

DRAFT ENVIRONMENTAL ASSESSMENT

APPENDICES A and B

HAWAII WILDFIRE MANAGEMENT ORGANIZATION

CRITICAL FUEL BREAK MANAGEMENT AND

DIP TANK PROJECT

FEMA 1640-DR-HI, HMGP 1640-7

DECEMBER 2013

Appendix A—Community Wildfire Protection Plan for Northwest Hawaii Island

Appendix A

Appendix A contains the Community Wildfire Protection Plan for Northwest Hawaii Island, dated July 2007. The plan, developed by the Hawaii Wildfire Management Organization, identifies and prioritizes areas for hazardous fuel reduction treatments, recommends the types and methods of treatment that will protect Northwest Hawaii, and recommends measures to reduce the ignitability of structures throughout the planning area.

Community Wildfire Protection Plan for Northwest Hawaii Island

Sponsored by the Hawaii Wildfire Management Organization
a 501(c)(3) nonprofit organization

With generous support from the Fire Management Program of the Hawaii State Department of Land and Natural Resources, Division of Forestry and Wildlife



July 2007
Written by Denise Laitinen
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Northwest Hawaii Community Wildfire Protection Plan Mutual Agreement Page

The Community Wildfire Protection Plan (CWPP) developed for Northwest Hawaii by the Hawaii Wildfire Management Organization (HWMO):

- Was collaboratively developed. Interested parties and federal land management agencies managing land in the vicinity of Northwest Hawaii have been consulted.
- This plan identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment that will protect Northwest Hawaii.
- This Plan recommends measures to reduce the ignitability of structures throughout the planning area.

The following entities mutually agree with the contents of this Community Wildfire Protection Plan:

Paul J. Conry
State Forester, Division of Forestry and Wildlife

Date

Darryl Oliveira
Fire Chief, Hawaii Fire Department

Date

Troy Kindred
Administrator, Hawaii County Civil Defense

Date

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Executive Summary:

The leeward or west side of Hawaii Island with its arid weather conditions and sprawling grasslands, interspersed with housing development is a wildland urban interface (WUI). The wildland/urban interface (WUI) is any area where wildlands abut houses or a development. This interface area poses the highest risk of loss of life and property due to wildland fire. The risk of wildland fire impacting structures in the WUI is determined by several factors, including the ignitability of fuels, structural ignitability, weather conditions, and topographical features, such as slope.

Unlike the contiguous United States, wildfire is not a natural part of Hawaii's ecosystem. In Hawaii, wildfires destroy native ecosystems, which impacts watersheds and traditional cultural activities. Wildfires have also caused the demise of or have fragmented the habitats that support native flora and fauna, many of which are listed as endangered or threatened. Sixty-five percent (65%) of Hawaii Island's dryland forest ecosystems have been lost primarily due to wildfire carried by invasive grasses. Consequently, Hawaii's dryland habitats are mere remnants of what was once referred to as the most diverse dryland ecosystem in the state. Wildfires in Hawaii also cause soil erosion, which negatively impacts our ocean reefs. Exposed soils pose a significant health hazard as well when the loose particulates are picked up in the wind and carried to populated areas.

The overwhelming majority of wildfires in Hawaii are caused by arson or human error. Human error includes errant fireworks, burning rubbish, cooking, or agricultural fires that get out of control in the wildland-urban interface, as well as vehicle-caused wildfires.

Principal stakeholders who have an interest in protecting Northwest Hawaii from wildfire include Hawaii Wildfire Management Organization, which sponsored this CWPP, Hawaii Fire Department, Hawaii County Civil Defense, Department of Land and Natural Resources Division of Forestry and Wildlife, Department of Hawaiian Home Lands, the U.S Army, the U.S. Fish and Wildlife Service, and large landowners. These decision makers were invited to participate in the development of this Plan.

