

Papahānaumokuākea

MARINE NATIONAL MONUMENT



Management Plan Midway Atoll Conceptual Site Plan

U.S. FISH AND WILDLIFE SERVICE · NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION · STATE OF HAWAII



VOL. IV



Midway Atoll Conceptual Site Plan

**VOLUME IV
MONUMENT MANAGEMENT PLAN**

**MIDWAY ATOLL NATIONAL WILDLIFE REFUGE
BATTLE OF MIDWAY NATIONAL MEMORIAL
PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT**

produced by

Jones & Jones Architects and Landscape Architects, Ltd.
Seattle, Washington

for the U.S. Fish & Wildlife Service on behalf of the
Papahānaumokuākea Marine National Monument Management Board

December 2008



TABLE OF CONTENTS

1 Vision		5 Midway Atoll Conceptual Site Plan	
Vision Statements	2	Introduction	48
Protected Area Mission and Purposes	2	Sand, Eastern, and Spit Islands Management Zones	49
Protections and Significance of Midway	3	Sand Island Conceptual Site Plan	50
2 Project Mission / Purpose and Process		Agency Research and Operations Facilities Concept	64
Monument Planning Context and Midway Atoll Conceptual Site Planning	8	Inner Harbor Concept	66
Description of Midway Conceptual Site Planning Process	10	Airport Welcome Center Concept	68
3 Site Overview		6 Priority Actions	
Site Analysis	14	Prioritization and Implementation	72
Challenges at Midway Atoll	29	Resources	
4 Midway Atoll Improvement Guidelines and Principles		Planning Documents	77
Goals	32	Selected References of the Draft Management Plan	79
Design Guidelines and Principles	32		
Management Zones and Site Zones	34		
Alternatives Considered	36		
A Model for Sustainability	38		
Summary of Midway Atoll/Sand Island Conceptual Site Model	42		



Midway Atoll Vision



1. Vision

VISION STATEMENTS

PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT VISION:

To forever protect and perpetuate the ecosystem health and diversity and Native Hawaiian cultural significance of Papahānaumokuākea.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE / BATTLE OF MIDWAY NATIONAL MEMORIAL VISION:

As part of the Papahānaumokuākea Marine National Monument, Midway Atoll is a unique and peaceful treasury of wildlife and history in the midst of the Pacific where nature rules, and the health of people, wildlife, and ocean are intrinsically connected. Native habitats and species dominate the Midway landscape, while remnants of the historic Battle of Midway are protected along with rehabilitated historic structures that support a cooperative interagency Monument field station. Coordinated management promotes ecological restoration, research, service-based tourism, and education to preserve and enhance this fragile island and coral reef system. Midway Atoll is the “window” to the Monument that offers people a rare opportunity to immerse themselves in the rich history, culture and ecology of the Northwestern Hawaiian Islands, a remote ecosystem of international significance. As a living classroom, Midway provides restoration and sustainability lessons for current and future generations worldwide to apply to their home communities.



Laysan albatross chick with parent

PROTECTED AREA MISSION AND PURPOSES

PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT MISSION:

- Carry out seamless integrated management to ensure ecological integrity and achieve strong, long-term protection and perpetuation of NWHI ecosystems, Native Hawaiian culture, and heritage resources for current and future generations.

MIDWAY ATOLL NATIONAL WILDLIFE REFUGE PURPOSES:

- “...maintaining and restoring natural biological diversity within the refuge;
- providing for the conservation and management of fish and wildlife and their habitats within the refuge;
- fulfilling the international treaty obligations of the United States with respect to fish and wildlife;
- providing opportunities for scientific research, environmental education, and compatible wildlife-dependent recreational activities; and
- in a manner compatible with refuge purposes, ...recognize and maintain the historical significance of the Midway Islands consistent with the policy stated in Executive Order 11593 of May 13, 1971.” (Executive Order 13022, October 31, 1996).

BATTLE OF MIDWAY NATIONAL MEMORIAL PURPOSE:

- “[S]o that the heroic courage and sacrifice of those who fought against overwhelming odds to win an incredible victory will never be forgotten.” (Secretary’s Order 3217, September 13, 2000)

All activities considered in this Conceptual Site Plan will be consistent with this mission and these purposes.



beach at Rusty Bucket

PROTECTIONS AND SIGNIFICANCE OF MIDWAY

On June 15, 2006, President George W. Bush issued Presidential Proclamation 8031, which designated and protected 139,792 square miles of emergent and submerged lands and waters in the Northwestern Hawaiian Islands as a Marine National Monument. It was renamed in 2007 by Proclamation 8112 as the Papahānaumokuākea Marine National Monument. This action significantly enhanced protection for the region's natural, cultural, and historic resources, and established one of the world's largest marine protected areas. Papahānaumokuākea Marine National Monument is administered jointly by three Co-Trustees – the Department of Commerce, Department of the Interior, and the State of Hawai'i – and represents a cooperative conservation approach to protecting the entire ecosystem. Co-Trustee agencies in cooperation with the Office of Hawaiian Affairs manage the Monument through the Monument Management Board. The Monument area includes the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, Midway Atoll National Wildlife Refuge/ Battle of Midway National Memorial, Hawaiian Islands National Wildlife Refuge, the State Seabird Sanctuary at Kure Atoll, and Northwestern Hawaiian Islands State Marine Refuge.

The Monument designation encompasses and maintains agency management responsibilities for all existing federal and state terrestrial and marine protected areas, including Midway Atoll National Wildlife Refuge (NWR). Midway Atoll NWR is administered by the U.S. Fish and Wildlife Service (FWS) and is part of the Hawaiian and Pacific Islands National Wildlife Refuge Complex, which consists of 19 refuges. The FWS began operating an "overlay refuge" on Midway Naval Air Station in 1988. Administration of Midway Atoll was transferred to the FWS in 1996. In 2000, the lands and waters of Midway Atoll NWR were designated as the Battle of Midway National Memorial.

Midway Atoll plays a key role as a staging ground for multi-agency field operations throughout the Monument and is critical to the operations of the State Seabird Sanctuary at Kure Atoll. Due to its accessibility by airplanes and large vessels, and its existing infrastructure, such as housing, offices, laboratories, and food service, Midway serves as an operational focal point for resource protection, management, research, and education activities in the northern section of the Monument. Additionally, considering Midway's facilities and public interest, the Presidential Proclamation establishes Midway as the only area within the Monument that can support a recreational visitor program. Midway's strategic location and physical assets also make it the ideal location to reinstate dive facilities for conducting shore based marine management in the northern atolls; enhance small boat facilities in support of seasonal enforcement operations; establish a marine research station and short term field school opportunities; and enable a more comprehensive study of maritime heritage resources particularly from World War II.

As one of the Northwestern Hawaiian Islands, Midway Atoll is representative of a remarkably unique and important marine ecosystem. Located near the northern end of one of the highest-latitude coral reef ecosystems in the world, it is bathed in relatively cold water for coral reefs, making it a vital case study in the global incidence of heat-induced coral bleaching. Part of a volcanically created and subsiding island chain, Midway is an example of atoll formation, a poorly understood geological process that can contribute to our understanding of the relationship between climate,



Midway House



Laysan albatross nesting

1. Vision

reef development, and carbon sequestration. Because of its remote location in the middle North Pacific, it is also an important node in the global network of ongoing biogeographical and oceanographic research.

Due to its geographic isolation, Hawai'i in general has a very high percentage of endemism, or occurrence of species that are found nowhere else in the world. Many of these species are threatened or endangered, often as a result of human activity; the isolation of the Monument provides them with a huge refuge habitat. Midway Atoll is host to a wildlife spectacle on land, including the largest colony of nesting albatrosses in the world. More than 20 species of seabirds – as many as 2 million birds – nest or rest at Midway. Finally, the Northwestern Hawaiian Islands are one of the last intact, predator-dominated coral reef marine ecosystems in the United States and the world, making it invaluable to scientists' understanding of marine ecology. It also hosts a high degree of marine endemism, reaching over 50% of fish biomass. The access to this remote ecosystem provided by the infrastructure at Midway enables unparalleled opportunity for studying these isolated marine ecosystems and for providing unique field study and comparative research opportunities.

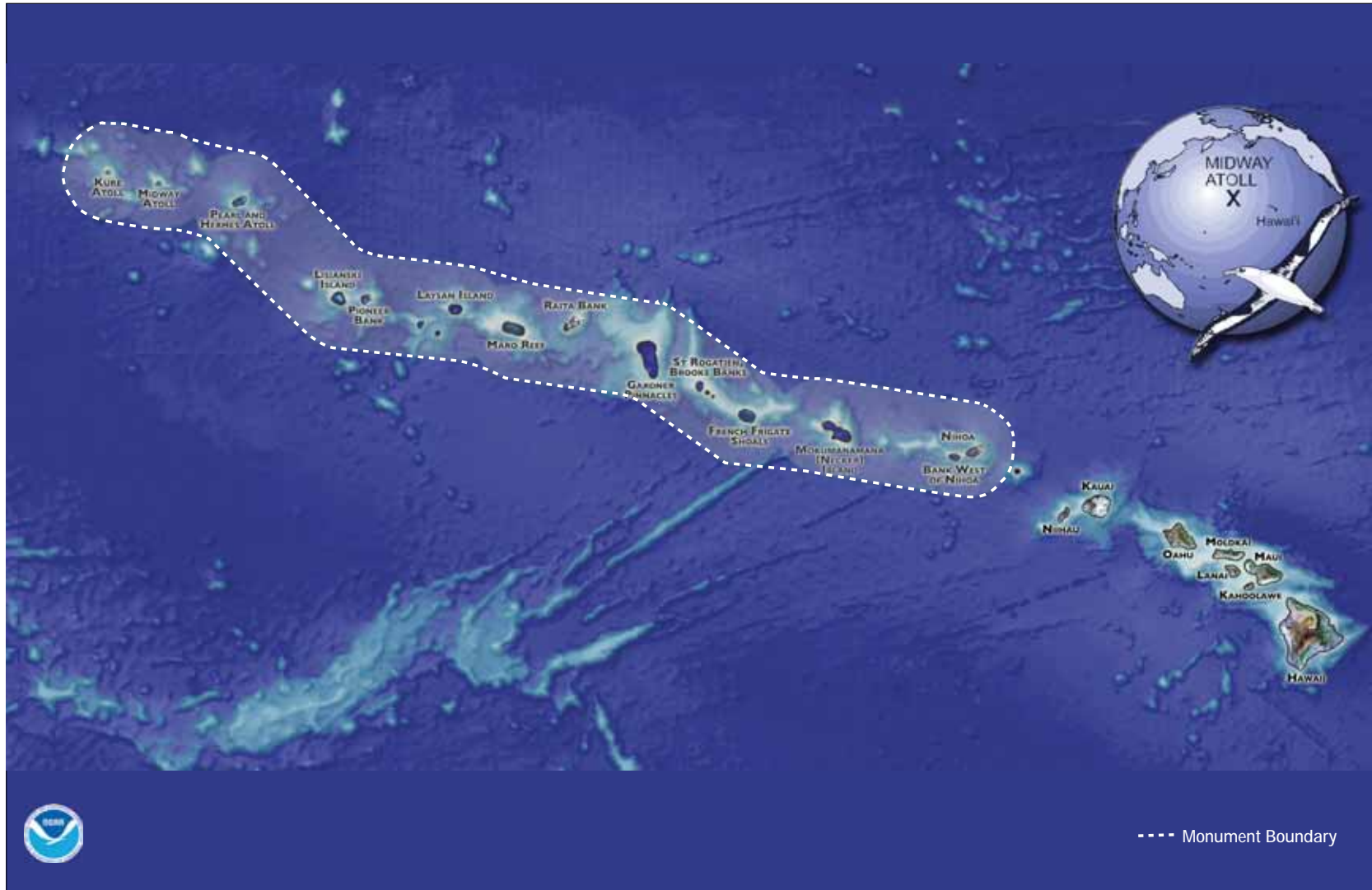
In addition to its rich assemblage of marine life, Midway Atoll contains numerous heritage resources that collectively tell the story of commerce, military, transpacific communication, and human modification of the atoll environment. Despite its small size and remote location, Midway's strategic location in the middle of the Pacific Ocean has drawn great attention over the last 100 years. Notably, Midway's pivotal role in World War II, commonly known as the "Battle of Midway," and the sacrifices of military personnel who fought at Midway, are memorialized in history. Today, Midway contains 63 existing historic properties eligible for the National Register of Historic Places; these include defensive structures, military architecture, both industrial and residential, and architecture from the Commercial Pacific Cable Company period (1903) and World War II period.

The designation of Midway as a special management area of the Monument elevates the atoll's significance regionally and globally. Midway will be a hub of Monument-wide management and operations, and the only atoll where visitors can experience the Northwestern Hawaiian Islands. Bringing people to the place in a way that does not diminish, but rather enhances, the integrity of Midway Atoll is beneficial to the Monument. Equally important is bringing the place to people who cannot visit, so that the valuable lessons and experiences of Midway reach across the world to local communities.

A key question is: How do we tell the amazing story of the natural, cultural, and historic resources of the Northwestern Hawaiian Islands and support Monument operations while preserving the atoll's character and integrity? The Midway Atoll Conceptual Site Plan offers the opportunity to re-envision the island as a powerful case study in how humans can and must live in balance with a delicate ecosystem over a long timeframe. This precept is a vital one where the atoll's remoteness and terrestrial isolation make a model of sustainability essential. In addition, Midway Atoll has a delicate ecosystem and is of a scale where our actions, both positive and negative, quickly have an enormous impact. Midway Atoll can provide a vital biosphere experiment in a natural setting, which if we learn to manage successfully, could become a model of how to take better care of the planet at large, and a great source of environmental public awareness.



Albatrosses and WWII gun battery on Eastern Island





Lumpy rice coral (Montipora turgescens)

Project Mission / Purpose and Process

2

2. Project Mission / Purpose and Process

MONUMENT PLANNING CONTEXT AND MIDWAY ATOLL CONCEPTUAL SITE PLANNING

MANAGEMENT PLANNING

The Monument Management Board recently completed a Monument Management Plan. To aid in development of the Central Operations and Coordinated Field Operations portions of the Monument Management Plan, the Co-Trustee agencies initiated two successive detailed planning processes. The first endeavor was a Papahānaumokuākea Marine National Monument requirements planning process designed to identify the agencies' existing assets and future infrastructure requirements Monument-wide. This present document, the Midway Atoll Conceptual Site Plan, is the result of the second endeavor. With the full range of agency goals, requirements, and constraints articulated for Midway in the Papahānaumokuākea Marine National Monument infrastructure requirements planning process, the Midway Atoll Conceptual Site Plan focuses with increased specificity on the required infrastructural and operational changes, offering a range of redevelopment options and solutions.



Sea turtles resting on beach

PAPAHĀNAUMOKUĀKEA MARINE NATIONAL MONUMENT REQUIREMENTS ASSESSMENT AND PLANNING

An important first step in effective site planning is the identification of existing assets alongside current and future field operational requirements. A multi-agency infrastructure requirements planning process took place over the course of six months in 2007, providing a general outline of people, programs, assets, and operations associated with the Monument. It summarized the functions and numbers of personnel along with the types of supporting facilities required at each location within the Monument. Those requirements were then combined to define a "Monument level" requirement at each location.

Recommendations from the requirements planning process guided development of this Midway Conceptual Site Plan. Specifically, the process identified the need for two consolidated operational strategies to be developed: one for Midway and one for the remaining locations within the Monument. The operational strategies will identify the needs of each agency, identify resource-sharing opportunities, and include mutually agreeable cost-sharing guidelines. Agencies are working to develop cooperative agreements that meet these needs.

One goal of the site and operational strategies is to promote a sustainable agenda. The Monument Management Board is working to adopt an aggressive, measurable goal to reduce conventional fuel consumption through a combination of conservation, green architecture, and renewable energy.



white tern

SCOPE OF MIDWAY ATOLL CONCEPTUAL SITE PLAN

Midway Atoll is a hub of operations for all State and federal agencies conducting Monument resource protection, management, education, and research activities. It is the only location in the Monument that allows for recreational visitor experiences. All of these activities occur in an environmentally and historically sensitive area. As such, Midway requires careful and thoughtful conceptual site planning and development to ensure that our current vision for the Atoll's use and management over the next 15 years and beyond is aligned with the mission of the Monument, the purposes of the National Wildlife Refuge and the Battle of Midway National Memorial, and the mission of the National Wildlife Refuge System. Since Midway is the primary hub for agency activities and visitor programs within Monument boundaries and contains the most existing infrastructure, it is important that the conceptual site planning begin here. The lessons drawn from the development of this plan will result in a better process to plan for and coordinate all site infrastructure and field operations needs throughout the Monument to ensure that natural, cultural, and historic resources are minimally impacted, and critical resource protection, management, and research needs and requirements are addressed.



FWS Planning Team members on Sand Island

The Midway Atoll Conceptual Site Plan builds on the results of the Monument requirements planning process and the extensive infrastructural repair work that has taken place at Midway over the past 10 years. Since 2003, the Fish and Wildlife Service has implemented recommendations proposed by the Infrastructure Condition Assessment and Modification Report for Midway Atoll National Wildlife Refuge, commonly referred to as the “right-sizing” plan. When the Monument was established in 2006, it was necessary to revisit previous decisions and consider new interests and needs for managing the Northwestern Hawaiian Islands. With the designation, Midway Atoll and the rest of the Northwestern Hawaiian Islands were elevated to a status of national and global significance and public recognition. Under this plan, the Monument Management Board's goal is to protect and enhance the natural, cultural, and historic resources of Midway, while enabling more effective resource management and response to the northern Monument and providing opportunities for the public to experience its lessons and become champions of these special marine ecosystems of the Pacific.



2. Project Mission / Purpose and Process

DESCRIPTION OF MIDWAY CONCEPTUAL SITE PLANNING PROCESS

Midway Atoll conceptual site planning began in Spring 2007 occurring in tandem with the Marine National Monument management planning effort.

Staff and consultants conducted site analysis, document review, workshops, and mapping to identify primary issues and goals specific to Midway design and planning. Key design guidelines and preliminary building programs based upon biological constraints and historic preservation objectives were developed. The team facilitated a workshop in July 2007 to present preliminary concepts and receive input from management partners.

Based on the workshop findings, the Planning Team refined the Midway Atoll alternatives and the preferred site alternative. The draft Midway Atoll Conceptual Site Plan Report was produced and reviewed in three cycles by FWS and the Monument Management Board. The Midway draft report was included within the Draft Monument Management Plan as Volume IV, and distributed for public review. The comments received regarding the draft conceptual site plan and draft management plan (Volume I) regarding Midway were taken into consideration in finalizing this plan.



This Midway Atoll Conceptual Site Plan should be considered as a conceptual document, not as a definitive operational plan or design blueprint. Much more work, including engineering studies, architectural drawings, and specific environmental analyses, will need to be completed prior to construction activities. Even so, this document provides an atoll-wide overview that will guide us into the future. The conceptual plan will be reviewed every five years as part of a review of the overall Monument Management Plan.



Midway Atoll supports the largest colonies of Laysan and Black-footed albatrosses in the world





Site Overview



3. Site Overview

SITE ANALYSIS

Located near the far northern end of Papahānaumokuākea Marine National Monument, Midway Atoll is approximately 1,250 miles northwest of Honolulu, Hawai‘i. The second oldest coral atoll in the NWHI, Midway originated as a volcano approximately 27 million years ago. Midway Atoll comprises an elliptical outer reef nearly 5 miles in diameter, 580,392 acres of submerged reef and associated habitats, and three flat coral islands totaling approximately 1,549 acres. Sand Island (1,117 acres) and Eastern Island (366 acres) are the two most prominent coral islands of the Atoll, while Spit Island is only about 15 acres in size. Sand Island contains the highest number of historic resources as well as all visitor facilities.



Midway Atoll is an unincorporated territory of the United States and is the only atoll/island in the Hawaiian archipelago that is not part of the State of Hawai‘i. Midway Atoll National Wildlife Refuge is owned and administered by the U.S. Fish and Wildlife Service (FWS) on behalf of the American people and has international significance for both its historic and natural resources.

Key Midway Atoll site issues are described on the following pages.

BIOLOGICAL

Midway Atoll’s plant and animal species are protected under several Federal laws, including the Endangered Species Act, the Marine Mammal Protection Act, and the Migratory Bird Treaty Act. Twenty-three species of plants and animals listed under the Endangered Species Act are known to occur in the NWHI. These include the Hawaiian monk seal, several turtle species such as the green and loggerhead turtle, whale species, Laysan duck, short-tailed albatross, and a half-dozen native plant species. Midway is also home to several endemic species, found only in Hawai‘i, that merit special protection and management efforts.

