, unwilling to slow the pace of the already delayed project (Doyle 2011:5).



Figure 9: B-29 on assembly line at Wichita plant (Airplanes of the Past 2017)

Since its inception, the B-29 was destined for the broad reaches of the China-Burma-India and Pacific Ocean theaters (see Figure 10), where its long range would provide an ineluctable

advantage (Polmar 2004:6). The first overseas bases for the B-29 were constructed in China and India under plan Matterhorn as a means of bringing the powerful new B-29s into war against Japan as soon as possible (Polmar 2004:6). With the acquisition of the Mariana Islands, the aircraft were moved to Saipan and Tinian, the first one, “Joltin’ Josie” Bureau Number (BuNo) 42-24614, touching down at Isley Field on October 12, 1944 (Birdsall 1980b:102).

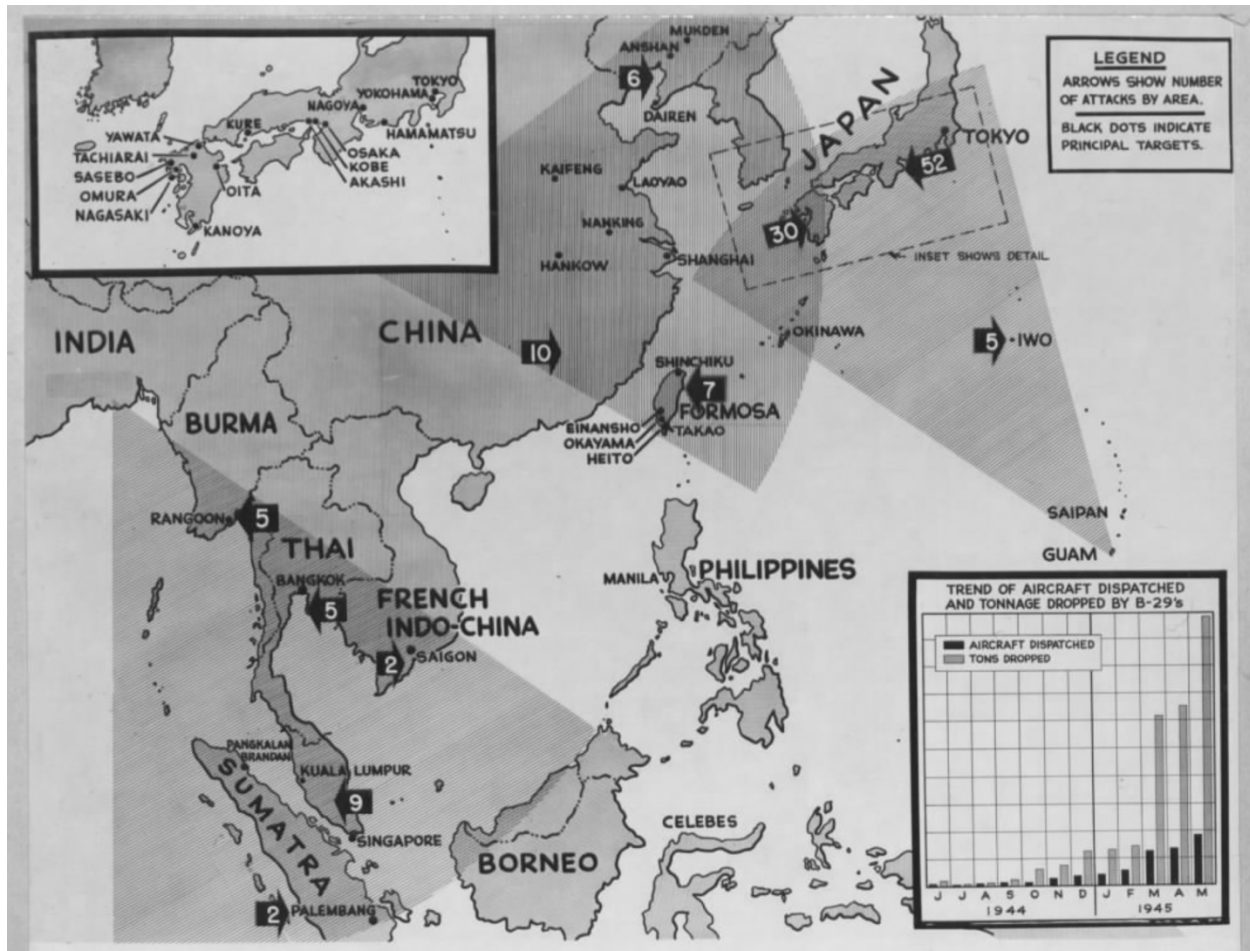


Figure 10: Map of B-29 activity in the Pacific Theater (NARA 342-FH-3A45106-57752AC 1945)

3.4 Action During the War

Once the B-29s were brought to Saipan, training missions commenced against Truk and Iwo Jima (Birdsall 1980b:105). The first real mission that the B-29's conducted from the

Mariana Islands was an assault on the Nakajima Musashino aircraft manufacturing plant which produced more than a quarter of all engines for the Japanese combat aircraft (Birdsall 1980b:108). The target accuracy results of the first B-29 raid on Tokyo were mediocre as the crews adjusted to combat operations in these aircraft; however, the intangible results of the first raid on Tokyo were the most significant: the Superfortresses “had paraded over the toughest target area of Japan without excessive losses, and the Japanese knew they would be back” (Birdsall 1980b:122). This mission established the success of high-altitude, daylight precision strikes against Japanese industrial targets and demonstrated the power of the B-29 (Birdsall 1980b:122).

On January 19, 1945 the 73rd Bomb Wing conducted a highly successful mission with no aircraft losses against a Kawasaki plant in Akashi (Birdsall 1980b:142). This successful mission hit every significant building at the target (38 percent of the roof area showed damage in photographs) and reduced production at the plant by 90 percent (Birdsall 1980b:142). The Akashi mission was significant because it was flown at twenty-five thousand feet (7,620m), setting a lower bombing altitude to improve accuracy, and demonstrated that it was possible to destroy selected targets using selective precision bombing (Birdsall 1980b:144–145).

The decision to use B-29s as tactical support in the Iwo Jima campaign was justified by the argument that attacks against targets in Japan would serve as indirect support for the amphibious landing at Iwo Jima, protecting the landing forces from attacks from the sky (Birdsall 1980b:162). The acquisition of Iwo Jima by US forces would play an inordinate role in the success of the B-29 in WWII. US control of Iwo Jima would: protect the Mariana Islands from stealth attacks; create a direct route, without having to avoid Iwo Jima, to Japan from the B-29 bases; act as a navigational aid; serve as a back-up airbase as well as a staging base for longer

B-29 missions; house rescue units; and provide an emergency landing base for B-29s en route to mission objectives in Japan (Birdsall 1980b:162). The control of Iwo Jima would remediate the differences in range between fighter aircraft and the B-29, enabling B-29 formations to be accompanied by fighter aircraft which could engage the Japanese fighter aircraft and let the B-29s complete their missions (Birdsall 1980b:163).

Without enough success to justify continued pursuit of precision bombing tactics, the US turned to incendiary bombing techniques. In March 1945 General Arnold pursued tactics that would use the B-29 to take advantage of the vulnerability of Japanese construction to “sweeping conflagrations” which could reduce major cities to ashes with a couple of thousand tons of incendiary bombs, a feat that was not being accomplished with standard precision bombing (Birdsall 1980b:177). Applying the Superfortress to incendiary bombing required a change in strategy: incendiary raids were conducted at night, and the fire bombs were dropped from a lower altitude to ensure precision (Birdsall 1980b:179). This change would require a more coordinated formation to avoid losses due to friendly fire or collisions in the chaos of a large bombing raid (Birdsall 1980b:179). Tokyo was chosen as the target for the first incendiary bombing mission on March 9, 1945 and was struck by pathfinders with M-47 napalm bombs to start fires, marking the target and drawing fire-fighting equipment to the scene (Birdsall 1980b:182). The target of the mission would then be bombed from approximately seven thousand feet (2,134m) with over 2,000 tons of M-69 incendiary bombs dropped in five-hundred pound clusters from each of 334 B-29s (Birdsall 1980b:183). The official Japanese casualty estimates from the fire raid on Tokyo determined that 78,660 people died that night across a burned out area of 40.9 km^2 (15.8 mi^2) (Birdsall 1980b:190).

Ultimately, the B-29 changed the nature of warfare through its capabilities and use during WWII. Its ability to travel farther and faster while carrying more weight led to its use for both atomic and non-atomic weapons. The use of the B-29 to deliver the atomic bombs made it famous in the minds of US citizens, although, far more destruction was caused by the non-atomic weapons that it dropped over Japan throughout the course of the war.

4 Literature Review

4.1 Battlefield Archaeology

The recent advances in technology available to archaeologists has raised challenges to previously held hypotheses and expanded the capabilities of current research, enabling the rise of new fields of study including battlefield and conflict archaeology as well as aviation archaeology (Scott and McFeaters 2011:103). John Ellis (1986:9) poignantly linked the relationship between technology, war and social organization when he writes “the history of technology is part and parcel of social history in general.” He argues that “war [is] a function of particular forms of social and political organization and particular stages of historical development” (Ellis 1986:9). This passage was intended for military historians; however, it can be appreciated by archaeologists interested in classical and historic battlefield archaeology, or, more inclusively, conflict archaeology (Scott and McFeaters 2011:104).

The archaeological study of battlefields is a derivative of historical archaeology. The specific designation of “conflict archaeology” originates from the nature of battle and battlefields, that there are many events and activities that occur before and after a battle that are not definite sites of fighting, but are nonetheless critical to the conduct of warfare (Scott and McFeaters 2011:105; Smith 2014:117). In this field of archaeology, military behavior across all aspects of military organization, including military posts, temporary camps, and on the battlefield is viewed as an expression of the society from which it comes, and thus as a subcultural unit (Banks 2014:24). The theoretical premise of conflict archaeology is that “sites of conflict exhibit a cultural behavior by combatant parties that can be retrieved and recorded through archaeological methods and theory” (Scott and McFeaters 2011:104). This frame of reference liberates archaeologists

from the limitations of examining strategy, maneuver and tactics to understand the dynamics of warfare (Scott 2009:300).

Perhaps the most well-known battlefield archaeological study, and the work that established historic battlefield and conflict archaeology as legitimate areas of archaeological inquiry, was the project conducted at the Battle of Little Bighorn battlefield in Montana (Scott 2000). The process of investigating the Little Bighorn led to the development of a disciplined, systematic approach for surveying battlefields with metal detectors and meticulously recording the spatial data of recovered artifacts (Scott and McFeaters 2011:109). This significant investigation also employed modern firearms identification techniques, enabling individual firearms to be identified by class, and individual characteristics among the weapons to be noted (Reeves 2010:87). This analysis and identification led to the ability to track individual weapons around the battlefield, and to understand the movements of the people that used them during the battle (Reeves 2010:87). The ability to observe and analyze the behavior of a series of individual combatants led to the creation of a post-Civil War battlefield archaeological model that allows a more in-depth understanding of combat behavior (Scott and McFeaters 2011:109; Scott 2000:146).

The US Army Field Manual (United States Army 2003) presents the process of conducting warfare in three levels: strategic, operational, and tactical. Strategy relates to the level of ideas for using power to achieve objectives (Scott 2014:9). Operations is the level at which strategic policy is refined to specific action, planning, conducting and sustaining field operations (Scott 2014:9). The tactical level is that in which combat occurs, it is the strata in which bullets and weapons strike people and targets, and the level at which conflict enters the material record and archaeology can begin (Scott 2014:10).

The introduction of remote sensing technology, starting with the metal detector and

expanding to include other geophysical instruments, enabled the modern archaeologist to “see” beneath the soil and through the substrate (Pollard 2010:109). The ability to access information that was not readily visible to the eye, and to do so without invasive techniques, allowed archaeologists to see that conflict sites often included preserved constructions or other features that could be studied with contemporary archaeological practices and which could then orient later work at the same sites (Drexler 2003:6).

The archaeological study of conflict has expanded to include new analytical techniques, including GIS technology to predict potential artifact assemblage patterns and conduct viewshed and terrain analyses, all of which contribute to the collective understanding of historic conflict (Sivilich and Sivilich 2015:50). Archaeologists such as Lawrence E. Babits (Babits et al. 2011:3) have come to realize that “in order to truly understand the actions of military forces and the ways in which campaigns or engagements unfolded, it is imperative to study the military art”. This understanding has led to the use of fundamental military principles to model and evaluate warfare events using historical and archaeological data as independent evidence (Scott and McFeaters 2011:112). Scott and McFeaters (2011:112) define the fundamental principles of military actions as “armed forces in combat seek[ing] to impose their will on the enemy and victory is the objective, no matter the mission”. The use of military vocabulary and concepts that were developed to plan and execute war are the simplest and most effective way to analyze battlefields and military sites from an archaeological perspective (Scott and McFeaters 2011:112). The use of training publications designed by the military to orient new personnel can help the archaeologist understand the execution of military activities for combat at all levels, from individual and small unit actions and tactics to the general formation of military policy and the range of activities involved in organizing and conducting combat (Scott and McFeaters

2011:113). This information can be used to address observable features and support the use of archaeological material to make inferential interpretations (Scott and McFeaters 2011:113).

Conflict archaeology provides a theoretical and methodological framework for archaeologists to gain an increased understanding of the role of the warrior in warfare in addition to the warrior's lifestyle through time and space (Scott and McFeaters 2011:117). The effectiveness of conflict archaeology is due to the predictability of combat behavior. Those who engage in combat fight in established manners and patterns in which they have been trained, and materials that result from these combat incidents enter the material record in a predictable way, resulting in an assemblage of artifacts that can be recovered and interpreted using archaeological aspects of the anthropology of warfare (Fox and Scott 1991:102).

The widely used American Battlefield Protection Program's (ABPP) Battlefield Survey Methodology is an approach to researching, documenting and mapping battlefields (NPS 2016:1). This methodology was first developed to assist the work of the Civil War Sites Advisory Commission (NPS 2016:1). It solicited volunteers to visit each of a list of Civil War related sites with a goal of locating the historic extent of the battlefields on modern maps and on the actual ground where the battles occurred, as well as determining site integrity, providing an overview of surviving resources and assessing short and long term threats to integrity (NPS 2016:2). Since the inception of the ABPP a generalized methodology of battlefield recording has been maintained, as archaeologists, preservationists, and preservation planners have adapted the approach for their purposes (NPS 2016:3). The ABPP has, as new technology is introduced, continued to add material or make changes to improve the survey forms and clarify definitions or procedures for both professional and vocational use (NPS 2016:3).

Vince Holyoak applied battlefield archaeology to airfields, arguing that Britain's Fighter

Command airfields acted as front lines in the defense of Britain during WWII and that they maintain their cultural significance by their formidable presence within the English landscape (Holyoak 2001:253). Holyoak (2001:258) demonstrates the significance of these airfields, viewing them through an archaeological lens to draw inferences about resource availability during wartime, strategic planning (constructing airfields around highly profitable farmland, maintaining a food supply for the homeland) and the changing expectations of these airbases based on the war situation. He writes “construction at airfields was never a single event, it was a series of events, each one a response to the changing war situation” (Holyoak 2001:258). This perspective sets a precedent for a more deconstructive analysis of military installations within the cultural milieu of the individuals who fought at those bases.

4.2 Aviation Archaeology

This section provides an overview of archaeological work conducted on submerged aviation cultural resources. The study of aircraft and aircraft-related structures is a recent development in the field of archaeology because aircraft are a relative newcomer to the material record.

Throughout the twentieth century, the development of air power and its worldwide application to conflicts has led to a globally distributed collection of aviation cultural resources (Cooper 1994:134). Aviation archaeology is difficult to define. Many define this form of archaeology as solely concerned with the recovery of downed aircraft (De La Bédoyère 2001; AAIR 2013). Wotherspoon suggests, however, that aviation archaeology covers any type of research into, or collection of artifacts at all related to the history of aviation (Wotherspoon 2006:12). Spennemann (1998a) argues that it is a field that covers the archaeology of single airplane wrecks, as well as the archaeology of the support structures of aviation. Deal, Daley and

Mathias (2015:3) define it more broadly as the recovery, conservation, and interpretation of abandoned aviation resources. Perhaps the most comprehensive definition of aviation archaeology to date was posited by Peter Fix (2011:1001) as “the archaeological study of humans and their interactions with the atmosphere from sea level to the outer limits of the troposphere, and can include terrestrial sites related to these activities such [as] factories, airports, navigational beacons, docks, and ramps”. This multitude of definitions is reflective of the varied nature of aviation archaeology.

According to Spennemann (1998a:2), aviation resources include four major categories related to aviation: sites and buildings, aircraft remains, aviation artifacts, and indirect resources such as anti-aircraft batteries or bomb craters. Sites and buildings can include research and testing facilities, production plants, airfields and their related structures such as runways and taxiways, aircraft revetments and hangars or service aprons, as well as other support structures such as repair shops, weapons assembly and testing plants, barracks buildings and personnel support structures (Spennemann 1998a:2–3; Holyoak and Schofield 2002; Lake 2002:172–188; Milbrooke 1998). Aircraft remains include the planes themselves that remain in the historical record (Spennemann 1998a:3). Examples of these include both Japanese and US aircraft that were active in the area and known wreck sites (e.g., Spennemann (1998c; 1998a; 2000)).

Aviation artifacts consist of individual aviation related objects that may have been repurposed, such as oxygen cylinders being used as cooking pots, propeller blades being used as reflectors, or aircraft fuselage aluminum sheeting being used as a coconut grinder blade, or a husking stick point (Spennemann 1998a:9–11; McKinnon and Bell 2014:286).

In a compilation of essays called “Essays on the Marshallese Past,” Spennemann (1998b) uses case studies to discuss aviation archaeology in the Marshall Islands and the effects of

aviation in creating greater uniformity among the Marshallese people. After the introduction of aviation, and the widespread availability of air travel the language and dialect of the Marshallese people changed markedly, becoming more similar, and slightly more homogenous (Spennemann 1998b). After providing a cultural background of the Marshallese people, Spennemann discusses the importance of understanding a plane's identity, the circumstances under which it crashed and the identity of the crew members in reaching new dimensions in the interpretation of aircraft wreck sites (Spennemann 1998b). He touches on site formation processes, the study of mass transportation systems, and the interpretive uses of such non-military sites (Spennemann 1998b). He addresses the issues that aviation archaeology faces, such as aircraft wreck ownership, both actual and moral, problems with the preservation of historic aircraft wrecks, as well as the difficulties encountered in the interpretation of aircraft wreck sites (Spennemann 1998b). Using case studies including airfields (Spennemann 1998a), a Consolidated B-24 J (Spennemann 1998c), a Consolidated B-24 D (Spennemann 1998a), a Grumman TBF "Avenger" (Spennemann 2000), a Kawanishi H8K Flying Boat (Spennemann 1998a), two Aichi D3A "Val" Dive Bombers (Spennemann 1998a), various aircraft at Kwajalein and Bikini Lagoons (Spennemann 1998a), as well as drop tanks, oxygen cylinders, propeller blades, Marston matting and pieces of the fuselage (Spennemann 1998a), Spennemann (1998a) provides a thorough interpretation of many of the aircraft wrecks in and around the Marshall Islands.

Historic aircraft wrecks have been discussed in submerged cultural resources reports since at least 1991 (Carrell 1991). Archaeologists such as Carrell (1991), Delgado, Lenihan, and Murphy (1991), Holyoak (2001; 2002) and Gillespie (2004) have applied methods and frameworks from aviation archaeology to add information to the historical record.

Carrell (1991) first addressed submerged aircraft in a cultural resources assessment of

Micronesia. While working for the National Park Service Submerged Cultural Resources Unit (SCRU), Carrell used non-invasive archaeological techniques to locate and assess four aircraft in the waters around Saipan (Carrell 1991:502). Her team also identified two sunken aircraft in the water around Guam (Japanese Navy Aichi D3A2 “Val”, and Japanese Navy Mitsubishi A6M5 “Zero”) (Carrell 1991:523) and several aircraft and debris scatters in the Republic of Belau in the Caroline Islands (Japanese “Jake” Float Plane, a Japanese G4M “Betty”, and disarticulated aircraft wreckage) (Carrell 1991:536).

Two years later Diebold (1993:1) proposed a methodology for the application of historic preservation concepts to aircraft, which are not fixed or concrete resources with defined locations. As mobile artifacts, Diebold argued that the operation of aircraft necessarily means change, mandating that artifact integrity is not a realistic standard for aviation resources (Diebold 1993:3). Due to these challenges, it is difficult to nominate aircraft as a historic place and secure legal protections that preserve static cultural resources. Using a non-labor-intensive survey method, Diebold was able to generate an inventory list of historic aircraft in Indiana that might meet the requirements of the National Register of Historic Places (NRHP) (Diebold 1993:3). From this inventory, he was able identify a specific aircraft that met the requirements for a historic places listing and secure the official recognition of a nomination to the NHRP for B-17G No. 44-83690 (Diebold 1993:7).

At the same time that Diebold, working in Indiana, nominated an aircraft to the NHRP, Kevin Foster (1993) described efforts that were occurring on a national scale for Naval aviation resources. Foster described the three primary elements of the Department of Defense’s Legacy Program including an inventory, a National Register Bulletin and a thematic study (Foster 1993:6). An inventory of global USN shipwrecks and aircraft wrecks is a necessary component

in the management of cultural resources in order to control salvage efforts and maintain archaeological standards (Foster 1993:7). The production of a *National Register Bulletin* on aviation resources would provide the military, as well as the aviation and preservation communities, with a methodology for assessing the significance and integrity of historic aircraft and aviation facilities (Foster 1993:7). Finally, a Naval Aviation Heritage National Historic Landmark Theme study would serve as a basic framework for the production of other nominations for aviation resources (Foster 1993:7).

In 1994, the Program in Maritime Studies at ECU partnered with the University of Hawaii at Manoa's Marine Option Program and the NPS to conduct a field school in Kaneohe Bay, Oahu (Rodgers et al. 1998:8). The goal of this field school was to conduct a pre-disturbance survey and archaeological documentation of a sunken flying boat (Rodgers et al. 1998:8). Despite their inexperience with submerged aircraft, the team was able to locate the aircraft and identify it as a PBY Catalina, locate and map sections of fuselage, wing, and tail, in addition to a submerged buoy resembling a PBY mooring buoy (Rodgers et al. 1998:13). The archaeological evidence of aircraft configuration, damage to the airframe, and the presence of the mooring buoy, led to the conclusion that the aircraft was likely destroyed during the 7 December 1941 attack on the Naval Air Station on Oahu (Rodgers et al. 1998:17).

While Rodgers, Coble, and Van Tilburg conducted fieldwork in Oahu, David Cooper (1994) examined the state of US Naval aviation resources and archaeology at the time. Cooper addressed issues that impacted the development of naval aviation, such as space constraints on ships and the skill required for take-off and landing on aircraft carriers to argue for a more specialized field of archaeology devoted to historical aviation cultural resources (Cooper 1994:137–138). He argued that a specific sector of archaeology devoted to the development of a

greater understanding of aircraft in the material record would enhance the USN's ability to manage their cultural resources (Cooper 1994:138).

Milbrooke (1998), working with the NPS and the NRHP published an official set of guidelines for evaluating and documenting historic aviation properties. This publication provided a methodology for recognition by the NRHP, enabling both concerned citizens, as well as professional cultural resource managers, to nominate historic aviation resources for national protection (Milbrooke 1998:7).

Matthew Holly (2000a; 2000b), working for the Republic of the Marshall Islands HPO conducted a Phase II archaeological reconnaissance survey on known sites in both Majuro and Kwajalein Atolls. The purpose of the project was to collect information that could be used by the HPO to develop and/or protect the sites for tourism purposes (Holly 2000a:9; Holly 2000b:10). The cultural heritage sites that Holly visited in Majuro Atoll ranged from aircraft wreck sites to aspects of the cultural landscape such as seaplane ramps, railways, docks and wharves (Holly 2000a:12). In Kwajalein Atoll, Holly surveyed submerged shipwrecks in addition to submerged aircraft wrecks and cultural landscape features (Holly 2000b:13).

Silvano Jung (2001; 2007b; 2007a) studied the remains of flying boats lost in Roebuck Bay, Broome, Western Australia, during a Japanese air assault in March of 1942. Jung applied a theory of the site formation process of aircraft wrecks that he developed in Darwin Harbor to their identification in Broome, arguing that "archaeologists investigating the Catalina wreck sites must also be aware of how each aircraft was lost because evidence for their wrecking events can help indicate how the wreck sites could be identified" (Jung 1996:33). Through his research, Jung has illustrated the impacts of site formation processes upon underwater aircraft wrecks using archaeological data in conjunction with historic line drawings (Jung 2007a). His

understanding of the wrecking process has been successful in identifying aircraft that could not be identified through the historical record alone.

Vince Holyoak (2001:259) applied aviation archaeology to study airfields as bases for the world's largest combined tactical and strategic air forces in England. He viewed the airbases as visible records of advances in aeronautical engineering, changing military strategies and progress in air campaigns (Holyoak 2001:257). His analysis of artifacts identified at archaeological sites drew inferences about strategic choices during wartime, such as using flares to communicate, instead of radio communication which could be overheard or intercepted by the enemy (Holyoak 2001:253). Ultimately, Holyoak analyzed the greater and more immediate effect that the construction of airbases in England had on Britain's rural landscape than any battle, campaign or other engineering program (Holyoak 2001:254). Holyoak was able to derive significance from evidence of the construction of airfields to indicate the evolution of the air war and the continuous improvement of strategic air tactics (Holyoak 2001:260). He touches on the continual modification that was carried out upon historic aircraft while in the field, and may or may not have been documented or entered into the historical record, discussing difficulties in establishing provenience and site integrity when it comes to aviation cultural resources (Holyoak 2001:259–260).

Coble (2001; 2002) approached the issues related to submerged military sites from a cultural resource management (CRM) perspective, laying out the legal implications of material culture in international waters and explaining the sovereign immunity provisions of admiralty law (Coble 2001:27). Coble addresses issues associated with cultural resource tourism, writing “rarely do humans look but not touch” (Coble 2001:29). She explains the difficulties faced by the NHC in managing such a large number of submerged military equipment, including the issues of looting

and salvage that are the largest threats to these resources (Coble 2002:34). Coble emphasizes the importance of cooperation and reciprocal information sharing among federal, state, and local law enforcement, as well as cultural resources managers, in order to protect historically significant cultural resources (Coble 2002:36).