A wildfire hazard assessment determined that WUI areas in Northwest Hawaii communities have a high risk of wildfire. Wildland fires occur frequently throughout Northwest Hawaii, threatening area residents. The largest wildfire in state history was in Northwest Hawaii in 1969 and burned more than 47,000 acres and a 2005 wildfire that burned 25,000 acres forced the evacuation of thousands of people. The continued invasion of non-native plant species, which are considered high-intensity burning fuels, increases the wildfire risk within Westside communities. Grazing traditionally assisted in reducing fuel loads and wildfire risk. However, due to a variety of circumstances, grazing has been reduced or eliminated in many areas, which has contributed to the accelerated wildfire risk in areas that were previously less prone to wildfire. The lack of reliable water resources for both ground and helicopter fire suppression crews have also compromised the rapid response to these disasters and have contributed to the increased fire spread. Communities vary in their access of water, with some communities relying on private water systems or catchment water basins, with others accessing county water.

Meetings with community members and fire agency personnel identified a variety of mitigation measures to reduce the chance of fires starting in Northwest Hawaii, as well as to attempt to minimize the impact of a wildfire. These measures include: 1) installation of pre-staged static water and helicopter dip tanks; 2) acquisition of adequate resources for first responders, including off-road tankers; 3) reduction of fuel loads and/or appropriate conversion of fuels along road sides, in community open areas, and individual homes; 4) adoption of development standards and community planning that requires the mitigation of wildfire risks; 5) creation of secondary emergency access roads and emergency egress signage within subdivisions; 6) development of emergency staging areas within

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communities; 7) reduction and/or control of invasive species that possess inherent fire or ignition properties; 8) continued fire prevention education, including arson prevention; and 9) integration of communication equipment to increase effective firefighting response.

While homes and structures have been lost to wildfire in the past, Hawaii County has been fortunate in controlling wildland fires in and around communities. To date, there has been no loss of life contributed to wildfire disasters. However, the existing wildfire risk is severe given the fire history, rapid development of the region, and the increasing fire fuel load. The mitigation measures outlined in this CWPP will enable Northwest Hawaii communities to reduce their risk to wildfire and create a more efficient fire-protection plan. The mitigation measures listed above identify pro-active projects that communities and fire agencies can undertake to minimize losses from a major wildland fire.

Background:

This CWPP covers a broad expanse (451,086 acres) of the leeward side of Hawaii Island. Figure 1 depicts the Base Map of the Northwest Hawaii CWPP. The area included in this CWPP extends from Kohala (intersection of Akoni Pule Highway and Old Coast Guard Road) south to Hina Lina subdivision in Kailua-Kona and from sea level in the west, eastward to Kohala Mountain Road in Kohala, Pu'u Kapu in Waimea, Waiki'i, and the extensive state land holdings east of Mamalahoa Highway between Saddle Road and Kamehameha School land holdings. Covering an expanse from sea level to the 8,800-foot elevation, this CWPP encompasses the base of Mauna Loa, the world's largest volcano. The inhabited areas at potential risk to wildland fire include Kohala Ranch, Kohala by the Sea, Kohala Estates, Kawaihae, Kawaihae Village, Puako, Waimea, Pu'u Kapu, Waiki'i, Pu'u'anahulu, Pu'u Wa'a Wa'a Waikoloa, Kona Palisades, Kealakehe, and Hina Lani, as well as vast areas of state and federal lands, and open grasslands.