Midway Atoll consists of vast expanses of coral reef, sediment beds, and algal substrate that support a wide array of species unique to the Hawaiian Archipelago. The three small, low-lying islands are protected by encircling barrier reefs, and are marine in character: constantly under the influence of ocean weather conditions, susceptible to periodic inundation, and constructed from oceanic materials. The islands support birds and terrestrial wildlife that prey on marine species and contribute to nutrient runoff into the shallows. The interdependence between the land and nearshore waters intrinsically connects the welfare of all Monument wildlife to the health of both terrestrial and marine ecosystems. This simple and profound reality is the underpinning of the integrated approach taken by the Co-Trustees to managing the Monument.

Midway is one of the few remaining predator-dominated coral reef marine ecosystems, an anomaly among modern marine ecosystems, but typical of the Northwestern Hawaiian Islands (DeMartini and Friedlander 2006). Abundant populations of sharks, jacks, grouper, dolphins, and other “top predators” live at Midway Atoll.



endangered Laysan ducks



SAND ISLAND EXISTING CONDITIONS

MIDWAY ATOLL CONCEPTUAL SITE PLANNING

3. Site Overview

SITE ANALYSIS



1940s Officers' Quarters designed by Albert Kahn

Approximately 200 Hawaiian spinner dolphins rest within Midway's lagoon and forage outside its reef. Bottlenosed, striped, spotted, and rough-toothed dolphins may occasionally be seen in the open ocean, as well as beaked, pilot, and endangered humpback whales.



Spinner Dolphins

Almost 2 million breeding seabirds of 19 species make Midway one of the most important breeding areas of seabird conservation in the Pacific. Midway supports the largest nesting colonies of both Laysan and black-footed albatrosses in the world. Midway's breeding populations of white terns, black noddies, and red-tailed tropicbirds constitute the largest colonies in the Hawaiian archipelago.



Male frigatebird

HISTORICAL/CULTURAL

The first visitors to Midway Atoll were likely Polynesians/Hawaiians exploring the Pacific Ocean in deep-sea voyaging canoes. Although no physical evidence of their visits has yet been found, numerous oral histories and chants refer to distant low-lying islands with abundant birds and turtles providing record of Native Hawaiian knowledge and experience gained through these purposeful journeys. One Native Hawaiian name given to the atoll is "Pihemanu," which means "the loud din of birds." Today, Native Hawaiian history and cultural practices are a vital part of the Monument's management, and education and visitor programs at Midway provide important opportunities to feature the cultural significance of the Northwestern Hawaiian Islands alongside the natural and historic components.

Midway Atoll contains the most historic resources within the Monument. Numerous Federal laws, regulations, and policies mandate the protection and management of historic resources, including the National Historic Preservation Act of 1966, the Archaeological Resources Protection Act of 1979, and the Preserve America Executive Order of 2003 (Executive Order 13287). Historic resources at Midway Atoll include several sites, structures, artifacts, and places representative of the historic periods associated with early 20th Century transpacific communications and military operations. At Midway, there are four types of National Register eligible historic resources including:

1. a National Historic Landmark,
2. Cable Station, 3. Albert Kahn



Cable Station Building



Concrete pillbox on Sand Island

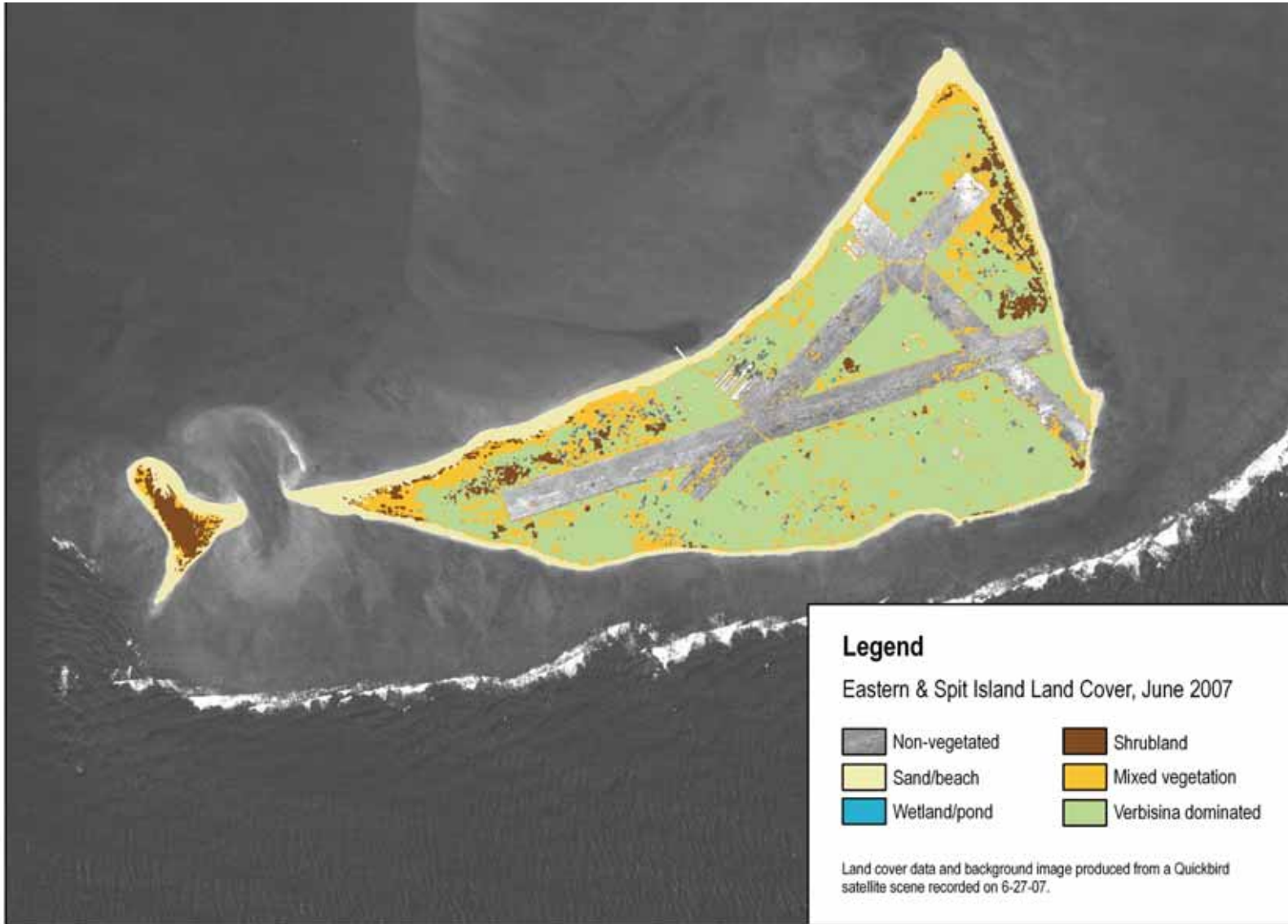
3. Site Overview

SITE ANALYSIS



SAND ISLAND LAND COVER MIDWAY ATOLL CONCEPTUAL SITE PLANNING





EASTERN AND SPIT ISLAND LAND COVER
 MIDWAY ATOLL CONCEPTUAL SITE PLANNING



3. Site Overview

SITE ANALYSIS

residential and industrial architecture, and 4. other historic elements, including Battle of Midway remnants not within the National Historic Landmark.

A Programmatic Agreement (1996) and Historic Preservation Plan (1999) were developed to guide management of the historic properties at Midway Atoll and will be updated to address preservation issues at Midway within the context of the recent Monument designation. The Midway Atoll Historic Preservation Plan focuses on long-term management and treatment for each of the 63 historic properties. It also identifies procedures for treating new discoveries and caring for museum collections, and includes recommendations for interpretation, education, and public outreach.

The Programmatic Agreement and Historic Preservation Plan prescribe one of six different treatment categories to the historic properties. The treatment categories are 1. reuse, 2. secure, 3. leave as-is, 4. fill in, 5. demolish, or 6. relocate. Many factors were used to determine the treatment category to which a historic property was assigned, including historic importance, interpretive value, overall setting, association with key historic themes, and structural integrity. Preservation treatment primarily focuses on adaptive reuse of the historic buildings; reconstruction is generally not viewed as an appropriate treatment.

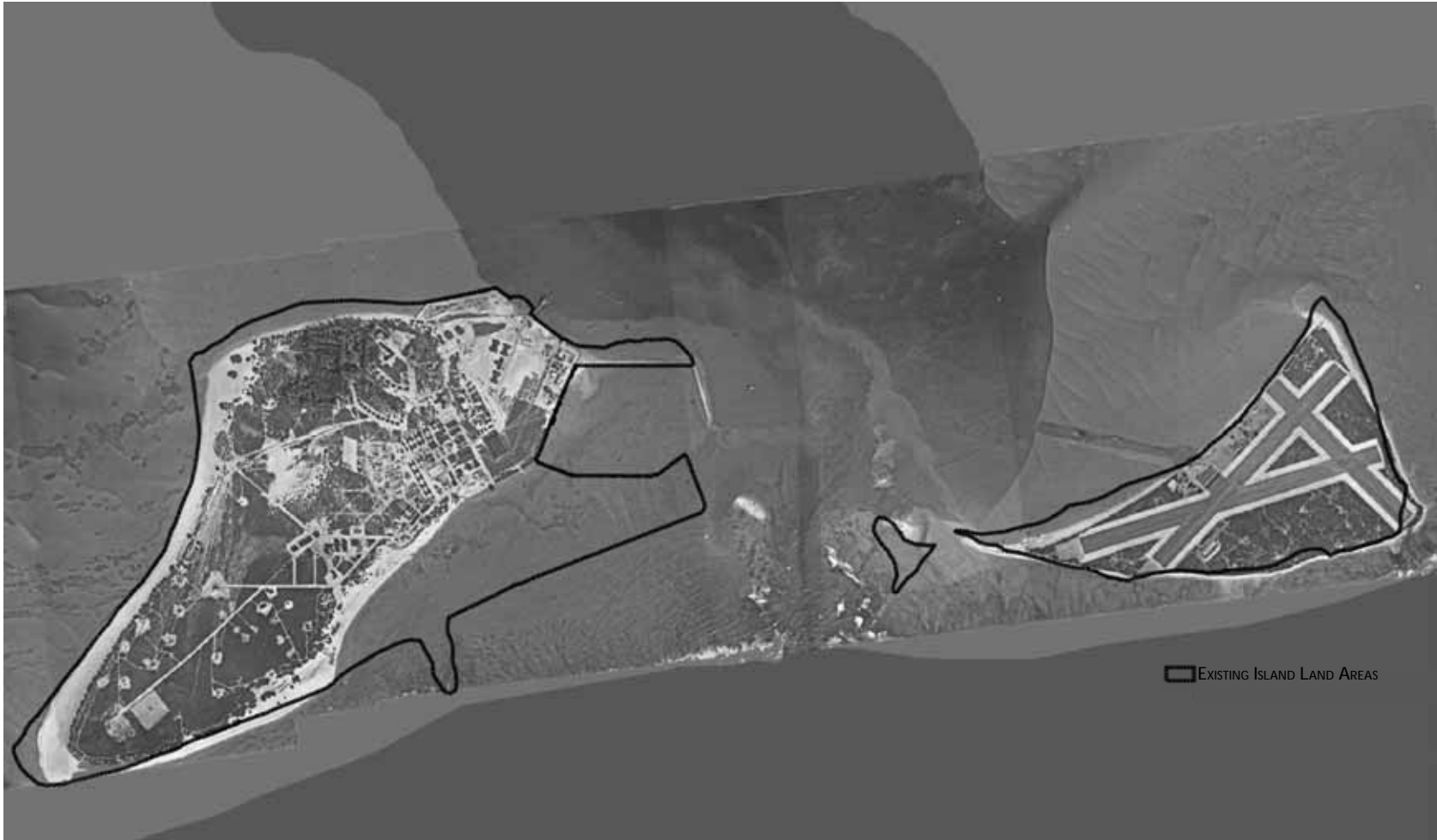


In 2007, a cultural resources team of the FWS Pacific Region conducted further evaluations and provided treatment recommendation for specific buildings. Several buildings are severely deteriorated (e.g., Cable Station) or require significant repair (e.g., Seaplane Hangar). The Cultural Resource Team’s recommendations were incorporated into the Midway Conceptual Site Planning process and are reflected in the Building Program and the Preferred Site Plan. Reuse of historic structures is a primary strategy that meets several goals: 1. repair and preserve historic structures, 2. avoid new development that would degrade historic landscape quality or wildlife habitat value, 3. meet agency operations and visitor needs, and 4. be cost-effective compared to new construction costs.

The historic properties require continual repair and maintenance according to the terms of the Historic Preservation Plan and the Secretary of the Interior’s Standards for the Treatment of Historic Properties. The effects of weathering and erosion by saltwater, salt spray, salty soils, precipitation, plant growth, termites, solar radiation, and wind continue to threaten the integrity of the historic properties at Midway Atoll. Additionally, lead-based paint must be removed from structures to eliminate a hazardous material that is extremely toxic to the albatross populations.

Submerged historic resources around Midway will require additional understanding and warrant further consideration in their management. A careful study of the wrecks in the lagoon and nearshore rim of the atoll will be conducted. The submerged items need to be accurately identified in order to establish their historical association and eligibility to the National Register. Two Midway maritime heritage sites associated with World War II, the USS Macaw and a World War II-era Corsair, have been preliminarily documented.





SAND, SPIT, & EASTERN ISLANDS HISTORIC CONDITIONS

MIDWAY ATOLL CONCEPTUAL SITE PLANNING



3. Site Overview

SITE ANALYSIS

UTILITIES AND OPERATIONS

Midway Atoll is so remote that it must operate independently as a small town. It operates its own power system, water treatment and distribution, facilities maintenance, sewage treatment, waste management systems, communications systems, and all the other operational necessities found in a small municipality.

DRINKING WATER SYSTEM

A new drinking water treatment system and distribution main were placed into service in October 2005.

The old system is no longer treated to drinking water standards and was left in place to provide firefighting water. This took care of the major public health-related concerns, but sections of the water delivery system need to be modified to complete the full system upgrade. The new treatment system is sized for a short-term maximum population of 200 persons at a per capita daily use rate of 100-gallons per day, totaling 20,000 gallons per day. However, the actual efficient operating capacity is much lower. A regular on-island population above 120 people will require added capacity.

Rainwater is collected in a pond, and then pumped to storage tanks. The new electrical grid was not extended to provide power for the rain water pumps. The pumps are grossly oversized for current needs and should be replaced with smaller units. Electrical power can be furnished by extending a new electrical grid, by installing a small generator, or by installing renewable energy systems. These pumps are operated infrequently, following significant rainfall events; thus a small portable generator may be an economical way to provide power.



Caterpillar electric generator

Stored rainwater is conveyed to the treatment plant via gravity flow through an existing pipeline. Gravity flow allows use of only about half the total stored volume of water. The total storage volume, approximately 12 million gallons, is greatly in excess of current use. Using a daily use rate of 20,000-gal, the system has about 300 days of water accessible via gravity flow. However, this same rainwater storage feeds the “old” water system. The old system leaks approximately 10,000-gpd, so that reduces the storage volume to approximately 200 days.

The existing pipeline that conveys untreated water to the plant is asbestos cement. This pipeline should be replaced. In addition, a small pump should be installed to pump stored water to the treatment plant, thus making the entire storage capacity available.

The new water distribution pipeline was connected to existing lateral service pipes at certain buildings through the core area of town (basically, from the FWS Office northward to the Clipper House restaurant). The distribution system would need to be extended to serve any newly constructed or remodeled facilities located outside the vicinity of the new water main.

The Inner Harbor area and the Cargo Pier area near the old fuel tank farm do not currently have drinking water service. Water that is available comes from the old system and is no longer potable. An evaluation will be conducted to determine whether these areas would be best served by new water pipes, new catchment systems, or left dry.

The Inner Harbor area and the Cargo Pier area near the old fuel tank farm do not currently have drinking water service. Water that is available comes from the old system and is no longer potable. An evaluation will be conducted to determine whether these areas would be best served by new water pipes, new catchment systems, or left dry.

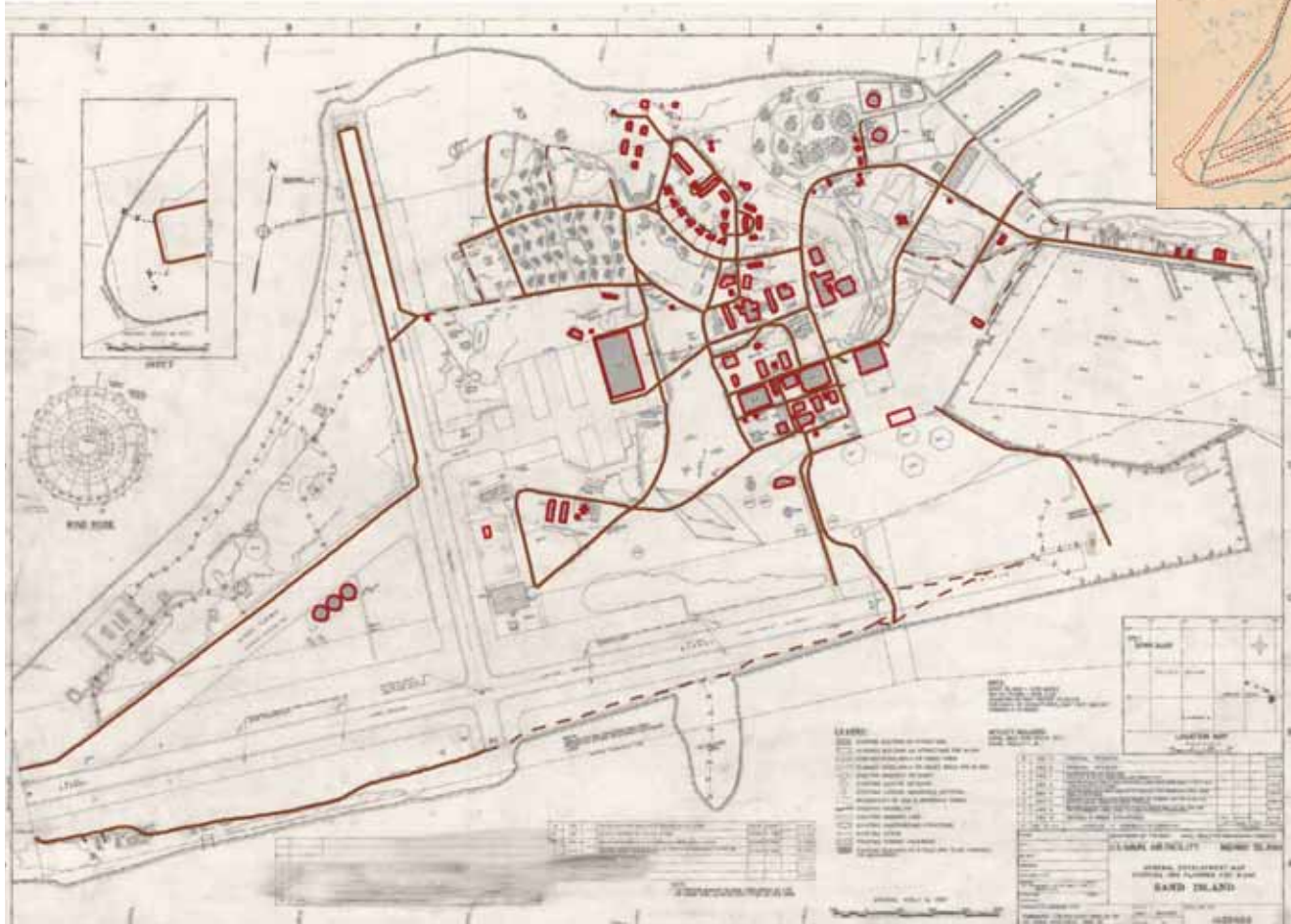


Water collection tanks



Water treatment facility

MAP OF SAND ISLAND C. 1964



MAP OF SAND ISLAND 1935

3. Site Overview

SITE ANALYSIS

ELECTRICAL GENERATION AND DISTRIBUTION

Electricity for the island is provided by combustion of JP-5 fuel in electrical generators. Two new electrical generator sets were installed to operate in an automatic duplex mode and were placed into service in approximately October 2005. These new generators were downsized from existing systems to better match generator capacity to connected load. For the most part, only one generator is needed to satisfy island electrical demand. When load exceeds the capacity of one generator, the second automatically comes on-line, automatically shutting off again when electrical demand reduces.

Maintenance activities can be accomplished on the “down” generator during that time. When the primary generator is due for service, the roles are switched and maintenance is then performed on the second generator. This style of engine-driven generator cannot be run continuously and must be periodically shut down for maintenance. Every few years, depending on operating hours, they must undergo a major engine overhaul. At that time, or whenever both smaller Caterpillar 3456 units are down, the system is run using the older, larger, but fully functional Caterpillar 3516 unit.