At the same time that Coble was viewing aviation resources from a CRM approach, Holyoak (2002:657) reviewed a developing interest in military aircraft crash sites of 1912-1945 in and around the UK. The research aims to determine why these sites are important, what archaeological interest remains in them, and how best to manage them going forward (Holyoak 2002:657). The resources are considered in response to amateur excavations that were not to a sufficient standard of accuracy and ethics (Holyoak 2002:658). Holyoak argues that there is archaeological research value in any remains surviving within the context of crash sites prior to 1945, especially due to the lack of complete or even substantially complete preserved examples of many of the 121 types of military aircraft in use over the UK up to that time (Holyoak 2002:661). Holyoak emphasizes the range of valuable information by stating, “for all aircraft, regardless of rarity, crash sites offer primary data on internal fittings and equipment, color schemes and finishing techniques, field modifications, repairs and adaptations which together demonstrate how they were actually used operationally” (Holyoak 2002:662). These technical details are given meaning by his analysis of the cultural meaning of historic aircraft wrecks, the effects of these wrecks and their associated human tragedy upon the inhabitants of the towns and communities in which they crashed (Holyoak 2002:662). This research aids in providing a framework within which aircraft crash sites can be considered along other twentieth century military remains as mainstream elements of the communal cultural heritage (Holyoak 2002:663).

Matthew Holly (2006) published a broad survey of the submerged cultural resources of

Maloelap Atoll in the Marshall Islands, using non-intrusive survey techniques to evaluate the submerged sites for significance. He provided an in-depth analysis of each site, using archaeological data to identify yet unidentified shipwrecks and aircraft wrecks and then applied the Historic Preservation Legislation of 1992 passed by the Republic of the Marshall Islands to assess each site and propose recommendations for grass-roots preservation programs enacted by the local population to develop a sense of local pride and ownership of the resources, as well as reduce visits by tourists to combat tourism-based looting activities.

William Jeffery (2004) applied aviation archaeological theory to underwater sites in Truck (Chuuk) Lagoon and attempted to establish a sense of urgency for the protection of the valuable historic resources. He demonstrates that the submerged resources are in grave danger from dynamite fishing, looting, and ships improperly mooring on and around the sites. Two years later, Jeffery (2006) published the results of a research project that used a CRM approach to investigate submerged cultural resources in Chuuk Lagoon. His publication was one in a series of articles that attempted to examine the conflicts in the management and perception of these sites and provides a post-colonial perspective to these issues. Jeffrey argues that the submerged remains are a part of the Chuukese landscape, and represent Japanese WWII aircraft and the differences between what was available during the construction of those aircraft, and what was required in that battle area. Much like Cooper (1994) and Holyoak (2001) Jeffery is able to extract information about what was going on at the time of construction, from the remains of structures related to WWII. For his doctoral dissertation, Jeffery (2007) took a post-processual approach to the study of connections between values and uses of the Chuukese, the Japanese, and the US. Jeffery applies a well-rounded perspective, providing a view of events as they might have seemed to the Chuukese. In his recommendations for cultural resource management, Jeffery

attempts to incorporate into a resource management plan, the desires of the indigenous population, in addition to their cultural values. His work clearly demonstrates a belief that archaeological sites are not merely repositories for the past, they are living things, with emotional meanings and are closely tied to the populations that live around them.

Samantha Bell (2010) completed a master's thesis on submerged aircraft in Saipan using a process-oriented approach to understand site formation theory. Bell investigated four submerged sites in Tanapag Lagoon, CNMI – an Aichi E13A (“Jake”), a Kawanishi H8K (“Emily”), a PBM Mariner, and a TBM Avenger. She amended shipwreck site formation models seminally proposed by Keith Muckelroy (1978) to fit submerged aircraft (Bell 2010:15) and identified various environmental and cultural factors that apply to submerged aircraft, and proposed modern site formation processes that are specific to aircraft (Bell 2010:125). Ultimately, Bell was able to use process-oriented site formation theory to understand the material impact of intangible cultural significance on submerged aircraft wrecks (Bell 2010:130).

In 2011, McKinnon and Carrell (2011) used the KOCO_A (Key terrain, Observation and fields of fire, Cover and concealment, Obstacles, Avenues of approach and retreat) terrain analysis, in conjunction with the archaeological and historical records to add greater understanding to the submerged cultural resources in Saipan, focusing on those resources related to the Underwater Heritage Trail. Previous research about the Battle of Saipan, the events that occurred both before and after it, as well as other projects on submerged WWII cultural resources, provided a backdrop upon which to place defining features of the landscape, identified through KOCO_A analysis. The Battlefield Survey Method put forward by the ABPP helped to establish the edges of the battlefield on a map. Using KOCO_A analysis techniques and Battlefield Survey Methodology, a GIS database of known sites and artifacts was created which

could be used to nominate sites to the NRHP. The project goal was to increase public awareness and guarantee long-term preservation of the cultural resources, as well as generate information for the public about the sites along the trail. This publication provided a road-map for the successful generation of public outreach materials while using GIS to answer previously unanswered questions and identify opportunities for further research.

In 2014 McKinnon and Bell (2014) applied aviation archaeological theory to the study of four sunken WWII aircraft wrecks in Saipan's Tanapag Lagoon. McKinnon and Bell directly addressed the site formation processes of aircraft as a significant area of archaeological inquiry, examining both the natural and cultural factors that affect site formation processes. Natural factors that affected site formation were identified including: wave action, the difficulty of marine biota adhering to the smooth aerodynamic surfaces of aircraft in addition to the differences in construction materials that could be derived from the electrochemical corrosion potentials of each site (an indication of metal composition). Culturally, they identified site impacts from anchor and mooring damage, looting and movement of artifacts, the addition of artifacts such as sake bottles, as well as the differences between site interactions and memorialization by Japanese tourists versus US tourists through graffiti and opportunistic salvage. McKinnon and Bell used information about site formation processes and wrecking events to identify aircraft wrecks that could not be identified through the historical record alone.

Heather Brown (2014) addressed issues of aircraft wreck site value from a military perspective, even when the identification of the aircraft cannot be determined, as well as how that value is determined. Brown identified multiple sources from which aircraft wreck site value is derived: a reminder of the time period, a source of information about the wrecking event, a tangible representation of the risks inherent in combat aviation, a source of information

pertaining to resourcefulness and limitations or excesses of supplies, the economic role of aircraft manufacturing, as well as case studies for conservation and corrosion research (Brown 2014:278). She argued that it is imperative to reassess the currently maintained criteria of value, in order to bring the material culture afforded by submerged aircraft into a broader socio-cultural and historical context (Brown 2014:281).

James Pruitt (2015) studied pre- and post-depositional site formation processes that affected submerged WWII aircraft in Tanapag Lagoon, Saipan, CNMI. He argued that maritime archaeologists had an incomplete understanding of the processes that create and alter submerged aircraft sites (Pruitt 2015:2). Using an analysis of site formation processes on the specific level of the type of aircraft (Consolidated PB2Y Coronado), the general level of all flying boats, and the broad level of aircraft wreck types and artifact distributions, Pruitt (2015:2) added to the collective understanding of the impacts of humans and nature on aircraft wreck sites. Pruitt then applied the results of his study to the larger issues around the management of submerged aircraft wrecks (Pruitt 2015:161).

4.3 Cultural -scapes

Christer Westerdahl (1992:5) developed the concept of a maritime cultural landscape as a scientific term for the unity of remnants of maritime culture on land as well as underwater. The concept signifies the human economic utilization of maritime space by boat, using watercraft for fishing, hunting, and shipping, including all of the “sub-cultures” of shipping, such as pilotage, and lighthouse and seamark maintenance (Westerdahl 1992:5). This cultural landscape includes the entire network of sailing routes, both old and new, along with ports and harbors along the coast, as well as constructions and remains of human activity, both underwater as well as

terrestrial, that relate to the network (Westerdahl 1992:6). With this broad span of space, Westerdahl (1992) was able to relate underwater cultural heritage to the land that humans occupied through a cultural lens.

In his study of cultural landscapes, Westerdahl (2005b:15) crystalizes the definition as “the whole network of sailing routes, with ports, havens and harbors along the coast, and its related constructions and other remains of human activity, underwater as well as terrestrial”. His theoretical framework includes both material remains as well as cognitive aspects, including mental maps with “toponymous landscape (place names)” aspects, combining the physical landscape and the cognitive landscape into a cultural landscape (Westerdahl 2005b:15). From this *maritime* cultural landscape, Westerdahl extracts eleven core aspects of any cultural landscape: the topographical landscape, which determines the human approach to the launch point in a literal sense; the economic landscape; the transportation or communicative landscape, which includes the terrestrial roads and their relationship to sea routes; the power/resistance (internal), territorial (external) landscapes (aggression/warfare and defense); the outer resource landscape; the inner resource landscape, which is a landscape of agricultural surplus; the toponymical “cognitive” landscape, or the “mental map”; the ritual/cultic landscape; the social (demographic) landscape; the urban harbor landscape; and the leisure landscape (Westerdahl 2005b:17–18). While a complete analysis of all of these various aspects is beyond the scope of this project, some of them such as the topographical, transportation/communicative, power/resistance, territorial, outer resource, and, toponymical and ritual landscapes must be considered in order to conceptualize an airtcape.

4.4 GIS Theory

Geographic Information Systems (GIS) are automated, spatially referenced systems that are used to capture, store, retrieve, analyze and display information about a geographic area (Kimerling et al. 2016:597; Mather and Watts 2009:4). GIS combine spatial data and tabular or text data in a way that enables cultural resource managers and archaeologists to store, organize and recover data (Mather and Watts 2009:3). The capacity to interrelate, analyze and display multivariate spatial data sets renders GIS a significant tool for archaeologists (Mather and Watts 2009:3). Archaeologists have used GIS to geographically identify known submerged cultural resources, areas of potential resource sensitivity, waterway development and maintenance impact areas, helping to prioritize archaeological investigations and resource management activities (Mather and Watts 2009:3). GIS are applicable to both regional analyses as well as site-specific analyses; for example, the programmability of GIS software has enabled organizations such as Tidewater Atlantic Research Inc., to customize valuable management tools for both cultural resource management as well as site-specific investigations (Mather and Watts 2009:12).

Excavation and documentation records, arguably the backbone of archaeology, dovetail with the capabilities of GIS to generate coverages complex enough to build an electronic image, or a reconstruction of the entire site (Potts et al. 1996:206; Neubauer 2004:160). Features of the geographical model can then be linked to detailed drawings, photographs, historical records, literature, or data from similar sites (Mather and Watts 2009:12). As GIS becomes more widely used in the field of archaeology, cultural resource managers will be increasingly able to compare, communicate and learn from comparable or similar sites through spatial databases and sharing more information across the field of archaeology (Mather and Watts 2009:12; Aldenderfer and Maschner 1996:215).

Using GIS, Conolly and Lake (2006:2) demonstrate the possibility of answering questions about location, condition, trend, routing, pattern and modeling. GIS systems can place objects and artifacts in the context of space using two descriptors to relate data to the real world: attributes and locations (Conolly and Lake 2006:3). They explain that attributes are records of what is present, while locations indicate where the attributes are in the world (Conolly and Lake 2006:3).

In order to analyze a spatial model, it is imperative that the theoretical conception of space be defined. One perspective proposes a “relative concept”, viewing space as “a positional quality of the world of material objects or events” (Conolly and Lake 2006:3). Another perspective applies an “absolute concept”, defining space as “a container of all material objects, which exists independently of any objects that might fill it” (Conolly and Lake 2006:3). Within archaeology, recordings of stratigraphy are considered to employ a relative concept because the primary concern is not to record what is present in each unit of the site grid, but rather the locations and relationships between the stratigraphic layers (Conolly and Lake 2006:6). In contrast, field survey by surface collection employs an absolute concept of space in that the primary goal is to identify locations with particular attributes (Conolly and Lake 2006:6).

Since its introduction, archaeological uses of GIS have been combined with remote sensing, photogrammetry and other spatial analysis methods to create three dimensional maps that can be useful in archaeological site information modelling and management (ASIM). Al-Ruzouq and Abu Dabous (2017) developed a methodology that integrated photogrammetry and three dimensional GIS to capture and model the details and information that is needed for proper conservation and management of an archaeological site. Using Ajloun Castle in Jordan as a case study, the authors created a 3D GIS model from which information relating to site access through

available roads, access to certain sections of the site from within the site itself, equipment storage areas, texture, size and façade details, and elevation or topography details could be derived (Al-Ruzouq and Abu Dabous 2017:169). This information aids in the planning of restoration or conservation projects, indicating best access routes to certain portions of the site, scaffolding needs, most convenient storage areas for equipment needed in the restoration project and other details necessary for site management. Ultimately, the authors confirmed the feasibility of integrating different sciences and technologies to generate multiple layer information models with multiple layers of data to gain a better understanding of archaeological sites and structures (Al-Ruzouq and Abu Dabous 2017:169).

A more varied application of GIS technology in the field of archaeology has led to a theoretical conundrum in its use for landscape archaeology. Heather Richards-Rissetto (2017) applies a semiotic framework to 3D GIS in an effort to intertwine environmental and cultural factors in the creation of an archaeological landscape that is not environmentally deterministic. Using the theory of semiotics (a theory that views cultural phenomena as systems of signs or social configurations that convey culturally constructed meaning) the author argues for space as an active agent in culture, linking GIS data and methods to social actions (Richards-Rissetto 2017:11). Using the ancient Mayan city of Copan as a case study, the author created a GIS model of the landscape (based on environmental data) and then applied to this the study of how the organization of the landscape influences where people go, what they do, whom they interact with and how these factors shape their experiences (based on cultural data) (Richards-Rissetto 2017:12). With 3D modelling technologies, the author studied the city of Copan with an interest in accessibility and visibility as proxy measurements to extract cultural data by applying specific cultural circumstances to the interpretation of quantitative data (Richards-Rissetto 2017:18).

4.5 Investigations of B-29s

In July 2016, while on a deep-water exploration of the Mariana Islands expedition, the National Oceanic and Atmospheric Administration (NOAA) ship *Okeanos Explorer* used a remotely operated vehicle (ROV) called *Deep Discoverer* (D2) to investigate a sonar anomaly from a 2015 expedition (pers. comm. Frank Cantelas). Resting at a depth of 370m (1,214 ft.), an inverted B-29 aircraft wreck (see Figure 11) was observed (NOAA 2016). The ROV conducted a perimeter survey around the left wing of the aircraft wreckage and collected data that would serve as an inventory of the contents of the site (NOAA 2016). During this inventory, the ROV documented apparent fire damage on one of the engines, information that could be diagnostic in identifying the aircraft remains (NOAA 2016). The ROV also documented wreckage nearby from the forward section of the B-29, including the lower section of the forward gun turret, partially buried gun barrels as well as the flight engineer's control panel (NOAA 2016).

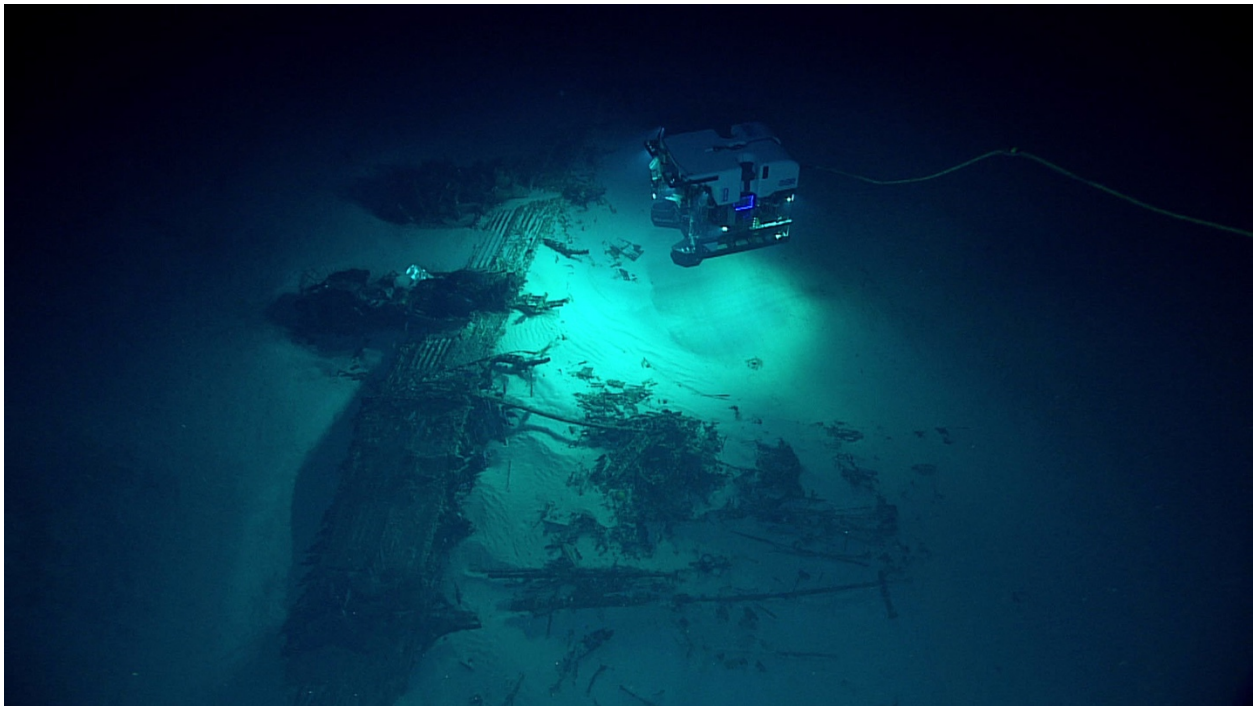


Figure 11: Image of inverted B-29 aircraft wreckage, showing the ROV D2 above it (NOAA 2016)

In 2001 a private dive team, using a side-scan sonar, discovered the wreckage of a B-29 at the bottom of the Overton Arm in Lake Mead, a US National Park (NPS 2018). In 2002, the NPS in conjunction with an independent contractor, used an ROV to assess the wreckage, and discovered evidence of unauthorized diving and looting of the site (NPS 2018). The aircraft was identified as RB-29A BuNo 45-21847 which crashed with no loss of life while participating in an upper atmosphere research project for the US military (NPS 2018). In 2003, a team of technical divers surveyed the wreckage at 91m (300 ft.) and the NPS banned all further diving on the aircraft wreck site until 2007 (NPS 2018). Since 2007, diving has been permitted on a limited basis; although, as of January 2018, the B-29 was considered a protected cultural resource and diving on the site was not allowed (NPS 2018).

Additionally, members of the US Air Force (USAF) conducted research based on Missing Air Crew Reports (MACRs) and Reports of Major Accidents (RMAs) to construct a chart of the approximate crash locations of all B-29s within a five-mile radius of Saipan and Tinian (pers. comm. Jeffrey Meyer USAF). The creation of this chart highlighted the difficulties encountered by researchers of historic military records from wartime: the inaccuracy of MACRs and RMAs due to “no GPS, the ocean current [and] overexcited Airmen” (pers. comm. Jeffrey Meyer, USAF). Ultimately, it is hoped that organizations such as the Defense POW/MIA Accounting Agency (DPAA) will be able to locate these missing aircraft and identify lost airmen, providing closure to their families and relatives.

4.6 Surviving Airworthy B-29 Aircraft

Since the end of their use in combat, two B-29s have been restored to airworthiness according to Federal Aviation Administration (FAA) requirements for a certificate of

airworthiness (FAA 2010). In the early 1970s, a group of individuals belonging to the Commemorative Air Force (CAF) identified B-29 BuNo 44-62070 as a candidate for restoration (Commemorative Air Force 2013). At the time they identified this aircraft, it was being used as a missile target at the USN Proving Ground at China Lake, CA, a USN training facility (Commemorative Air Force 2013). They retrieved the aircraft and restored it to airworthiness (FAA 1991), giving it the name “FIFI” (registration number N529B) and flying it for over thirty years until, in 2006, the chief pilot determined that a complete power plant re-fit was required to maintain the safety of the aircraft in flight (Commemorative Air Force 2013). In 2010, “FIFI” was deemed once again, airworthy, the result of a four year restoration effort wherein the aircraft was refurbished with four custom built hybrid engines (Commemorative Air Force 2013). Since 2010, “FIFI” has been flown across the country to airshows and fly-ins where aviation enthusiasts can learn about the aircraft and even ride in it (Commemorative Air Force 2013).

The only other currently airworthy B-29 is BuNo 44-69972 (registration number N69972) nicknamed “Doc” (FAA 2012). After its use in combat, like “FIFI”, “Doc” was stored at the USN Proving Ground at China Lake, CA for use in target practice by the USN (Doc’s Friends, Inc. 2017). In early 1987, 30 years after its arrival there, the aircraft was selected for restoration. It was not until 12 years later, in late 1998, that “Doc” was removed from the Mojave Desert by Tony Mazzolini, 42 years after it had arrived (Doc’s Friends, Inc. 2017). It was soon divided into sections and transferred to Wichita, KS where it was reassembled and restored, only hundreds of feet from the assembly line that built it more than 50 years previously (Doc’s Friends, Inc. 2017). In 2012, “Doc” received a certificate of airworthiness after hundreds of hours of restoration and conservation in Wichita (FAA 2012). Today, the aircraft is managed by a 501c3 organization, Doc’s Friends, Inc. devoted to the continued restoration and maintenance

of BuNo 44-69972, “Doc” (Doc’s Friends, Inc. 2017).

In addition to “FIFI” and “Doc” twenty four other complete B-29s have survived in museums either as display pieces or in storage (see Table 1) (Howlett 2015:172). Many of them were rescued from the USN Proving Ground at China Lake, CA. In addition to these complete aircraft, a number of partial airframes remain also in museum displays or museum storage facilities (Howlett 2015:172).

BuNo	Location
42-65281	Travis AFB, Fairfield, California
44-27297	USAF Museum, Wright Patterson AFB, Dayton, Ohio
44-27343	Tinker AFB, Oklahoma City, Oklahoma
44-70064	Castle AFB, Merced, California (parts of 44-61535 and 44-84084)
44-61669	March AFB, Riverside, California
44-61671	Whiteman AFB, Knob Noster, Missouri
44-62220	USAF History & Traditions Museum, Lackland AFB, San Antonio, Texas
44-69729	Museum of Flight, Seattle, Washington
44-70016	Pima Air Museum, Tucson, Arizona
44-70113	Dobbins Air Force Reserve Base (AFRB), Marietta, Georgia
44-84053	Robins AFB, Warner Robins (Macon), Georgia
44-84076	Strategic Air Command Museum, Omaha, Nebraska
44-86408	Hill AFB, Ogden, Utah
44-87627	Barksdale AFB, Shreveport, Louisiana
44-87779	Ellsworth AFB, Rapid City, South Dakota
45-21748	National Atomic Museum, Kirtland AFB, Albuquerque, New Mexico
44-62022	Pueblo Weisbrod Aircraft Museum, Pueblo, Colorado
42-93967	Georgia Veterans State Park, Cordele, Georgia
44-61975	New England Air Museum, Windsor Locks, Connecticut
44-61748	Imperial War Museum, Duxford, England
44-86292	National Air and Space Museum, Washington, DC
45-21739	KAI Aerospace Museum, Sacheon, South Korea
45-21787	Weeks Fantasy of Flight Museum, Polk City, Florida
44-70049	In storage at Borrego Springs, California, for Kermit Weeks

Table 1: Complete surviving B-29s and their locations (Howlett 2015:172)

The salvage and restoration of B-29s has brought history alive for countless individuals, allowing the children and grandchildren of veterans to appreciate the colossal size of this aircraft and the effort that went into its development. Restoration projects such as those undertaken by the CAF and Doc’s Friends have honored the actions and sacrifices made by the military

personnel who flew and maintained these aircraft.

5 Methodology

5.1 Archaeological Field Work

This chapter describes the research and archaeological methods employed in the study of an aircraft wreck site located on the western face of Mount Tapochau, as well as structures and sites related to the activities of the B-29 on Saipan. First, the island survey and archaeological survey that were used to gather information about the role of the B-29 on Saipan will be explained. This will include methods used during the island survey and photographic survey. After the survey methodology, the archival research methodology will be explained, including the methods used to attempt to identify the aircraft. Following the archival and historical research procedures, the methodology used to generate a three-dimensional model of a B-29 Airscape in ArcScene will be detailed. The last section of this chapter will consist of an analysis of the limitations to this research, as well as an outline of their impact on the integrity of this site.

5.1.1 Island Survey:

The islands of Saipan and Tinian were both surveyed for structures that related to the operations of the B-29, a procedure recommended by Spennemann (1998a). These surveys included “windshield” and “pedestrian” surveys. Using a project vehicle, Isley Field, nee Aslito Airfield, was visited and extant structures were documented using photography and GPS points (with 2-5m (6.5-16.4ft) accuracy). Similarly, a project vehicle was used to visit significant structures related to the history of Saipan in WWII.

The structures at Saipan’s Isley Field that were photographed and geolocated included the hardstands, the Japanese power plant facility, the Japanese oxygen generating building, the bomb

magazine, three Japanese air raid shelters, and the remains of the railroad tracks (see Appendix A). On the island of Saipan, photographs were taken of Japanese gun emplacements, Japanese rock shelter facilities, Japanese storage facilities, and significant air-navigational landforms such as Banzai Cliff, Suicide Cliff, Marpi Point, Magicienne Bay and Mount Tapochau.

On Tinian, sites related to the operations of the B-29, especially sites related to the atomic bomb were visited including the West Airfield, an old radio antenna base on Mount Lasso, Chulu beach, and the North Airfield. At the West Airfield, the runway and overgrown hardstands were documented. At Mount Lasso, a radio station antenna platform and its associated fencing from the period of Japanese fortification and occupation was documented using photographs. At Chulu Beach, referred to as White Beach 2 during the invasion of Tinian, a Japanese bunker was detailed. At North Airfield, runway Able, Baker field, the Japanese bomb storage and fuel drum storage, the atomic bomb pits, the Japanese air administration building and strafing marks in the tarmac were documented.

5.1.2 Archaeological Survey

The potential B-29 aircraft crash site lies on the western side of Mount Tapochau. Though it is well known among local inhabitants of Saipan, and has been written about on blogs, on guide websites, and on internet reviews of Saipan, no record could be found by the author at the HPO of previous archaeological work conducted on this aircraft wreck site. In March 2017, a team of archaeologists conducted a phase I non-disturbance survey of this site.

For the purposes of this thesis, data was collected using GPS points with 3-6m (9.8-19.6ft.) accuracy and scaled photography. The site itself is divided between two locations, and the data was separated into a “field site” which is scattered in a field behind the home of Dr. Daniel

Lamar, and a “jungle site” which is on Dr. Lamar’s property, an approximately 30-minute hike down Mount Tapochau, in the jungle (see Appendix A).