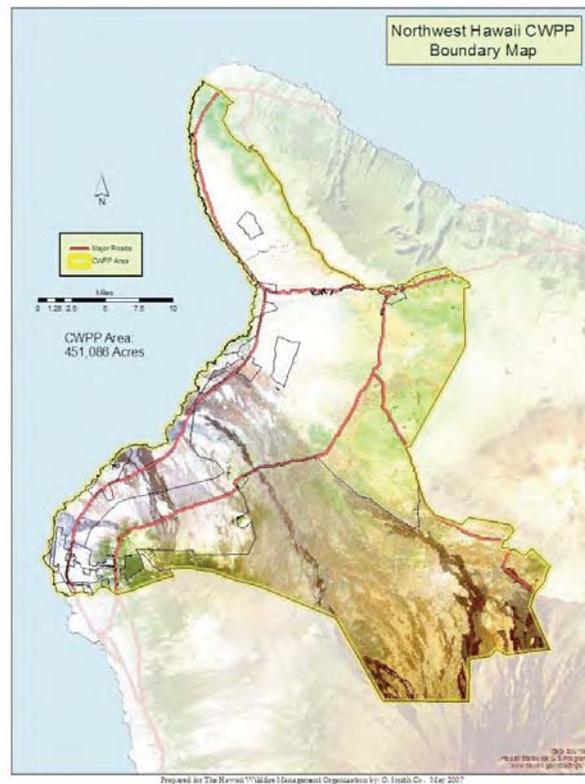


Figure 1: The Northwest Hawaii CWPP area of consideration is outlined in yellow and covers more than 451,086 acres.

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There are five main roads in West Hawaii: Queen Kaahumanu Highway, Mamalahoa Highway, Akoni Pule Highway, Waikoloa Road, and Kohala Mountain Road. Queen Kaahumanu Highway (Route 19) runs north-south along the coast from Kona to Kawaihae as does Mamalahoa Highway (Route 190), which also runs north-south, upslope and parallel to Queen Kaahumanu Highway at an elevation ranging from 1,000 – 2,000 feet. In Kawaihae, Queen Kaahumanu Highway continues north as Akoni Pule Highway (Route 270), while Route 19 veers to the east – upslope to Waimea along Kawaihae Road. Kohala Mountain Road also runs north-south from Waimea to Hawi and is roughly parallel to Akoni Pule Highway at a higher elevation. Waikoloa Road runs east-west, connecting Queen Kaahumanu Highway and Mamalahoa Highway and is the primary access to the Waikoloa community. These five roads provide access to all the communities covered by this CWPP.

Within Northwest Hawaii there are several communities, including, from north to south, Kawaihae, Waimea, Puako, Pu'uanahulu, and Waikoloa. Communities covered by this CWPP vary in size from 100 single-family home subdivisions to more than 2,700 dwellings with single-family homes, condominiums, retail outlets, schools, historical sites, recreational areas, and commercial facilities. Some of the subdivisions in the coverage area are: Waiki'i, Puakea Ranch, Kohala by the Sea, Kohala Ranch, Kohala Estates, Kawaihae Village, Pu'u Kapu, Pu'u Lani Ranch Estates, Kona Palisades, Kealakehe, and Hina Lani Estates. In addition, there are several internationally known world-class resorts that draw thousands of visitors from around the world.

Within the CWPP boundary, county fire stations are located in Waimea, Puako, and Waikoloa with volunteer fire stations in Pu'uanahulu, Kohala Estates, Waiki'i, and Kona Palisades. A fire station in Kapa'au, while outside the boundary of the CWPP, is responsible for the northern most area included in the CWPP. Each county station has four personnel on duty and is manned 24 hours a day. Volunteer fire stations rely on volunteer personnel.

The Waikoloa county fire station houses a Type 1 engine, ambulance, and hazardous materials vehicle with no firefighting capability, as well as battalion chief quarters for West Hawaii. The South Kohala fire station, located on the Kohala Coast between Waikoloa and Puako, houses a Type 1 engine, 750-gallon tanker, ambulance, and a Type 3 helicopter. The Waimea fire station, near downtown Waimea, houses a Type 1 engine, a 750-gallon tanker, and an ambulance.

In addition to the communities and subdivisions, large landowners within the CWPP coverage area include Parker Ranch, Department of Hawaiian Home Lands, the State of Hawaii, Queen Emma Land Corporation, and Kamehameha Schools. The majority of Queen Emma land within the CWPP boundary area is leased to Parker Ranch for grazing. Figure 2 below illustrates the various large landowners within the Northwest Hawaii CWPP boundary.