Current capacity for electrical generation is sufficient for existing population demand but nears maximum capacity during times of heavy load (summer). Existing and future projects will be evaluated with a goal to increase energy efficiency and transition to sustainable energy systems. The continuous adoption of energy conservation practices may increase the operational capacity of the existing electrical supply. If island population increases or electrical demand grows to require that two generators must run continuously, additional electrical generation would be necessary. This could be accomplished either by operating other existing generators or by installing sustainable energy



Electrical switch gear

generating devices such as solar water heaters, solar electric panels, incinerators, or gasification systems. The latter may also have the added benefit of using marine debris, solid waste, and alien species biomass to generate energy.

A new electrical distribution grid was constructed and placed into service in late 2006. The extent of this new grid was downsized in comparison to the existing old grid. The new grid was designed to supply electricity to only those facilities identified for future use, based on what was foreseeable in early January 2006. Facilities connected to the old grid are currently provided power through a backfeed to the old grid. The materials and equipment of the old grid are aged, in disrepair, and some are obsolete. As long as there are no failures in the old grid, all island facilities will continue to have electricity. When a failure occurs, it most likely will not be able to be repaired and all facilities connected to that portion of the old grid will go “dark.” The new grid does not extend services to the peninsula with the tug pier and finger piers, the old Fuel Farm area, or the large hangar. Either the new grid would have to be extended to serve any new developments or the facilities would be designed to generate their own energy. The same applies for any remodeled facilities that are currently connected to the old grid.

WASTEWATER SYSTEM

The current wastewater treatment and disposal system (central septic tanks with drainfield) is overloaded by storm water intrusion and suspected groundwater infiltration. A new sewer system and treatment and disposal system have been designed to meet a goal of efficiency and water conservation. The design serves only certain facilities located in the core area of town. Some work is being accomplished to eliminate storm water intrusion. Dispersed septic design as opposed to centralized septic is preferable for fitting smaller wastewater treatment clusters around sensitive habitat areas and avoiding bird nesting sites. Estimated construction cost of new wastewater system is approximately \$2 million. Implementation of a graywater utilization system and composting toilets will be considered with a goal of reducing demand on a wastewater system in new construction.

SOLID WASTE DISPOSAL

General waste is collected and burned in an incinerator when adequate waste fuel is available, or in an open air pit when fuel is not available. Ashes are buried in the existing small landfill/dump. Aluminum cans are collected, compacted, and periodically sent (via barge) to a recycling facility in Hawai'i. Glass is collected, crushed, and buried in the landfill/dump. There is no adequate system in place to deal with hazardous waste (asbestos and lead specifically). This issue will be addressed before any planned reuse, renovation, remodeling, or removal of existing structures takes place.



New fuel tanks lead industry in spill protection

An incinerator or gasification system that could burn the waste as fuel to generate power is the type of technology needed on Midway to handle the island's waste long-term. It could also be modified to burn marine debris collected throughout the Monument. Several such machines are under development in the U.S. at this time but none are currently commercially available. Development of such incinerators should be tracked as plans for Midway develop, since burning waste for power would be a powerful cost and carbon-emissions savings.

FUELING FACILITIES

Midway's fuel supply is delivered by barge approximately once a year. It is used to refuel aircraft, ships, and motor vehicles, as well as provide all of Midway's electricity. Roughly 65 percent of Midway's fuel is currently used to generate electricity.

A new modular fuel tank system became operational in October 2007. Storage capacity for fuel is currently 450,000 gal. That amount is anticipated to meet

FWS and Coast Guard annual fuel needs at present consumption levels. An additional tank for gasoline and a new fuels lab are scheduled for completion in late 2009. More fuel storage capacity will be installed to meet NOAA and State needs, largely for the operation of small boats and equipment for land-based marine research and management operations.

TELECOMMUNICATIONS

A new fiber optic distribution system was constructed during 2006/2007. The satellite antenna was relocated and partially refurbished in October 2007. Satellite service is in the process of being upgraded. These upgrades will only moderately improve telecommunications for the existing island population and are not designed to allow expansion of the system to additional customers. Any new offices/programs on Midway will have to invest in additional upgrades/additions to the system in order to meet their telecommunication needs.

In 2008 and in partnership with the Midway Atoll National Wildlife Refuge, NOAA's Office of National Marine Sanctuaries purchased an additional antenna for installation on Midway, including T1 speed communications capacity for education, outreach, and research purposes. In 2009 the link will be used for telepresence to classrooms and schools from Midway Atoll, and will provide capacity for remote wildlife viewing via wildlife cams in the near future. The new equipment will also provide emergency fail-over for existing satellite equipment in case the primary link goes down.

Due to its isolation in the North Pacific, Midway is an important location for many types of data collection. In order to realize its scientific, enforcement, and educational potential, Midway will require additional data transmission capabilities, such as Internet 2 links.



Satellite telecommunications

3. Site Overview

SITE ANALYSIS

AVIATION AND MARINE TRANSPORTATION

Midway Atoll is accessible by two transportation modes: aviation and marine vessel. Currently there is no visitor welcome area at either Henderson Airfield or the Inner Harbor.

Midway is used as a required emergency landing site for extended twin-engine operations (ETOPS) flights across the Pacific Ocean. Under current regulations, twin-engine aircraft must be within a maximum of 180 minutes from a Part 139 certified airfield in case of an emergency. Midway's 7,900-foot runway is capable of handling almost any type of aircraft.

Relatively few flights are conducted in the Monument, and most of them are to and from Midway Atoll. Henderson Airfield on Sand Island handled a total of 86 flights during 2007. Most of these, 51 flights, were by Gulfstream aircraft operated by Maritime Air, the charter company used by FWS/FAA. The next largest user is the U.S. Coast Guard, which had 18 flights to Midway in 2007. The remaining flights were a mix of military and civilian aircraft, most associated with special events held during the year. A new airport operations center was constructed southwest of the current hangar in 2007.



Most visitors arrive by plane to Midway Atoll



Cruise ships occasionally visit Midway Atoll NWR

Marine traffic in the waters around Midway Atoll primarily consists of research ships, merchant ships, and occasionally Coast Guard vessels, recreational boats, and passenger vessels. Midway Atoll receives day visitors mainly via a small number of vessels. Three passenger vessels visited Midway Atoll in 2004. In 2005, 2006, and 2007, one passenger vessel visited the atoll each year (Maxfield 2007 pers. com.). No passenger vessels visited in 2008. Due to port security requirements at Midway, when large passenger vessels do visit they offload passengers 3 to 4 miles outside the lagoon and transport them ashore in small boats.

POLLUTANTS AND TOXIC MATERIALS

Building Materials

All historic buildings on Sand Island contain hazardous materials such as lead-based paint or asbestos. These toxic materials pose health and safety concerns for humans and wildlife. Lead paint flakes are ingested by albatross chicks, causing growth deformities and mortality. Lead-based paint abatement is a high priority action for Sand Island structures.

No Dig/Landfill Areas

"No Dig" areas, found on both Sand and Eastern Islands, are Land Use Controls remaining from the closure of the Navy base. Areas identified for land use restrictions are former landfills or areas where contamination or solid waste was left in place at or below 4 feet from the surface. Restrictions were placed on these sites to avoid future exposure of humans or wildlife to potentially contaminated soil or groundwater. Human activities that expose potentially contaminated soil or groundwater within the site footprints would transfer the responsibility for the site from the Navy to FWS. Although the



Old fuel tanks located in "no-dig" area

contaminants are expected to degrade through time, the amount and rate of degradation are unknown. Therefore, these land use restrictions will remain in place in perpetuity to protect humans and wildlife.

One area on Sand Island that needs continued monitoring and potentially further remediation is known as the Old Bulky Waste Landfill. This site is an uncharacterized landfill that was created by the disposal of scrap metal, used equipment, and unconsolidated waste off the south shore of Sand Island to create a peninsula approximately 1,200 feet long by 450 feet (average) wide by 9 feet high (Navy 1995). It is surrounded on the three seaward sides by an approximately 10-foot-thick band of concrete and stone rip rap. Wastes known to have been deposited in the landfill are metals (lead, cadmium, chromium, and nickel), gasoline, battery acid, batteries, mercury, lead-based paint, solvents, waste oil, PCBs, dioxins, furans, transmission and brake fluids, vehicles, equipment, tires, and miscellaneous debris (BRAC SI 1996 vol. 1). The landfill was covered in approximately 2 to 2.5 feet of soil in an attempt to contain the waste. Currently the Old Bulky Waste Landfill is eroding, and the soil placed on top is sifting into the debris, causing large holes to open up around the edge and in the center of the landfill. Additionally, burrowing birds are bringing up buried soil and nesting below the cover. Over 500 bird burrows have been counted in the landfill.

Marine Debris

Marine debris accumulation on the reefs and beaches of NWHI is a staggering problem, and an estimated 57 tons of new debris enters NWHI on an annual basis (Dameron et al. 2007). Marine debris, especially derelict fishing nets and gear, plastics, and hazardous materials, is a severe chronic threat to shallow ecosystems such as Midway Atoll. It adversely impacts the endangered Hawaiian monk seal, threatened and endangered sea turtles, albatrosses, and other wildlife species which become entangled in or ingest these materials. Large masses of fishing nets degrade coral reef health by shading, abrading, or dislodging fragile corals or by preventing reef regeneration.

Over 15 agencies and partner groups have worked since 1996 to remove large accumulations of marine debris. The total debris removed from 1996 to 2008 in NWHI was 610 tons. Midway staff periodically clean the beaches and reefs to remove entanglement hazards and collect the ongoing accumulation of plastics, glass, and metal for eventual disposal in Honolulu, sent by barge at great expense. As discussed in the **Electrical Generation and Distribution** section, this cost may be defrayed through on-site incineration or gasification, generating electricity as a byproduct.

TERRESTRIAL ALIEN SPECIES

Human occupation and development at Midway Atoll has transformed the atoll since the Commercial Pacific Cable Company established its operation on Sand Island in 1903. The cable company attempted to make the “sand spit” as self-sufficient as possible through the cultivation of gardens and small livestock. Due to the lack of organic soil on the islands, barge loads of soil were brought from O’ahu and Guam, and contained not only the organic matter that made gardening possible, but also all the associated soil organisms such as ants, centipedes, fungi, and other nonnative species.

Additionally, trees and ornamentals were planted on Sand Island, such as ironwoods, eucalyptus, and acacia. So successful were these introductions that, by 1922, an estimated two-thirds of Sand Island was covered with imported vegetation. The black rat (*Rattus rattus*) was successfully exterminated on Midway in 1997; however, mice (*Mus musculus*), along with various species of ants, termites, wasps, ticks, and mosquitoes, continue to infest the island. Mosquitoes are of special concern as they are potential vectors for diseases such as West Nile virus, avian malaria, and avian pox. Termites have compromised most of the historic wooden buildings on Midway.



Tons of marine debris pollute Pacific Ocean and islands

3. Site Overview

SITE ANALYSIS

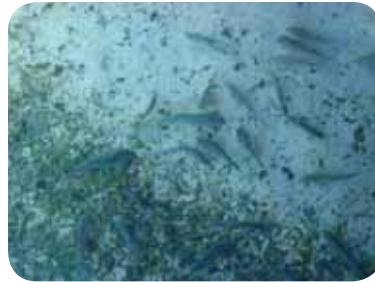
The number of alien land plants in the NWHI varies from only 3 introduced at Nihoa to 249 introduced at Midway Atoll. The level of threat from introduced plants also varies between species. For example, the invasive plant golden crownbeard (*Verbesina encelioides*) displaces all native vegetation in nesting areas, causing entanglement and heat prostration and killing hundreds of albatrosses each year (J. Klavitter, pers. com. 2007).

MARINE ALIEN SPECIES

Several alien species also threaten Midway's waters and reefs. One alien fish species and four alien invertebrate species are known to exist at Midway. One additional alien invertebrate species was found on a ship's hull at Midway and is thought not to be established at Midway. Although the ecological implications are unclear so far, at a minimum these species compete for resources with native species. Two of the invertebrate species have the potential to change the character of coral reefs where they become established.

Several other species have been identified as potential threats to Monument waters including Midway, having been documented in the main Hawaiian Islands or isolated locations in the Northwestern Hawaiian Islands. These include two fish species, one octocoral species, two algae species, and two invertebrate species. In particular the octocoral and algal species have the potential to alter the character of coral reefs where they become established.

Although marine alien species have been found at Midway, they are not believed to currently impact its infrastructure.



Fish school in Eastern Island shallows



Golden crown-beard is a major invasive plant

CLIMATE CHANGE AND SEA LEVEL RISE

Sea level rise is expected to have significant effects on the islands within Papahānaumokuākea Marine National Monument (Baker et al. 2006). Projected terrestrial habitat loss by 2100 among French Frigate Shoals, Pearl and Hermes Atoll, and Lisianski is expected to be 3 to 65% under a median scenario (48 cm rise), and 5 to 75% under the maximum scenario (88 cm rise). Spring tides would probably periodically inundate all land below 89 cm (median scenario) and 129 cm (maximum scenario) in elevation. Although Midway Atoll was not included in this study, Sand and Eastern Islands are more similar to Lisianski Island, which is expected to lose about 5% of its land area by 2100 (Baker et al. 2006). The environmental consequences of island inundation would likely be greater for Midway, with its buried toxic materials.

Changes in sea surface temperatures have been demonstrated to cause coral bleaching. Mass coral bleaching in the NWHI occurred in 2002, and was most severe in the three northernmost atolls, including Kure, Pearl and Hermes, and Midway. The occurrence of coral bleaching in the cool waters of the Northwestern Hawaiian Islands has been interpreted by some as indicative of climate change (Kenyon et al. 2006).

The measured increase of carbon dioxide in the atmosphere has been linked to ocean acidification, which slows the growth of coral reefs, and in some cases is predicted to dissolve them (Fine and Tchernov 2007). This is of great concern for Monument managers.



Shoreline access is restricted to protect wildlife



CS plane amid gooney birds

CHALLENGES AT MIDWAY ATOLL

Midway Atoll is a highly unique setting that presents tremendous challenges and issues that must be considered in all planning and design efforts. This Conceptual Site Plan, along with ongoing work by Co-Trustee and other agencies, begins to suggest some creative solutions to address these compelling problems. Some of the key challenges specific to Midway include the following points:

- Sand Island and Eastern Islands are highly disturbed landscapes greatly impacted by human use since the early 1900s. Dredging and filling of the land and water environments, nonindigenous plant and animal species introduction, and disruption of native species habitats are some indicators of the tremendous manipulation of the atoll.
- Global impacts adversely affect Midway Atoll's biological health. These adverse effects include marine debris accumulation (several tons of plastic washed up to shore annually), sea level rise, elevated sea surface temperatures, sea water acidification, and the possibility of changing ocean currents and wave patterns.
- Midway Atoll contains both historically and biologically unique features. Preservation and enhancement of the historic and ecological systems must be carefully evaluated from the lens of both perspectives.
- Carrying capacity is very limited on Midway Atoll due to its small land mass, sensitive biological and historic resources, and limited infrastructure. This capacity may be slightly increased, but human activities such as on the ground management and restoration activities, research, education, recreation, etc., must fit within this overarching constraint.
- Creative education and interpretation opportunities such as remote learning offsite, or sustainable tourism onsite, must be developed that help elevate public awareness while not creating impacts.
- Toxicity and hazardous materials cleanup at Midway Atoll is a major priority for ecological health, historic preservation, and public safety.
- Remote location of Midway Atoll creates impediments to transporting goods, materials, and people on- and off-island. Modes of travel to Midway and related logistical constraints are pivotal issues. Disposal and removal of surpluses or damaged items or materials is also problematic as the expense involved in proper disposal is prohibitive.
- High construction costs due to logistics
- Limited construction techniques
- Harsh climate conditions for materials
- Severely deteriorating buildings and infrastructure
- Limited staff and funding
- Development restrictions based on contaminants, historic conditions, and wildlife



Plastics ingested by albatross



Peeling lead-based paint



Deteriorated bulkhead on Inner Harbor



Midway Atoll Improvement Guidelines and Principles

4

4. Midway Atoll Improvement Guidelines and Principles

GOALS

Design and planning goals developed for Midway Atoll are aligned with the Papahānaumokuākea Marine National Monument Management Plan goals.

GOAL 1—Protect, preserve, maintain, and where appropriate restore the physical environment and the natural biological communities and their associated biodiversity, habitats, populations, native species, and ecological integrity.

GOAL 2—Support, promote, and coordinate research, ecosystem characterization, and monitoring that increases understanding of the NWHI, improves management decision-making, and is consistent with conservation and protection.

GOAL 3—Manage and only allow human activities consistent with Proclamation 8031 to maintain ecological integrity and prevent or minimize negative impacts for long-term protection.

GOAL 4—Provide for cooperative conservation including community involvement that achieves effective Midway Atoll operations and ecosystem-based management.

GOAL 5—Enhance public understanding, appreciation, and support for protection of the natural, cultural, and historic resources.

GOAL 6—Support Native Hawaiian practices consistent with long-term conservation and protection.

GOAL 7—Identify, interpret, and protect Monument historic and cultural resources.

GOAL 8—Offer visitors opportunities at Midway Atoll to discover and appreciate the wildlife and beauty of the NWHI, enhance conservation, and honor its unique human history.

DESIGN GUIDELINES AND PRINCIPLES

The Planning Team developed Design Guidelines and Principles that will inform appropriate design and planning efforts at Midway Atoll. These guidelines reinforce the key concept that Midway will become a “model of sustainability.” They provide the framework for preserving and enhancing Midway’s ecological and historic values in the course of implementing the Monument Management Plan at the Midway site-scale.

Several of these principles are mutually reinforcing, with each principle independently pointing to a common solution. For example, removing lead-based paint from historic structures removes a toxic substance that directly impairs wildlife and human health while preserving the historic integrity of these buildings. Adaptively reusing existing historic structures prolongs their life cycle and preserves their historic value while also meeting lodging, operations, research, and visitor services needs, simultaneously reducing the need for new construction that would adversely impact native species and habitat. Generating electricity with localized alternative energy devices to reduce carbon emissions and increase energy efficiency may save the cost of wiring the structure to the existing utility grids. Similarly, installing an incinerator or gasification system in order to avoid the high costs and carbon emissions of burning transported fuel reduces the need to ship much of Midway’s waste to Honolulu. Building new structures on existing concrete pads within the historic core/redevelopment zone helps to meet the “no net habitat loss” principle while also staying in character of Midway’s historic development patterns.

Design solutions such as these which meet several of the stated principles should permeate the Midway Atoll redesign plans. Midway Atoll is sufficiently small that opportunities exist to design ‘closed’ systems, minimizing required inputs, wastes, and operational costs.

Overarching design principles also include compliance with numerous Federal requirements, including those for accessibility such as the Rehabilitation Act of 1973 (as amended), Section 504 and 508; and the Architectural Barriers Act (ABA) of 1968.