Ultimately, two trips were made to the aircraft wreck site. The first visit occurred on the afternoon of March 9, 2017. This initial visit lasted for about one hour at the “field site” and one hour at the “jungle site” and was used for general reconnaissance, general photographic documentation, determining the approximate size of the site, assessing the amount of aircraft wreckage remaining, and to establish a general familiarity with the site layout through an in-field sketch of the site.

The second site visit occurred several days later on March 15, 2017 in the morning and involved a larger group of people. The team began investigation at the field site before moving to the jungle site. At each site researchers spread out and identified debris to be recorded using a camera and GPS. The GPS points for large pieces of extant structure as well as individual pieces of debris scatter were collected using a Garmin Rino 665t with 3-6m (9.8-19.6ft.) accuracy. Scaled photographs were collected using an 8cm card scale and a 20cm scale bar. Throughout the scaled photograph data collection process, four cameras were used: Canon EOS Rebel T5i, LG Electronics K520, FujiFilm X20, or Canon Digital IXUS 990 IS. A Samsung S7 Galaxy Camera was used to collect images for a photogrammetric model of the engines at the jungle site. Measurements were collected using 50m tapes for certain structural features at the jungle site, including the large piece of metal and the hinges that lay near it. Finally, a search was conducted of the engines for markings, stamps, etchings or serial numbers that could be diagnostic in establishing the identity of the aircraft remains, all of which were photographed with a scale.

Post-processing of the data included the creation of a photolog, the generation of a 3-dimensional (3D) photogrammetric model, and the construction of a site plan. The photolog was

created using Microsoft Excel v15.31. Agisoft PhotoScan was used to generate the photogrammetry model (Yamafune 2016). The GPS points were used to construct a site plan with 3-5m accuracy. Due to the difficult environment and the large scatter area, the archaeological features were placed in the sitemap entirely using GPS points. No central datum was established from which to gather distance measurements using baseline offsets or trilateration.

5.2 Archival Research

The author conducted internet-based historical research at the National Archives and Records Administration (NARA), Fold3.com, and at other online records sources. The search for references to the archaeological site, the aircraft serial numbers, and aircraft crash reports through digitized record collections was followed up with a visit to the NARA facility in College Park, MD. The author searched for MACRs, as well as examining Record Groups 18, 342 and 554 for information that might be related to the activities of B-29 aircraft on Saipan.

After searching for MACRs, the author searched for references to individual aircraft that had been identified as candidates for the identification of the aircraft wreckage on Mount Tapochau. To locate these references, the author examined records related to missions conducted by unit affiliations for candidate BuNos in Record groups 18, 342 and 554. Record Group 18 was selected because it contains information pertaining to the USAAF. Record Group 342 was consulted with the intention of locating information about the USAAF commands, their activities and organizations, while Record Group 554 was consulted for information on records of the General Headquarters, Far East Command, Supreme Commander Allied Powers, and the United Nations Command during WWII. To aid in identifying specific record boxes to be examined,

research consultants at NARA directed the author towards records sources containing information organized by unit number.

After searching for references to aircraft serial numbers in Record Groups 18, 342, and 554, the author began to search the internet for information about specific engine parts identified through the archaeological survey. Records related to manufacturers of engine parts during WWII were searched, as well as patent records that might relate to technology references found on identification plates affixed to the aircraft wreckage.

5.3 GIS Methodology

ArcScene was used to generate a three-dimensional geo-spatial model of a B-29 airspace. A Digital Elevation Model (DEM) map of Saipan was used as a basemap because of its ability to be converted into a three-dimensional image (Potemra 2017). After the DEM map was imported into ArcScene, the base height property was changed to float the 2-dimensional map on a custom surface with an elevation factor conversion of 0.0001, effectively draping it over the three-dimensional information contained in the raster image, and generating a three-dimensional image of the island of Saipan. Once the map was converted into a three-dimensional feature, cultural landscape features and characteristics of the space and landscape identified through a cultural analysis were added on as shape file layers. Coordinate locations were determined from NRHP nomination forms, or located on a satellite image, and drawn in ArcMap to be placed in the model.

6 Results

6.1 Island Survey

The pedestrian and windshield surveys that were conducted on Saipan and Tinian explored sites and structures related to the use and operations of B-29s on these islands (see Figure 12). On Saipan, the author visited the US-named Isley Field (under Japanese military occupation, the airfield was called Aslito Airfield) (see Figure 13), Banzai Cliff, Suicide Cliff, Marpi Point, Magicienne Bay and Mount Tapochau, as well as Japanese gun emplacements, rock shelter facilities, and storage facilities. On Tinian, the author visited West Airfield, a radio antenna base on Mount Lasso, Chulu beach and the North Airfield.

The survey of Isley Field included sites and structures constructed by both the Japanese military as well as the US military. The area termed “central Isley” by Denfeld and Russell (1984:31) included a large number of extant structures associated with the Japanese military use of the airfield under the Japanese title Aslito Field. The southern end of Isley field consists mostly of sites and features built after the capture of Aslito field by US forces. These sites and features were constructed as a part of the Isley Field expansion and are mostly associated with the B-29 operations on Saipan. Within “central Isley”, the author visited and documented the Japanese power plant building, and the Japanese oxygen generating plant that was located directly east of it, as well as the bomb magazine, the remains of the Japanese administration headquarters building, three Japanese air raid shelters and the remains of the railroad tracks. The Japanese power plant (see Figure 14) consists of a two-story concrete structure measuring 8.9m (29.1ft.) by 10.9m (35.7ft.) (Denfeld and Russell 1984:40). Associated with this structure



Figure 12: Survey sites (yellow) on Saipan and Tinian (Map by Author)



Figure 13: Relative locations of survey sites (yellow) at Isley Field, Saipan (Map by Author)



Figure 14: Japanese power plant facility at Isley Field, Saipan (Photograph by Author)

are concrete water holding tanks for cooling (see Appendix B Figure 1) and a muffler system (see Appendix B Figure 2) (Denfeld and Russell 1984:40).

The oxygen generating building (see Figure 15) has considerably less structure intact; however, the author was able to identify an air dryer (see Appendix B Figure 3) and an oxygen reservoir (see Appendix B Figure 4) inside, and locate the water cisterns behind it (see Appendix B Figure 5) (Denfeld and Russell 1984:40).



Figure 15: Japanese oxygen plant at Isley Field, Saipan (Photograph by Author)

The bomb magazine (see Figure 16) is an underground bomb storage bunker that consists of a reinforced concrete structure and an L-shaped revetment wall. The bunker is covered by earth and originally had a tramway on top of it (Denfeld and Russell 1984:72). This tramway is no longer identifiable, but the approximate shape of it can be identified by the presence of earthen mounds (see Appendix B Figure 6). The bunker itself is accessible through double steel doors which run along tracks in the floor (see Appendix B Figure 7). The steel doors are mounted in concrete which still shows discernable traces of camouflage paint (see Appendix B Figure 8). The interior of the structure is 21.0m (68.9ft.) wide by 11.0m (36.1ft.) deep, with a ceiling height of 3.0m (9.8ft.) (Denfeld and Russell 1984:72). Suspended from the ceiling are

tracks which were used to move bombs inside the structure (see Appendix B Figure 9). The 1.3m (4.3ft.) thick concrete ceiling is supported by three concrete columns within the storage chamber (see Appendix B Figure 9). The large chamber is ventilated through eight metal pipes located around the edges of the chamber (see Appendix B Figure 10). On the roof of the structure, accessed by climbing the earthen mound, the ventilation flues rise into 42cm (16.8in.) high chimneys which are 40cm (15.7in.) in diameter (see Appendix B Figure 11). Located 6.6m (22ft.) west of the structure was observed an old radio transmitter, presumably related to the operations of the bomb magazine during WWII (see Appendix B Figure 12).



Figure 16: Entrance to the Japanese bomb magazine at Isley Field, Saipan (Photograph by Author)

The Japanese administration headquarters building is no longer extant; however, the entrance steps, circular driveway and concrete planter are still identifiable (see Figure 17).

Behind a wire fence, and near the service aprons for the functional Saipan International Airport is an air raid shelter which is in good condition (see Figure 18). The two Japanese air

raid shelters documented by the author are located to the west and southwest of the administration building (see Figure 19).



Figure 17: Japanese administration building, Isley Field, Saipan (Photograph by Author)



Figure 18: Photo of air raid shelter, Isley Field, Saipan (Photograph by Author)

The railroad tracks are located in an overgrown copse and have been taken up and abandoned (see Appendix B Figure 13). The author recorded the railroad tracks and located an unidentified associated structure, hypothesized to be a well (see Appendix B Figure 14).

Japanese Air Raid Shelter
By Dorothy Sprague
December 1, 2017

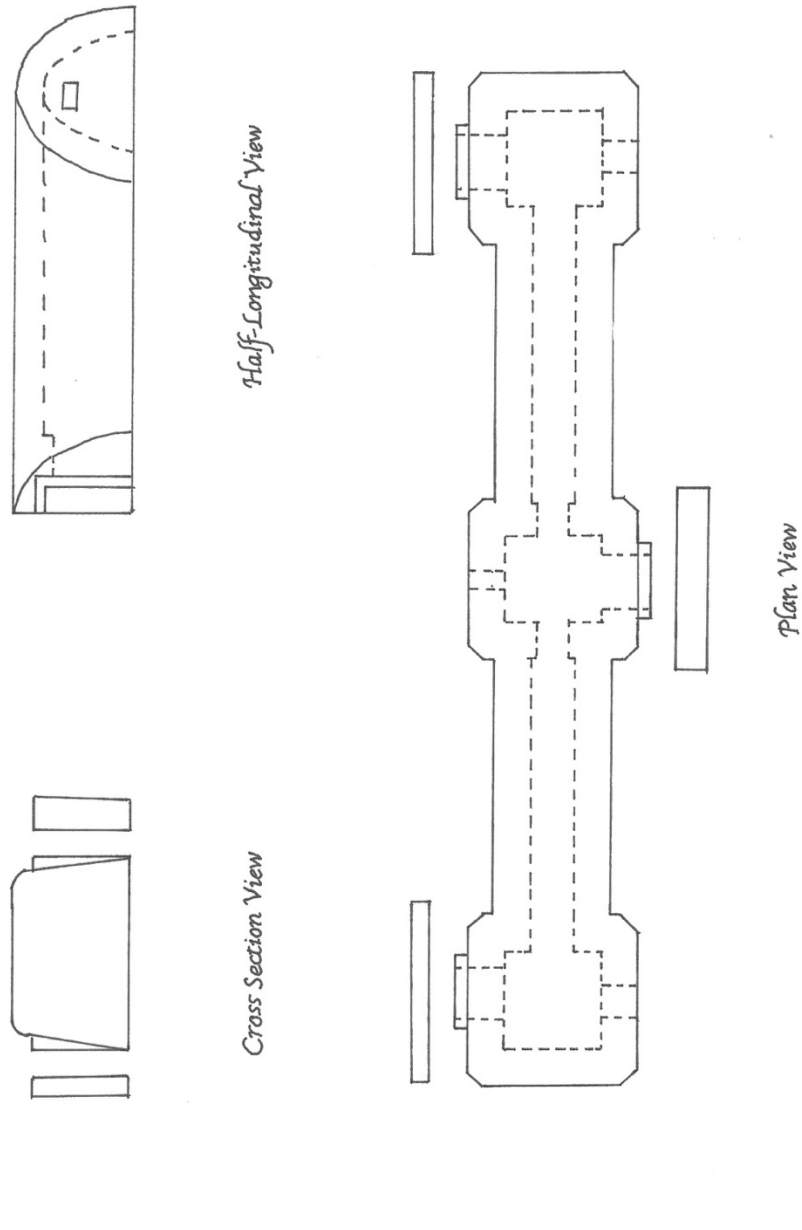


Figure 19: Japanese air raid shelter (Illustration by Author)

Constructed by US forces as a part of the Isley Field expansion project in preparation for the arrival of the B-29 on Saipan, the author documented the B-29 hardstands which are overgrown (see Figure 20).



Figure 20: Showing overgrown B-29 hardstands at Isley Field, Saipan (Photograph by Author)

The author visited the sites of horrific mass suicide events during the Battle of Saipan known as Banzai Cliff, located at Marpi Point, and Suicide Cliff, a bluff slightly inland and south of Marpi Point. Towards the end of the US military invasion of Saipan, surviving members of the Japanese military, along with hundreds of civilians fled towards the northern end of Saipan to escape from the advancing US soldiers. Convinced by Japanese propaganda that they would be tortured and killed by the US military, these individuals used firearms or grenades to kill themselves and their families, including their children, or alternately, chose to jump off of Suicide Cliff or Banzai Cliff in order to escape certain misery and death (Cabrera 2015:23).

The peak of Mount Tapochau is the highest point on Saipan (see Figure 21). As such, it served as a significant military objective for both sides during the Battle for Saipan. Once seized

by US military forces, Mount Tapochau was used to direct naval gunfire against Japanese military forces (Rottman 2004:17).



Figure 21: Showing Mt. Tapochau as the highest point on Saipan (Photograph by Author)

The author visited the site of the former North Field on Saipan which can be viewed from Suicide Cliff (see Figure 22). The former airfield, today, serves as a refuse collection site (see Appendix B Figure 15). Within the refuse collection site, artifacts from different locations appear, mixed together without any organization or provenience (see Appendix B Figures 16 and 17).

Japanese gun emplacements and rock shelters around Saipan were photographed and visited. These emplacements and rock-shelters were used by the Japanese as cover and concealment for surprise attacks upon US military personnel. Visiting sites such as these aid in understanding the experiences of those involved in the Battle of Saipan and the events that led up to the B-29 bases and structures on Saipan (see Appendix B Figures 18 through 29).



Figure 22: Current view of North Field from Suicide Cliff, Saipan (Photograph by Author)

On Tinian, West Field was visited and documented using a GPS. West Field was used by the 58th Bomb Wing of the 20th Air Force and consisted of two runways constructed to support the massive weight of the B-29, and a third runway for smaller planes. The third runway today serves as the main runway for Tinian Airport. The rest of the airfield has not been maintained and the B-29 hardstands are no longer visible (see Appendix B Figure 30).

The invasions of Saipan and Tinian relied on precisely coordinated activities across land, sea and air. A radio antenna platform on Mt. Lasso was visited which provided a strategic view of Tinian for directing heavy artillery (see Appendix B Figures 31 and 32). Chulu Beach (see Appendix B Figure 33), one of the landing beaches during the Battle for Tinian (see Appendix B Figure 34), was defended by pillboxes (see Figure 23).



Figure 23: Pillbox at Chulu beach, Tinian (Photograph by Author)

At the North Airfield (see Figures 24 and 25), the author visited and documented sites related to the B-29 activities on Tinian. These included runway Able, a fuel storage facility, the atomic bomb loading pits, the air administration building, and strafing marks on the tarmac.



Figure 24: Showing overgrown location of North Field, Tinian (Photograph by Author)



Figure 25: Survey Sites (Yellow) at North Airfield, Tinian (Map by Author)

On Tinian, sites related to the B-29 and the atomic bomb were visited including Runway Able. Runway Able was the runway upon which Colonel Paul W. Tibbets took off in the *Enola Gay* at 0245 on the morning of August 6, 1945, carrying the “Little Boy” atomic bomb, destined for Hiroshima (see Appendix B Figure 35).

The bomb and fuel drum storage bunkers were two facilities that were cut into a coral hill, enclosed in massive concrete shells, and protected with steel plate doors. The fuel drum storage facility (see Appendix B Figure 36) was ignited by the Japanese during the US invasion of Tinian, causing extensive fire damage that can still be discerned today (see Appendix B Figure 37).

Atomic loading pits were constructed to load the enormous weight of the atomic bombs into the modified B-29 Silverplate aircraft that would carry them to Japan and ultimately drop them on Hiroshima and Nagasaki. On August 5, atomic loading pit one (see Appendix B Figure 38) was used to load the “Little Boy” onto the aircraft *Enola Gay* flown by Colonel Paul W. Tibbets (Birdsall 1980b:296). The atomic loading pit two (see Appendix B Figure 39) was used to load the “Fat Man” atomic bomb onto the aircraft *Bockscar*, piloted by Major Sweeny, on the morning of August 8, and dropped on Nagasaki on August 9 (Birdsall 1980b:300).

The Japanese air administration building on Tinian was also visited (see Figure 26). This structure served as the headquarters for the Japanese Navy’s First Air Fleet, commanded by Vice Admiral Kakuji Kakuta. The First Air Fleet was completely destroyed during the Battle of the Philippine Sea.



Figure 26: Japanese air administration building, Tinian (Photograph by Author)

The author also documented strafing marks on the tarmac at the North Airfield (see Appendix B Figure 40). These strafing marks were created by the USAAF during the Battle for Tinian (pers. comm. Shawn Arnold).

6.1 Archaeological Survey

The entire aircraft wreck site covers an extensive area on the western face of Mount Tapochau and consists of scattered aircraft debris and three identifiable engines, two of which have propellers attached to them (see Figure 27). The author chose to divide the debris field into two sections: a “field site” which is located in a semi-cultivated field with a heavy slope that lay in the back-yard of Dr. Daniel Lamar’s home; and a “jungle site” which is located farther down Mount Tapochau in an area heavily overgrown by jungle flora.



Figure 27: Relative Locations of jungle site and field site artifact scatters (Yellow) for B29 wreck on Mt. Tapochau, Saipan (Map by Author)

6.1.1 The Field Site

The area containing the “field site” is currently used and maintained as a plantation of sorts, containing banana trees, palm trees, coffee, pineapple plants and other edible and non-edible plants. Dr. Lamar employs a gardener, Carlos, to maintain this field (pers. comm. Dr. Daniel Lamar). Within the field, debris was generally collected and placed into multiple small piles scattered at the edges of planted areas, presumably placed in these collections by Carlos or other groundskeepers in the course of clearing the land for planting, mowing or tending the plants. The field is on a steep grade and consists of several level “steps” which can be seen in satellite imagery obtained from Google Earth (see Figure 28).



Figure 28: Aerial view of “field site” showing stepping landscape, Saipan (Google Earth 2018)

Upon arriving at the field site (see Figures 29 through 31), the most prominent feature was a propeller (see Appendix C Figures 1 and 2) located in a dense cluster of vegetation. Scattered around the vegetation were visible aircraft wreckage remains (see Appendix C Figures 3 through 9). Warped and twisted pieces of metal were visible in the ground and in piles

throughout the field. A piece of engine cowling housed a pineapple plant, while another piece of cowling (see Appendix C Figure 10) contained debris that appeared to have been cleared from other areas of the field. As one moved farther east, additional aircraft remains could be identified along a cleared swath that ran on an earthen “step” (see Appendix C Figures 11 through 23). Moving north, and going down onto successive steps, other pieces of aircraft debris were observed (see Appendix C Figures 24 through 30). As the author moved through the site aircraft debris pieces that were encountered were photographed, tagged with a GPS and identified as “Miscellaneous” with a different letter appended ranging from “Miscellaneous A” to “Miscellaneous Q”. To the east of the engine under a tree an engine cylinder head with a piece of metal resting atop it was identified (see Appendix C Figure 8). On the northern side of this tree, the author located a partially buried grenade (see Appendix C Figure 9). Recognizable artifacts included the propeller (see Appendix C Figures 1 and 2), an engine cowling (see Appendix C Figure 10), an engine cylinder head (see Appendix C Figure 8), a grenade (see Appendix C Figure 9), a piece of pipe bushing (see Appendix C Figure 3), and a piece of metal bearing the mark “Ryan Aeronautical” (see Appendix C Figures 13 and 14).

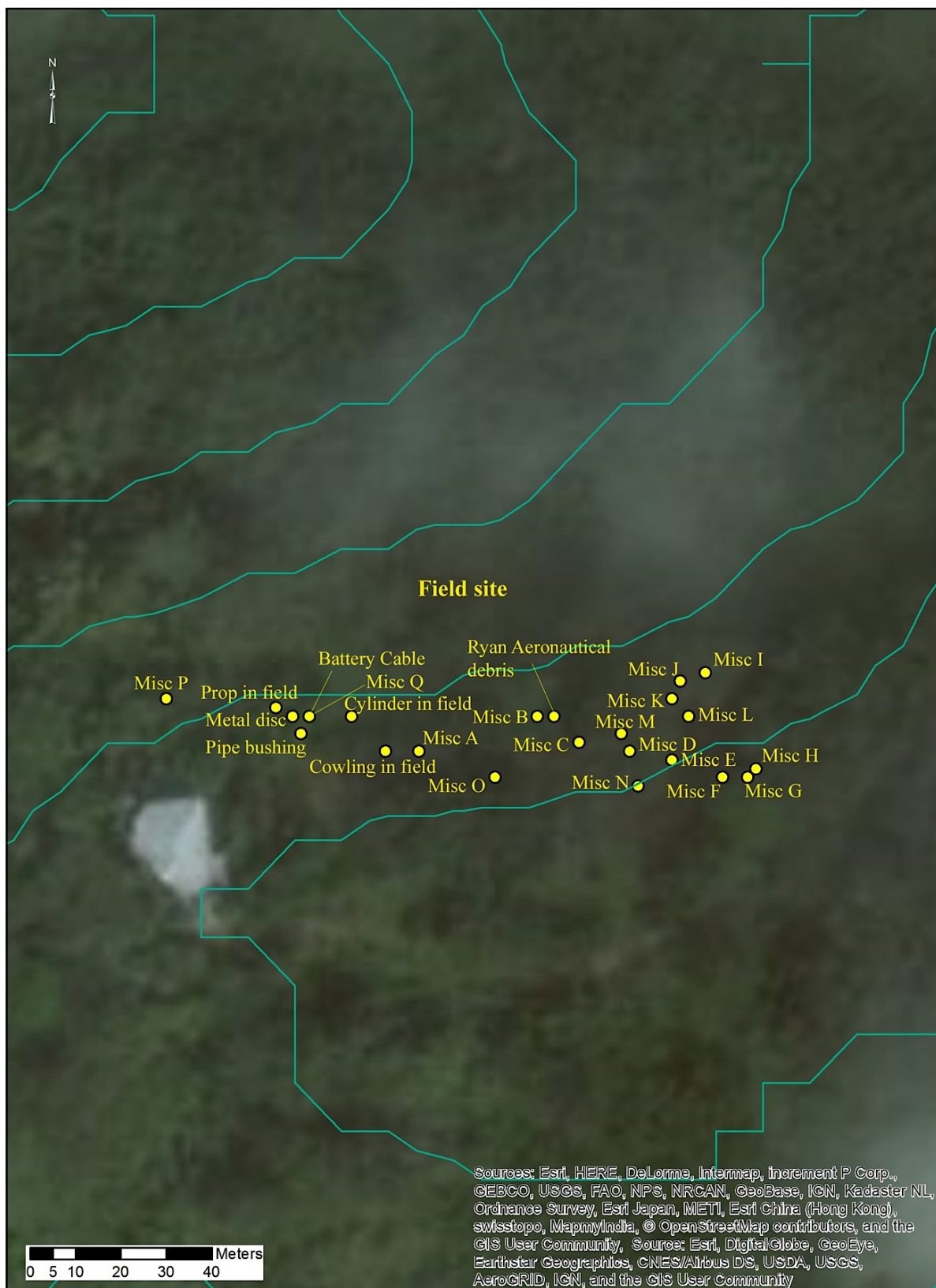


Figure 29: Field site artifact scatter (yellow) with contour lines (teal) at 5m elevation increments (Map by Author)

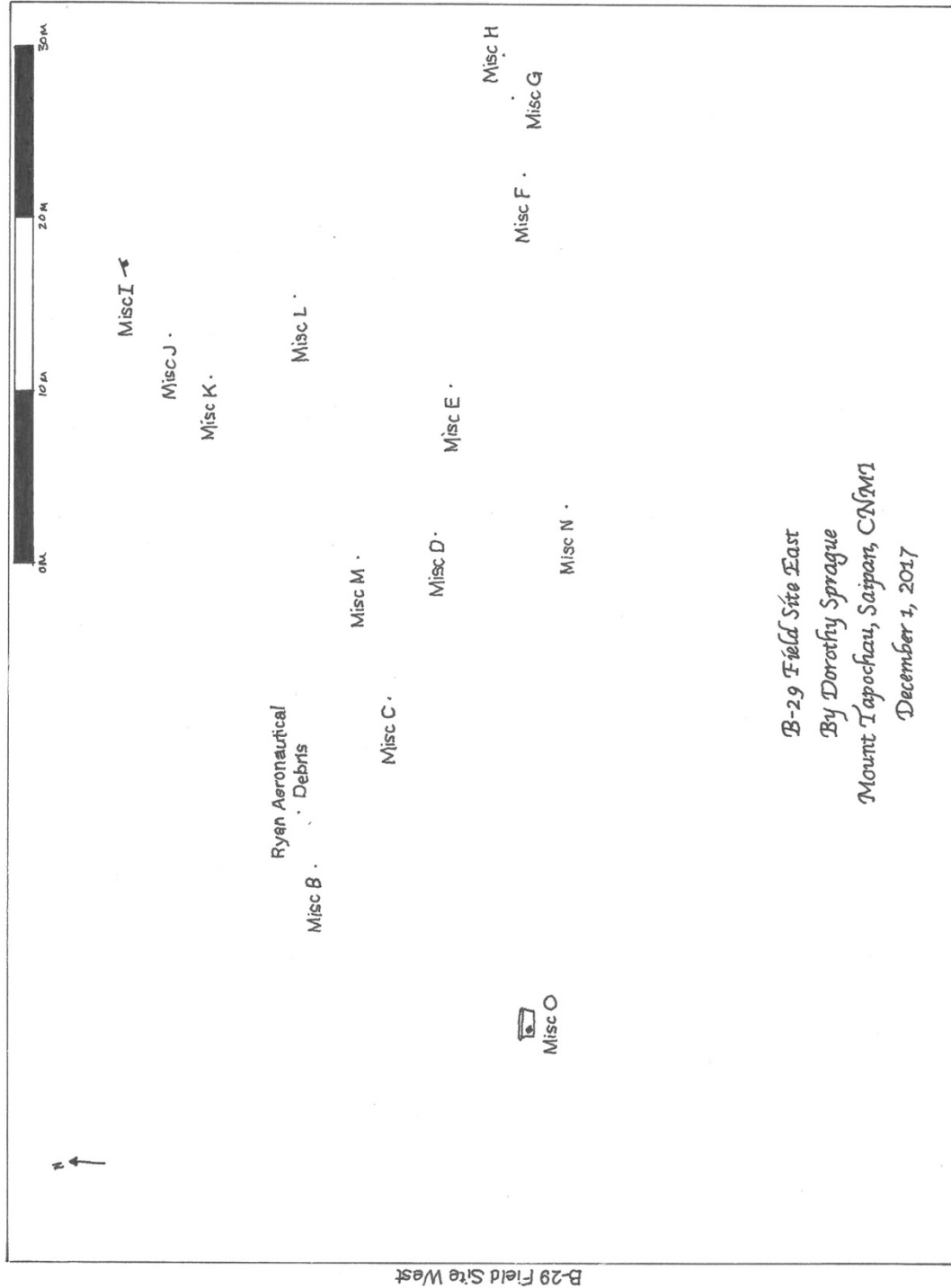


Figure 30: Site plan of B-29 field site east, Saipan (Illustration by Author)