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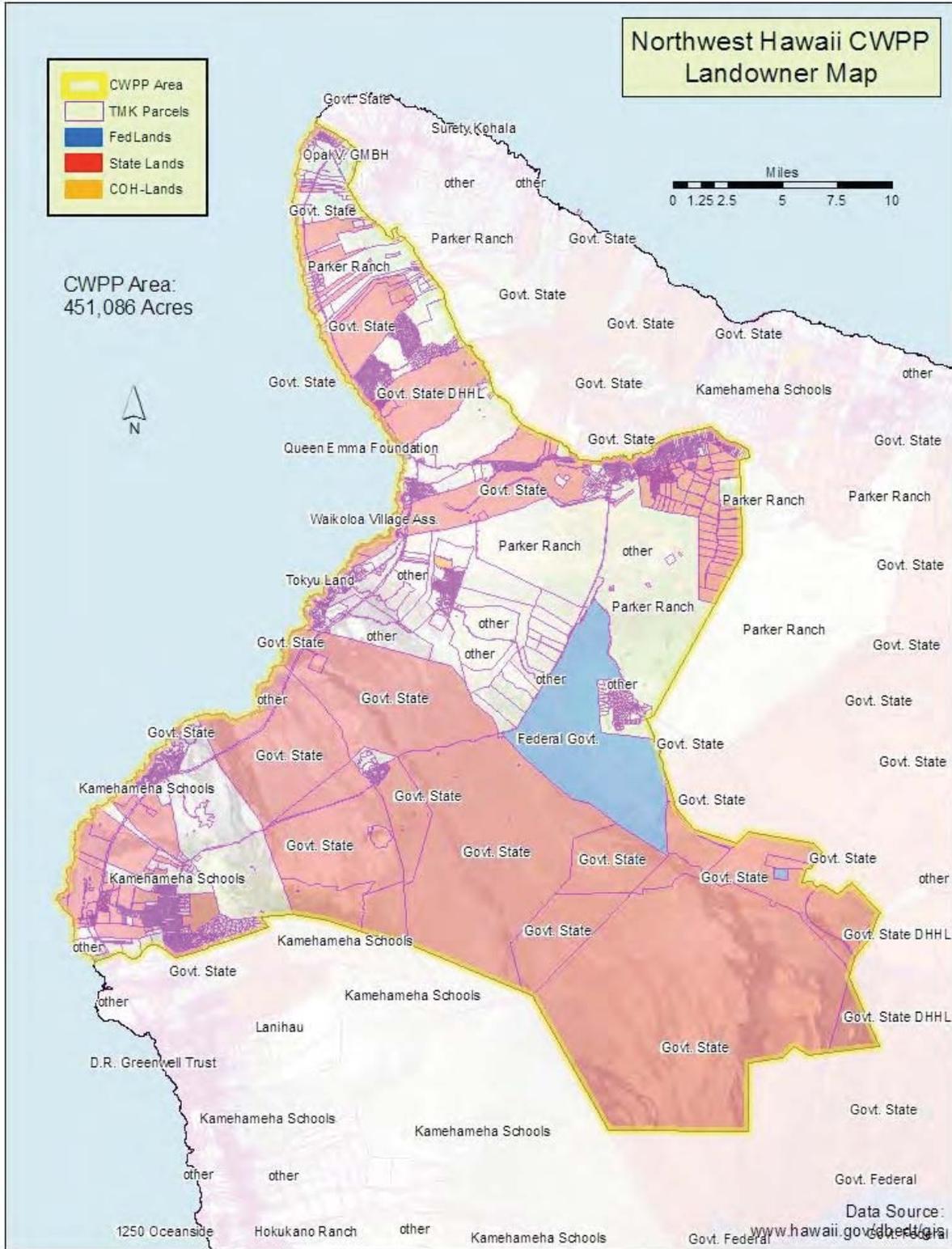


Figure 2: Map depicts major landowners within Northwest Hawaii CWPP coverage area. Reddish areas are state lands, while those in gold are county lands. Queen Emma Land Corporation, Kamehameha Schools, Parker Ranch, and the Department of Hawaiian Home Lands also own extensive land tracts.

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As seen in Figure 3 below, land use in Northwest Hawaii varies between agricultural, conservation, rural, and urban. The majority of land, or 52 percent of the area within the CWPP boundary, is used for agricultural purposes.