PROTECT HISTORIC STRUCTURES & LANDSCAPES

- ✓ Protect, maintain, and interpret historic resources.
- ✓ Follow Secretary of the Interior Standards to protect and maintain buildings that maintain integrity and/or identified as historically significant and eligible for or listed on the National Historic Register.
- ✓ Follow Secretary of the Interior Standards to protect historic landscape features and characteristics
- ✓ Follow National Historic Preservation Act (36 CFR Part 800) to document historic buildings and structures that do not exhibit integrity and will be secured in place (building envelope is sealed) or demolished. Salvage materials and leave footprints or ruins for interpretation that are safe and compatible with wildlife.
- ✓ Explore adaptive re-use of historic buildings

PROTECT HABITAT & BIOLOGICAL RESOURCES

- ✓ Adhere to National Wildlife Refuge System principle "Wildlife comes first"
- ✓ Protect, maintain, enhance habitat and biological resources
- ✓ No net loss of habitat
- ✓ Construct new structures in footprints, building foundations, or pads of non-historic footprints
- ✓ Remove invasive species
- ✓ Protect nest sites
- ✓ Reduce high structures to minimize bird strikes
- ✓ New construction will not interfere with wildlife
- ✓ Remove pollutants (lead based paint, shore debris, toxic substances)
- ✓ Protect shallow water systems and reef sites
- ✓ Restore native habitat where feasible

ALTERNATIVE ENERGY SYSTEMS & WASTE REDUCTION

- ✓ Reduce consumption
- ✓ Use energy efficient strategies and alternative energy systems
- ✓ Consolidate power generators and power sources
- ✓ Construct new structures that are energy-efficient or generate own energy
- ✓ Recycle materials for construction or enhancement projects
- ✓ Evaluate the use of alternative fuels for transportation and equipment

OPERATIONS AND MAINTENANCE

- ✓ Address current and future maintenance needs
- ✓ Communicate management plan to staff, e.g., training in historic resource protection, biological resource protection
- ✓ Consolidate development (utilities, infrastructure, buildings)
- ✓ Appropriate infrastructure matched to current/new development and operations

SUSTAINABLE ARCHITECTURE & LANDSCAPE ARCHITECTURE

- ✓ Re-use existing structures that still have integrity
- ✓ Sustainable design (materials, energy, etc.)
- ✓ Recycle materials, e.g., scrap metal, glass, ropes, etc.)
- ✓ Construct pre-fabricated components off-site
- ✓ Apply Performance Standards for new construction
- ✓ Apply sustainable design standards such as LEED
- ✓ Use termite-resistant building materials

DESIGN AESTHETICS

- ✓ Maintain historic character
- ✓ Build new structures in the historic or tropical vernacular
- ✓ Reduce noise pollution
- ✓ Reduce light pollution

VISITOR USE & EXPERIENCE

- ✓ Limit human presence to appropriate visitation levels
- ✓ Zones of use (direct visitor uses while protecting wildlife and habitat)
- ✓ Regenerative design, e.g. hydroponic gardens
- ✓ Develop facilities to accommodate visitors
- ✓ Eco-tourism focus: wildlife/historic landscape immersion experience; interpretation/education
- ✓ Service and volunteer work opportunities offered to visitors
- ✓ Midway Site will be a demonstration model for sustainability
- ✓ Develop opportunities for people who cannot visit to learn about Midway Atoll (e.g., website, cam, online environmental data)

BUILD PARTNERSHIPS AND MANAGEMENT-DRIVEN RESEARCH

- ✓ Collaborative management and development (FWS/NOAA/State of Hawai'i)
- ✓ Develop new partnerships and alliances
- ✓ Corporate sponsorships
- ✓ Research opportunities



DECEMBER 2008

DESIGN GUIDELINES & PRINCIPLES

MIDWAY ATOLL CONCEPTUAL SITE PLANNING

4. Midway Atoll Improvement Guidelines and Principles

MANAGEMENT ZONES AND SITE ZONES

SAND ISLAND MANAGEMENT ZONES

The Planning Team delineated Management Zones for Midway Atoll, including Sand Island, Eastern Island, and Spit Island. These zones show the physical areas where specific management, planning, and development activities occur.

The zones are as follows:

Marine Protection Zone

Protected shoreline and marine habitat that supports bird, wildlife, and fish species, and their critical life activities such as resting, feeding, nesting, fledging, migrating, etc. No public access is allowed.

Revegetation/Habitat Zone

Midway Atoll is a highly disturbed system that hosts pervasive invasive plant species, toxic materials, and human development remnants that, taken together, have created significant adverse impact on indigenous species and their habitat. Most of the islands within Midway Atoll are designated as the Revegetation/Habitat Zone to focus efforts on restoring atoll habitat and enhancing species populations.

Beach Zone

Shoreline that is open to the public for passive recreation and educational activities such as walking, bird and wildlife watching, and beach viewing. Primarily this zone occurs on the north beach of Sand Island. No beach access is available on Spit Island, and the only access allowed on Eastern Island is via the boat dock.

Inner Harbor Zone

This zone includes the historic Inner Harbor and its associated shoreline, piers, and facilities. One of two approaches to the island (by boat or airplane), the inner harbor zone is critical to visitor arrival, transportation of services and goods, and water-based activities (e.g., ecotourism via passenger vessels, marine research, rescue operations, security).

Airfield Operations Zone

The Airfield Operations Zone on Sand Island comprises the active Henderson Airfield and includes the new operations center, the old hangar, the active runway, and inactive runway portions. One of two approaches to the island (by boat or airplane), the airfield operations zone is critical to visitor arrival, transportation of services and goods, and aviation activities (ecotourism via air travel, research, emergency operations, security).

Freshwater Protection Zone

The Freshwater Protection Zone is a large triangular portion of the runway area from which surface water is collected in the catchment basin and then pumped into the three freshwater storage tanks.

Historic and Primary Development Zone

The Historic and Primary Development Zone designates Sand Island's historic core and redevelopment area. It delineates an area that is highly significant in terms of historic development patterns on Sand Island related to the Cable Company historic period (early 1900s) and World War II historic period (1940s). Several historic structures and features are contained within this zone. Conversely, this zone indicates the primary area where development of new facilities or adaptive reuse of existing or historic structures is an appropriate activity.



Albatrosses and people



BEQ Barracks: replace with "green-designed" multi-plex units



4. Midway Atoll Improvement Guidelines and Principles

MANAGEMENT ZONES AND SITE ZONES

No Dig Areas/Landfill Zone

The “No Dig” areas are sites that contain contaminated soils or other materials, and cannot be built upon or otherwise disturbed. These sites include Old Bulky Waste Landfill on the south beach point, and the old fuel farm on the north beach.

The “No Dig” areas were designated in the Base Realignment and Closure process (BRAC) as Land Use Controls where digging below 4 feet is prohibited (or FWS assumes all responsibility). These areas, and several landfills, were determined to not necessitate further cleanup unless the controls were not effective. The Old Bulky Waste Landfill, however, is an example where the control is not sufficient and further remediation needs to be addressed through the BRAC process.

Sand Island Building Treatment and Site Zones

The Planning Team assessed site zones and building treatment opportunities within Sand Island’s Core Historic Zone. Evaluation factors included the following: 1. FWS historic treatment recommendations; 2. current and historic functions as well as potential future uses; 3. architectural and structural integrity; and 4. spatial organization of roads, operations, buildings, and landscape.



BOQ barracks



Cable Station building complex



Termite damage to structural roof members of historic Machine Shop

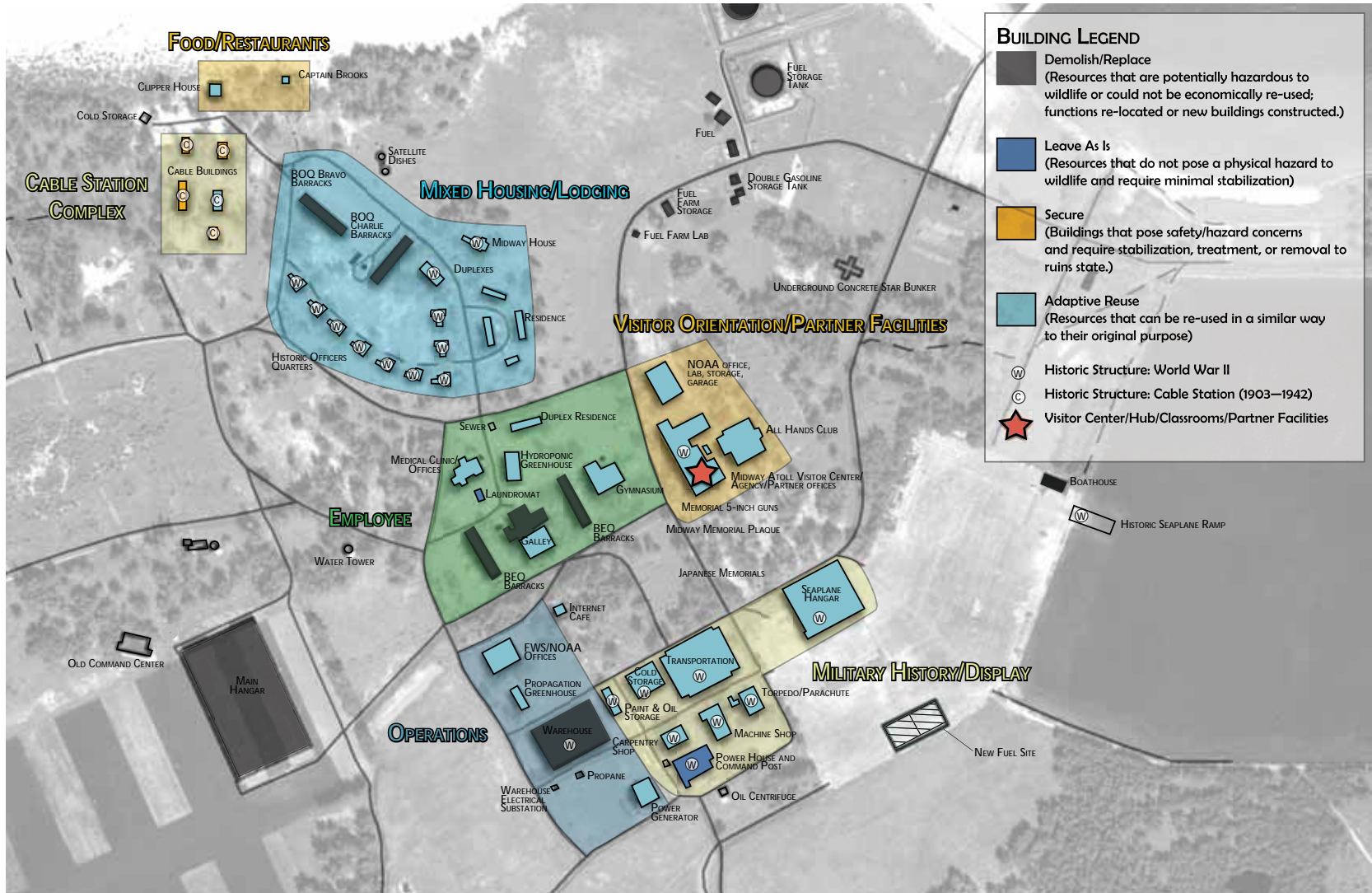
ALTERNATIVES CONSIDERED

In the draft conceptual site plan, three alternatives were considered. Based on that analysis and the public comments received, Alternative B, “Model for Sustainability” was selected for this final plan.

In brief, Alternative A would have maintained current management activities in place at Midway at the time of the Proclamation. Alternative C was focused on accelerated restoration of Midway Atoll habitat and species, as well as on historic preservation efforts. As much onsite treatment as possible would have occurred under Alternative C. Resources, staff, facilities, and programs would have been primarily dedicated to restoring Midway Atoll’s natural habitat and historic landscape to the highest functioning state over the next 15 years. The maximum overnight population would have increased to 180 persons, and ecotourists would have been replaced by volunteer service workers.



Officers' Quarters



BUILDING LEGEND

- Demolish/Replace
(Resources that are potentially hazardous to wildlife or could not be economically re-used; functions re-located or new buildings constructed.)
- Leave As Is
(Resources that do not pose a physical hazard to wildlife and require minimal stabilization)
- Secure
(Buildings that pose safety/hazard concerns and require stabilization, treatment, or removal to ruins state.)
- Adaptive Reuse
(Resources that can be re-used in a similar way to their original purpose)
- W Historic Structure: World War II
- C Historic Structure: Cable Station (1903–1942)
- ★ Visitor Center/Hub/Classrooms/Partner Facilities

4. Midway Atoll Improvement Guidelines and Principles

A "MODEL FOR SUSTAINABILITY:" INTEGRATED BIOLOGICAL, HISTORIC, AND VISITOR PROGRAMS (PREFERRED ALTERNATIVE)

This model, identified in the draft plan as Alternative B and the 'preferred alternative', provides an integrated approach for enhancing protection and understanding of biological and historic resources at Midway Atoll/Sand Island while providing a moderate increase in visitor services and interpretive, educational, and research programs and facilities. It also provides an operational hub for agencies within the Monument.

Resources will be allocated to elevating the programs and facilities in three areas: 1. biological protection, understanding, and restoration; 2. historic resource preservation and adaptive reuse; and 3. visitor education and interpretation.

Short-term overnight visitation will not exceed 50 people, while seasonal or long-term contractors and researchers will not exceed 100 people, thus totaling

no more than 150 people on any given night. The increased island population from the current regular capacity of 120 people will require enhancements in utility systems infrastructure. Up to three large groups of day visitors per year will primarily access the island via passenger vessel or aircraft, and generally no more than 400 people will be on-island at any one time.

New facilities and systems will utilize green design and energy principles. Midway's physical structures as well as interpretive and education programs will emphasize the atoll's sensitive resources and its role in worldwide resource conservation and human history.

Key activities implemented under this model include the following:

- Treat, stabilize, and clean-up all World War II-era historic buildings (e.g., rehabilitation, lead-based paint removal) to use for lodging, operations, and visitor services (approximately 18 buildings)
- Rehabilitate/repair Cable building #643 for interpretation. Partially dismantle other four Cable Station historic structures to ensure human and wildlife safety, leaving the concrete cores for interpretive purposes. Salvage recyclable materials such as windows and doors for use in Cable building #643
- Demolish B, C, and BEQ Barracks (4 buildings total) and replace in same footprint with smaller scale, energy-efficient multiplex units
- Construct low-impact-style shelters (< 200 sf) on existing concrete pad(s) or demolished building footprints as temporary lodging or ecotourism overnight facilities
- Reuse one Officers Quarters building as a hostel to accommodate overnight visitors
- Rehabilitate historic Midway Mall to serve as the new "Midway Atoll Visitor Center;" facility will be a multi-purpose center containing visitor facilities, multi-agency offices, and classrooms



Green turtle © James Watt

4. Midway Atoll Improvement Guidelines and Principles

A "MODEL FOR SUSTAINABILITY:" INTEGRATED BIOLOGICAL, HISTORIC, AND VISITOR PROGRAMS (PREFERRED ALTERNATIVE)

- Demolish nonhistoric structures or structures that do not meet the Secretary of the Interior Standards for historic preservation, and create habitat in vacated areas
 - Expand biological enhancement, marine management, and research programs as part of multi-agency and partnership effort
 - Plan, design, and build a marine laboratory/quarantine facility
 - Construct a Hawaiian monk seal captive care facility
 - Remediate all lead-based paint and other toxic materials related to structures, facilities, and soils that are creating exposure hazards to humans and wildlife within 15 years
 - Monitor landfills and, if necessary, enact further remediation within 15 years
 - Construct a new boathouse, dive center, and storage facility to facilitate marine-based activities
 - Expand the new fuel farm to meet Co-Trustee needs
 - Construct new ramp/boat dock near location of historic seaplane ramp
 - Construct two welcome facilities for visitors arriving by ocean vessel and by airplane
 - Replace and upgrade finger piers in the Inner Harbor
 - Expand drinking-water capacity to meet needs for 30 additional people
 - Expand sewage and solid waste disposal capacity
 - Install new satellite antenna for telepresence, remote wildlife viewing, and research use
- Benefits of implementing this model include:
- o Visitation volumes do not exceed Midway Atoll's carrying capacity
 - o No further net loss of biological and historic resources occurs
 - o Significant improvements are implemented to enhance biological and historic resources
 - o Midway's exceptional historic resources are preserved and interpreted
 - o Facilities and infrastructure are upgraded to meet projected lodging, operations, visitation, safety, and maintenance needs
 - o Several biological research and habitat initiatives are implemented, e.g., Hawaiian monk seal captive care facility
 - o Educational and interpretive program is greatly enhanced; public outreach and stewardship opportunities are actively promoted at local, onsite scale to global, remote scale
 - o Partnerships and coalitions encouraged under this site plan may attract more funding dedicated to biological and historic preservation activities on Midway and throughout the Monument, e.g., development of a marine lab or research station, programming for field schools and other education programs
 - o Sustainable low-impact development at Midway will serve as a model of sustainability for remote field operations fostering conservation, recycling, and reduction of fossil fuel use
 - o Facilities, whether renovated or new, will incorporate sustainable design principles to enable the reduction of fossil fuel usage
 - o Implementation of priority projects will enable Co-Trustee investment in the atoll, greatly enhancing the field operational capacity of the Monument overall



Midway Atoll provides important habitat for albatrosses

4. Midway Atoll Improvement Guidelines and Principles

SUMMARY OF MIDWAY ATOLL/SAND ISLAND CONCEPTUAL SITE MODEL

MAXIMUM POPULATION ON MIDWAY ATOLL

As indicated in the following table, the maximum overnight population allowed on Midway Atoll will be 150 people, which at any one time may include transient, short-term, seasonal, and permanent personnel. The average daily population range is expected to be between 100-120 people during the year. Total visitation to Midway is constrained by the existing infrastructure; levels above 120 people will require additional infrastructure support on the island as outlined in Chapter 3 of this document, **Site Overview**. The personnel requirements for Midway were developed through a multiagency requirements planning process. They will be regularly assessed and may be modified in light of evolving agency needs and infrastructural constraints at Midway to ensure that each agency's goals continue to be achieved and mandates satisfied.

At varying times of the year, Midway's overnight population may be comprised of different types of users, which are described below. Although the combined totals of personnel may seem to exceed the daily maximum capacity, proper scheduling will minimize overlap of these various groups to ensure that the overall overnight population does not exceed 150 people.

Transient use. Individuals stay on Midway less than 1 week, and typically include VIPs and agency representatives, such as employees departing or joining a NOAA, Coast Guard, or military vessel stopping at Midway or State personnel en route to Kure Atoll. They may also include agency personnel or contractors with a specific assignment on Midway, such as repairing or installing infrastructure or supporting a large group of day visitors. Since most of the field activities within the Monument occur during the summer and early fall, it is likely transient use will peak during the months of July through October. The maximum number of transients on island will depend upon the availability of housing, but the typical daily maximum will likely be fewer than 15 people.

Short-term use. Individuals stay on Midway from 1 to 4 weeks, and include agency staff and visitors participating in the approved visitor program. The number of people participating in the visitor program may not exceed 50 at any one time, and generally is much lower. The number of visitors usually peaks during albatross season, November through June. Short-term agency staff would likely include researchers, biologists, or marine debris cleanup personnel conducting projects at Midway Atoll; such use is concentrated in the summer and fall months. The maximum number of short-term visitors on island will depend upon the availability of housing, but the typical daily maximum will likely be fewer than 50 people.



Black-footed albatross chick



Green turtle

Seasonal use. Individuals stay on Midway from 1 to 8 months, and include agency staff and volunteers. Agency staff are typically involved in leading the visitor program, habitat restoration, seabird monitoring, or Hawaiian monk seal monitoring and captive care programs, while volunteers assist in these efforts. During major construction projects, seasonal use may also include contractors. The maximum number of seasonal personnel on island will depend upon the availability of housing, but the typical daily maximum will likely be fewer than 30 people.

Permanent use. Individuals stay on Midway more than 8 months during the year, and consist of FWS or NOAA staff (including enforcement personnel) and FWS contractors operating the atoll's infrastructure. The maximum number of permanent staff on island will depend upon the availability of suitable housing, but could be up to 20 agency staff and 65 contractors. Combined, the typical daily maximum will likely be fewer than 80 people.

Day use. In addition to overnight use of Midway, the Co-Trustees have established a limit on the number of day-use-only visitors to the atoll. A maximum of three large groups (50-800 people) of day visitors per year may visit the atoll. These visitors typically stay no more than 4 to 8 hours and arrive via aircraft or large passenger vessel. No more than 400 day visitors may be on the island at one time, unless specific arrangements have been approved for a special event, such as a ceremony commemorating an anniversary of the Battle of Midway.

If in the future the Co-Trustees desire to increase the maximum overnight population level above 150 people or the day visitor limit above 800 people, FWS would first need to determine that such use would be compatible with the purposes of the Refuge and the mission of the National Wildlife Refuge System, as required by the National Wildlife Refuge System Administration Act of 1966, as amended. Such proposals also would require analysis under the National Environmental Policy Act, as well as potentially the Endangered Species Act and other applicable laws.