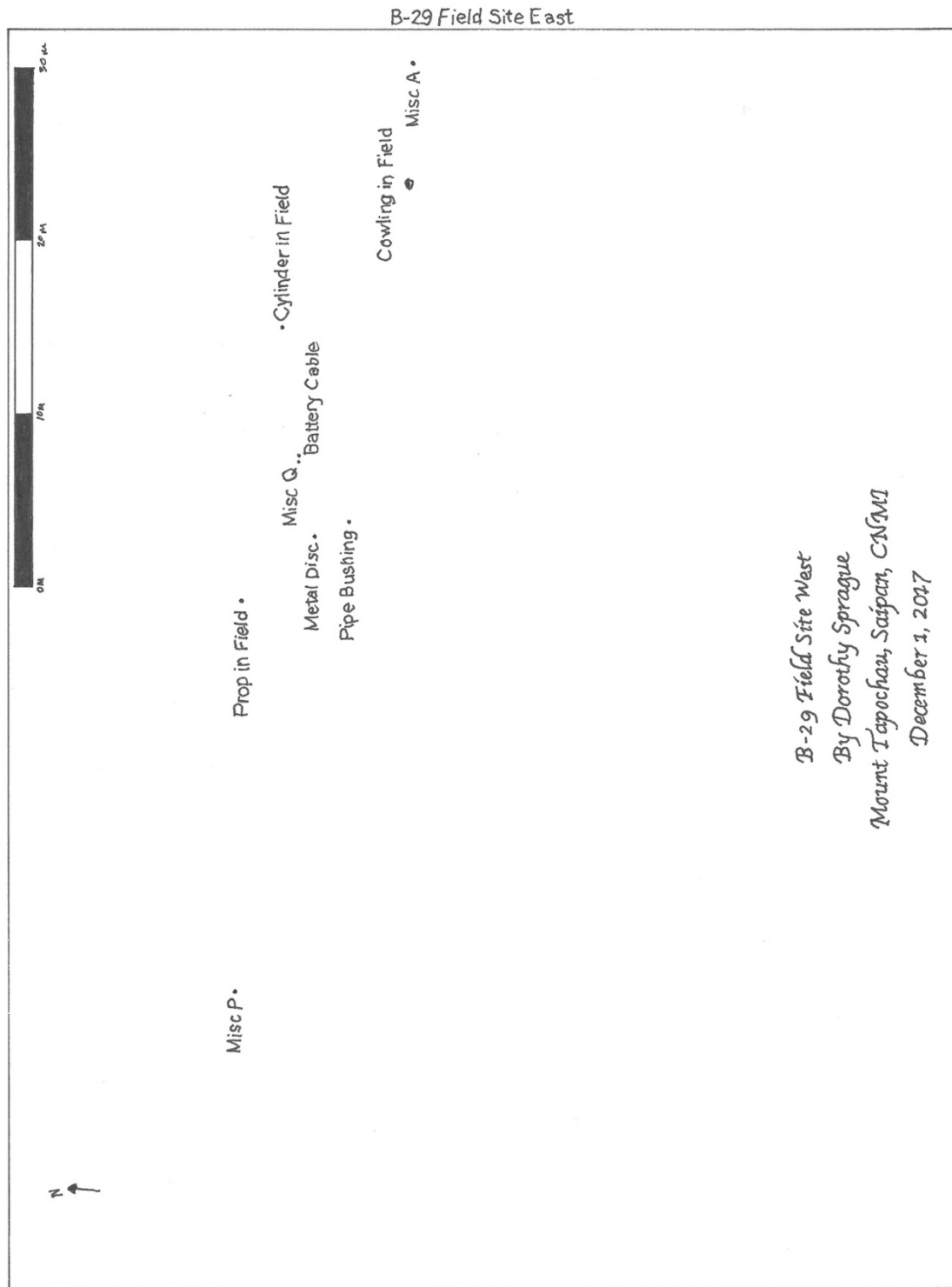


Figure 31: Site plan of B-29 field site west, Saipan (Illustration by Author)

6.1.2 The Jungle Site

The jungle site (see Figures 32 and 33) is accessible from the top of Mount Tapochau via a trail that Dr. Lamar has cleared between his property and the aircraft remains. In an effort to improve public access, a trail has also been cleared from public lands below the aircraft wreckage to the site (pers. comm. Dr. Daniel Lamar). When approaching the site from Dr. Lamar's property (either approaching from above the site or from the south), upon arriving at a clearing containing the larger pieces of debris, the most prominent feature was a large piece of a wing (see Appendix C Figure 34) showing a cabin air heat exchanger (see Appendix C Figure 35). Approximately 27m due east of the westernmost edge of the large piece of wing structure was a set of wheels, presumably the landing gear; although, they were unable to be definitively associated with a B-29 aircraft (see Appendix C Figure 36). Affixed to the underside of the wing structure was a hydraulic pump (see Appendix C Figures 37 and 38) and visible fuel cell walls (see Appendix C Figure 39). Behind the piece of wing debris was a tube assembly (see Appendix C Figure 40) with flap tracks still attached to it (see Appendix C Figure 41). Due west of the wing debris was a series of wing struts and spars (see Appendix C Figures 42 and 43). Scattered around the wing assemblage were disarticulated aircraft materials including a cylinder head, hinges and attachment points, and other unidentified debris (see Appendix C Figures 44 through 50). Farther west (34m [112ft.] along a heading of 263°) an engine could be identified (see Appendix C Figure 51) with a propeller still attached to it (see Appendix C Figure 52). From the engine with the propeller still attached, 36m (118ft.) along a heading of 256° another engine without an attached propeller could be located (see Appendix C Figure 53).

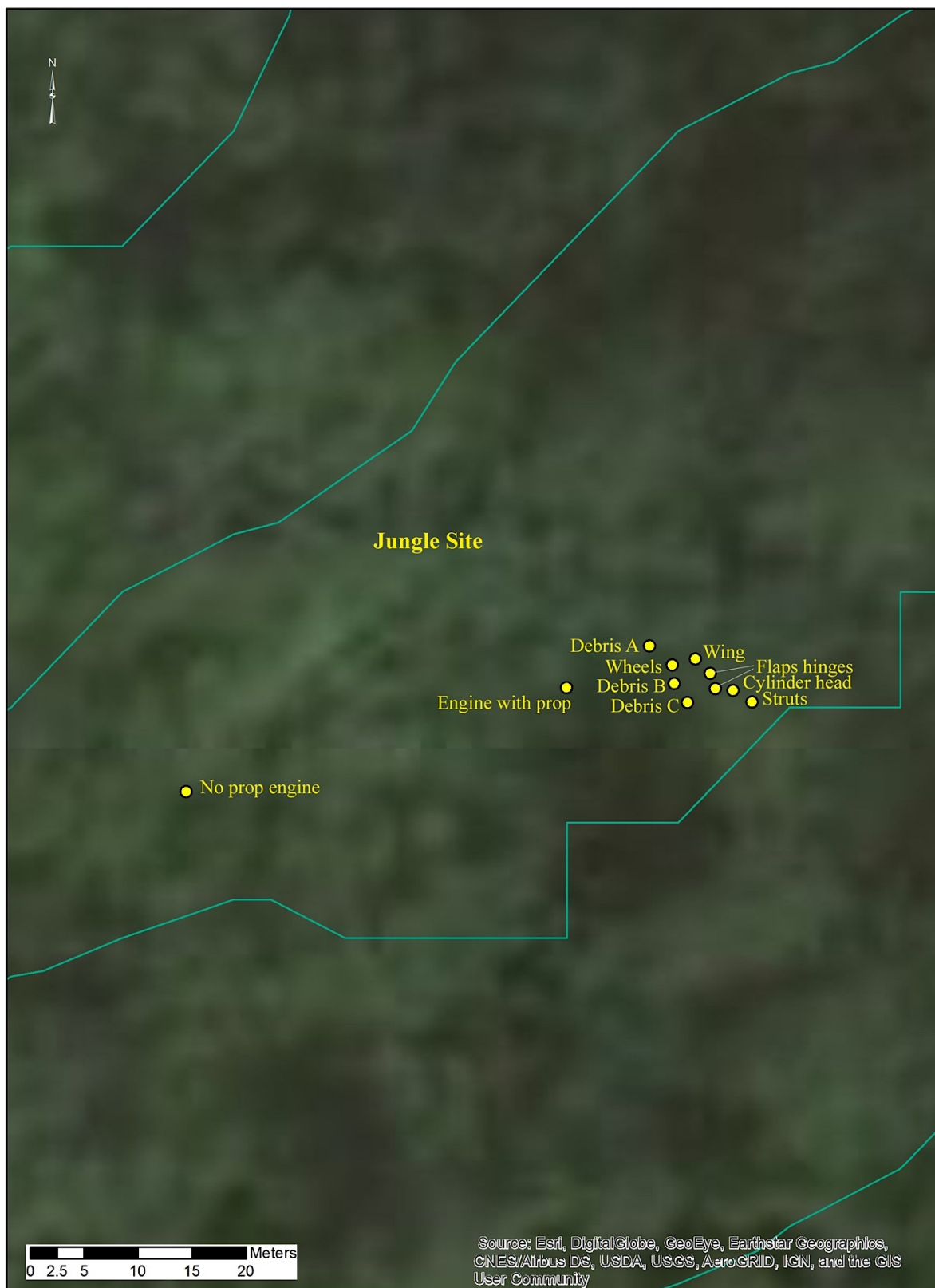


Figure 32: Jungle site artifact scatter (yellow) with contour lines (teal) at 5m elevation increments (Map by Author)

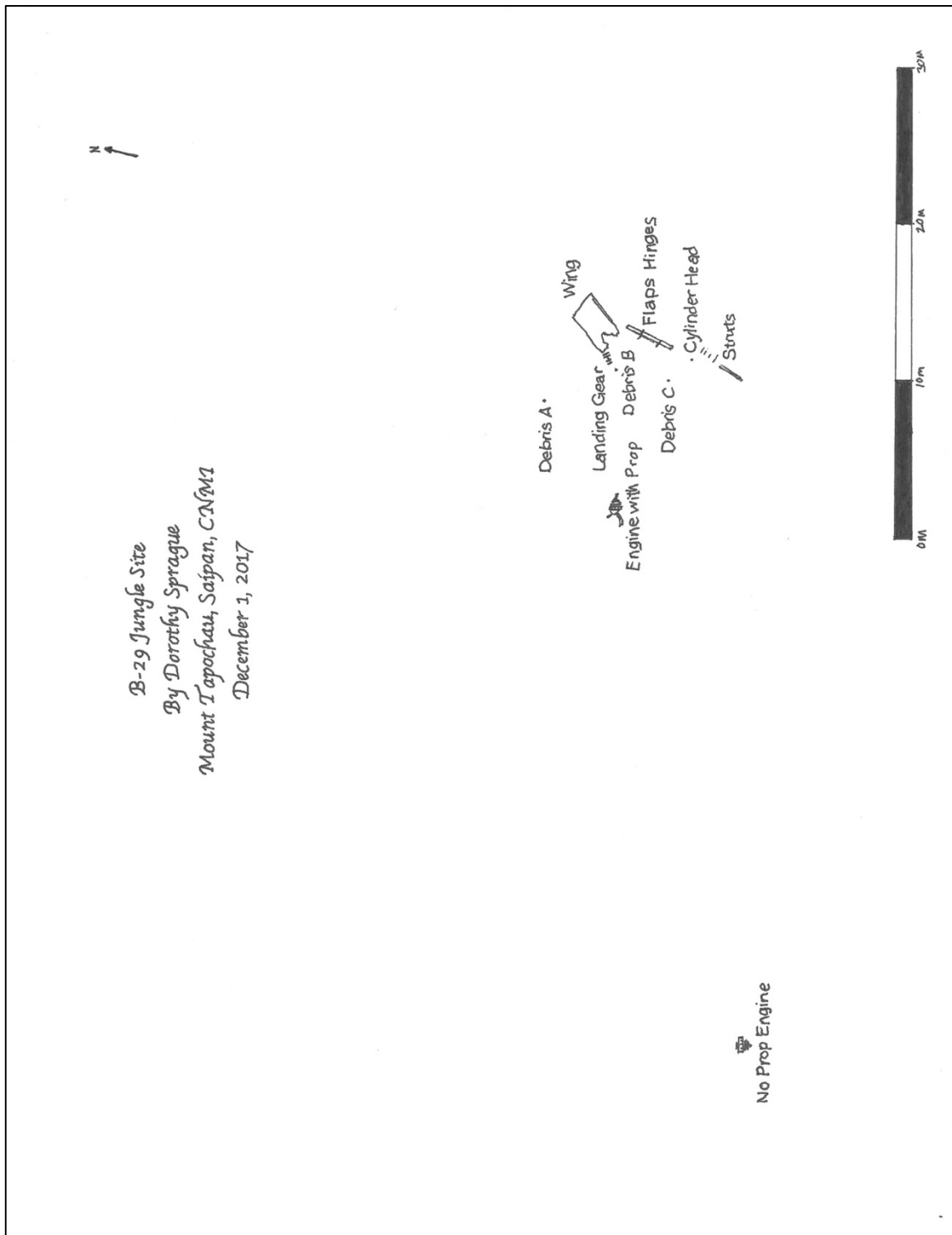


Figure 33: Jungle site plan, Saipan (Illustration by Author)

6.1.3 Markings and Identified Part Numbers

While in the field, the author recorded multiple numbers and markings on the two engines located at the jungle site. From these markings, the author was able to identify the objects by the part number stamped upon the piece of metal (see Figures 34 through 36). This section presents the results of research on those markings.



Figure 34: Jungle site part 114377NS – COVER: Engine mounting bracket substituting (United States Air Force 1952:73) (Photograph by Author)



Figure 35: Jungle site part 114996N2 – COVER: Gun synchronizer impulse generator substituting cover attached to the supercharger rear housing stud (United States Air Force 1952:87) (Photograph by Author)



Figure 36: Jungle site part 120611-C ADAPTER: Rear oil pump external oil inlet tube (United States Air Force 1952:125) (Photograph by Author)

6.2 Archival Research

The author was able to identify two possible BuNos for the B-29 aircraft wreck site through historic research. Additionally, using comments from online forums and blogs that reference the aircraft wreck site, the author identified BuNos 42-94060 and 44-83899 as potential serial numbers and identities for the aircraft wreckage. These possible identities were corroborated by sources at the Defense POW/MIA Accounting Agency (pers. communication LCDR Scott Zeigenhorn). Aircraft 42-94060 was affiliated with the 30th Bomb Squadron (BS) of the 19th Bomb Group (BG) under the 314th Bomb Wing (BW) within the USAAF and carried a crew of eleven (see Table 1) when it crashed on May 5, 1945 (Smith 2017b). Aircraft 44-83899 was affiliated with the 402nd BS of the 502nd BG under the 315th BW in the USAAF and carried a crew of ten (see Table 1) when it crashed on August 27, 1945 (Smith 2017a).

The author began her research by attempting to locate a MACR for either potential aircraft. NARA had compiled multiple lists of the same data that were organized to allow a researcher to search for a MACR by aircraft serial number, individual crew member name, or date. When the author attempted to search by aircraft serial number, records indicated that no MACR was available for either 42-94060 or 44-83899. To address the possibility for mistakes in the record, the author also searched for MACRs by individual crew names, locating their registration cards which would cite a MACR number if one existed. For each individual on both air crews, the registration cards indicated no MACR (see Figure 37 and Figure 38). The author also viewed all MACR's for the dates of the aircraft wrecking events, accounting for the possibility of typos or holes in the archival databases. Ultimately, all MACRs from May 5, 1945 and August 27, 1945 were consulted, and none contained references to the serial numbers of either aircraft, nor mention of their crew members.

Crewmember Name	Position
<i>42-94060</i>	
Capt. Maurice T. Fay	Commander
2 nd Lt. David Blumenfield	Copilot
2 nd Lt. Milton Orkin	Navigator
Capt. James Landers	Bombardier
2 nd Lt. John Milton Brady II	Radar Operator
T/Sgt. Wylie Alfred Ross	Flight Engineer
Cpl. Aloysius Carl Rieger	Radio Operator
Charles Garrett	Fire Control Operator
Cpl. Michael Soback	Left Gunner
Cpl. Robert I. Parson	Right Gunner
Cpl. Alexander Mozdierz	Tail Gunner
<i>44-83899</i>	
Capt. Claude S. Lawson Jr.	Pilot
1 st Lt. Lawrence C. Honeycutt Jr.	Copilot
1 st Lt. Robert R. Kindig	Navigator
1 st Lt. Bernard P. Beine	Bombardier
2 nd Lt. Hartphey Haller	Radar Operator
T/Sgt. Orval Newton Myrick	Flight Engineer
Sgt. Ray M. C. Card	Radio Operator
Sgt. Matthew M. Schemer	Not Assigned
Sgt. Howard L. Robinson	Not Assigned
M. N. Olson	Not Assigned
L. Smith	Not Assigned

Table 2: Crew and positions on two potential B-29 BuNos (Smith 2017a; Smith 2017b)

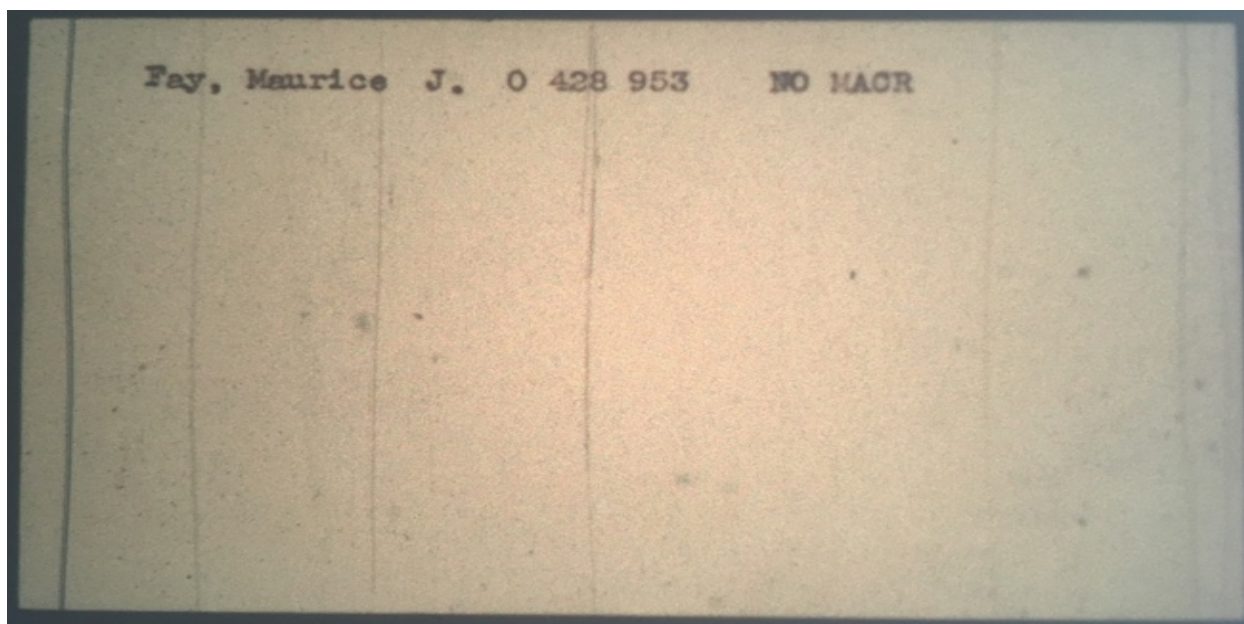


Figure 37: Crew member card for Maurice J. Fay showing no MACR in the record (NARA RG 92 M1420 Roll 18 1945)

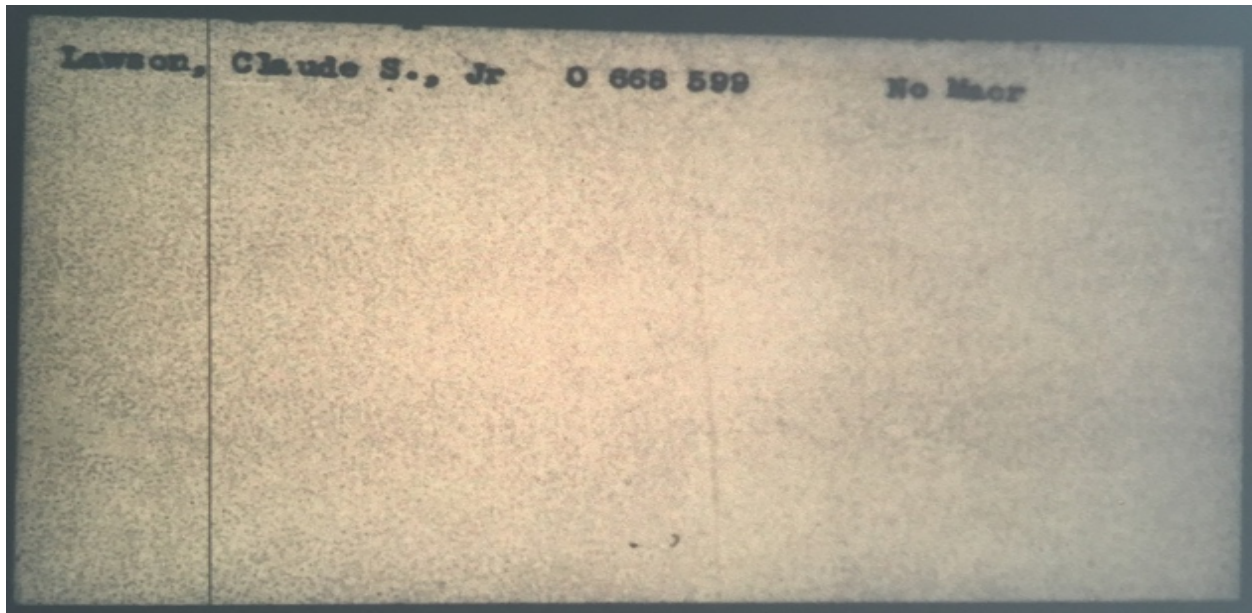


Figure 38: Crew member card for Claude S. Lawson Jr. showing no MACR in the record (NARA RG 92 M1420 Roll 35 1945)

With the discovery that there were no MACRs for either of these two possible aircraft, the task of identification became significantly more difficult. The author then took a broader approach and attempted to locate any references to these two aircraft in the archival record by viewing records related to missions conducted by their respective unit affiliations. The author thus began to review the records contained within RG 18, 342 and 554, as previously determined. RG 18 was searched the most thoroughly for sources of information that might be diagnostic in the identification of this aircraft, or that might contain some reference to missions flown on May 5, 1945 or August 27, 1945. Records related to the 30th bomb squadron, the 19th Bomb group, as well as the 402nd Bomb squadron of the 502nd Bomb group were searched for references to the individuals known to have been on aircraft 42-94060 or 44-83899 respectively. This line of inquiry produced a single reference to aircraft serial number 44-83899, and its role in a parachute supply mission.

RG 18, entry 7, World War II Combat Operations Report 1941-1946, box 4518, 314th Bomb Wing to 315th Bomb Wing contained a reference to 44-83899 and provided several

communication records from the Commander General Bomb Wing 315 to the Commander of Bomb Groups 16, 331, 501 and 502 (see Figure 39). These communications included information about expected times of departure, procedure for departure from Guam, estimated times of return, as well as information regarding the pre-mission briefing time and location. A document (NARA RG 18 Entry 7 Box 4523 1945) was also located that included extremely detailed information pertaining to bomb-group specific procedures for takeoff intervals en-route to the Florida Blanca Airfield in the Philippines where 12,000 type G-1 cargo parachutes were to be collected and brought to the Mariana Islands for use in Prisoner of War (POW) relief supply missions that would also be flown by B-29's. Despite the information gathered about the last mission of aircraft 44-83899, there was no information found that was diagnostic in differentiating between the two possible aircraft at the site.

Another potential avenue for identification that was pursued by the author pertained to information gathered from the manufacturing plates that were recorded on the engines during archaeological survey. Unfortunately, while there was at one time a complete record of parts purchased including batch numbers and individual serial numbers, those individual maintenance and assembly reports for each aircraft were temporary, and thus not retained for permanent storage in the National Archives (pers. comm. Patrick Osborn).

With these more targeted research approaches to identification proving unfruitful, a more general approach was adopted wherein the author searched for any records pertaining to the manufacturers of the engine parts identified during archaeological survey. The author began by searching for Jack & Heintz Inc., in an attempt to locate an official order form that might have a date and contain a block of serial numbers that matched those documented on an identification plate at the jungle site. Unfortunately, the only records that could be obtained were official

SECRET

9403

*Not Out.
May We Please*

RGV V KQIN NRA OPOP SECRET

FROM: CONGENBOMUG 315 211243Z

TO: CONGEN AAF 20

AOMCR 5467

SUBJECT: AIR LIFT PARACHUTES, FLORIDABLANCA, P.I., TO MARIANAS.

REFERENCE AINCR 5931, AINCR 5927 AND AINCR 5941

(1)&(2) AIRPLANE NUMBERS & AIRPLANE COMMANDERS

A/C COMMANDER	A/C SERIAL	A/C CALL
STRANATHAN, C. L. COL	42-63623	TEMPER 38
VOIDA, J. A. CAPT	42-63713	TEMPER 5
HALL, H.W. CAPT	42-63711	TEMPER 2
TURNER, H.W. CAPT	44-63614	TEMPER 27
BOULWARE, H.F. 1ST LT	42-63686	TEMPER 8
RAHEY, G. U. CAPT	44-83981	TEMPER 9
DIPPEL, A. U. CAPT	42-63695	TEMPER 3
DOOGHERTY, K. E. CAPT	42-63701	TEMPER 10
LAWSON, C.S. 1ST LT	44-83899	TEMPER 11
SWENSON, R. T. MAJ	42-63622	TEMPER 12
ETHIER, D. E. 1ST LT	42-63656	TEMPER 6
VORIKEL, C. H. CAPT	42-63712	TEMPER 14
TRASK, D. Z. CAPT	42-63742	TEMPER 26
BROWN, H. L. CAPT	44-83925	SLICKER 8
PAXTON, R. J. CAPT	42-63616	SLICKER 1
RIBBLE, R. H. CAPT	44-83891	SLICKER 6
GORING, A. W. CAPT	42-63690	SLICKER 2
BAUGHN, J. H. CAPT	42-63631	SLICKER 22
WEBSTER, J. B. CAPT	44-83944	SLICKER 11
DETON, E. D. CAPT	44-83895	SLICKER 46
MAHONEY, D. J. 1ST LT	44-83961	SLICKER 29
BROWN, H. W. 1ST LT	42-63658	SLICKER 26
GRIFFIEON, L. P. 1ST LT	44-83897	SLICKER 25
MOORE, R. F. 1ST LT	42-63609	SLICKER 41
HAYES, J. D. 1ST LT	44-83898	SLICKER 45
WILLIAMS, J. V. 1ST LT	42-63612	SLICKER 42

SPARE AIRCRAFT:

BOND, W.F. CAPT

42-63613

44-83939

TEMPER 30

SLICKER 50

(3) UNIT TO WHICH PLANES ARE ASSIGNED: 315TH WING

(4) DEPARTURE POINT: NORTHWEST FIELD, GUAM

(5) FINAL DESTINATION: FLORIDABLANCA, P. I.

(6) FLIGHT PLAN: DIRECT TO FLORIDABLANCA ALTITUDE 10,000 FT.

END

TOD.....1343Z JS K

ROGER V RGV 1343Z JL

AR

SECRET

Figure 39: List of aircraft assigned to mission (NARA RG 18 Entry 7 Box 4523 1945)

contractors forms and contained no reference to specific parts sold by Jack & Heintz Inc. or received by the USAAF, nor any reference to serial numbers. With no records located at the archives, the author conducted internet research into the Jack & Heinz Inc. history, as well as its fate after the conclusion of WWII. Bill Jack and Ralph Heintz of Cleveland, OH formed Jack & Heintz Inc. in 1940 in Palo Alto, CA; however, they quickly moved their company into a small plant in Maple Heights, Cleveland OH (Rotman 2011). The company was conceived as an aircraft parts manufacturer and soon received a military contract for the production of aircraft starters (Rotman 2011). Lower prices and faster production gave “JAHCO”, as it would soon be called, a competitive advantage in the manufacture of airplane parts under military contract, and so they soon received a significant contract for the production of autopilot devices (Rotman 2011). Jack & Heintz Inc. would grow both in size and production, becoming notable for its exceptional treatment of workers, and near zero absenteeism (Rotman 2011). The company expanded to employ 8,700 employees by 1944 (Rotman 2011). After the war, the lucrative military contracts that enabled Jack & Heintz to provide such excellent working conditions came to an end, and the company merged with Precision Products in 1946, becoming Jack & Heintz Precision Industries, Inc. (Joslin 2015). By 1961, the company was acquired by Lear Siegler Corp, which today, is known as the Lear Corporation (Joslin 2015).

With no dated transaction of Jack & Heintz engine components, the author turned her attention to the other identification plate that was documented on the engine at the jungle site indicating that it was a Shielding Assembly Ignition System Radio which was manufactured by Dodge in its Chicago plant. The author contacted the Dodge company and discovered that all sales and operations data from the Chicago plant during WWII no longer existed in the Dodge Chrysler Jeep Ram archives (pers. comm. Dodge Historic Services).

With no results from the individual part numbers, the author attempted to locate a patent date that might indicate that one of the two identified parts was manufactured after 1942, the production year of aircraft 42-94060. The author was able to locate the official patent applications for those patent numbers printed on the identification plates; however, none of those patents proved diagnostic, all having patent dates from before 1942 (pers. comm. Patrick Osborn).

6.3 Aircraft Accident Reports

Upon returning from the National Archives without a MACR, the author began to search for an RMA that might be related to aircraft BuNo 42-94060 or 44-83899. In this pursuit, the author was successful and was able to obtain copies of the RMAs for both aircraft in addition to copies of their individual aircraft record cards (Fuller 2010). The RMA for BuNo 42-94060 was originally filed under a typo, identifying the aircraft as 42-49060, an error that was later rectified (United States War Department 1945a). The aircraft was a B-29A based on North Field, Guam with the 20th AF 21st BC 314th BW 19th BG 30th Squadron (United States War Department 1945a). The aircraft was manufactured on February 23, 1945 and so had never been overhauled (United States War Department 1945a). At the time of its loss, it had only 128 hours and 45 minutes of time in flight and was piloted by Maurice J. Fay, an airplane commander who received his aeronautical rating for pilot on April 29, 1942 (United States War Department 1945a). Fay attended the Army Air Force Pilot School at Roswell Army Air Field in Roswell, New Mexico (NM) where he specialized in 4-engine aircraft (United States War Department 1945a). He had his instrument rating (meaning he could fly in non-visual flight rules (VFR), otherwise known as instrument flight rules (IFR) conditions such as during storms with poor

visibility and under conditions in which the ground was not visible from the aircraft) (United States War Department 1945a). He was instrument rated for the White type B-29 on February 24, 1945 at the Pyote, Texas (TX) check station (United States War Department 1945a). At the time of the accident, Fay had 2,141 hours and 5 minutes' experience as the first pilot or solo pilot of an aircraft with an additional 422 hours and 20 minutes as the second pilot or as a student (United States War Department 1945a). He had 139 hours and 10 minutes' experience as the first pilot of a B-29A, with 125 hours and 10 minutes of that total occurring in the previous 90 days (United States War Department 1945a). In the previous 30 days, he had flown as the first pilot for 46 hours and 20 minutes (United States War Department 1945a). Under IFR conditions, Fay had 100 hours' total experience as a first pilot with only 5 hours and 15 minutes' time logged in the previous 6 months, 3 hours and 15 minutes of that occurring in the previous 30 days (United States War Department 1945a). His logged flight hours as first pilot at night were 50 hours and 25 minutes in the previous 6 months, and only 5 hours and 30 minutes in the previous 30 days (United States War Department 1945a). Despite his flight experience, Fay had no actual combat experience (United States War Department 1945a).

When the aircraft crashed, all personnel perished and no parachutes were used, indicating that there was no warning of the impending crash (United States War Department 1945a). The aircraft was designated a total loss (United States War Department 1945a). The weather was recorded as a 1000 ft. (305m) ceiling with 1 mile (1.6km) visibility and a light rain (United States War Department 1945a). Ultimately, the cause of the crash was attributed to the low ceiling and the pilot's unfamiliarity with landing at Isley Field (United States War Department 1945a). No violations of regulations were noted during the mission from Guam to Honshu and back to Guam (United States War Department 1945a). The description of the accident states that

the “airplane flew into Mt. Topatchau, Saipan upon return from strike mission. Weather was poor and main factor for accident” (United States War Department 1945a).

The RMA for BuNo 44-83899 revealed that the aircraft was a B-29B based on Northwest Field, Guam with the 20th AF 21st BC 315th BW 502nd BG 402nd Squadron (United States War Department 1945b). The aircraft was manufactured in 1944 (United States War Department 1945b). At the time of its loss, it was piloted by Claude S. Lawson, an airplane commander who received his aeronautical rating for pilot on December 13, 1942 (United States War Department 1945b). He attended multiple training schools including a Basic Technical flight school at Randolph Field, TX in July 1942; Advanced Technical school at Foster Field, TX in October 1942; training school at Kelly Field in San Antonio, TX in December 1942 (United States War Department 1945b). In January of 1943 he transferred to Liberal AAF base in Kansas before becoming a specialist in 4-engine aircraft in August 1943 (United States War Department 1945b). He was instrument rated for the White type B-29 on January 23, 1945 at the Miami, FL check station (United States War Department 1945b). At the time of the accident, Lawson had 1,846 hours and 15 minutes’ experience as the first pilot or solo pilot of an aircraft with an additional 369 hours and 40 minutes as the second pilot or as a student (United States War Department 1945b). He had 1341 hours and 15 minutes’ experience as the first pilot of a B-29B, with 199 hours and 10 minutes of that total occurring in the previous 90 days (United States War Department 1945b). In the previous 30 days, he had flown as the first pilot for 88 hours and 25 minutes, and had not flown in the previous 24 hours (United States War Department 1945b). Under IFR conditions, Lawson had 33 hours and 25 minutes’ time logged in the previous 6 months, 4 hours and 40 minutes of that occurring in the previous 30 days (United States War Department 1945b). His logged flight hours as first pilot at night were 129 hours and 25 minutes

in the previous 6 months, and 58 hours and 15 minutes in the previous 30 days (United States War Department 1945b). In addition to his piloting experience, Lawson had 117 actual combat hours (United States War Department 1945b).

Like BuNo 42-94060, when BuNo 44-83899 crashed, all personnel perished, no parachutes were used, and the aircraft was designated a total loss (United States War Department 1945b). The weather was recorded as a 500 ft. (152m) ceiling, the sky was 10/30 covered with 1 mi. (1.6km) visibility, 15 mph winds from 150 degrees (SSE) and scattered precipitation (United States War Department 1945b). After several unsuccessful landing attempts, with two feathered engines, Lawson accidentally crashed into the side of Mount Tapochau after missing the runway due to poor visibility (United States War Department 1945b). The mission was the delivery of POW supplies (United States War Department 1945b). The recommendation provided in an effort to prevent future accidents such as this one indicated: “Recommend that an experienced flying officer be on duty in the tower at Isley Field, Saipan, during the active hours of operation. It is believed that a rated officer might have prevented this accident because he would not allowed Temper Eleven to make his approach during bad weather which caused him to miss the runway and ultimately crash into the hill” (United States War Department 1945b). The indicated action taken was an emphasis placed on briefing flying personnel regarding terrain, outstanding features and operational facilities for strange field landings (United States War Department 1945b).

Based on the information contained within these two RMAs, the author cannot state that the aircraft wreckage is more or less likely to be that of 44-83899 than that of 42-94060. The RMA for 44-83899 indicates that the aircraft crash site was “approximately five (5) miles NNE of Isley Field and the elevation is approximately 800 feet” (United States War Department

1945b:6). The archaeological aircraft wreck site scatter is located 5.1 miles (8.3km) along a heading of 7° true at its westernmost artifact in the Jungle Site (artifact titled “NO PROP ENGINE”), and 5.2 miles (8.4km) away from Isley Field on a heading of 9° at its easternmost artifact in the Field Site (artifact titled “MISC H”). The GPS point for the artifact with the lowest elevation was the engine with the propeller still attached in the Jungle Site at an elevation of 862 feet (263m), and the artifact with the highest elevation was marked “MISC H” with an elevation of 1101 feet (336m). Objectively, this indicates that the aircraft wreck site is that of 44-83899; however, when attempting to plot this on a map, the route between Isley Field and the aircraft wreck site crosses the peak of Mt. Tapochau. Unless the pilot was completely lost and turned around, a difficult assumption considering that he had so recently seen the runway and been in contact with the tower, it is implausible that he went around Mt. Tapochau and then crashed into the other side of it. That being said, most bombing activities by B-29’s occurred in the vicinity of Japan which is roughly to the North-Northwest. Returning from a mission in this region would bring an aircraft attempting to land at Isley Field across the top of Mt. Tapochau to enter the traffic pattern for the airfield and could result in an aircraft wreck site on the eastern face of the mountain. The absence of information about the circumstances of the crash of 42-94060 makes this a difficult site to identify solely on the archaeological information that was collected. With a more intrusive archaeological excavation, artifacts and information might be found which could more specifically identify this aircraft wreck site.

During the course of the author’s research on Saipan, it was suggested that there was another B-29 aircraft wreck site on the island that was located in a gulch (personal communication Genevieve Cabrera). The author was unable to visit this aircraft wreck site, and therefore, was unable to gather information that might have led to a positive identification of it

which would, by omission, help to identify the Mt. Tapochau site. In the published loss records of all B-29 aircraft there are only two aircraft that are recorded as having crashed on the island of Saipan. Many aircraft were recorded as wrecking in the waters surrounding the Mariana Islands (Mann 2004); however, there were only two recorded B-29 aircraft crashed on the island of Saipan itself.

6.4 Limitations

Before presenting the data collected during this project, it is necessary to acknowledge the limitations of this project. With regard to the historical and archival research conducted relating to the B-29, its activities on Saipan, and the identity of this site in particular, reference desk staff at the national archives greatly influenced the records reviewed. Each visit to the reference desk involved a consultation with a different staff member, and their knowledge of the contents of the archives drove the records that were viewed. Despite working with multiple staff members, virtually all of whom recommended a similar methodology, it is possible that records exist which are related to this topic but were not identified or examined in this study.

Limitations of the island survey relate to the elapsed time since WWII, and the loss of material remains that occurred in that interval. Between the time of their use and the author's visit, the hardstands became completely overgrown, and were not able to be photographed or recorded. Additionally, many of the sites that are still extant and accessible on the island pertain to the invasion of Saipan, and the activities of the Japanese prior to US invasion. The continued use of Isley Field as an active, modern airport necessitated the modification and removal of many historical structures to make room for the new airport, undoubtedly removing many B-29 related structures.

Limitations to the archaeological site were related to time, personnel, scope and access to site

features. Only two site visits were conducted, one during the late afternoon, and one during the morning. The first visit was limited by access to daylight, limiting the amount of time that could be used for data collection. Each visit included a different set of individuals, requiring a site orientation each time. This project also focused on a single terrestrial B-29 crash site, limiting the information that could be derived from the material record to a single aircraft. Limitations in scope affect the results of this project which might have been more broadly applicable if the author had the resources to record multiple B-29 sites, thus increasing the amount of data collected.

The scatter site for aircraft materials was effectively divided into two sites, one on a utilized portion of the property-owners land, and another farther down the mountain through dense jungle terrain. In the field site, portions of aircraft wreckage debris were gathered into obviously artificial debris piles distributed throughout the field. The author hypothesizes that these debris piles were created by the caretakers of the property to make mowing of the grass easier. Documentation of the jungle site was limited by the density of the jungle growth, potentially obscuring site features, as well as limiting physical access to visible site features, and thus preventing the collection of GPS data at the location of that site feature. Additionally, the length of time that has elapsed since the aircraft wrecking event, and the tropical, rainy environment may have caused site features and aircraft remains to become buried by mud, or washed farther down the side of Mount Tapochau. The separation of the debris fields speaks to the probable loss of material that might have rolled farther down the mountain either during the wrecking event or at some later time. The rain and exposure to environmental factors may have also led to certain aircraft remains becoming so rusted as to completely disintegrate and be lost to the material record entirely. One limitation that was clearly visible to the author was the effects of human

salvage. Dr. Lamar, the landowner, pointed out evidence of cut marks, and informed the author of missing pieces of the wreckage which indicated that individuals had visited the wreckage site and removed parts of the engines, propellers, and other pieces of the aircraft, potentially for sale, or merely as a souvenir of their time on Saipan (pers. comm. Dr. Daniel Lamar).

Limitations to archival research include poorly organized records and missing records, as well as illegible records. During times of war, knowledge regarding the status a piece of equipment – useable or not – is of far greater importance than the reason that piece of equipment may be incapacitated. This is not surprising, for it is the primary objective of the nation to win the war, not to have perfectly accurate records. Especially during times of action when equipment is lost or damaged, there is not enough time to record the circumstances of the loss. This leaves the process of recording to a later date and in turn can lead to loss of information or unintentional false recording of information due to the fallibility of memory. As a result, when historians attempt to study historic records, the level of detail in reports and the accuracy of the information contained therein may leave much to be desired. In other cases, the information is of sufficient detail and accuracy; however, the state of the physical record may render that information illegible and thus of little historical value. In the course of this research, illegible records have most often been the result of the process of copying records multiple times over many years.

The biases present in this research must be acknowledged. “History is written by the victor” is a statement attributed variously to Winston Churchill and Niccolo Machiavelli (Robbins 2012) and serves as a reminder that all historical research is inherently biased. As a native citizen of the US, researching a US aircraft that crashed at a US airfield base during operations in support of US foreign policy, this research relies more heavily on US sources. While the author strove to

understand and present WWII from the perspectives of the Japanese, the US, and the indigenous Chamorro in this study, the resulting data likely retains some levels of bias.

7 Discussion and Conclusions

7.1 Cultural Landscape

Having presented the theoretical, archaeological and historical data collected, this chapter combines and applies these ideas to the construction of a B-29 airscape for the Northern Mariana Islands, and more specifically Saipan and Tinian, both bases for the B-29 fleet. Without a definitive identity for the archaeological site, the author created a generic B-29 airscape based on a tactical mission report located at the NARA.

As stated by Cooper (1994:136) aircraft are used as a means of “projecting force far beyond the grasp of armies and fleets”. Due to the extensive range of aircraft, the author chose to limit the airscape analysis to the areas around Saipan. This limitation in range allowed the author to provide a more comprehensive analysis of the airscape around the hub of B-29 activities.

The usefulness of defining an airscape for the B-29 is limited by the extent to which it can be contextualized. To gain value from the information that could be derived from this type of analysis, the milieu in which it operated was examined from a cultural perspective. The use of a cultural landscape allows for the study of the ways in which cultural identities and communal histories are tied to physical landscape features and held in cognitive perceptions of space. The use of a landscape analysis enabled the author to investigate the physical manifestations of a cultural existence and create a perceptual meaning that was attached to the physical landscape. One of the challenges in considering a cultural landscape is that multiple perceptions exist of the same region and are equally relevant and accurate.

In his discussion of cultural landscapes, Westerdahl (2005a:17) breaks down the general maritime cultural landscape into component aspects including the topographical landscape, the

transport and communication landscape, the outer resource landscape, and the toponymical landscape. In a maritime application, the topographical landscape considers the landscape features that impact human access to the shore, and plays a significant role in the localization of harbors. The transportation and communication landscape refers to significant points along “corridors of movement and contact” (Westerdahl 2005b:21). These are not the same as sea routes or land road systems, rather they consist of several routes or road systems that are used for heavy transport using varying transport techniques adapted to “technical, social, economic and cultural vicissitudes” (Westerdahl 2005b:21). The outer resource landscape is an analysis of the supply routes and transfer of resources used by the culture in question (Westerdahl 2011:746). The toponymical landscape consists of the cognitive landscape or “mental map” that can be understood through oral traditions, place names, and the ritual and symbolic landscape (Westerdahl 2011:746).

An airtape, like a seasape or maritime cultural landscape, is fluid and evolving much like a life form; therefore, it can be said to exhibit a type of “anatomy” and “physiology” (Bryan 1933:18). The anatomy consists of physical features that are fixed and connected to the environment, while the physiology consists of the movement of culture through the landscape, and is impermanent and less connected to the environment (Bryan 1933:59).

At airports on Saipan such as Isley Field, Kagman Point, Kobler Field, Marpi Point and Susupe field, the topographical landscape influenced the construction of these bases. At the time of the US invasion of Saipan, there were three aviation facilities: Aslito Airfield, an airstrip near Charan-Kanoa, and an airfield under construction at Marpi Point (see Figure 40). Aslito Airfield was captured four days after the invasion of Saipan, but was found to be damaged by shelling and covered with shrapnel (United States Civil Engineer Corps 1947:340). On the fifth day of the

Saipan invasion, three companies of the 121st Naval Construction Battalion (NCB 121), also known as the 121st Seabees, began clearing and rehabilitating the damaged airstrip. Within two days, they were able to repair the entire strip, 150ft wide by 4,500ft. long, and a Navy TBF Avenger aircraft landed on Saipan (United States Civil Engineer Corps 1947:340). As part of the US occupation and use of the airfield, aviation gasoline was unloaded and stored in Japanese-built gasoline storage blockhouses (United States Civil Engineer Corps 1947:340). When the runway had been sufficiently cleared, the Seabees, in conjunction with Army Aviation Engineers, began the process of enlarging it, opening it for Army patrol operations only seven days after the initial landing on Saipan (United States Civil Engineer Corps 1947:340). US civil engineers repaired the railroad from Charan Kanoa to Aslito Field, facilitating the movement of supplies from the landing docks at Charan Kanoa to the airfield where construction was occurring.

In addition to the aviation facilities built by the Japanese before the US invasion of Saipan, the US Aviation Engineers, in conjunction with the Seabees constructed Kobler Field and Kagman Point airfield, in addition to extending the existing airbases (United States Civil Engineer Corps 1947:343). When locating and constructing an airfield for military use, nature was taken into account. The natural features that affected airfield construction were part of the topographical landscape within the greater aircscape. When identifying places for airstrips, aviation engineer reconnaissance teams were sent out to identify potential sites before construction commenced. The considerations for airstrip location were: area; accessibility, communications and supply logistics; obstructions; meteorological conditions; hydrologic conditions; topography; clearing and grubbing; soil characteristics and quality of subgrade; availability of local materials; water supply; prevailing weather during construction; camouflage;

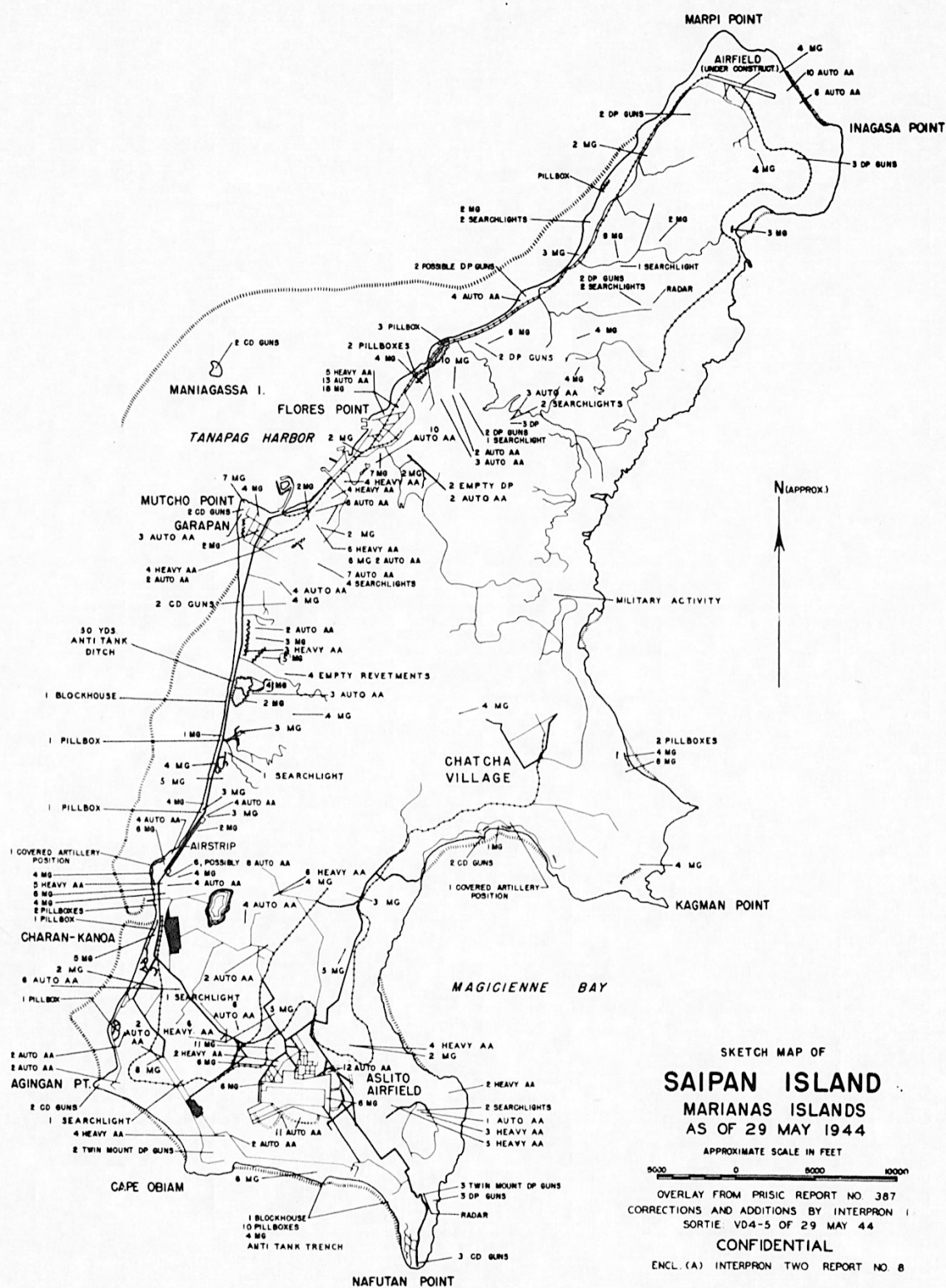


Figure 40: Infrastructure on Saipan at the time of the US invasion (NARA RG 38 Roll 2034 MSN 156316 2010:200a)

defense and protective construction (United States Department of the Army 1944:55). Once a location was chosen, the layout of the airfield was dictated by the natural forces at work. For example, the center line of a landing strip was typically laid approximately in the direction of the prevailing wind wherever possible, with a deviation not to exceed 22.5° on either side (United States Department of the Army 1944:36).

The qualifications for suitability as a site for construction also served as the boundaries that define an airspace's strategic topography. The stringent requirements for an airfield site made any terrain that met those requirements highly valuable. Terrain that could be utilized for the long-range projection of power was key to the effective employment of the B-29 (see Figure 41).

For Saipan and its use as a B-29 base, potential sites had to be of sufficient area to accommodate a 7,000ft (2,134m) runway and a desired additional 1,000ft (305m) clear zone at each end of the runway, with a minimum runway width of 200ft (61m), 300-500ft (92-153m) including runway and shoulders, with a 400-500ft (122-153m) wide landing strip and minimum safety clearance zone of 1,000ft (305m) (United States Department of the Army 1944:37). Based on these requirements, the only locations that were conducive to the construction of an airfield were those at Marpi Point, Kagman Point, and on the southern end of the island, away from Mount Tapochau (see Figure 42).

Additionally, an approach zone, free of obstructions above the angle of glide (the degree angle of the nose of the aircraft below the horizon) of 3.406° had to be cleared to an area of 2 mi (3.22km) in length and, for the B-29, a minimum 2,900ft (884m) or maximum 3,000ft (915m) in width for a total area of $1.098\text{--}1.136\text{ mi}^2$ ($2.843\text{--}2.942\text{ km}^2$) (United States Department of the Army 1944:38) (see Figure 43).