Coral reef and shallow water protection is a vital activity

4. Midway Atoll Improvement Guidelines and Principles

SUMMARY OF MIDWAY ATOLL/SAND ISLAND CONCEPTUAL SITE MODEL

Description/Theme	Integrated Biological, Historic, and Visitor Programs
	Coordinated management and operations program at Midway
Maximum overnight population	150
Average Population Range	100–120
Day Visitors	Up to 3 large groups of <800 annually; <400 ashore at once
UTILITY SYSTEMS	
Drinking Water	Increase capacity for up to 30 added people during regular periods
Electricity	Increase capacity for up to 30 added people during regular periods
Sewage	Increase capacity for up to 30 added people during regular periods
Solid Waste Disposal	Increase capacity for up to 30 added people during regular periods
LODGING FACILITIES	
<i>Officer Quarter Residences</i>	
	Reuse 1 officer quarter structure as hostel for short-term visitors
	Reuse 1 structure for short-term visitors
	Reuse 7 structures for seasonal or permanent staff

Description/Theme	Integrated Biological, Historic, and Visitor Programs
<i>Barracks</i>	
BOQ Bravo	Replace B barracks structure with (2) cable-style multiunit 2-story structures for short-term visitor lodging
BOQ Charlie	Repair C barracks to maximize capacity for interim. Eventually replace barracks structure with (3) multiunit 2-story structures for short-term visitor lodging
BEQ Barracks (1)	Replace barracks structure with (3) 8-plex 1 or 2-story structures for employees
BEQ Barracks (2)	Replace barracks structure with (3) 8-plex 1 or 2-story structures for employees
<i>Duplexes</i>	Maintained as seasonal/permanent staff lodging
<i>Low-Impact Shelters</i>	Up to 12 new primitive shelters constructed
<i>Midway House</i>	Maintained as FWS Midway Manager residence
NUMBER OF HOUSING UNITS	
Hostel style 1200 sf	2
Duplex Style <900 sf	11
2-story 12 x 24 Units 330 sf	48–56
8-plex 1 or 2-story structures <340 sf	48–96
Officers Quarters residences	8
Low impact shelters<200 sf)	3
<i>Total Number of Housing Units</i>	123-179

4. Midway Atoll Improvement Guidelines and Principles

Description/Theme	Integrated Biological, Historic, and Visitor Programs
Cable Station Buildings	Repair one cable station building (#643). Remaining cable structures partially dismantled for safety, historic landscape is interpreted
FOOD SERVICE AND ENTERTAINMENT FACILITIES	
Clipper House	Expand or replace for additional kitchen, and cold storage and dining facilities
Captain Brooks	Maintained as is
Galley Bldg	Reuse as café/store/entertainment center
All Hands Club	Demolished or reused for partner facilities; functions moved to other buildings (e.g., Galley)
AGENCY OFFICES AND VISITOR FACILITIES	
FWS Office Building	Agency offices and visitor services move into Midway Mall Visitor Center; maintain existing office building
Midway Mall	Midway Atoll Visitor Center established with visitor services, agency offices, and classrooms
Contractor Admin Building	Maintained as is
Gymnasium	Repaired and operational; used for emergency shelter

Description/Theme	Integrated Biological, Historic, and Visitor Programs
RESEARCH/LAB/STORAGE	
Old Commissary Building	Reused for agency offices, and shared research facilities e.g., cold storage/lab
Equipment Storage	Expanded in existing structures
Seaplane Hangar	Use for equipment storage; replace roof and restore glass façade for interpretation and/or exhibitory
Educational Classrooms/lab/library/ workroom	Phase I of Midway Mall Visitor Center
Monk Seal Holding Tanks	Yes
Biological Quarantine Facility	Yes
Monk Seal Captive Care Facility	Yes
BOATING FACILITIES	
Large Dock for Barges or Ships	Cargo pier maintained as is; fuel pier abandoned—disposition TBD
Midsized Dock for medium research vessels	Existing tug pier rehabilitated Tug pier replaced and upgraded
Seaplane/boat ramp for small vessels	New dock constructed in Inner Harbor; new dock/ramp built near seaplane ramp
Finger Docks for small vessels	Replace & upgrade finger piers in the Inner Harbor
Boat House	Replaced with new facility combined with dive infrastructure

SUMMARY OF MIDWAY ATOLL/SAND ISLAND CONCEPTUAL SITE MODEL

Description/Theme	Integrated Biological, Historic, and Visitor Programs
AIRPORT FACILITIES	
Runway	North strip removed and restored to habitat within 10 years
Main Hangar	Demolished and restored to habitat within 10 years
Airport Terminal Welcome Building and Staging Area	Constructed
HABITAT ENHANCEMENT	
Old Fuel Tank Area	Demolished and area restored to habitat; new fuel tank area located south of seaplane hangar
Abandoned, derelict, or non-historic structures	Reuse, maintain as is, or demolish
Vegetative Buffer in Inner Harbor Area	Yes
Upland Habitat	Invasive vegetation removed and restored to native habitat (controlled w/in 15 yrs)
Shoreline Edge	Additional protection to direct public access away from sensitive areas
Coral Reef System	Investigate coral reef habitat improvements; metal wreckage removal

Midway Atoll Conceptual Site Plan

5

5. Midway Atoll Conceptual Site Plan

INTRODUCTION

The Planning Team selected the “Integrated Biological and Historic Preservation and Visitor Services—A Model for Sustainability” for implementation. This model provides an integrated approach for enhancing protection of biological and historic resources at Midway Atoll/Sand Island while providing a moderate increase in visitor services and interpretive and educational programs and facilities. The model meets the Monumentwide vision to “forever protect and perpetuate the ecosystem health and diversity and Native Hawaiian cultural significance of Papahānaumokuākea” by focusing on species and habitat recovery. The concept also recognizes Midway’s special role as a hub of the Monument for resource protection, management and research activities, and as the only atoll open to the public, the touchstone where humans can be immersed in the Northwestern Hawaiian Islands’ rich history, wildlife, and Pacific marine environment.

Resources will be allocated to elevating the programs and facilities in three primary areas: 1. biological and ecological understanding, protection, and restoration; 2. historic resource preservation and adaptive reuse; and 3. visitor education and interpretation.

Protection, research, and restoration of atoll systems and species, and protection of historic resources are promoted activities within the appropriate level of human interaction. Consideration is given to the atoll’s carrying capacity—how many people, structures, and facilities the island system can support without adverse impact to its health. Visitation will be increased approximately 16% over the recommended capacity targeted in the Interim Visitors Services Plan. Short-term overnight visitation will not exceed 50 people, while seasonal or long-term contractors and researchers will not exceed 100 people, thus totaling no more than 150 people on any given overnight. Day visitors will continue to visit the island with a maximum of three large groups of no more than 800 people per year, and generally no more than 400 visitors on Sand Island at any one time. Maximum overnight population will increase from the current level of 120 people to 150 people.

The focus of management and development of Midway facilities and programs will be on sustainability and sustainable tourism; creating the lowest carbon footprint possible on Midway Atoll is a primary goal. New and adapted facilities and systems will utilize green design and energy principles, and reduce consumption and waste. Midway’s physical structures in combination with its interpretive and education programs will emphasize the atoll’s sensitive resources and its role in worldwide conservation, ecological systems, and human history.

Patterns of uses are grouped into Site Zones:

- Visitor Orientation and Partner Facilities
- Mixed Housing/Lodging
- Employee
- Cable Station
- Food/Restaurants
- Military History and Display
- Operations

Each primary building within the Historic and Primary Development Zone is identified by color code in the map on page 51, in terms of appropriate historic treatment. The treatment categories are: 1. demolish and replace functions to another building, or replace existing structure; 2. leave as is, and stabilize structures that do not pose threats to wildlife or humans; 3. secure structures that pose hazards to wildlife or humans; and 4. adaptive reuse of structures that have sufficient historic or structural integrity to be used as a Midway Atoll facility.

SAND, EASTERN, AND SPIT ISLANDS MANAGEMENT ZONES

As described in Chapter 4, Sand Island is zoned according to the following physical areas where specific management, planning, and development activities are appropriate: Marine Protection Zone, Revegetation/Habitat Zone, Beach Zone, Inner Harbor Zone, Freshwater Protection Zone, Airfield Operations Zone, No Dig/Landfill Zone, and Historic and Primary Development Zone.

The Historic and Primary Development Zone designates Sand Island's historic core and redevelopment area; it delineates an area that is highly significant and contains several historic structures and features eligible for listing on the National Register of Historic Sites. This zone indicates the primary area where development of new facilities or adaptive reuse of existing or historic structures should occur. This proposal will not only help preserve the integrity of the historic landscape, but will also protect wildlife and their habitat by limiting development to existing structures or impacted areas.

Specific activities for Sand Island are described in detail in the following section, **Sand Island Conceptual Site Plan**.

EASTERN ISLAND

Eastern Island is primarily zoned in Marine Protection Zone and Revegetation/Habitat Zone. No new major development or structures are proposed for this unoccupied island, which provides critical shoreline and island habitat for birds and marine wildlife. Limited human access is provided via a boat dock and trails. Eastern Island's role during World War II is instrumental in the interpretation of Midway Atoll's incredible history. Numerous historic features remain, including the World War II runway, artillery, bunkers, and sand dune airplane revetments.

Eastern Island has been the focus of successful restoration and wildlife enhancement efforts. Volunteers and staff have removed large areas of the exotic species *Verbesina encelioides* and have planted native bunchgrass (*Eragrostis*) species. Biologists successfully created freshwater wetlands and established a Laysan duck population on Eastern Island.

Ongoing activities will continue to focus on habitat protection and restoration, and the interpretation of historic and biological features. No overnight visitation occurs on Eastern Island, and visitors will arrive for day visits only for the purpose of interpretation, volunteerism, or study of the island's history and ecology.

Activities for Eastern Island include the following:

- Continued restoration of native habitat and species (e.g., remove invasive plants, enhance bird habitat, reintroduce native species, etc.)
- Participatory restoration and research programs
- Build upon Eastern Island historic interpretation and educational program, guided tours, and protection and rehabilitation of historic sites
- Reconstruct sand dune airplane revetment with built-in crew/sleeping area
- Improved trail system linking historic features and memorials
- Determine appropriate treatment of historic runway, e.g., trails, historical interpretation, or partial habitat restoration
- Installation of remote wildlife viewing cameras for monitoring and educational purposes

SPIT ISLAND

Spit Island is primarily zoned in Marine Protection Zone and Revegetation/Habitat Zone. It is important habitat for monk seals, sea turtles, birds, and other wildlife. No public access is allowed, and no development will occur on Spit Island to promote thriving wildlife populations and habitat. Spit Island will continue to support research and biological programs.



WWII airplane revetment on Eastern Island

5. Midway Atoll Conceptual Site Plan

SAND ISLAND CONCEPTUAL SITE PLAN

MARINE AND SHORELINE PROTECTION

The Marine Protection Zone designates protected shoreline and fringing marine habitat on Sand Island that supports wildlife and their critical life activities such as resting, feeding, nesting, fledging, migrating, etc. Public access is generally not allowed in these sensitive shoreline areas, and these areas will remain undeveloped. However, biological programs, research, and management activities will continue to occur. Key actions for this zone are as follows:

- Limit human access mainly to the pursuit of biological programs, research, and management
- Install permanent moorings at regularly used anchorages to prevent coral reef damage
- Conduct coral reef rehabilitation projects when and where appropriate, using the best available information about predisturbance conditions.
- Reinforce, repair, or improve limited trail access, viewpoints, and signage, create viewing stations for wildlife watching
- Evaluate the potential for natural beach restoration, particularly along hardened or rip-rapped shorelines such as the South Beach, and the shoreline near Turtle Beach. Further studies are required to determine feasibility.

Reef habitat recommendations from the Monument Management Plan include the following strategies and activities from section 3.2.3, **Habitat Management and Conservation Action Plan** (HMC):

Strategy HMC-1: Within 15 years, develop and implement a strategy for restoring the health and biological diversity of the shallow reefs and shoals where anthropogenic disturbances are known to have changed the ecosystem, using best available information about predisturbance conditions.

Activity HMC-1.1: Identify and prioritize restoration needs in shallow water reef habitats impacted by anthropogenic disturbances within 5 years.

Activity HMC-1.2: Analyze historical and present impacts on reef growth at Midway Atoll and determine factors limiting nearshore patch reef growth to facilitate restoration of natural reef building.

Activity HMC-1.3: Where feasible, implement appropriate restoration activities.

HABITAT RECOVERY

Despite the incredible abundance of terrestrial and aquatic wildlife, wonderful beaches, and crystal clear water, Midway Atoll is a highly disturbed atoll system containing invasive plant and animal species, toxic materials in building materials and soils, and human developments that have created significant adverse impact on indigenous species and their habitat. Most of the Midway Atoll is designated as the Revegetation/Habitat Zone in this Conceptual Site Plan to focus efforts on restoring atoll habitat and enhancing species populations.

The conceptual plan for habitat management and restoration at Midway Atoll over the next 15 years is to increase the amount of habitat available for all species of breeding seabirds, overwintering migratory birds, Laysan ducks, and potential future translocated native birds by removing nonhistoric abandoned structures and pavement installed by the U.S. Navy, controlling and eradicating nonnative vegetation, and planting and seeding appropriate native plants.

As described in the Monument Management Plan's section 3.3.2, **Alien Species Action Plan**, FWS will control or eradicate golden crown-beard (*Verbesina encelioides*), ironwood (*Casuarina* spp.), haole koa (*Leucaena leucocephala*), castor bean (*Ricinus comunus*), Spanish needle (*Bidens* sp.), lantana (*Lantana camara*), pluche (*Pluchea indica*), cheeseweed (*Malva parviflora*), poinsettia (*Euphorbia cyathophora*), Guinea grass (*Panicum maximum*), vervain



Black-footed albatrosses



SAND ISLAND CONCEPTUAL PLAN

MIDWAY ATOLL CONCEPTUAL SITE PLANNING



5. Midway Atoll Conceptual Site Plan

SAND ISLAND CONCEPTUAL SITE PLAN

(*Verbena litoralis*), umbrella plant (*Cyperus alternifolius*), nonnative morning glory (*Convolvulaceae*), ivy gourd (*Coccinia grandis*), black mustard (*Brassica nigra*), buffel grass (*Cenchrus ciliaris*), New Zealand spinach (*Tetragonia tetragonioides*), Chinese banyan (*Ficus microcarpa*), sand bur (*Cenchrus echinatus*), and spiny pigweed (*Amaranthus spinosus*).

Over the 15-year life of the plan approximately 937 acres of nonnative vegetation (coastal mixed grasses and shrubs) will be restored to a native dominated landscape. Native species used for restoration will be chosen on the basis of historical records at Midway and historical and pollen records from Laysan Island and will include bunchgrass (*Eragrostis variabilis*), naupaka (*Scaevola sericea*), morning glory (*Ipomoea pes caprae*, *I. indica*), *Solanum nelsonii*, *Capparus sandwichiana*, *Chenopodium oahuense*, and *Lepidium bidentatum*.

Approximately 118 acres of abandoned buildings and paved areas will be removed and converted into useable habitat. Demolition costs are estimated at several million dollars, however, so this will likely be a longer-term activity. The refuge will remediate lead-based paint from buildings and the surrounding soil to prevent adverse effects to wildlife.

Additionally, the Monument Management Plan includes the following activities related to habitat recovery in Midway Atoll (for detailed information, see section 3.2.3, **Habitat Management and Conservation Action Plan (HMC)**):

Strategy HMC-4: Within 10 years, restore and maintain coastal mixed grasses and shrubs on all the coralline islands and atolls of the Monument using best available historical information about the original indigenous ecosystem.

Activity HMC-4.1: Propagate and outplant native species chosen on the basis of historical records at Midway and historical and pollen records from Laysan Island in 250 acres of vegetated area at Midway Atoll, focusing on the original footprint of the island and then moving to the dredge spoils section.

Strategy HMC-8: Maintain no more than 150 acres of ironwood woodlands on Sand Island, Midway Atoll, to provide seabird nesting and roosting habitat for the life of the plan.

Activity HMC-8.1: Remove ironwood on Sand Island from 50 acres outside designated woodland and control young ironwood in areas managed for grass and shrubs.

Strategy HMC-2: Within 10 years, investigate, inventory, and map sources of known contamination from historical human uses of the NWHI and, where appropriate, coordinate with responsible parties to develop plans and complete cleanup actions.

Activity HMC-2.7: Conduct ecological risk assessment to determine allowable lead levels in soils at Midway and remove lead from buildings and soils to nonrisk levels.

No Dig Areas/Landfills

The “no dig” areas are sites that contain contaminated soils or other materials that cannot be disturbed. These sites include the Old Bulky Waste Landfill on the South Beach point and the old fuel farm on the North Beach.

The “No Dig” areas were designated in the Base Realignment and Closure process (BRAC) as Land Use Controls where digging below 4 feet is prohibited (or FWS assumes all responsibility). These areas, and several landfills, were determined to not necessitate further cleanup unless the controls were not effective. The Old Bulky Waste Landfill, however, is an example where the control is not sufficient and further remediation needs to be addressed through the BRAC process.



South point at Old Bulky Waste landfill

To the extent feasible, it is recommended that the “No Dig/Land Fill” areas that contain contaminated soils and/or facilities be enhanced for habitat. The largest area is in the vicinity of the old fuel tanks in the northeastern part of Sand Island. It is proposed that the tanks and associated facilities be removed, and nonnative vegetation be replaced with native vegetation. Further plans and procedures for remediation of an area such as the fuel farm are required to ensure that contaminated areas are clean and will not impair wildlife.

Additionally, the Monument Management Plan includes the following activities related to land fills and dumps in Midway Atoll (see section 3.2.3, **Habitat Management and Conservation Action Plan (HMC)**):

Strategy HMC-2: Within 10 years, investigate, inventory, and map sources of known contamination from historical human uses of the NWHI and, where appropriate, coordinate with responsible parties to develop plans and complete cleanup actions.

Activity HMC-2.2: Work with partners and responsible parties to verify the integrity of known landfills and dumps and to conduct additional remediation if necessary.

HISTORIC RESOURCES

Within the Monument Management Plan (see section 3.1.3, **Historic Resources Action Plan (HR)**), five strategies affecting historic resources at Midway Atoll are identified for achieving the desired outcome of identifying, interpreting, and protecting historic resources in the NWHI.

Strategy HR-1: Update the Midway Atoll Historic Preservation Plan to meet the present needs of the Refuge and Monument within 1 year.

Strategy HR-2: Implement, supervise, and monitor the historic preservation treatments identified in the Midway Atoll Historic Preservation Plan at two historic properties each year.

Strategy HR-3: Prepare an updated Battle of Midway National Historic Landmark nomination within 4 years.

Activity HR-3.4: Implement repair and maintenance treatments at National Historic Landmark features within 6 years.

Strategy HR-4: Improve the function and capacity of the Midway museum within 8 years.

Activity HR-4.1: Prepare a Scope of Collections Statement within 5 years.

Activity HR-4.2: Remodel the Midway museum space within 7 years.

Activity HR-4.3: Organize and curate collections within 8 years.



Midway Mall interior: ideal space for offices, classrooms, and visitor services



Native bunchgrass successfully restored on Eastern Island



Midway Atoll offers important historic preservation and interpretation opportunities



Historic WWII Torpedo shop with parachute tower

5. Midway Atoll Conceptual Site Plan

SAND ISLAND CONCEPTUAL SITE PLAN

Strategy HR-6: Conduct archaeological and historical research on the historical events and structures at Midway Atoll NWR within 15 years.

Activity HR-6.2: Conduct archaeological investigation of the Commercial Pacific Cable Station site within 10 years.

Additional strategies and activities targeted at understanding and protecting Midway Atoll's submerged historic resources are found in the Monument Management Plan in Section 3.1.4, **Maritime Heritage Action Plan (MH)**:

Strategy MH-1: Document and inventory maritime heritage resources throughout the life of the plan.

Activity MH-1.2: Plan and carry out coordinated field mapping surveys of selected sites annually.

COORDINATED FIELD OPERATIONS

As a hub of operations for the Monument, Midway Atoll is the primary focus of the Coordinated Field Operations Action Plan in the Monument Management Plan. The following activities related to an integrated program in Midway Atoll are included (see section 3.6.3, **Coordinated Field Operations Action Plan (CFO)**, for details):

Strategy CFO-1: Conduct necessary site planning and infrastructure improvements to increase safety and enhance Monument field operations capacity over the life of the plan.

Activity CFO-1.1: Initiate and complete necessary planning to implement the Midway Atoll Conceptual Site Plan.

Activity CFO-1.3: Develop alternative energy systems and waste reduction strategies for the Monument within 2 years.

Activity CFO-1.4: Plan for use of sustainable engineering, technology, and landscape architecture for facilities and assets throughout the Monument.

Strategy CFO-3: Maintain and improve housing and field camp safety and operational efficiency using short-, medium-, and long-term approaches to protect Monument resources across the life of the plan.

Activity CFO-3.1: Design and construct pilot low-impact shelter.

Activity CFO-3.2: Utilize the existing footprint of Bravo Barracks for replacement housing at Midway Atoll.

Activity CFO-3.3: Utilize the existing footprint of Charlie Barracks for replacement housing at Midway Atoll.

Activity CFO-3.4: Rehabilitate "Officers Row" Housing at Midway Atoll.

Strategy CFO-4: Meet fuel requirements for aircraft, vessel, utility, and equipment needs at Midway Atoll to support operations to protect and manage Monument resources.

Activity CFO-4.1: Maintain recently replaced fuel farm at Midway Atoll.

Activity CFO-4.2: Develop biodiesel fuel capacity or other sustainable fuel types at Midway Atoll within 2 years.

Strategy CFO-5: Rehabilitate critical utility systems and ailing structures and facilities at Midway Atoll within 5 to 15 years.

Activity CFO-5.1: Rehabilitate water catchment and distribution system.

Activity CFO-5.2: Rehabilitate septic and wastewater systems.

Activity CFO-5.3: Treat all wooden historic structures at Midway Atoll for termites.

Activity CFO-5.4: Evaluate and optimize food services as necessary.

Activity CFO-5.5: Rehabilitate seaplane hangar.

Activity CFO-5.6: Repair inner harbor sea wall.