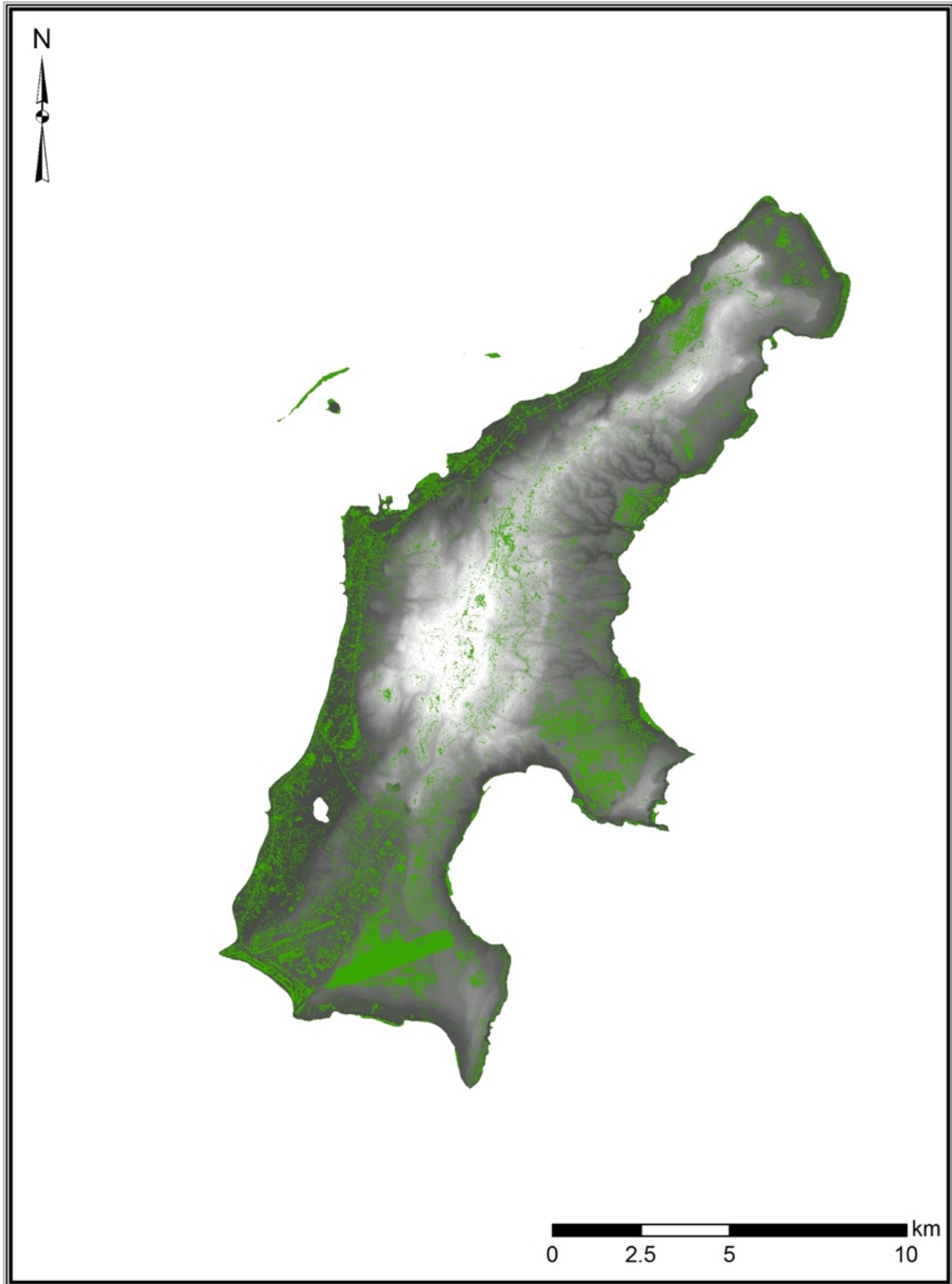


Figure 41: Showing regions of Saipan for possible airstrips where the average grade is less than 5% (lime green) (Map by Author)

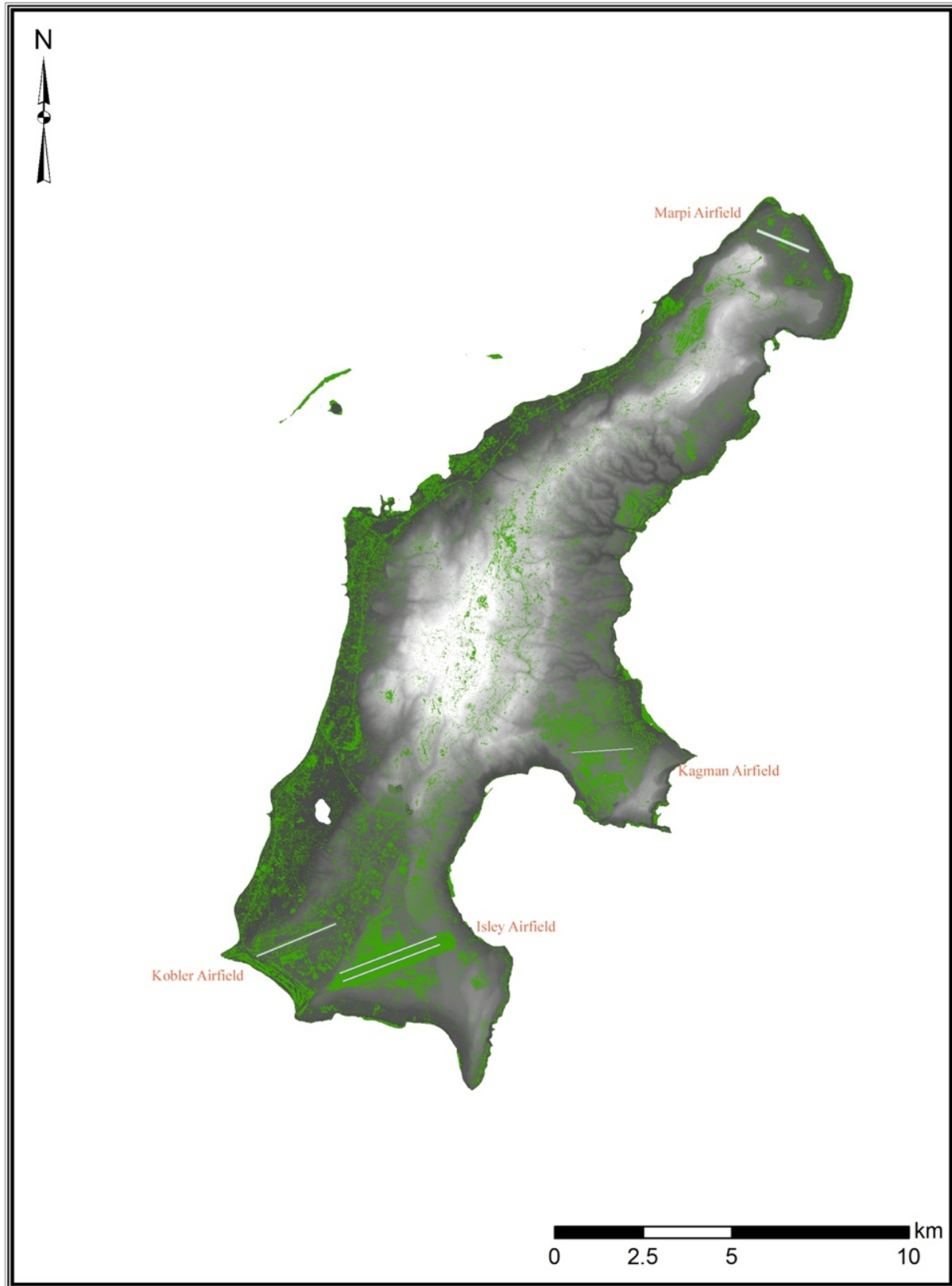


Figure 42: Airstrip locations (pastel green) constructed on regions of sufficient area where average grade is less than 5% (lime green) (Map by Author)

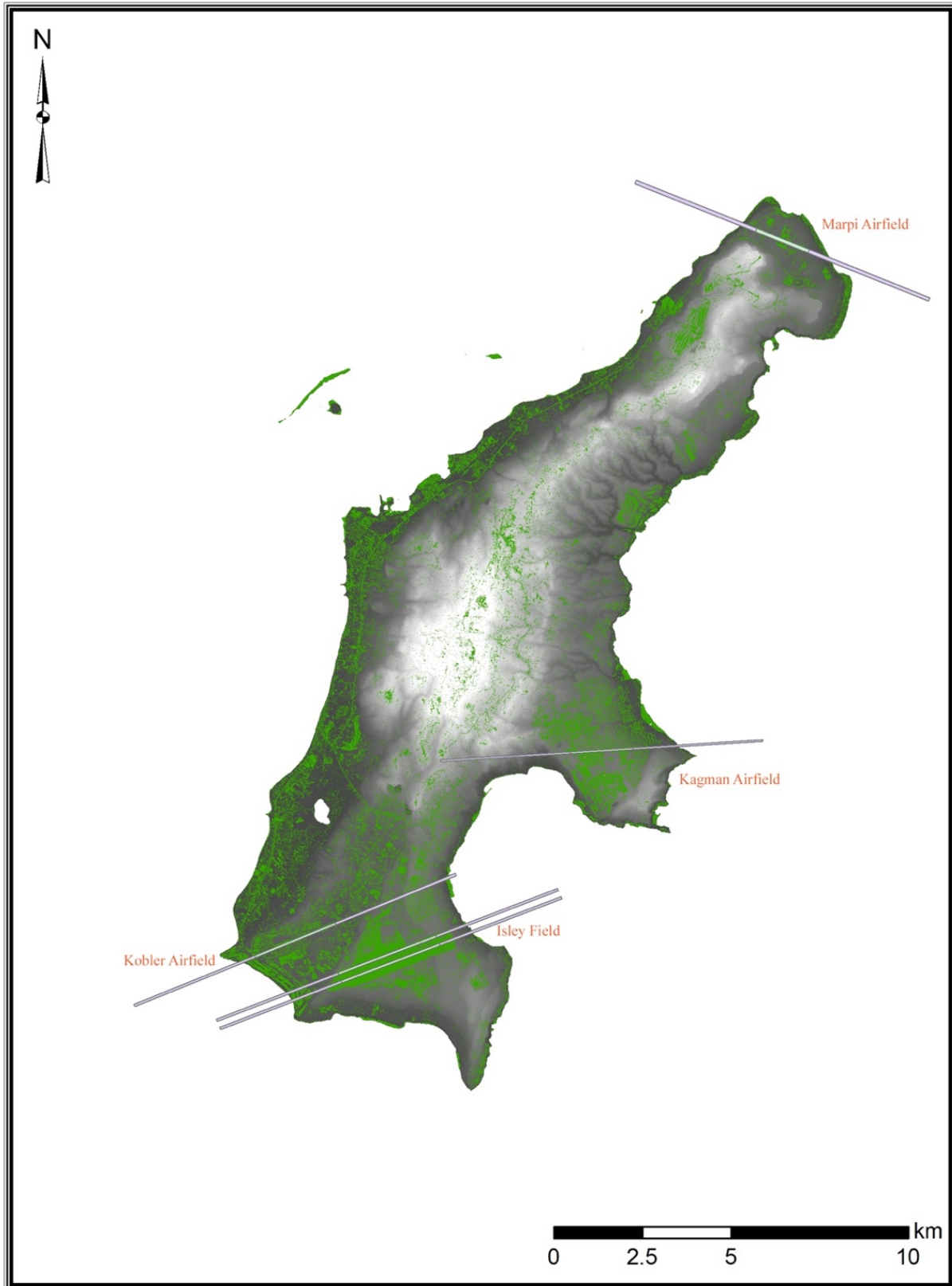


Figure 43: Airstrips (pastel green) extended to show approach zone from ground level to an altitude of 191.6m above ground level (lavender) (Map by Author)

The spatial dimensions of an avenue of approach for a B-29 airspace began when the aircraft entered the airfield traffic pattern (see Figure 44). This approach zone above the angle of glide served as the final segment of the avenue of approach and had to be clear of obstructions. For airbases constructed on Saipan, the airstrips were aligned with the prevailing wind to enable aircraft to take off and land into the wind, while also being aligned parallel to natural obstructions, such as Mount Tapochau, so that aircraft taking off were not immediately forced to avoid natural obstacles.

The longitudinal grade for the landing strip could not be greater than 1% for heavy bombers, a requirement that affected the avenues of movement, whether approach or departure (United States Department of the Army 1944:38). In addition to landing strips and runways, airdromes required taxiways for the movement of aircraft off of the landing strips. Typically, taxiways were laid out as a series of straight lines joined by horizontal curves along a main loop connecting the ends of the landing strip. The loop principle provides alternate routes of travel so that planes at hard stands were not blocked from the landing strip by a direct bomb hit at any point along the taxiway (United States Department of the Army 1944:41). Typically, taxiways were not attached to the direct ends of runways because the ends of the runway often suffered from bombing attacks, and because attachment to the ends of the runway would lead to regularly spaced hardstands at intervals, making it easier for the enemy to maximize damage during strafing or bombing runs. For B-29 taxiways, the minimum width of stabilized surfaces or paved sections was 75ft (23m), with at least 95ft (29m) between shoulder lines (United States Department of the Army 1944:41). The taxiways brought the aircraft to the hard stands. The hard stands were always spaced 300ft (92m) to 500ft (153m) apart (500ft (153m) for the B29) and staggered so that they did not line up in any direction to serve as a linear target (United States Department of

the Army 1944:42). Hardstand locations were chosen to take advantage of terrain and natural cover for protection and concealment. In terms of distance from the runway, bomber hard stands were located farther away for purposes of dispersion and concealment at the cost of farther distances to travel resulting in overheated engines prior to take off, wasted fuel and additional wear on landing gear and engines (United States Department of the Army 1944:42). The individual hardstands were constructed based on the minimum turn radius, which for the B-29 was approximately 50ft (16m), requiring a minimum hard stand diameter of 100ft (31m), with a wing-tip clearance line around the hardstand of 70ft (22m) (half the wingspan of the aircraft) for a combined cleared area diameter of approximately 240ft (73m). In order to leave the taxiway, the aircraft required a stub end with a minimum radius of 50ft (16m) (United States Department of the Army 1944:43). In addition to these facilities directly related to the aircraft performance characteristics, roads and additional facilities for the operation of the airdrome were required. The additional facilities that had to be constructed included: gasoline, grease and oil storage; bomb, ammunition and chemical storage; aircraft repair facilities; the marking and lighting of runways for both daylight and nighttime operations; warehouses for air force supplies; operations room, pilots' room and a control tower; personnel accommodations; air depot group facilities including warehouses, repair shops, repair hangars, administration buildings, hospital wards, incinerators and tool sheds; transportation infrastructure such as roads; and utilities services including sewage disposal, water lines, electricity and telephone lines (United States Department of the Army 1944:255). During the construction of aerodromes concealment and cover were important considerations, ensuring that bomb and fuel storage facilities were not consolidated in one single, easily visible location.

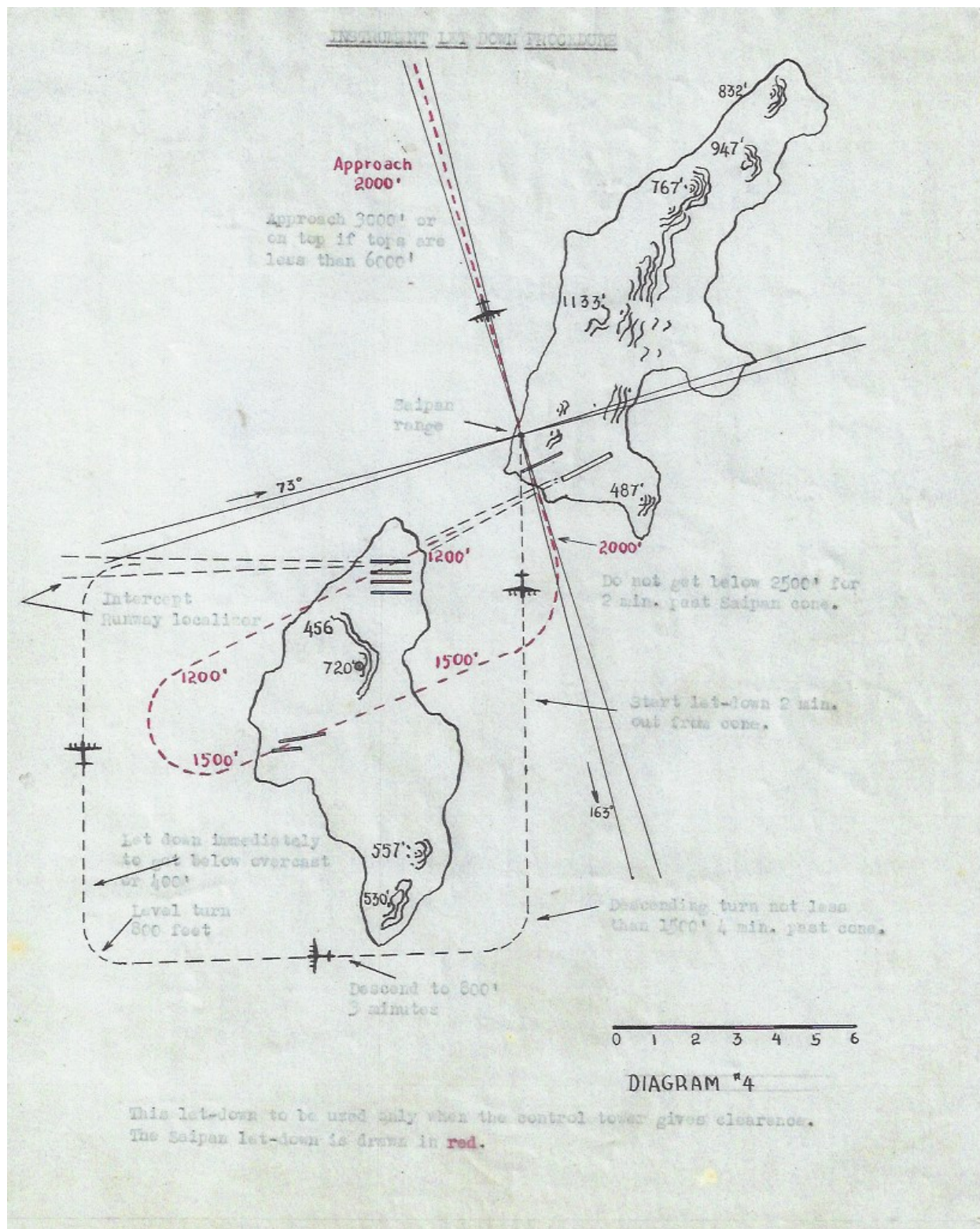


Figure 44: Air traffic patterns for Saipan (red) and Tinian (black) (Image Provided by Scott Russell, Pers. Comm.)

In the case of Saipan and the use of the B-29s, the topographical landscape influenced the construction of airbases by imposing limitations. To construct an airbase, a space of sufficient area had to be located that was large enough and gradable to accommodate the construction of a fully functional airdrome. The location had to be accessible via roads and the existing rail system on Saipan at the time of the US invasion (see Figure 45). The airfield had to be free of obstructions within the approach areas, meaning that no airfield could be at the base of suicide cliff, nor very proximal to Mount Tapochau. The prevailing winds and the mechanics of flight dictated the orientation of the runway, which subsequently influenced the significance of large natural obstacles such as the cliffs and mountains of the island. Clearing considerations were less significant to the construction of airbases because at the time of US invasion, the majority of Saipan was used for the cultivation of sugarcane, meaning that most of the island consisted of large open fields that did not require clearing. The geological characteristics of Saipan, as a volcanic island with significant coral reefs around it, made construction much easier due to the availability of local materials. Coral and stone quarries were able to be established and provided easy sources for construction materials that were used both in grading and building runways, as well as constructing buildings and facilities for the operation of the airfields.

When it came to the transportation landscape, aircraft, as a rule, were not physically limited in their choice of route between two locations as there were no permanent physical barriers to prevent an aircraft from traveling directly, in a straight line, from the point of origin, to the destination. The flexibility in routes, meant that the cultural landscape for an aircraft was mostly incidental to the terminal facilities and break-of-bulk points where two different forms of transport met (Bryan 1933:55). Unlike railroads and terrestrial forms of transportation, the route for an airscape was of very little significance in the cultural landscape, but the terminal was the

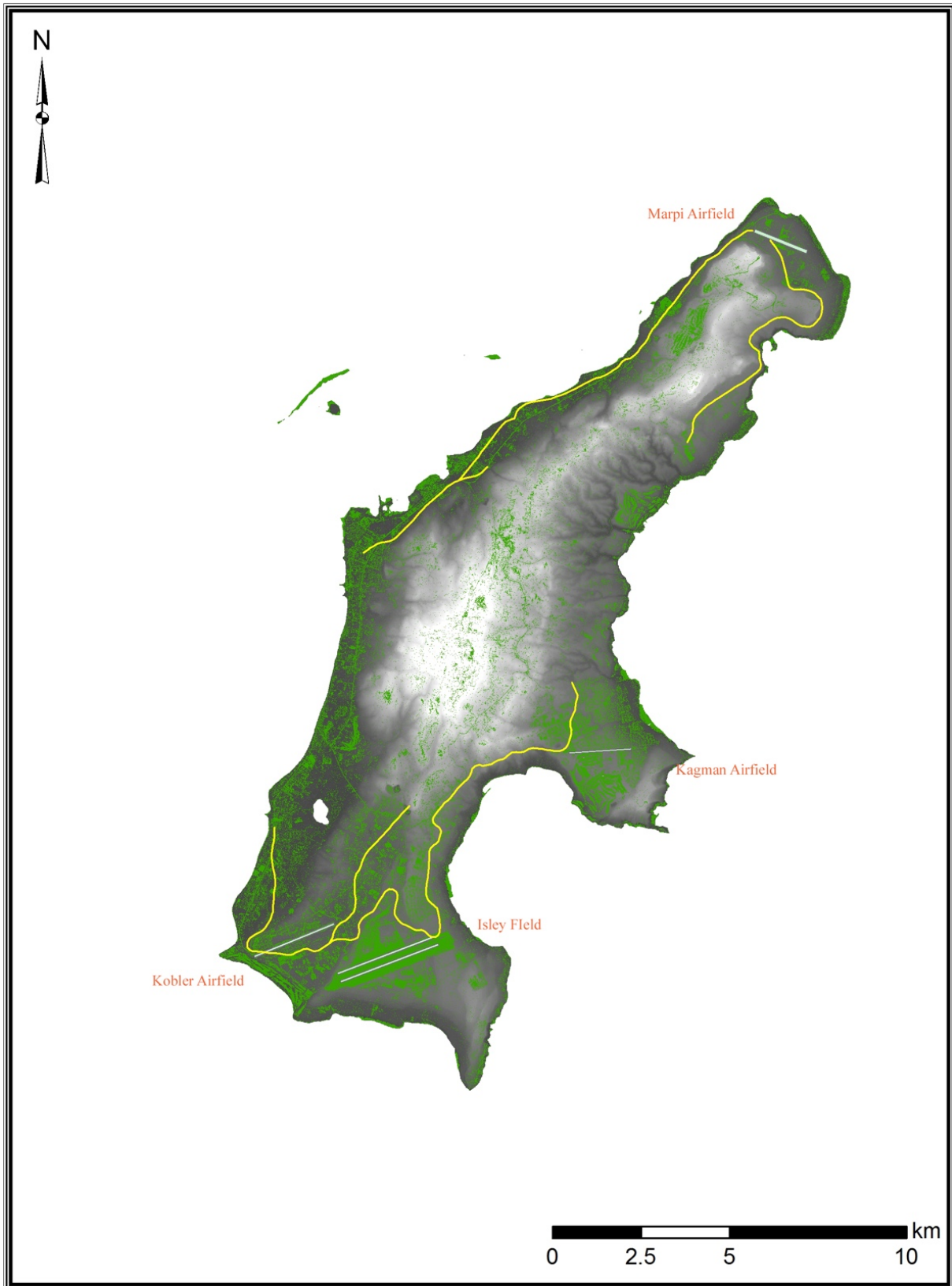


Figure 45: Locations of railroads (yellow) at the time of the US invasion of Saipan and their proximity to locations selected for airfields (pastel green)

most significant location (Bryan 1933:56). For railroads and roadways, the route was impacted by the presence of mountains which had to be navigated around or through, lakes and rivers to be avoided, and other natural features of the topographical landscape that impacted the route. As a result of these impacts, roads and railroads took certain prescribed paths, along which towns and cities sprang up because of the access to resources, and the commercial opportunities that significant transportation of goods and individuals brought. For aircraft, the landscape was only changed at points of arrival and departure where cargo must be moved and repackaged. As such, it was at the terminals that lights and markers were installed to guide aircraft around prominent obstacles (see Figures 46 and 47), where landing strips were built, aircraft hangars constructed, warehouses for air cargo built, administrative offices and control towers needed, and wind indicators installed.

The transportation landscape was comprised of the way or track that the transportation vessel moved along and its associated gear, the type of vehicle used, and the terminal facilities where break-of-bulk occurred. The way or track and related equipment includes the material that made the track, where it came from, and navigational equipment that might be associated with it as well as the modifications specific to the vehicle that would use it. This indicated the type of vehicle used for transportation, what the needs of that form of transportation were, and how those needs impacted the landscape. At the terminals and points of transition, the facilities where material was stored and manufactured featured in the landscape and provided insight into the culture that operated those terminals.

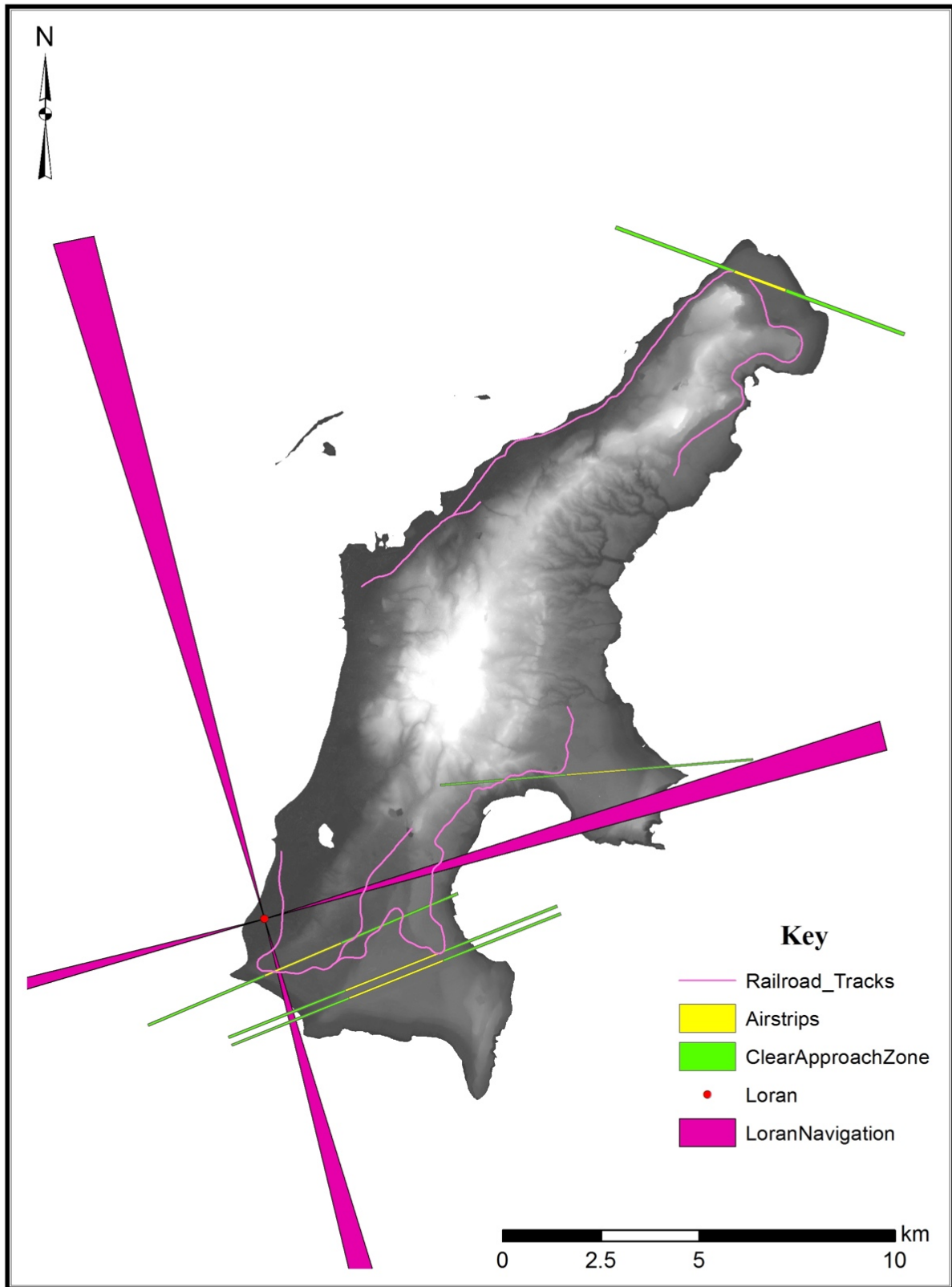


Figure 46: The airspace (railroads, LORAN, airstrips and areas of approach) with obstacles (mountains (white)) emphasized

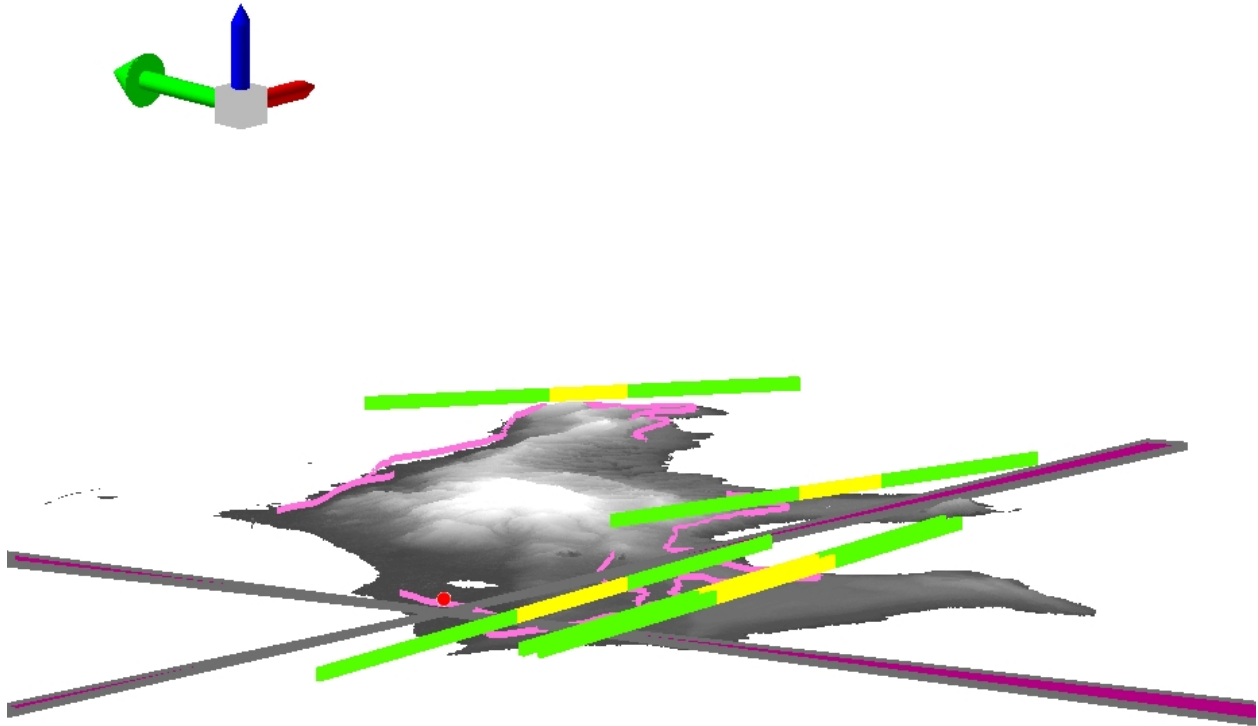


Figure 47: View at an angle (north arrow in green) to emphasize elevation attributes of airspace especially approach zones (Map by Author)

For the B-29, the way or track consists of the runway, the air – which is impacted by the environment, affecting flying conditions – and the signaling equipment that indicates location and position data. The runways that were constructed on Saipan for each airfield were: Isley: 2 strips, 8,500ft (2591m) long by 200ft (61m) wide each, constructed of blacktop surface; Kagman: 1 strip, 5,100ft (1555m) long by 150ft (46m) wide with 75ft (23m) shoulders, constructed of Macadam; Kobler: 1 strip, 7,000ft (2134m) long by 200ft (61m) wide, constructed of asphalt; Marpi: 1 strip, 4,600ft (1402m) long by 300ft (92m) wide, constructed of coral (Commander in Chief, Pacific Areas Command 1945:157). On Saipan in conjunction with installations on Guam, the use of LORAN and Radio technology aided in aviation navigation (see Figures 48 and 49), while runway markers and glide-path lighting aided landings. Between the airdromes being used on the island, navigational technology included: 2 LORAN receivers

and 2 TDP Transmitters, as well as one SCR-729-A for instrument approach and one Bludworth DF-1024 low-frequency omni-directional transmitter (Commander in Chief, Pacific Areas Command 1945:169–170). The deployment of LORAN and RADAR technology in airfields of WWII created a web of airways that represented precisely known locations, facilitating planning and navigation in flight. The use of air traffic control towers on each airfield on Saipan also contributed to the organization of movement of aircraft through the airfields and between the islands of Saipan and Tinian, a highly-congested region with multiple airfields within close proximity.

The type of vehicle used significantly impacted the construction of airdromes in the Pacific Theater, especially when considering the B-29. When planning the construction of airbases, superbombers such as the B-29 required a 75ft (23m) minimum width of stabilized, surfaced or paved section, with a minimum 95ft (29m) between shoulder lines (United States Department of the Army 1944:41). The requirements for stabilized, surfaced or paved sections for fighters and light bombers, and medium and heavy bombers were 30ft (9m) and 50ft (16m) respectively, meaning that the B-29 required fifty-percent greater width in graded and cleared taxiways than previous medium and heavy bombers such as the B-25, B-26, B-17, and B-24 (United States Department of the Army 1944:41). When establishing locations and material requirements for runways, the B-29 was again, in its own category of requirements. Fighters and light bombers required wheel loads of 15,000lbs (6,804kg) while medium and heavy bombers required 37,000lbs (16,783kg), well beyond these, the very heavy bomber, the B-29, required a wheel load of 60,000lbs (27,216kg) (United States Department of the Army 1944:44). These wheel loads translated into minimum thicknesses of concrete for pavement of runways, taxiways and hardstands. For the B-29, with a wheel load of 60,000lbs (27,216kg), the minimum thickness of

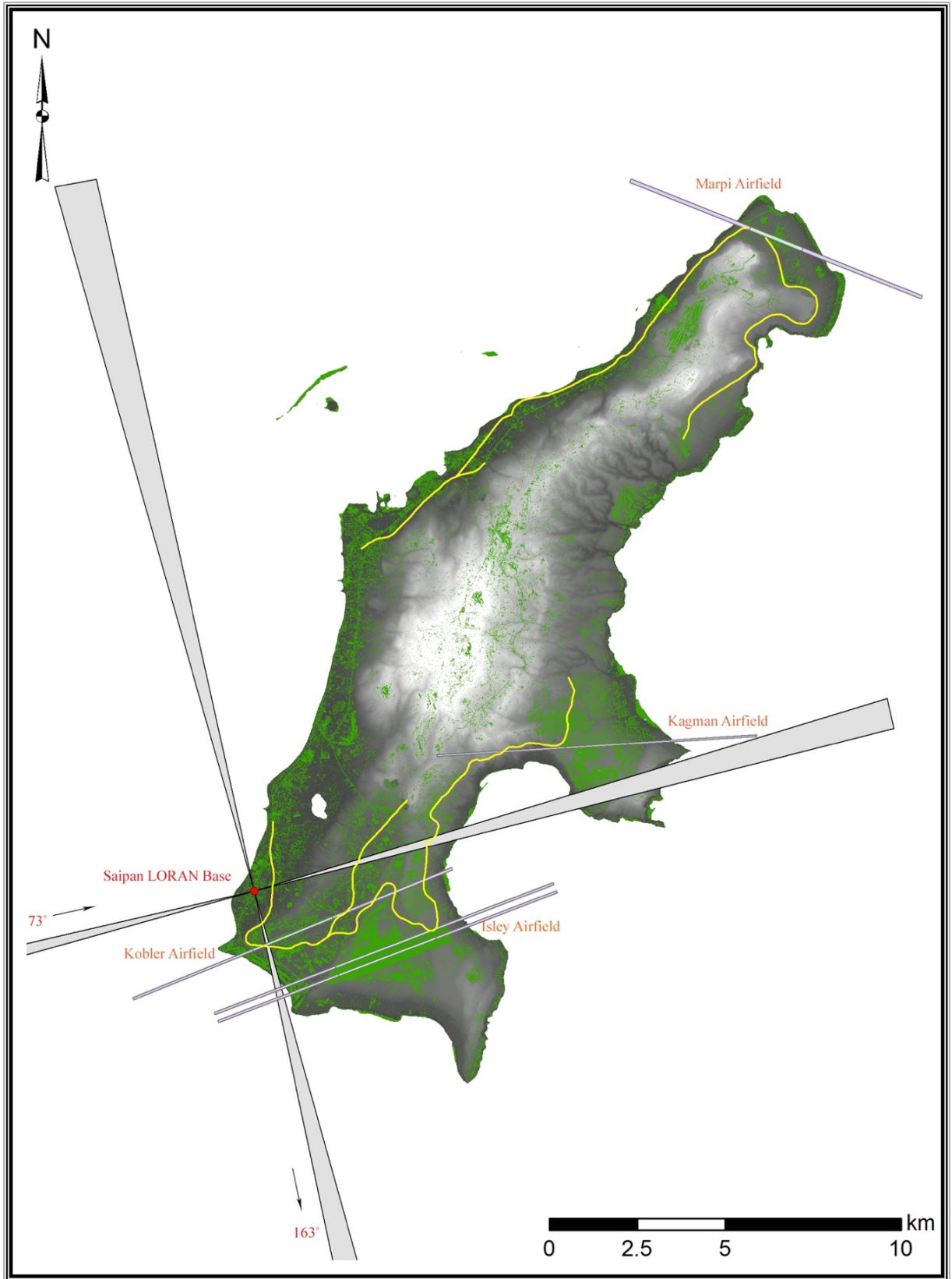
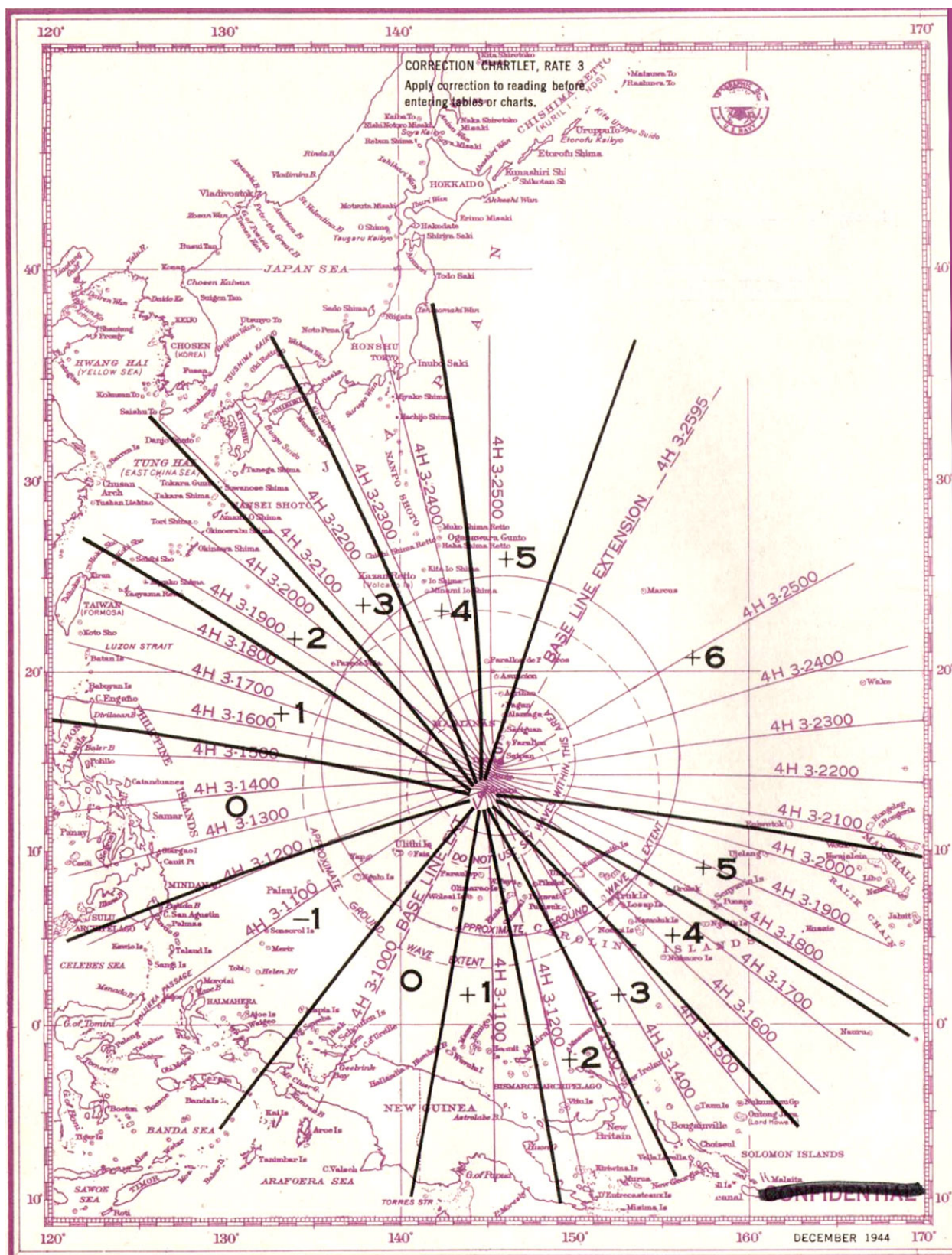


Figure 48: Location of LORAN radio signal center and the associated navigational headings (image by author)



concrete is 9in (23cm), ranging up to 11in (28cm) at a minimum, depending on subgrade soil type (United States Department of the Army 1944:225).

Based on the material differences between airdromes that could accommodate the B-29 versus any other type of aircraft, evidence of the type of vehicle that was used can be derived from the human-made changes to the landscape of Saipan. In examining the types of runways at Isley field, Kagman airstrip, Kobler field, and Marpi Point, it is possible to determine that airfields with surfaces of blacktop, asphalt and coral were able to accommodate the larger B-29, whereas, Kagman field, with a shorter and narrower runway constructed of bituminous macadam, could only handle use by aircraft lighter than the heavy bomber classification (United States Department of the Army 1944:44).

The terminal locations, where transportation vehicles were stored and their cargo modified or transferred to a different method of transportation, serve as the hubs of the communication landscape, based in the construction of structures to support the people who lived and worked there. Terminal features on Saipan included: hangars; refueling facilities; repair facilities; parking areas; railways; shops; personnel housing and messing facilities; recreational facilities; hospitals; dispensaries; sewage disposal; storage facilities for ammunition, general storage, fuel storage, refrigerated storage; training facilities; storage for armament not in the hands of troops; telephone facilities and switchboards; typewriter stations; cable connections; and water supply sources, storage for potable water and water distribution systems (Commander in Chief, Pacific Areas Command 1945:157–171). These features can be seen in plans for the construction of these airdromes (see Figures 50, 51 and 52).

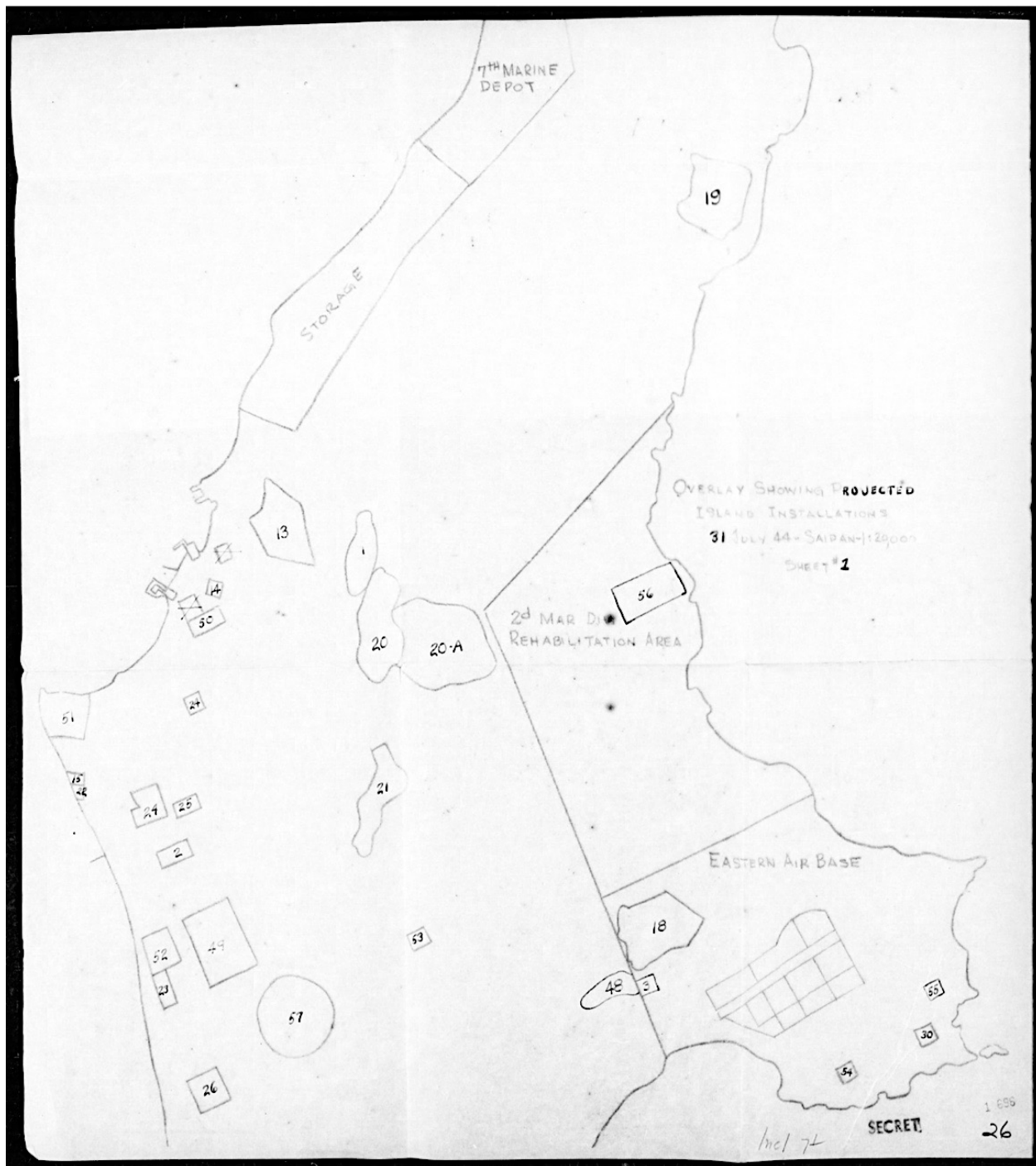


Figure 50: Planned locations for aviation-related facilities on northern end of Saipan (NARA RG 38 Reel A1844 MicroSN 139054 1944a:26)

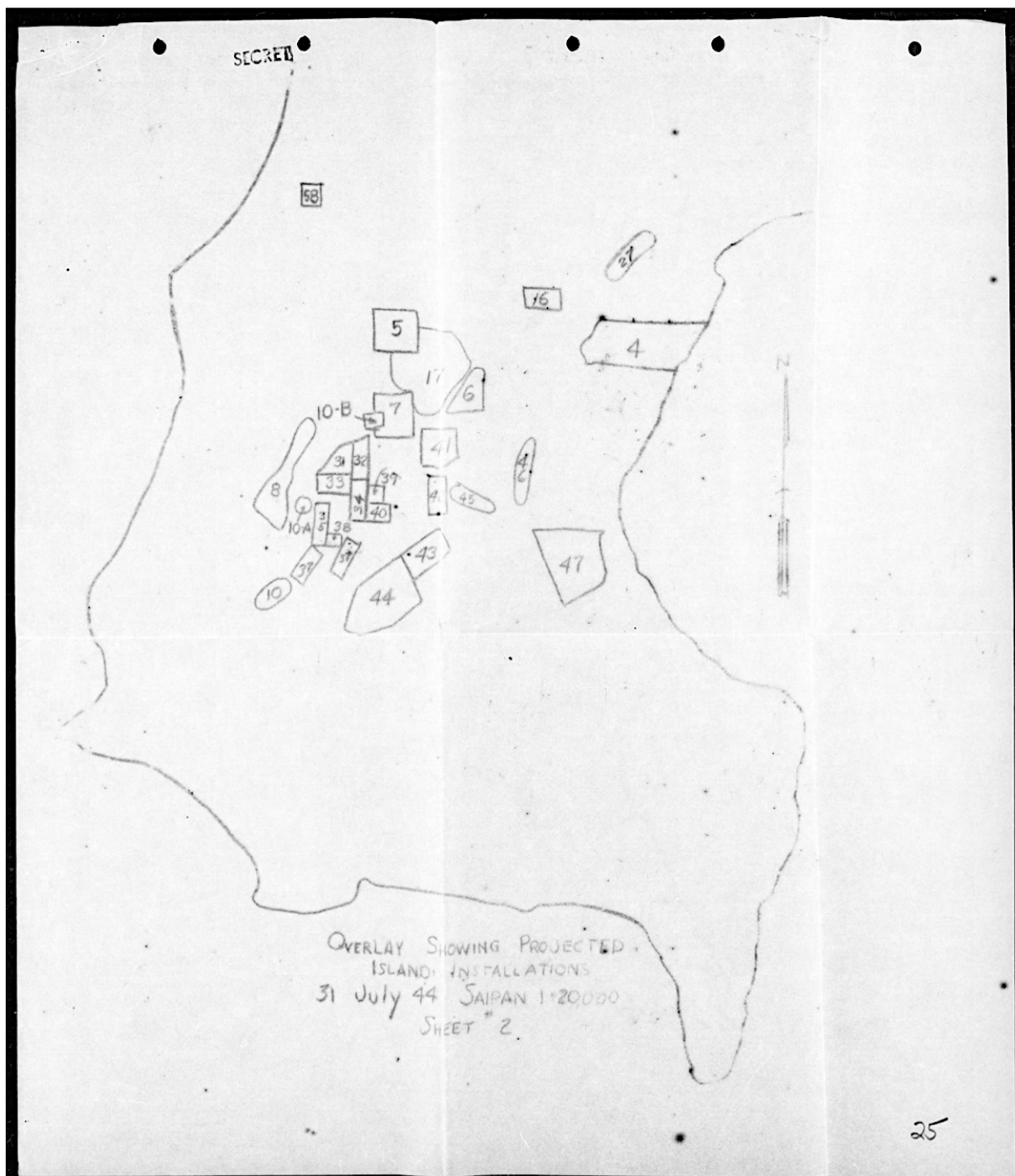


Figure 51: Planned locations for aviation-related facilities on southern end of Saipan (NARA RG 38 Reel A1844 MicroSN 139054 1944b:25)

LEGEND
TO

SECRET

IDENTIFY PROJECTED INSTALLATIONS FROM AN OVERLAY

NO.	INSTALLATION
1.....	149th Gen. Hosp.
2.....	ASP No. 2
3.....	ADC Radar
4.....	249th Sta. Hosp.
5.....	QM Bakery
6.....	American Cemetery
7.....	QM Oil Dump
8.....	QM Dump Class I, II, & III
9.....	7th Marine Field Depot
10.....	ASP No. 1
10-A.....	ASP No. 1-a
10-B.....	ASP No. 1-b
11.....	Grpms 8 Port Pool
12.....	Officers Grpms 8 & Port Pn
13.....	Port Pn. Housing Area
14.....	Grpms 8 Housing Area
15.....	CNS Shops
16.....	80th AAA Op Hq.
17.....	QM Dump Class I & II
18.....	QM Dump Class I & II
19.....	QM Dump Class I & II
20.....	ASP Hq Area
20-A.....	Area for Expansion of ASP
21.....	Radio & JCC Antenna
22.....	Ord Shops
23.....	CNS Storage
24.....	Magas Dist Point & Drum Storage
25.....	Magas Tank Farm
26.....	Ord Storage
27.....	Avgas Tank Farm
28.....	Radio Range
29.....	R.E.C.P.
30.....	Visual Station
31.....	Wing Hq
32.....	V.L.R. Sq
33.....	V.L.R. Sq
34.....	V.L.R. Sq
35.....	V.L.R. Sq
36.....	V.L.R. Sq
37.....	V.L.R. Sq
38.....	C.O. Hq for 35, 36, & 37
39.....	C.O. Hq for 32, 33, & 34
40.....	Photo Sq VEH
41.....	Av. Truck Co. Area
42.....	Photo VLR
43.....	Misc. Service Troops
44.....	2 Av. Engr. Bn.
45.....	Av Gas Tank Farm
46.....	Av Gas Tank Farm
47.....	Housing Area for 2 Serv. Ops. V.L.R.
48.....	Tank Farm Avgas H-10-C
49.....	Engr. Base Id.
50.....	Engr. Salvage Co.
51.....	QM Salvage Co
52.....	QM Truck Co
53.....	Radio Teletype
54.....	Sig. Sta. Navy
55.....	STO Radar
56.....	JCC Area
57.....	Hosp Area
58.....	Signal Dump

24

Figure 52: Legend to accompany planned locations for aviation-related installations on Saipan
(NARA RG 38 Reel A1844 MicroSN 139054 1944c:24)

The outer resource landscape consists of the manufacture sites for all war goods that traveled through Saipan. For aircraft, these sites include the aircraft part manufacturing plants, the aircraft assembly plants, the bomb manufacturing plants, aircraft engine manufacturing plants. For the entirety of the airscape, these locations include places where aircraft operations support resources were created, such as food for the personnel who worked in the airfield, the metals that were used to construct temporary structures, and the grading equipment that was used to construct the airfield. The individual resources of the outer resource landscape are virtually infinite, and thus outside of the scope of this study; however, in order to understand the overarching functionality of an airscape, the outer resource landscape must be included and kept in mind.