Strategy CFO-6: Within 5 years, improve the small boat operational capacity to enable quick, reliable access to the region in support of protection and management and continue to enhance the program throughout the life of the plan.

Activity CFO-6.1: Inventory, maintain, and coordinate the use of small boats and related field resources.

Activity CFO-6.2: Within 2 years, station additional vessels at Midway for use during the summer marine research field season.

Activity CFO-6.3: Within 5 to 10 years, station a small research/enforcement vessel at Midway Atoll.

Activity CFO-6.4: Construct new finger piers inside of Midway's inner harbor.

Activity CFO-6.5: Redevelop existing boathouse at Midway into a multiuse facility.

Activity CFO-6.6: Evaluate needed improvements to Pier No. 1 in the ship basin and the Tug Pier at Midway Atoll.

Activity CFO-6.7: Make needed improvements to or replace the pier at Eastern Island.

Strategy CFO-8: Develop a safe and comprehensive dive operations program for Monument management activities within 5 years.

Activity CFO-8.1: Refurbish or replace the dive recompression chamber at Midway.

Activity CFO-8.3: Incorporate a dive operations center into the refurbished boathouse facility at Midway.

Strategy CFO-9: Provide for necessary research, education, visitor, and administrative facilities that will further the protection of Monument resources across the life of the plan.

Activity CFO-9.1: Design a marine laboratory at Midway and develop in phases.

Activity CFO-9.2: Complete planning for and construct a captive care monk seal facility on Sand Island.

Activity CFO-9.4: Complete Phase I rehabilitation of Midway Mall and the commissary building.

Activity CFO-9.5: Construct airport welcome center on Sand Island within 2 years.

SAND ISLAND BUILDING PROGRAM

The four guiding principles of architectural design and construction on Midway are defined as: Sustainability, Historical Integrity, Biological Integrity, and Tropical Aesthetic.

Each construction project at Midway will be considered through the lens of sustainability and a low carbon footprint, taking into account use of nontoxic, durable materials; recycling building materials; natural solar and ventilation techniques; high energy efficiency; shared facilities and infrastructure; low massing of smaller buildings in place of cumbersome 3-story structures; on-site renewable power generation, on-site water catchment, and on-site waste treatment at each building; etc.

The Historic and Primary Development Zone designates Sand Island's historic core and redevelopment area; it delineates an area that is highly significant in terms of historic development patterns. Several historic structures and features are contained within this zone. This zone indicates the primary area where development of new facilities or adaptive reuse of existing or historic structures is an appropriate activity. Reusing existing historic structures is a very high priority to protect the cultural landscape and historic structures. Reuse of existing structures or the construction of new structures will fit the historic character of Sand Island (1900s Cable House style or 1940s Albert Kahn style), and will have either no impact or a positive impact on wildlife and habitat.

Design of new or renovated buildings will also take into account the tropical building vernacular, including platform construction, peaked roofs, and overhangs.

5. Midway Atoll Conceptual Site Plan

SAND ISLAND CONCEPTUAL SITE PLAN

Clustering development to reduce the extent of disturbance and create efficiencies in infrastructure and operations is a key recommendation. Reusing existing facilities and keeping the building program within the “Historic Zone” is another sustainability strategy in that it reduces the requirement to extend utilities, roads, equipment, and resources across the island.

With the limited window for construction and the likelihood that any construction will have to be tightly contained with limited areas for staging because of albatross habitat, the need for quality premanufactured, component construction would be desirable. This is not to be confused with mobile trailer type construction, which is contrary to the building guidelines that gained general acceptance with the client group.

Performance Standards for New Construction should be applied, as follows:

1. Energy-Efficiency Measures—Areas for Energy Savings:
 - Conservation through Building Design: Reduce Energy Consumption
 - Insulated building envelope, possibly “green roofs”
 - Weatherproofing
 - Airtight seals at windows and doors
 - Energy-efficient window glazing (Low-E)
 - Optimize daylighting strategies
 - Optimize natural ventilation strategies
 - Economize heating/cooling system
 - Energy-efficient equipment and appliances
 - Energy Star rated
2. Landscape and Site Design
 - Wind protection
 - Native landscape plantings clustered around buildings
 - Earthen berms to provide wind protection
 - Solar orientation

3. Alternative Energy Systems
 - Solar hot water heater
 - Full photovoltaic system
 - Fuel cells
 - Powered by hydrogen generated from electrolysis
 - Only if system does not impact local coral reef ecosystems

STRATEGIES TO ADDRESS SEA LEVEL RISE AND CLIMATE CHANGE

Midway power currently relies entirely on fossil fuel. Alternative energy systems should be explored, such as solar power, hydrogen fuel cells, or water-powered micro-turbines. Further study is required to measure the benefits of these alternative energy methods and their potential impacts to wildlife, birds, and marine systems. A goal for Sand Island is to have a plan in place within 15 years for alternative energy system(s) such as solar to replace the current power generation.

Midway’s islands will be affected by sea level rise through loss of land and higher spring tides, therefore restoration activities should be focused on the highest elevational areas and the original footprints of the islands. One possible mitigation measure to counter the effects of sea level rise in the NWHI may be beach nourishment, whereby sand is strategically deposited onto beaches (Baker et al. 2006).

Selective removal of rip-rap and bulkheads to restore natural beach deposition processes and shoreline habitat is one strategy that has successfully been applied to marine shorelines. It is recommended that a shoreline restoration/ stabilization study be performed within the next 5 years. Careful study is required to assess the current condition of seawalls, and to determine which seawalls need to be retained to protect the structures and landfill behind them, and which shoreline sections may be restored to a natural beach condition.

Managing a significant portion of the atoll as native grass and shrublands and a smaller portion of the atoll as ironwood will not only be beneficial to seabirds for breeding and resting habitat but will also demonstrate a commitment for carbon sequestering whenever possible (Conant et al. 2001; Shan et al. 2001).

Acquisition of a new airplane and small research vessel would enable fewer overall trips and increased transportation efficiency. Vessels should also be fueled by appropriately sourced biodiesel or other fuels if possible.

SAND ISLAND BUILDING PROGRAM WITHIN CORE HISTORIC/DEVELOPMENT ZONE Lodging

The Planning Team evaluated visitor capacity, visitor type, and length of stay in considering lodging needs. The maximum total population for any given overnight is set for 150 people. Short-term lodging is required for visitors, researchers, agency staff, and others who stay on Sand Island from 1 night to 2 weeks. Longer-term lodging is required for volunteers, staff, researchers, and others who stay on the island on a seasonal or permanent basis from 2 weeks to year-round. Additionally, emergency overnight lodging may be required due to the island's remoteness and isolation.

Given the varying lodging needs, the Planning Team identified a range in housing facility types to accommodate these diverse visitors while maximizing the existing structures and minimizing development impacts. Refer to Summary Table for details on housing units and visitor capacity. Housing facilities will

comply with accessibility requirements included within the Rehabilitation Act of 1973 (as amended), Section 504 and 508; and the Architectural Barriers Act (ABA) of 1968. The lodging types are as follows:

Officers' Quarters—Reuse eight historic officers' quarters as residences (approximately 1,600 sf each) for visitors, seasonal, or permanent staff. Convert one building into a bunkhouse with limited amenities to accommodate overnight visitors. The bunkhouse could accommodate about 14 people.

Duplexes—Repair and maintain existing duplexes (approximately 900 sf per unit). Duplexes can accommodate about 11 people, generally seasonal or permanent staff.

2-Story Cable-Style Units—Construct module units in place of Charlie and Bravo Barracks. Make structural repairs to Charlie Barracks immediately, and replace within 15 years. Replace Bravo Barracks by year 2010. New module structures will be constructed on existing pads, but designed in smaller units. The possibility of constructing buildings on pilings to allow better flow of wildlife and habitat and higher energy efficiency will be evaluated. These units will primarily house short-term visitors, researchers, and staff, but could easily accommodate seasonal or permanent staff and volunteers as well. Space and capacity: 12' x 24' units at 330 sf will house 48–56 people.

8-plex 1 or 2-story Units—Construct 1- or 2-story 8-plex units in place of BEQ Barracks 1 and 2. New module structures will be constructed on existing pads,



Cable House architectural vernacular may be applied to new lodging design



Energy efficient and smaller scale multiplex units will replace BOQ barracks



Officers' Quarters rehabilitated as residences

5. Midway Atoll Conceptual Site Plan

SAND ISLAND CONCEPTUAL SITE PLAN

but designed in smaller units and potentially on pilings to allow better flow of wildlife and habitat, and higher energy efficiency. These units will primarily house seasonal or permanent staff. Space and capacity: 12' x 25' units at 340 sf will house 48–96 people, depending on whether the structure is a single- or double-story building.

Low-Impact Shelters—As an optional short-term shelter type, construct clusters of low-impact shelters on existing concrete pads or on pads of demolished buildings within the residential district. Potential sites will be evaluated to rule out conflict with wildlife. These shelters will incorporate the design principles of Pacific Island regional architecture, e.g., simple structures, durable, nonpolluting and/or recycled materials, etc. These shelters will not be air-conditioned spaces. Natural ventilation, cooling, and weather protection will be designed into the structures. The footprint of each structure will be <200 square feet. These units will provide lodgings for ecotourists, visitors staying less than 1–2 nights, or emergency guests, and will demonstrate sustainable design principles. A pilot low impact structure/shelter will be developed within 4 years to determine the feasibility of such a design. The pilot will be constructed within the Sand Island housing zone.

Emergency Shelter—The existing gymnasium could be used for emergency shelter. Repairs to the gymnasium are required, e.g., roof replacement.

OTHER SAND ISLAND BUILDINGS

Cable Station Buildings—Most of these early 1900s structures are in extremely derelict condition and pose hazards to birds, wildlife, and humans. However, they are critical to telling the early Midway story related to the Commercial Pacific Cable Company period. FWS Cultural Resources staff has assessed these structures and their recommendations are incorporated into a proposal to the State Historic Preservation Office. All but one structure (#643) would be partially dismantled due to safety issues for people and wildlife. Building materials would be removed and recycled, as well as hazardous paint and materials, yet the structures' remnants would remain in place for the preservation and

interpretation of the historic landscape. Further assessment is required to determine the exact extent and methods for deconstruction. Building #643 would be stabilized and repaired to a level where the structure does not pose safety or toxicity hazards, and could be interpreted.

Seaplane Hangar—Repair of the roof is required to maintain the current structure. The Seaplane Hangar will be rehabilitated to the extent feasible to achieve functions of storage and potential military display. For example, the glass façade may be replaced.

Military Historic Structures—Several World War II-era structures still exist that historically were and still are part of island maintenance and operations. These include, among others, the Paint Shop, the Metal Shop, and the Carpentry Shop. These structures require repair and maintenance to protect the historic integrity of the buildings, and to remove hazardous materials, such as lead-based paint and asbestos, that pose threats to wildlife and humans.

VISITOR SERVICES AND FACILITIES

Midway Atoll Visitor Center—The Midway Mall will be rehabilitated and reused as the hub of Midway Atoll. It will become a multifunctional building, including visitor center, educational facilities and classrooms, museum/library, agency offices, and partner offices. Designed by 1940s industrial architect Albert Kahn, Midway Mall offers a lot of character and interest, and has a large amount of space to accommodate diverse activities. Its strategic location in the core historic/development area and easy access for Sand Island visitors are also positive features.



Midway Atoll Visitor Center: hub of agency offices, educational facilities, and visitor services

Visitor Welcome Centers—Welcome centers are required at the Inner Harbor and at Henderson Airfield, to greet, orient, and stage visitors arriving by boat or airplane. These centers will be modest, possibly open-air structures that would likely include interpretive exhibits.



Clipper House

Additionally, the Monument Management Plan and Visitor Services Action Plan recommend the following strategies and activities (see section 3.4.3, **Midway Atoll Visitor Services Action Plan (VS)**):



Captain Brooks

Strategy VS-1: Implement the Midway Atoll Visitor Services Plan, providing visitor opportunities for up to 50 overnight guests at any one time.

Activity VS-1.1: Provide visitors with opportunities for wildlife-dependent recreation to enhance their knowledge and appreciation of the Monument's natural resources.

Activity VS-1.2: Provide visitors with opportunities to learn about and appreciate the Monument's cultural and historic resources.

FOOD SERVICES

Clipper House—The Clipper House presently serves as the primary food service facility for Midway. Overall food services will need to be expanded to accommodate future population increases and enlargement of the Clipper House, reuse of older existing food service facilities, or construction of a new dining facility will be evaluated.

All Hands Club—Structure will be reused for agency operations and management due to its proximity to Midway Mall. Alternatively, the existing structure will be demolished and the area restored for habitat. Current functions will be moved to other facilities, e.g., the Galley building or Captain Brooks.

Captain Brooks—Will be maintained as is.

Galley Building—Galley Building will be reused as gift shop, snack bar, and Internet service for both visitors and staff. The rear half of the structure is in poor condition and will be demolished.

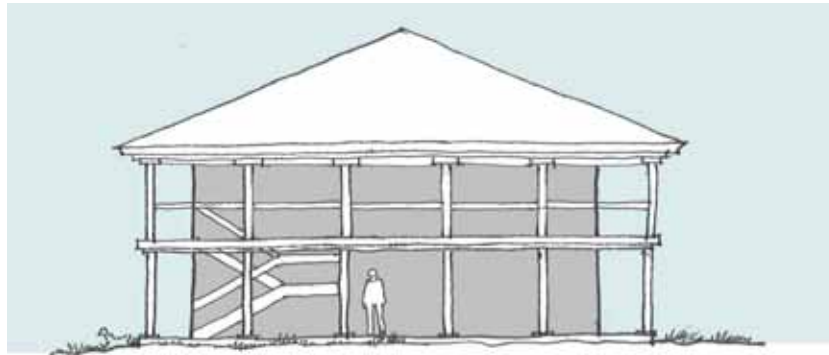
Hydroponic Greenhouse—Hydroponic greenhouse is used for growing produce so that Midway is more self-sufficient in terms of food production.



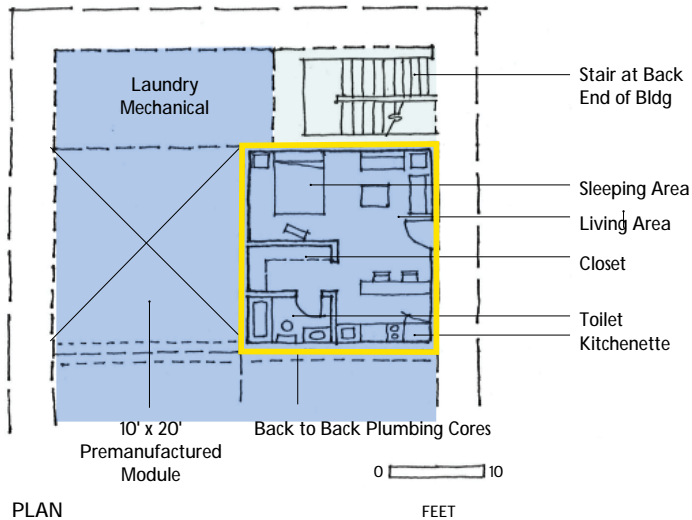
Sand Island transportation: foot, cart, or bicycle

5. Midway Atoll Conceptual Site Plan

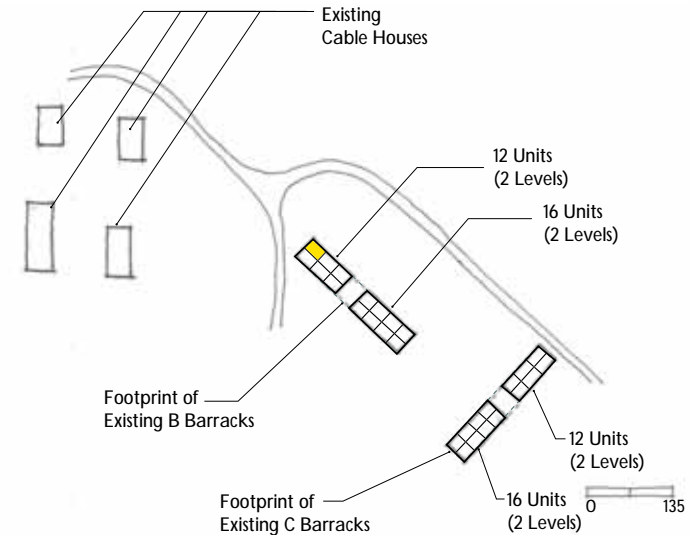
SAND ISLAND CONCEPTUAL SITE PLAN



ELEVATION



PLAN



SITE PLAN

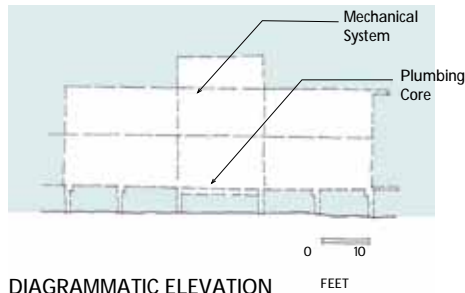
CABLE HOUSE STYLE ~ 1900s

- CONSTRUCT ON EXISTING CONCRETE PADS OR PADS OF DEMOLISHED BUILDINGS
- INCORPORATE DESIGN AESTHETIC OF HISTORIC CABLE STATION BUILDINGS
- SMALLER UNITS ALLOW HIGHER ENERGY EFFICIENCY AND FLOW OF WILDLIFE
- PROVIDE LODGING FOR SHORT-TERM VISITORS, VOLUNTEERS, AND STAFF, OR SEASONAL AND PERMANENT STAFF



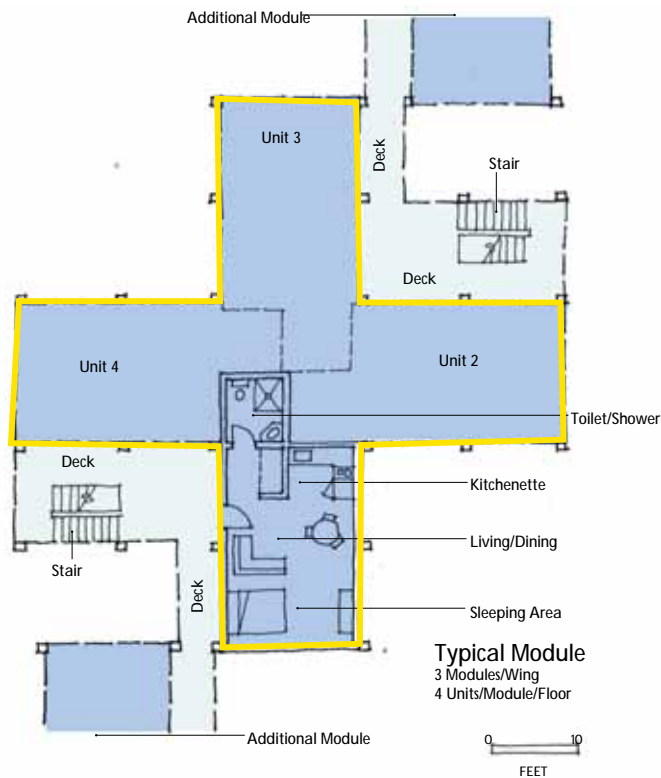
DECEMBER 2008

ARCHITECTURAL CONCEPT FOR NEW LODGING: CABLE HOUSE VERNACULAR MIDWAY ATOLL CONCEPTUAL SITE PLANNING

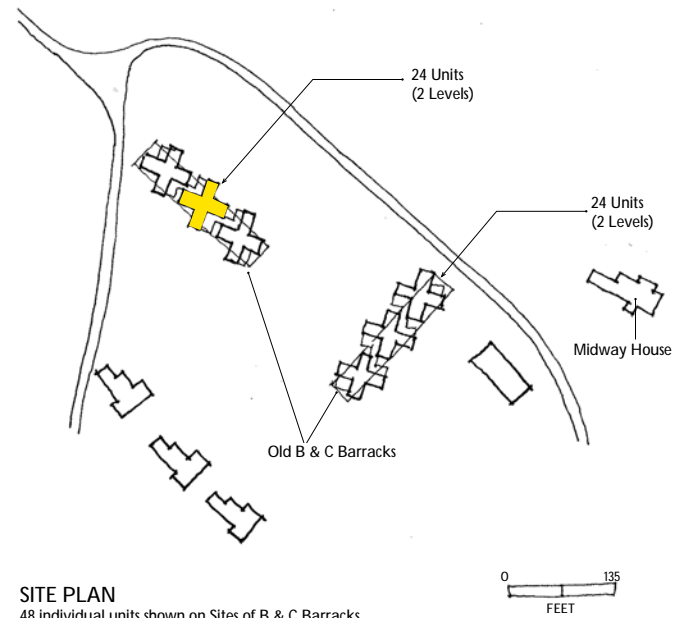


With "piling" design, this could be built in many locations without major disruption of the Albatross. This plan better reflects the Kahn Buildings. No attempt was made to express architectural character.