The toponymical landscape for the B-29, a highly-specialized piece of equipment is much more a landscape of knowledge. As a metaphysical landscape, it will be discussed as an idea, and not represented in three-dimensional space. The knowledge of emergency procedures, flight routes, weather patterns, tricks and strategies all contribute to an understanding of the behavior of individuals in the airscape. Sources such as the XX Bomber Command Combat Crew Manual provided invaluable information about the importance and effectiveness of training, the process of planning a mission, the roles and obligations of the airplane commander, the flight engineer, the navigator and the gunners, the current intelligence known about Japan and the tactics of the Japanese military, emergency procedures, typical weather conditions, survival in various environments, and the medical aspects of combat (XX Bomber Command 1944:3–5). In addition to the information that was provided by the military for strategic and effectiveness purposes, the toponymical landscape also includes the information that was casually passed among individuals. The sharing of information among individuals, whether during times of recreation, or under more

formal circumstances, contributed to the landscape of knowledge.

The knowledge-based aspects of the toponymical landscape tangibly influence the use of avenues of approach and retreat in the battlescape. On a purely physical level, the avenues of approach and retreat for Saipan, beyond the ways and tracks of the transportation landscape, include basic concepts of flight. The avenue of approach for Isley Field on Saipan is so structured as to avoid collisions with other aircraft that might be landing at nearby airfields, as well as to avoid natural terrestrial hazards such as Mount Tapochau and Mount Fina Susu. The information that the air traffic control tower provided, when combined with the knowledge gained in training, resulted in the efficient movement of large numbers of aircraft through an aerodrome.

The great distances traveled by aircraft, especially long range bombers such as the B-29, means that sources of observation and their associated fields of fire cannot be identified from the terrain. For aspects of the airscape that affect observation, the aircraft itself is a feature of the airscape that provides advantages in observation and fields of fire. For the B-29, ventral turrets and a higher altitude provided excellent opportunities for observation and fields of fire. Four gun turrets on the fuselage along with the tail turret enabled observation from all areas of the aircraft, including below the craft which previously acted as dead space (see Figure 53). Higher cruising altitude enabled the flight crew to see a farther horizon than aircraft at lower altitudes, enabling the US crew to see enemy aircraft before being seen by those enemy aircraft.

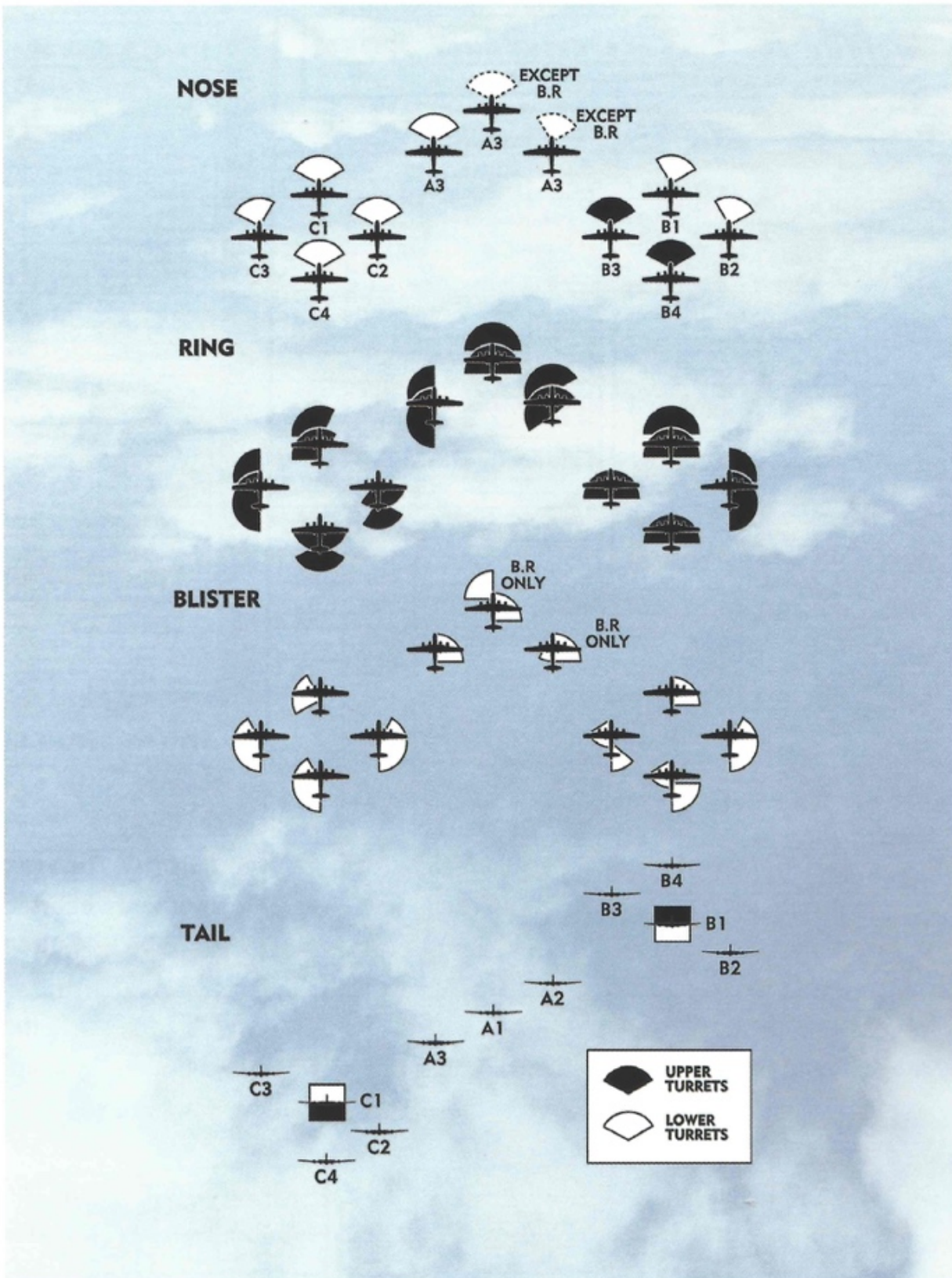


Figure 53: Observation capabilities of aircraft while in formation (Howlett 2015:139)

7.2 Conclusion

The aircraft wreck site on Mount Tapochau that was examined can be analyzed and understood in the context of the airspace that has been constructed. In the case of BuNo 44-83899, the aircraft with the most detailed RMA, the destination for the flight was Isley Field. The aircraft entered a right-hand traffic pattern around Isley Field on August 27, 1945 and established contact with the air traffic control tower. Inclement weather, a cloud ceiling of 500ft (153m) above ground level, inhibited the aircraft's ability to see the landing guide lights on Isley Field and led the pilot to adopt an incorrect avenue of approach for the airstrip. The elevation of Isley Field above mean sea level meant that when the control tower indicated that the aircraft should circle in the right-hand traffic pattern at 1800ft (549m) above mean sea level, the aircraft was actually only 300ft (92m) above the ground. This low ground clearance, when combined with poor visibility, contributed to the aircraft crashing into Mount Tapochau, an obstacle in the airspace.

The previously outlined airspace is spatially limited to the island of Saipan; however, the possible extensions of the airspace are endless. Future avenues for research include the extension of the LORAN airways of the time, constructing a map of the known locations of directional radio systems and the extension of their ranges throughout the Pacific theater of WWII. By plotting known aircraft wreck locations, the possibility exists for patterns to emerge. One possible pattern might be that aircraft wreck sites are located along LORAN directional beacons, indicating that pilots used LORAN beacons as "highways" to facilitate navigation.

The Boeing B-29 Superfortress, to this day, is remembered as a weapon that changed global politics. The heavily accelerated production and testing program, the ground-breaking flight capabilities, and the use of the atomic bomb all made this aircraft exceptional. From the

perspective of the air crew who flew these planes, the success of their missions was closely tied to the airspace within which they operated. As they taxied across the tarmac, and raced down the runways of the Mariana Islands air bases, they were making history.

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Appendix A: Survey GPS Points

Island Survey – Saipan	Latitude/Longitude Coordinates
Isley Field	
Japanese Power Plant Facility	N15° 7.480' E145° 43.774'
Japanese Oxygen Generating Plant	N15° 7.478' E145° 43.791'
Bomb Magazine	N15° 7.427' E145° 43.655'
Japanese Administration Building	N15° 7.489' E145° 43.726'
Japanese Air Raid Shelter	N15° 7.476' E145° 43.699'
Railroad Tracks	N15° 7.378' E145° 43.697'
Well Structure	N15° 7.380' E145° 43.686'
B-29 Hardstands	N15° 7.575' E145° 43.818'
Banzai Cliff	N15° 17.178' E145° 48.916'
Suicide Cliff	N15° 16.631' E145° 48.579'
North Field	N15° 16.424' E145° 49.212'
Japanese Rock Shelter Facility	N15° 16.951' E145° 48.332'
Japanese Gun Emplacement (north Saipan)	N15° 16.416' E145° 49.749'
Storage Cave Near Magicienne Bay	N15° 9.788' E145° 45.507'
Gun Emplacement Overlooking Magicienne Bay	N15° 9.719' E145° 45.545'

Island Survey – Tinian	
West Field	N15° 0.230' E145° 36.614'
Radio Antenna Platform on Mount Lasso	N15° 2.494' E145° 37.800'
Chulu Beach	N15° 4.348' E145° 36.965'
Pillbox on Chulu Beach	N15° 4.349' E145° 36.990'
North Airfield	
Runway Able	N15° 4.646' E145° 39.003'
Fuel Storage Bunker	N15° 4.899' E145° 38.243'
Atomic Bomb Loading Pit #1	N15° 5.021' E145° 38.039'
Atomic Bomb Loading Pit #2	N15° 5.013' E145° 38.091'
Japanese Air Administration Building	N15° 4.832' E145° 37.940'
Strafing Marks on Tarmac of North Airfield	N15° 4.780' E145° 37.983'

Archaeological Survey – Field Site	
Prop in Field	N15° 11.640' E145° 44.384'
Metal Disc	N15° 11.639' E145° 44.386'
Pipe Bushing	N15° 11.637' E145° 44.387'
Battery Cable	N15° 11.639' E145° 44.388'
Cylinder in Field	N15° 11.639' E145° 44.393'

Cowling in Field	N15° 11.635' E145° 44.397'
Ryan Aeronautical Debris	N15° 11.639' E145° 44.417'
Misc A	N15° 11.635' E145° 44.401'
Misc B	N15° 11.639' E145° 44.415'
Misc C	N15° 11.636' E145° 44.420'
Misc D	N15° 11.635' E145° 44.426'
Misc E	N15° 11.634' E145° 44.431'
Misc F	N15° 11.632' E145° 44.437'
Misc G	N15° 11.632' E145° 44.440'
Misc H	N15° 11.633' E145° 44.441'
Misc I	N15° 11.644' E145° 44.435'
Misc J	N15° 11.643' E145° 44.432'
Misc K	N15° 11.641' E145° 44.431'
Misc L	N15° 11.639' E145° 44.433'
Misc M	N15° 11.637' E145° 44.425'
Misc N	N15° 11.631' E145° 44.427'
Misc O	N15° 11.632' E145° 44.410'
Misc P	N15° 11.641' E145° 44.371'
Misc Q	N15° 11.639' E145° 44.388'

Archaeological Survey – Jungle Site	
Wing	N15° 11.650' E145° 44.283'
Landing Gear	N15° 11.649' E145° 44.268'
Debris A	N15° 11.650' E145° 44.268'
Debris B	N15° 11.647' E145° 44.268'
Debris C	N15° 11.648' E145° 44.268'
Flaps Hinges	N15° 11.647' E145° 44.271'
Cylinder Head	N15° 11.646' E145° 44.268'
Struts	N15° 11.647' E145° 44.271'
Engine With Prop	N15° 11.648' E145° 44.264'
No Prop Engine	N15° 11.643' E145° 44.245'

Appendix B: Island Survey Photographs



Figure 1: Water holding tank behind power plant facility, Isley Field, Saipan (Photograph by Author)



Figure 2: Muffler outside of power plant facility, Isley Field, Saipan (Photograph by Author)



Figure 3: Air dryer in oxygen plant, Isley Field, Saipan (Photograph by Author)



Figure 4: Oxygen storage reservoir in oxygen plant, Isley Field, Saipan (Photograph by Author)



Figure 5: Water cistern behind oxygen plant, Isley Field, Saipan (Photograph by Author)



Figure 6: Tram car way on top of bomb magazine, Isley Field, Saipan (Photograph by Author)



Figure 7: View of entry to bomb magazine from interior showing metal tracks in floor to open and close heavy double steel doors, Isley Field, Saipan (Photograph by Author)



Figure 8: Entry to bomb magazine with still-visible camouflage paint, Isley Field, Saipan (Photograph by Author)



Figure 9: Interior of bomb magazine showing metal tracks used to transport bombs within magazine, as well as concrete pillars used to support reinforced ceiling, Isley Field, Saipan (Photograph by Author)



Figure 10: Chimney vent from inside of bomb storage magazine, Isley Field, Saipan (Photograph by Author)



Figure 11: Chimney on bomb magazine, Isley Field, Saipan (Photograph by Author)



Figure 12: Old radio transmitter, Isley Field, Saipan (Photograph by Author)



Figure 13: Railroad tracks, Isley Field, Saipan (Photograph by Author)



Figure 14: Well structure near railroad tracks, Isley Field, Saipan (Photograph by Author)



Figure 15: The location of the former North Field on Saipan (Photograph by Author)



Figure 16: Ceramic shard characteristic of the time period of Japanese occupation, North Field, Saipan (Photograph by Author)



Figure 17: Modern car in same general area as ceramic shard, North Field, Saipan (photograph by Author)

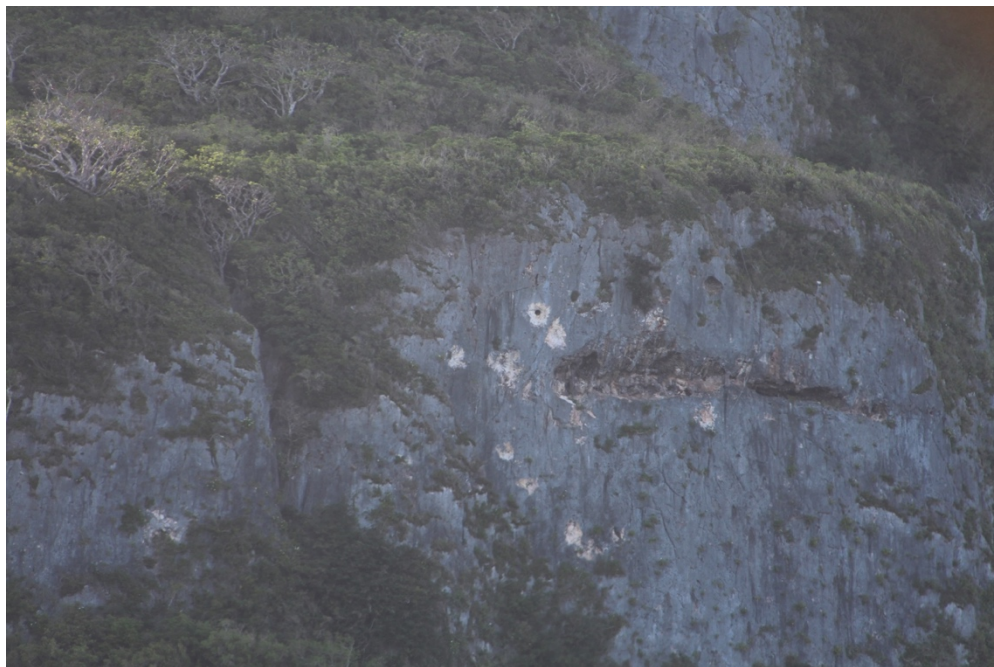


Figure 18: cliff face of Suicide Cliff, Saipan, featuring Japanese anti-aircraft emplacement and strafing marks from the Battle of Saipan (Photograph by Author)



Figure 19: Japanese rock shelter facilities included showers, Saipan (Photograph by Author)



Figure 20: Ceramic shard with typical Japanese patterning, Japanese rock shelter, Saipan (Photograph by Author)



Figure 21: Japanese military storage facility, Saipan (Photograph by Author)



Figure 22: Artifact scatter in one corner of the storage facility, Saipan, including shoe-sole and possible human remains (Photograph by Author)



Figure 23: Japanese gun emplacement on the northern end of Saipan (photograph by Author)



Figure 24: Interior of Japanese gun emplacement on Northern end of Saipan (Photograph by Author)



Figure 25: Entrance to cave near Magicienne Bay, Saipan, used for storage by Japanese during WWII (Photograph by Author)



Figure 26: Japanese gun emplacement overlooking Magicienne Bay, Saipan (Photograph by Author)



Figure 27: Entrance to Japanese gun emplacement overlooking Magicienne Bay, Saipan
(Photograph by Author)



Figure 28: Cannon inside gun emplacement overlooking Magicienne Bay, Saipan (Photograph by Author)



Figure 29: View of Magicienne Bay, Saipan, from Japanese gun emplacement (Photograph by Author)



Figure 30: Overgrown west field, Tinian (Photograph by Author)



Figure 31: Radio antenna platform, Tinian (Photograph by Author)



Figure 32: Panoramic view from antenna station, Tinian (Photograph by Author)



Figure 33: Chulu beach, Tinian (Photograph by Author)



Figure 34: Remains from invasion on Chulu Beach, Tinian (Photograph by Author)



Figure 35: Eastern end, looking west, runway Able, North Field, Tinian (Photograph by Author)



Figure 36: Japanese fuel storage facility, North Field, Tinian (Photograph by Author)



Figure 37: Japanese fuel Storage Facility interior showing damage from fire, North Field, Tinian
(Photograph by Author)



Figure 38: the first atomic bomb loading pit, North Field, Tinian (Photograph by Author)



Figure 39: the second atomic bomb loading pit, North Field, Tinian (Photograph by Author)



Figure 40: Strafing marks on tarmac, North Field, Tinian (Photograph by Author)

Appendix C: Archaeological Survey Images, Saipan



Figure 1: Photograph of field site showing grade of hillside, with propeller visible in foliage cluster (Photograph by Author)



Figure 2: Aircraft propeller in field site showing evidence of salvage or souvenir collection due to removal of the tip of the propeller blade (Photograph by Author)



Figure 3: unidentified metal pipe bushing in field site (photograph by author)



Figure 4: Unidentified metal disc debris in field site (Photograph by Author)



Figure 5: Unidentified piece of metal tubing, field site (Photograph by Author)



Figure 6: Partially buried metal fragments around edge of brush copse containing propeller blade identified by “Miscellaneous Q”, field site (Photograph by Author)



Figure 7: Battery Cable suspended from tree near propeller blade, field site (Photograph by Author)



Figure 8: Engine cylinder head under tree in field site with piece of metal resting atop it, field site (photograph by author)



Figure 9: Grenade located on northern side of tree near engine cylinder head in field site (photograph by Author)



Figure 10: Scaled photograph of overgrown engine cowling in field site (Photograph by Author)



Figure 11: Artifact identified as “MISC A” showing the mark of Boeing Company, field site (Photograph by Author)



Figure 12: Piece of plastic that could have been a piece of a window, field site (photograph by author)



Figure 13: Piece of metal bearing marking “Ryan Aeronautical”, field site (photograph by author)



Figure 14: Closer photograph of “Ryan Aeronautical” marking, field site (photograph by author)



Figure 15: Unidentifiable piece of aircraft in pile with Ryan Aeronautical metal piece, field site
(Photograph by Author)



Figure 16: Partially buried metal fragments oriented along an east-west axis identified as “Miscellaneous B”, field site (Photograph by Author)



Figure 17: Pile of debris at the base of a banana tree identified by “Miscellaneous C”, field site (Photograph by Author)



Figure 18: Scatter of metal shards identified as “Miscellaneous D”, field site (Photograph by Author)



Figure 19: Crumpled piece of metal identified as “Miscellaneous E”, field site (Photograph by Author)



Figure 20: Piece of fabric identified as “Miscellaneous F”, field site (Photograph by Author)



Figure 21: Piece of metal associated with fabric “Miscellaneous F”, field site (Photograph by Author)



Figure 22: Piece of metal with rivets identified with “Miscellaneous G”, field site (Photograph by Author)



Figure 23: Large piece of fabric identified as “Miscellaneous H”, field site (Photograph by Author)



Figure 24: Piece of metal with aircraft skin attached identified by “Miscellaneous I”, field site
(Photograph by Author)



Figure 25: Crumpled piece of aircraft skin identified as “Miscellaneous J”, field site (Photograph by Author)



Figure 26: Curved piece of metal identified by “Miscellaneous K”, field site (Photograph by Author)



Figure 27: Almost completely disintegrated metal identified by “Miscellaneous L”, field site (Photograph by Author)



Figure 28: Pile of metal debris identified by “Miscellaneous M”, field site (Photograph by Author)



Figure 29: Piece of fabric located at the base of a tree a piece of metal tubing or wire identified by “Miscellaneous N”, field site (Photograph by Author)



Figure 30: Piece of wire or metal tubing suspended in a tree over a piece of fabric identified by “Miscellaneous N”, field site (Photograph by Author)



Figure 31: Collected pile of debris near pineapple plants and with metal pole in the foreground identified by “Miscellaneous O”, field site (Photograph by Author)



Figure 32: Shards of plastic in the pile of debris identified as “Miscellaneous O”, field site (Photograph by Author)



Figure 33: Pile of metal debris identified by “Miscellaneous P”, field site (Photograph by Author)



Figure 34: Photograph showing heavily overgrown wing section at the Jungle Site (Photograph by Peter Harvey)



Figure 35: Overgrown wing, jungle site, showing Cabin air heat exchanger installation Part 15-12666 (United States Air Force 1950:86) (Photograph by Author)



Figure 36: Facing west, view of the underside of the overgrown wing section and potential landing gear wheels, jungle site (Photograph by Author)



Figure 37: Image of Oil System Hydraulic Shuttle on underside of wing section (United States Air Force 1950:85), jungle site (Photograph by Peter Harvey)

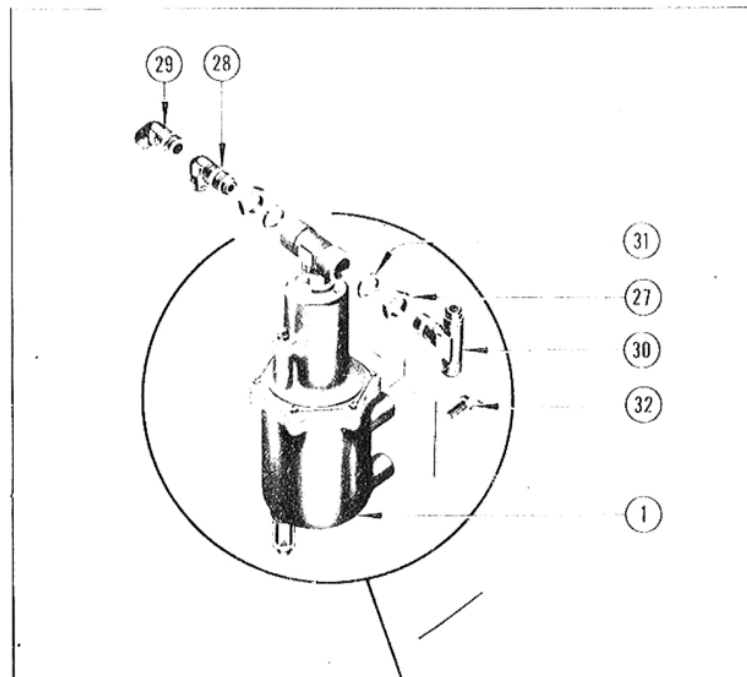


Figure 38: Showing the parts involved in the construction of a Hydraulic pump for the wing section (United States Air Force 1950:84)



Figure 39: Photo facing north showing fuel cell wall installations, jungle site (Photograph by Peter Harvey)



Figure 40: Tube assembly track support Part 8-2053 with wing flap tracks Part 14-2224 (United States Air Force 1950:15), jungle site (Photograph by Peter Harvey)



Figure 41: Flap track, image highlights the forward terminal of the flap track, Part 6-9923-2 (United States Air Force 1950:15), jungle site (Photograph by Peter Harvey)



Figure 42: Detail of wing spar, jungle site (Photograph by Peter Harvey)



Figure 43: Partially buried wing spars, jungle site (Photograph by Peter Harvey)



Figure 44: Piece of aircraft skin debris A, jungle site (Photograph by Author)



Figure 45: Disarticulated flap hinge, jungle site (Photograph by Author)



Figure 46: Hinge attachment point, jungle site (Photograph by Peter Harvey)



Figure 47: Cylinder head, jungle site (Photograph by Peter Harvey)



Figure 48: Piece of unidentified fabric, jungle site (Photograph by Peter Harvey)



Figure 49: Wing fuel tank wall (United States Air Force 1950:47), jungle site (Photograph by Peter Harvey)



Figure 50: Wing struts, jungle site (Photograph by Peter Harvey)



Figure 51: Engine with propeller still attached, jungle site (Photograph by Peter Harvey)



Figure 52: Propeller blade, jungle site (Photograph by Peter Harvey)



Figure 53: Engine with missing propeller, jungle site (Photograph by Peter Harvey)