DIAGRAMMATIC ELEVATION



PLAN



SITE PLAN

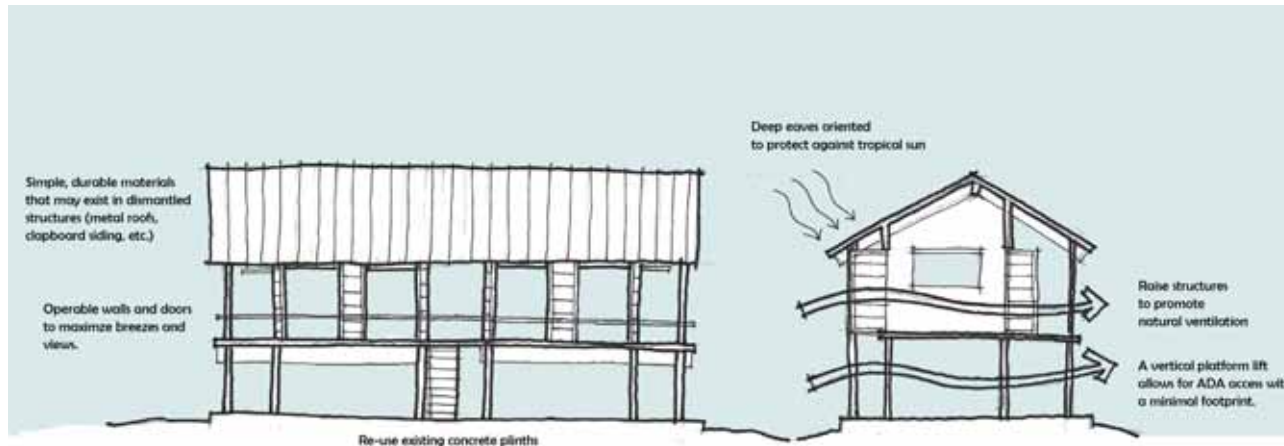
48 individual units shown on Sites of B & C Barracks

KAHN MODULES ~1940s

- CONSTRUCT ON EXISTING CONCRETE PADS OR PADS OF DEMOLISHED BUILDINGS
- INCORPORATE DESIGN AESTHETIC OF ARCHITECT ALBERT KAHN
- SMALLER UNITS ALLOW HIGHER ENERGY EFFICIENCY
- PROVIDE LODGING FOR SEASONAL OR PERMANENT STAFF

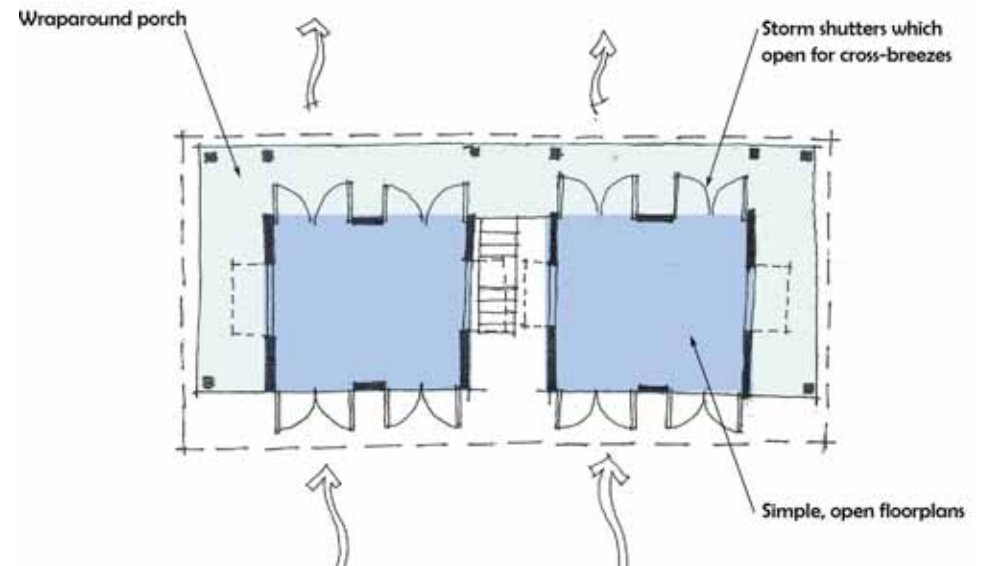
5. Midway Atoll Conceptual Site Plan

SAND ISLAND CONCEPTUAL SITE PLAN



LOW IMPACT SHELTERS

- CONSTRUCT ON EXISTING CONCRETE PADS OR PADS OF DEMOLISHED BUILDINGS
- INCORPORATE DESIGN PRINCIPLES OF PACIFIC ISLAND REGIONAL ARCHITECTURE
- NATURAL VENTILATION, COOLING, AND WEATHER PROTECTION
- DEMONSTRATE SUSTAINABLE DESIGN PRINCIPLES
- PROVIDE LODGING FOR ECO-TOURISTS, VISITORS STAYING FEWER THAN 1-2 NIGHTS, OR EMERGENCY GUESTS





Albatross chick

5. Midway Atoll Conceptual Site Plan

AGENCY RESEARCH AND OPERATIONS FACILITIES CONCEPT

Midway Mall—Co-Trustee offices and other partner facilities move into Midway Mall, which will also provide visitor services, classrooms, and other functions. Midway Mall is the hub of agency operations on Midway Atoll and field operations in the northern part of Papahānaumokuākea Marine National Monument. The primary hub of operations for NWHI is based in Honolulu FWS, NOAA, and State offices.

Fish and Wildlife Services Office—FWS office retained for additional office facilities.

Marine Laboratory—Wet lab, dry lab, refrigeration, quarantine, and office space will be integrated into a Marine Laboratory building. The Old Commissary Building's proximity to Midway Mall suggests reuse of the building for agency research or biological programs. However, several buildings will be evaluated for this purpose.

Monk Seal Captive Care Facility—NOAA has expressed interest in creating a new Monk Seal Captive Care Facility on Sand Island. A suggested location for this facility is near the Inner Harbor on existing asphalt pad. This location is close to water, transportation, and the agency facilities housed in Midway Mall.

The following are the NMFS monk seal research program facilities needs:

SEAL HOLDING

- a. For the first 5 years seal holding will consist of pools sufficient to hold 10–12 seals and the potential to isolate individuals. This could be accomplished with four 20' diameter holding tanks each enclosed with dry resting area to a combined foot print of 30' x 30' for each of the four tanks.
- b. It is anticipated that after 3–5 years, twice that holding would be used.
- c. The total footprint in the first phase will be about 4,500 sq ft with an addition expandable capacity to approximate total of 8–9,000 sq ft.

WATER

- a. Source—1000–1200 gpm sea water for 10–12 juvenile seals.
- b. Semi-open or closed systems could be considered when conducting environmental analysis.

ANCILLARY STRUCTURES

- a. Fish prep—200 sq ft area will be necessary to support the 10–12 seals
- b. Freezer—seal food will depend on the potential schedule of resupply.
- c. Housing for 6 animal care personnel and 2–3 associated seal scientists/biologists

Quarantine Facility—required for biological species protection and recovery programs administered by FWS and/or NOAA.

Holding Tanks—required for biological species protection and recovery programs administered by FWS and/or NOAA.



Midway Mall interior



Midway Mall reused as Midway Atoll Visitor Center



Monk seal



Chugach offices and Medical Clinic



Biological research is a vital Midway Atoll activity



Nursery pen for Laysan duck reintroduction on Sand Island

5. Midway Atoll Conceptual Site Plan

INNER HARBOR CONCEPT

The Inner Harbor area includes the historic Inner Harbor and its associated shoreline, piers, and facilities. One of two approaches to the island (by vessel or aircraft), the Inner Harbor zone is critical to visitor arrival, transportation of services and goods, and water-based activities (e.g., ecotourism via passenger vessels, marine research, rescue operations, security).

Several improvements to the Inner Harbor zone are recommended. The current seawall around the perimeter of the basin is extremely degraded and requires assessment and repair. Additionally, concrete rubble and other materials in-water near the west docking area impede vessel travel and anchoring; these materials need to be removed after determination of toxicity issues.

A new ramp and pier is proposed at or near the vicinity of the historic seaplane ramp in the west Inner Harbor area. The presently used ramp is too shallow to launch or load boats onto trailers without “floating the trailer out” beyond the launching vehicle. Further historic analysis is needed to determine if the seaplane ramp may be redesigned as a ramp suitable for boat launching, or whether it should remain in place and a new ramp and pier be constructed nearby. Additionally, a series of finger piers are needed to accommodate small or mid-sized boats.

If an additional mid-sized pier is required to separate uses (e.g., operations versus visitors), a second pier could potentially be sited in the inner harbor.

Further analysis will be necessary to finalize the location of any new infrastructure in the inner harbor.

The existing boathouse is periodically flooded by surface flows across the large asphalt surface. The structure will be resited further upland and possibly elevated on the existing concrete pad and reconstructed as a new boathouse/dive center to meet interagency needs. The boathouse will include a dive center, storage for marine-associated equipment, and potentially a temporary bunkhouse space for short-term use and limited interim lab space until other facilities are renovated or reconstructed.

A small welcome kiosk may be appropriate onshore in the Inner Harbor in the northwest corner of the Inner Harbor to greet and orient visitors arriving by water. Paths and circulation routes to the Midway Atoll Visitor Center will be clearly delineated along existing or historic routes.



Visitor arrival by boat



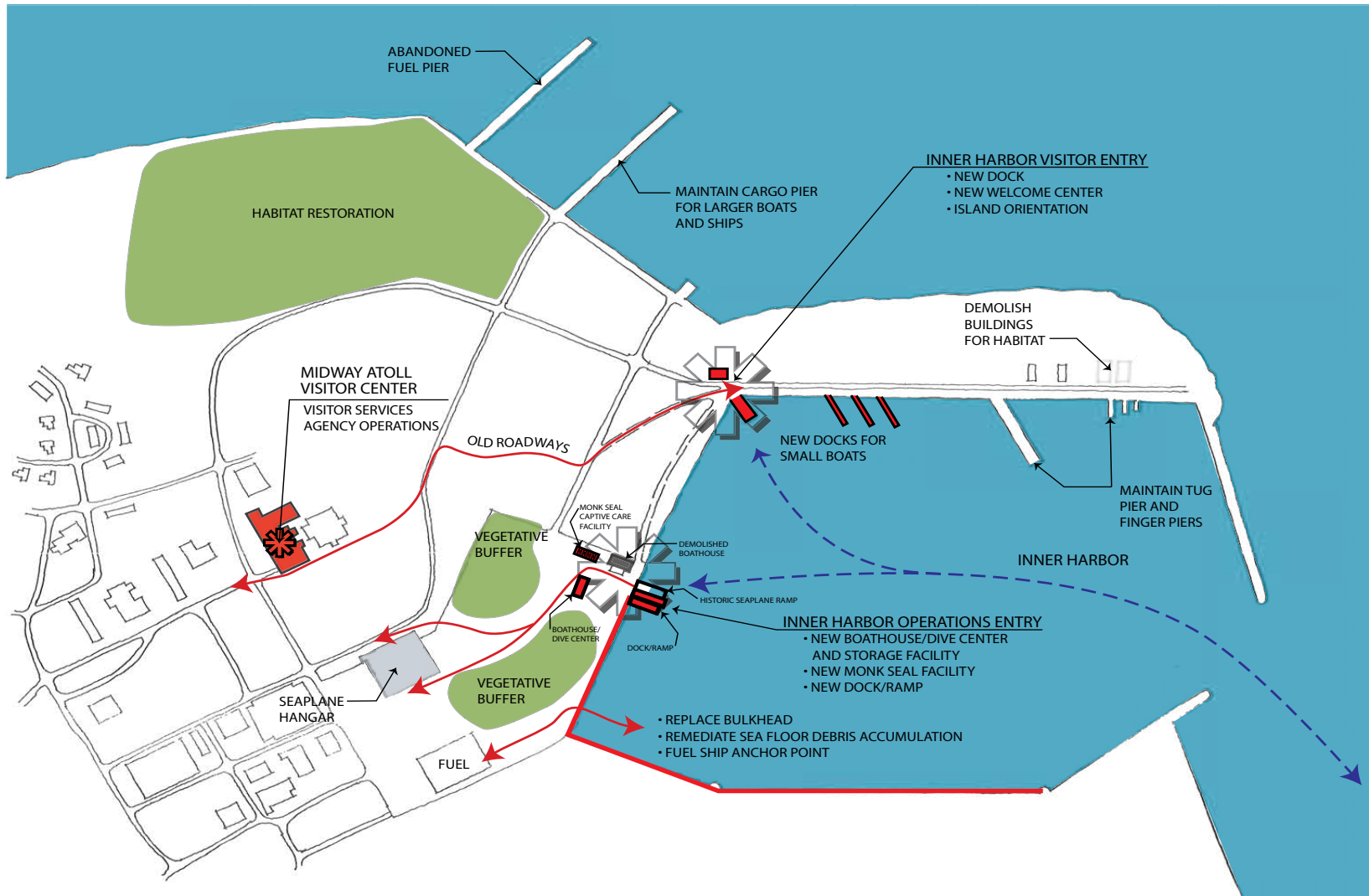
Historic seaplane ramp and existing boathouse



Inner Harbor seawall



new FWS boat



INNER HARBOR CONCEPTUAL PLAN

MIDWAY ATOLL CONCEPTUAL SITE PLANNING



DECEMBER 2008

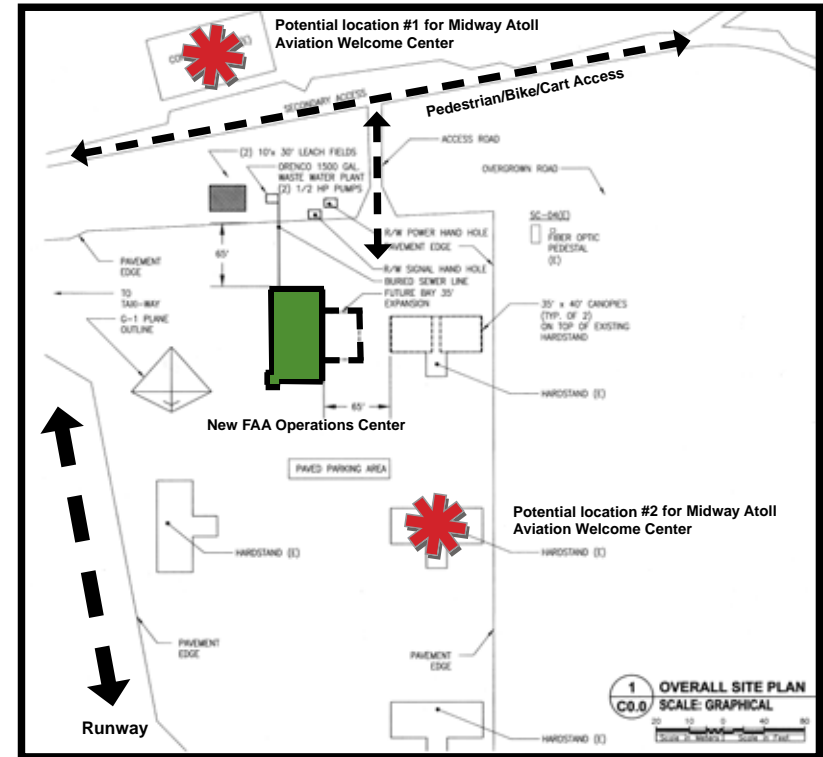


5. Midway Atoll Conceptual Site Plan

AIRPORT WELCOME CENTER CONCEPT

The Airfield Operations Zone on Sand Island includes the runway and the new Henderson Airfield operations center. One of two approaches to the island (by boat or aircraft), the Airfield Operations zone is critical to visitor arrival, transportation of services and goods, and aviation activities (ecotourism via air travel, research, emergency operations, security).

A new small Welcome Center will be appropriate to greet and orient visitors arriving by airplane. While the new operations center is now in place, there is no shelter to gather or greet visitors. Preliminary concepts for a Welcome Center indicate two potential locations that may be appropriate to build this facility. The proposed alternatives locate the structure on existing concrete or asphalt pads that are in close proximity to existing circulation routes but avoid conflict with airplane operations. Further analysis and coordination with FAA and Midway operations will be necessary to finalize the location of the Welcome Center.



Midway Atoll Aviation Node



Visitor arrival on Sand Island is a big event







Priority Actions and Next Steps



6. Priority Actions and Next Steps

PRIORITIZATION AND IMPLEMENTATION

This Plan provides long-term guidance for management decisions at Midway, including best estimates of future needs and project activities. These estimates are substantially above current construction budget allocations, and are included primarily for strategic planning and program prioritization purposes, although they also serve to make the public aware of the costs of possible actions. This plan does not constitute a commitment of funds, or a commitment to request funds, by Federal or State agencies. All funding for actions included here is subject to the budgeting and appropriations processes.



The following narrative provides a preliminary framework for beginning to organize actions in terms of implementation schedule. Agency partners will work together to identify project priorities, roles and responsibilities, potential funding sources, and comply with appropriate environmental assessment requirements. These projects are important to support Monument operations as a whole, benefiting all of the agencies involved with its management.

ANNUAL MAINTENANCE

Through the Base Operations and Support Services (BOSS) contract for operation of Midway, FWS and the Federal Aviation Administration (FAA) fund routine cyclical preventive maintenance and minor repairs of equipment and facilities. Larger maintenance projects, such as roofing replacement, are also routinely completed as an addition to the contract. Both FWS and FAA add funds for routine maintenance projects that are over and above the scope of the BOSS contract.

These two funding sources allow for required maintenance work to be completed over the course of a year to both historic and nonhistoric buildings and facilities. This ongoing program will continue throughout the life of the plan to ensure that Midway's infrastructure is maintained in the best possible condition within available funding.

Larger, more expensive projects are either:

- a) Developed and put into the Service's database for Deferred Maintenance projects for which the Service receives an annual appropriation from Congress. Midway's extensive infrastructure needs have provided justification for those larger Midway projects and their resultant funding. This has allowed the Service to systematically work toward reducing the large maintenance backlog at Midway, and it is anticipated that this level of support will continue throughout the life of this plan.
- b) Funded by the FAA's Airport Capitol Improvement Program. Funding is provided to the FWS to support the design and construction of new airfield infrastructure (Airport Operations Building), or the improvement of existing facilities (resurfacing the runway).

HISTORIC RESOURCES

Maintenance of many of Midway's significant historic buildings and facilities is included in the BOSS contract described above and as such is ongoing. However, it does not include all the historic elements as described in the Historic Preservation Plan, which makes maintenance of those elements outside the scope of the contract and a management challenge for the Service. As outlined in the Monument Management Plan (Section 3.1.3 Historic Resources Action Plan), the Historic Preservation Plan will be rewritten



within the next year to be consistent with this Conceptual Site Plan and reflect the Service's commitment to reuse as many of Midway's historic buildings as possible to meet the Monument's and Refuge's needs at Midway. To maintain those buildings, structures, and facilities, additional funding must be found. The Service will work with other federal agencies, private organizations, veterans' groups, and others to find the support needed to maintain these important aspects of Midway's history.



PRIORITY MAINTENANCE/CONSTRUCTION PROJECTS AT MIDWAY ATOLL

Design and Construct Airport Welcome Center on Sand Island

\$500,000 — 2 years

A small passenger terminal/welcome facility will be constructed at the airport to handle passenger arrival and departures from Midway. This simple facility will offer restrooms, baggage handling, information, and a waiting area for staging passengers out of the weather.

Develop Biodiesel Fuel Capacity or Other Sustainable Fuel Types

\$750,000 — 2 years

In an effort to advance the use of sustainable technologies at Midway, small boats, vehicles, and heavy equipment will be evaluated and, where feasible, transitioned to the use of biodiesel. This fuel could be stored on the existing concrete pad along the north wall of the inner harbor. Alternatively tanks could be located near the newly constructed fuel farm on the southwest corner of the inner harbor.

Utilize Existing Footprint of Bravo Barracks for Replacement Housing

\$10 million — 3 years

Demolition costs for existing building must be included in construction cost. Bravo Barracks replacement is essential in order to provide safe housing for permanent island residents and transients working on future maintenance/construction projects.

Complete Phase I Rehabilitation of the Commissary Building and Midway Mall

\$2 million — 3 years

Collectively the commissary building and the Midway Mall present ideal central locations for Co Trustee and partner office, classroom, storage, and basic laboratory space. Phase I rehabilitation of the commissary will include cleaning and maintenance, construction of office and classroom space, and a feasibility study of how best to incorporate solar power and other sustainable design principles. The Midway Mall will require more substantial design and a preservation plan for renovation to provide basic office and storage space along with visitor information.

Design and Construct a Pilot Low Impact Shelter

\$1.3 million — 4 years

Construct a low impact shelter for short term housing in the housing zone. The housing will be constructed as a sustainable design pilot project intended to showcase the synergistic potential of innovative design on the island. The design may elevate the building off the ground, providing for human habitation while increasing the total amount of available wildlife habitat, and providing environmental security from tsunamis and storm surges. This structure will incorporate



6. Priority Actions and Next Steps

PRIORITIZATION AND IMPLEMENTATION

Pacific Island regional design principles to consider local wind and sunlight patterns, will aim to be nonpolluting, and will incorporate recycled materials. The use of solar power, composting toilets, and, if needed, a small rain catchment system will be explored in an effort to sustain the building off the power grid and minimize wildlife impacts.

Treat All Wooden Historic Structures for Termites

\$2 million — 5 years

By treating all wooden/historic structures immediately we buy ourselves 5–10 more years to find funding for ultimate rehabilitation/restoration. Without treatment these structures either need to be rehabilitated immediately or abandoned forever.



Metal pillbox, Eastern Island

Rehabilitate Water Catchment/Distribution System

\$3 million — 5 years

Reliable water will be required to support any future build-up.

Rehabilitate Septic/Wastewater Systems

\$2 million — 5 years

Reliable septic/wastewater systems will be required to support any future build-up. To reduce the required capacity and cost of the system, on-site composting and waste reduction will be considered.

Redevelop Existing Boathouse into New Boathouse, Dive Center, and Water-based Storage Facilities

\$1.5 million — 5 years

Redevelop the existing boathouse at Midway into a multipurpose boathouse, dive center, and storage facility to support agency operations in the northwestern end of the Monument. The facility will have

maintenance bays and equipment for servicing small boats; a dive locker including a compressor, recompression chamber; and appropriate storage and work areas. The dive center may also support the visitor program. The building will be re-sited or reconstructed and potentially raised to address concerns of flooding on the seaplane pad.

Rehabilitate/Replace Finger Piers along the Inner Harbor

\$450,000 — 5 years

To meet small boat needs, within 5 years construct/rehabilitate three finger piers. These piers may be used for fueling, loading, and short-term in-water storage of vessels. These vessels will be used to support programs at Midway and neighboring atolls in the future.

Design a Marine Laboratory and Develop in Phases

\$2.25 million — 5 years

A variety of needs will be met by a marine laboratory at Midway. An evaluation and planning effort will help determine if the research and educational needs of potential users will be best met by developing several small facilities over time, or by a modular design that allows new requirements to be filled as they arise. Initially the lab would provide basic amenities to augment research and education capacity including field schools, seasonal research, and long-term monitoring. Wet/dry lab infrastructure, quarantine standards, and possibly freezer space will be included in the plan. Several locations are well-suited for a small laboratory, including the old commissary building adjacent to the Midway Mall, as well as several sites on the seaplane apron. The commissary building may be ideal for a first phase location and could help support the Hawaiian monk seal captive care program.



Green turtle on Eastern Island

Complete Full Rehabilitation of Midway Mall

\$8 million — 10 years

Midway Mall would be rehabilitated as the “Midway Atoll Visitor Center” and would be used as Co-trustee office space and for other potential partner personnel, as well as a hub for visitor services, classrooms, and education. Phase I rehabilitation would allow for agency offices and be completed within 3 years.

Rehabilitate Officers’ Row Housing

\$5 million — 10 years

The 10 historic Officers’ row houses serve as examples of historic Albert Kahn architecture and will be restored. This increased housing capacity will accommodate increased agency and partner personnel.

Remodel or Replace Clipper House

\$1.75 million — 10 years

The Clipper House presently serves as the primary food service facility for Midway. Overall food services will need to be expanded to accommodate future population increases and enlargement of the Clipper House, reuse of older existing food service facilities, or construction of a new dining facility will be evaluated.

Rehabilitate Seaplane Hangar

\$2.5 million — 10 years

Due to its size (large enough to hold heavy equipment, boats, workshops, etc.), its location (short distance from inner harbor and boat ramp) and its historic significance (designed by Albert Kahn, still contains scars from the Battle of Midway), this building needs to be utilized and preserved. Rehabilitation work will be guided by a detailed preservation plan.

Utilize Existing Footprint of Charlie Barracks for Replacement Housing

\$10 million — 10 years

Charlie Barracks replacement is essential in order to provide safe housing for island visitors and transient personnel. Demolition costs for the existing building must be included in the construction cost. This replacement is expected to take place within 10 years.

Repair Inner Harbor Sea Wall

\$20 million — 15 years

The harbor is critical to operations at Midway. Any future expansion of docking/pier facilities in the harbor must be preceded by the repair of the existing sea wall.



6. Priority Actions and Next Steps

PRIORITIZATION AND IMPLEMENTATION

REQUIREMENTS PLANNING PROCESS

Many of the priority projects listed above are the result of a Monument-wide field requirements planning process that took place in the fall of 2007. The goals of this process were to outline general infrastructure requirements within the Monument by matching projected field requirements with priority management needs. During this process the Monument Management Board analyzed current and future management needs and projected personnel, infrastructure, and equipment requirements to meet them. In addition, efforts were made to identify areas of overlap that could be consolidated to make field operations as efficient as possible.

The results of this process constitute a detailed vision of the long-term field requirements, primarily for Midway and neighboring atolls, but also for the Monument as a whole. These detailed requirements must have the appropriate infrastructure such as buildings, power, and water; as well as associated means of transportation, such as vessels and aircraft. The priority maintenance and construction projects listed above along with the activities in the Monument Management Plan's section 3.6.3, Coordinated Field Operations Action Plan, will support these requirements over the next 15 years.

Specific field requirements that were identified during the field requirements planning process include increases in visiting and permanently stationed personnel to oversee regular research, education, cultural, historic, management, and protected species work based out of Midway, but servicing neighboring atolls as well. Activities associated with this work will be phased in over time as the attendant infrastructure and modes of transport are developed in a way that is compatible with resource protection. The small boat and diving assets, supply needs, air transport, laboratory facilities, housing, and visitor outreach needs that were coarsely defined during the requirements process have been refined in the Midway Conceptual Site Plan and will be thoroughly evaluated and acted upon based on the strategies and activities found in the Monument Management Plan.

ASSESSMENT OF MIDWAY CONCEPTUAL SITE PLAN DURING THE MANAGEMENT PLAN 5-YEAR REVIEW

The Monument Management Plan will be reviewed every 5 years. The review represents an essential element of the adaptive management process and includes public involvement, characterization of issues, and review and evaluation of action plans. The Midway Atoll Conceptual Site Plan is part of the Monument Management Plan and will be assessed as part of this broader five-year plan review, or as needed, to determine if changes need to be made to this 15-year conceptual plan. This will also provide an opportunity to review the Midway Conceptual Site Plan after other site plans (i.e., Tern Island, Kure Atoll) are developed.

SUMMARY

Several other high-priority projects (habitat, cleanup, and visitor services projects) have been identified for Midway Atoll during the process of developing this Conceptual Site Plan and the larger Monument Management Plan. For detailed information on these projects, please refer to the appropriate Actions Plans contained in the Monument Management Plan.

As the Monument Management Board and partners work toward implementation of the Monument Management Plan, it is important for all parties to find ways to make incremental steps that will lead toward the many larger projects described in this document and the Plan. By working together and combining resources to achieve common goals, agencies and partners can realize the benefits and synergy that come from people working together. This Conceptual Site Plan offers an achievable view of Midway's future considering the resources that already exist and those that hopefully will be available in the future. The vision of Midway as presented in this plan is something that can be completed within the next 15 years—it will be a challenge and an opportunity for all involved to be a part of that transformation.

Resources

PLANNING DOCUMENTS

1991, January. *Natural Resources Management Plan for Naval Air Facility, Midway Island*. U.S. Fish and Wildlife Service Hawaiian Islands National Wildlife Refuge. Honolulu, Hawai'i.

1995. *Midway Atoll NWR Annual Narrative Report 1994*. U.S. Fish and Wildlife Service.

1995. *Sand and Eastern Islands, Midway Atoll Infrastructure Evaluation*. Prime Engineering, Inc. Atlanta, Georgia.

1995–1999 *Baseline Surveys for Alien Species in Marine and Terrestrial Habitats on Midway Atoll National Wildlife Refuge*. Remote Islands Team, Ecological Services, U.S. Fish and Wildlife Services.

1996, April. *Final Environmental Assessment for the Proposed Refuge Logistics and Operations Support and Public Use Program, Midway Atoll NWR*. U.S. Fish and Wildlife Service.

1997, August. *Operations and Maintenance Plan for Midway Atoll NWR*. U.S. Fish and Wildlife Service.

1998. *Interpretive Prospectus for Midway Atoll National Wildlife Refuge*. U.S. Fish and Wildlife Service, Pacific Regional Office Visitor Services Branch.

1998, October. *Naval Air Facility (NAF) Midway Island Land Use Restrictions (Draft)*. Ogden Environmental and Energy Services Co, Inc. Honolulu, Hawai'i.

1999. *Midway Atoll National Wildlife Refuge Historic Preservation Plan*. U.S. Fish and Wildlife Service, Pacific Region.

2003, May. *Midway Atoll National Wildlife Refuge and Battle of Midway National Memorial—A Summary of Midway's Natural and Historic Resources*. U.S. Fish and Wildlife Service.

2003, August 29. *Infrastructure Condition Assessment and Modification, Midway Atoll National Wildlife Refuge*. GeoEngineers, Inc., Honolulu, Hawai'i.

2005, April 12. *Midway Atoll National Wildlife Refuge—Visitor Program Market Analysis and Feasibility Study*. Pandion Systems, Inc. Gainesville, Florida.

2006. *Northwestern Hawaiian Islands Proposed National Marine Sanctuary, Draft Environmental Impact Statement and Management Plan, Vol. II of II*. National Oceanic and Atmospheric Administration. National Ocean Service, National Marine Sanctuary Program.

2006. *Henderson Airfield Master Plan*. PND Engineers, Inc., Anchorage, Alaska.

2006. *Midway NWR Vision, Goals and Objectives Exercise*. U.S. Fish and Wildlife Service.

2006. *Draft Interim Visitor Services Plan for Midway Atoll NWR, the Battle of Midway National Memorial, and the Northwestern Hawaiian Islands Marine National Monument's Midway Atoll Special Management Area*. U.S. Fish and Wildlife Service, Pacific Islands, Division of External Affairs and Visitor Service.

2007, March 27. *RONS (Refuge Operational Needs System) Project List, Midway Atoll NWR*. U.S. Fish and Wildlife Service. 9 pages.

2007, March 27. *SAMMS (Service Asset Maintenance Management System) Deferred Maintenance & Construction Projects, Midway Atoll NWR list*. U.S. Fish and Wildlife Service. 8 pages.

Midway Operations Contract—Statement of Work. U.S. Fish and Wildlife Service. (for "Chugach" contract). 7 pgs.



Laysan ducks in created wetland

Resources

PLANNING DOCUMENTS

2007, May 23. *Interim Visitor Services Plan for Midway Atoll National Wildlife Refuge and the Battle of Midway National Memorial and the Papahānaumokuākea Marine National Monument's Midway Atoll Special Management Area.* U.S. Fish and Wildlife Service Midway Atoll National Wildlife Refuge and Pacific Islands Division of External Affairs and Visitor Services.

2007, June 1. *Papahānaumokuākea Marine National Monument Draft NOAA Interim Management Plan.* National Oceanic and Atmospheric Administration (NOAA). Honolulu, Hawai'i.

2007, July. *Building Foundations for the Future: Historic Preservation on Midway Atoll NWR.* U.S. Fish and Wildlife Service, Pacific Region.

2007, November 14. *Papahānaumokuākea Marine National Monument Preliminary Draft Management Plan.* National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, State of Hawai'i. Honolulu, Hawai'i. 3rd Draft.

2008, December. *Papahānaumokuākea Marine National Monument Management Plan.* National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, State of Hawai'i. Honolulu, Hawai'i.



SELECTED REFERENCES OF THE MONUMENT MANAGEMENT PLAN

- Aeby G.S., J.C. Kenyon, J.E. Maragos, and D.C. Potts. 2003. First record of mass coral bleaching in the Northwestern Hawaiian Islands. *Coral Reefs* 22:256.
- Aeby, G.S. 2006. Baseline levels of coral disease in the Northwestern Hawaiian Islands. *Atoll Research Bulletin* 543:471-488.
- Antonelis, G.A., J.D. Baker, T.C. Johanos, R.C. Braun, and A.L. Harting. 2006. Hawaiian monk seal: status and conservation issues. *Atoll Research Bulletin* 543:75-102.
- Baker, J.D., C.L. Littnan, and D.W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. *Endangered Species Research* 4:1-10.
- Blackburn, T.M., P. Cassey, R.P.Duncan, K.L. Evans, and K.J. Gaston. 2004. Avian Extinction and Mammalian Introduction on Oceanic Islands. *Science* 305:1955-1958.
- Boland, R.C., and M. Donohue. 2003. Marine debris accumulation in the nearshore marine habitat of the endangered Hawaiian monk seal, *Monachus schauinslandi* 1999-2001. *Mar. Poll. Bull.* 34 46(11): 1385-1394.
- Citta, J. M., Reynolds, and N. E. Seavy. 2006. *Seabird Monitoring Assessment for Hawai'i and the Pacific Islands*. USGS Pacific Island Ecosystems Research Center. Unpubl. Rept. to U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Portland, Oregon.
- DeMartini, E.E. and A.M. Friedlander. 2006. Predation, endemism, and related processes structuring shallow-water reef fish assemblages of the NWHI. *Atoll Research Bulletin*. 543: 237-256.
- Eldredge, L. 2005. *Assessment of the potential threat to the introduction of marine non-indigenous species in the Northwestern Hawaiian Islands*. Final Report Prepared for Environmental Defense. Contribution No. 2005-001 to the Hawaii Biological Survey. Bishop Museum, Honolulu.
- Fine and Tchernov. 2007. Scleractinian Coral Species Survive and Recover from Decalcification. *Science* 315: 1811.
- Finkelstein, M.E., K.A. Grasman, D.A. Croll, B.R. Tershy, B.S. Keitt, W.M. Jarman, and D.R. Smith. 2007. Contaminant-associated alteration of immune function in Black-footed Albatross (*Phoebastria nigripes*), a North Pacific Predator. *Environmental Toxicology and Chemistry* 26:1896-1903.
- Friedlander, A., G. Aeby, R. Brainard, A. Clark, E. DeMartini, S. Goodwin, J. Kenyon, R. Kosaki, J. Maragos, and P. Vroom. 2005. The State of Coral Reef Ecosystems of the Northwestern Hawaiian Islands. Pp. 270-311. In: J. Waddell, Ed. *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005*. NOAA Technical Memorandum NOS NCCOS 11. NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. Silver Spring, Maryland. 522 pages.
- Hope, B., S. Scantolini, E. Titus, and J. Cotter. 1997. Distribution patterns of polychlorinated biphenyl congeners in water, sediment, and biota from Midway Atoll (North Pacific Ocean). *Marine Pollution Bulletin*. 34(7):548-563.
- Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Solomon, S, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller, Eds. Cambridge University Press, Cambridge, United Kingdom; and New York, NY, USA. 996 pages.
- Kenyon, J.C., G.S. Aeby, R.E. Brainard, J.D. Chojnacki, M.J. Dunlap, and C.B. Wilkinson. 2006. Mass coral bleaching on high-latitude reefs in the Hawaiian Archipelago. *Proceedings of the 10th International Coral Reef Symposium Okinawa* 2:631-643.
- Kenyon, J.C. and R.E. Brainard. 2006. Second recorded episode of mass coral bleaching in the Northwestern Hawaiian Islands. *Atoll Research Bulletin* 543:505-523.
- Ludwig, J.P, C.L. Summer, H.J. Auman, V. Gauger, D.Bromley, J.P. Giesy, R.Rolland, and T. Colborn. 1997. The roles organochlorine contaminants and fisheries bycatch in recent population changes of Black-footed and Laysan Albatrosses in the North Pacific Ocean. In G. Robinson and R. Gales, Eds. *Albatross Biology and Conservation*. Surrey Beatty & Sons, Chipping Norton. Pp. 225-238.

Resources

2. SELECTED REFERENCES OF THE MONUMENT MANAGEMENT PLAN

Michener, W.K., E.R. Blood, K.L. Bildstein, M.M. Brinson, and L.R. Gardner. 1997. Climate change, hurricanes and tropical storms and rising sea level in coastal wetlands. *Ecological Applications* 7:770-801.

Mooney, H.A. and E.E. Cleland. 2001. The evolutionary impact of invasive species. *Proceedings of the National Academy of Science* 98:5446—5451.

Nishida, G. 1998. Midway Terrestrial Arthropod Survey, Final Report prepared for USFWS, by Hawai'i Biological Survey, Bishop Museum, Honolulu, Hawai'i.

Nishida, Gordon, 2001. *Terrestrial Arthropods of the Northwest Hawaiian Islands (excluding Midway)*. Prepared for the US Fish and Wildlife Service. Hawai'i Biological Survey, Bishop Museum, Honolulu, Hawai'i.

NOAA 2003. Atlas of the shallow-water Benthic Habitats of the NWHI (Draft). 160 pp. National Ocean Service. Silver Spring, MD.

Ogden Environmental and Energy Services Co., Inc. 1996. *Naval Air Facility (NAF) Midway Island Site Inspection (SI) Report*. January. As cited in *U.S. Navy 2001*.

Ogden Environmental and Energy Services Co., Inc. 1997. *Remedial Investigation (RI) Report for Naval Air Facility (NAF) Midway Island, Volume I: Technical Report*.

Parrish, F.A., K. Abernathy, G.J. Marshall, and B.M. Buhleier. 2002. Hawaiian monk seals (*Monachus schauinslandi*) foraging deepwater coral beds. *Marine Mammal Science* 18:244-258.

Rehkemper, C. and E. Flint. 2002. Control and Eradication of the introduced grass, *Cenchrus echinatus*, at Laysan Island. In Veitch, C.R. and M.N. Clout, Eds. *Turning the tide: the eradication of invasive species*. IUCN SSC Invasive Species Specialist Group, IUCN, Glad, Switzerland and Cambridge, UK. 414 pages.

Shea, E. L, G. Dolcemascolo, C. L. Anderson, A. Barnston, C. P. Guard, M. P. Hamnett, S. T. Kubota, N. Lewis, J. Loschnigg, and G. Meehl. 2001. *Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change*. Published Report. East-West Center, Honolulu, Hawai'i. 100 pages.

Smith, S.V and R. M. Buddemeier. 1992. Global Change and Coral Reef Ecosystems. *Annual Review of Ecology and Systematics* 23:89-118.

Stambler, N. 1999. Coral reefs and eutrophication. *Marine Pollution* (July):360-361.

State of Hawai'i, U.S. Department of the Interior U.S. Fish and Wildlife Service, and the U.S. Department of Commerce National Oceanic and Atmospheric Administration (2006). *Memorandum of Agreement (MOA) for Promoting Coordinated Management of the Northwestern Hawaiian Islands Marine National Monument (MOA)*. December 8, 2006. Honolulu, Hawai'i.

USCG. 2003. Tern Island Ecological Risk Assessment Addendum-Bulky Dump. Technical Memorandum. CH2M Hill for U.S. Coast Guard Civil Engineering Unit Honolulu.

U.S. Fish and Wildlife Service (FWS). 2004. *Draft Revised Recovery Plan for the Laysan Duck (Anas laysanensis)*. U.S. Fish and Wildlife Service, Portland, Oregon. vii + 94 pages.

U.S. Navy, Bureau of Yards and Docks. 1947. *Building the Navy's Bases in World War II*. Two vols. Washington Government Printing Office.

U.S. Navy. 2001. *Action Memorandum for Time-Critical Removal Action of Abandoned Tug and Barge, LCM, Boiler, and PCB-Contaminated Marine Sediment Bulky Waste Landfill, Midway Atoll*.

U.S. Navy. 1995. *Technical Memorandum for Evaluation of Remedial Alternatives Naval Air Force (NAF) Midway Island*. Ogden Environmental and Energy Services Co., Inc. Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62742-90-D-0019 Cto No. 0136.

Vitousek, P. M. 1994. Beyond global warming: ecology and global change. *Ecology* 75:1861-1876.

Woodbury, D.O. 1946. *Builders for Battle. How the Pacific Naval Air Bases Were Constructed*. E.P. Dutton and Company, NY. 415 pages.





JONES & JONES

Architects and Landscape Architects, Ltd.
105 South Main Street Suite 300
Seattle, Washington 98104
tel 206 624 5702 • 206 624 5923 fax
www.jonesandjones.com