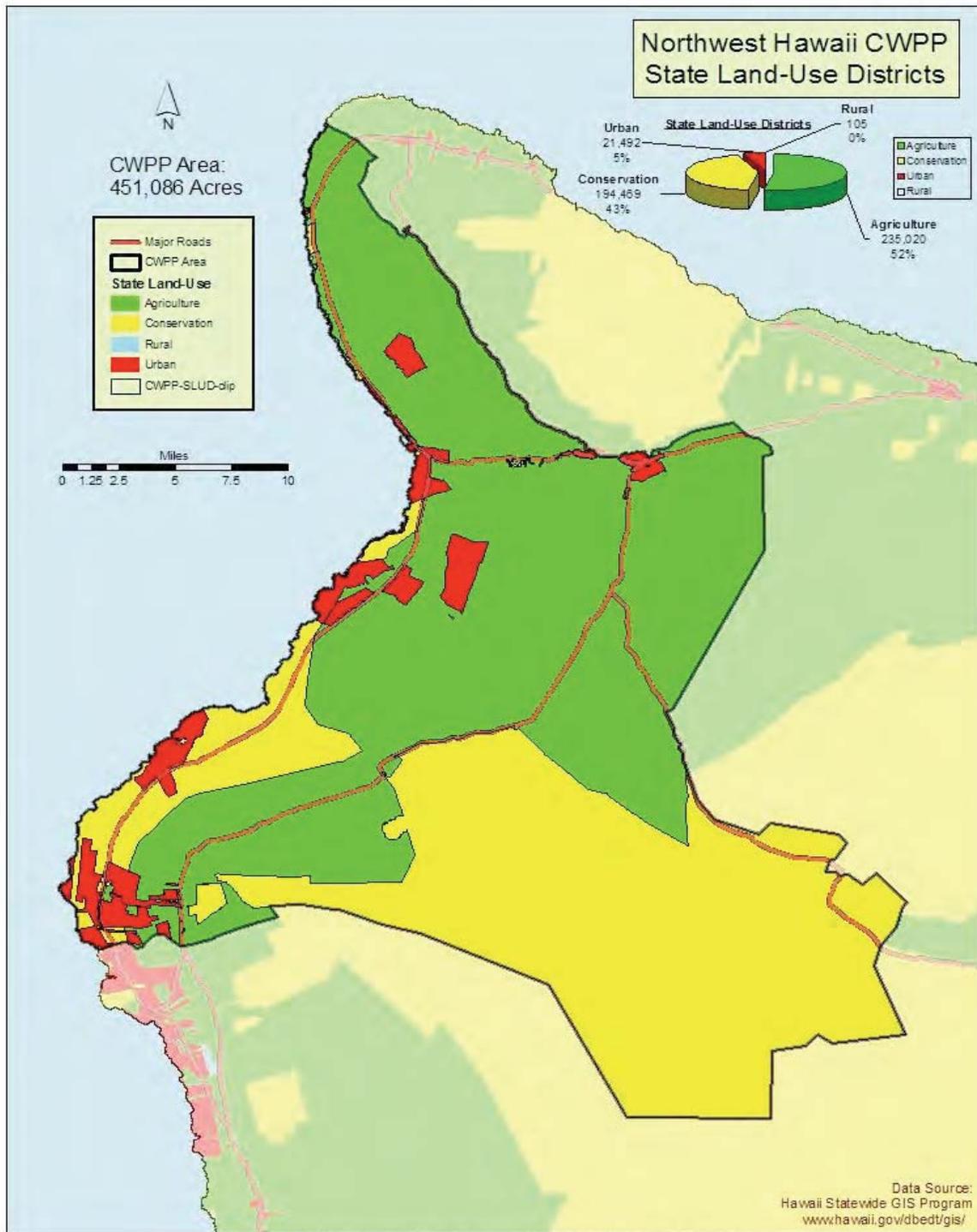


Figure 3: Map depicts land use districts within Northwest Hawaii. Green denotes agricultural areas (235,000 acres or 52 percent of CWPP area), yellow denotes conservation areas (194,469 or 43 percent of coverage area), blue denotes rural areas (0 percent), and red highlights urban areas (21,492 or 5 percent of CWPP area).

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The CWPP area encompasses historical, archeological, and cultural sites and natural areas of importance. Examples of these sites are: Pu'ukohola Heiau National Historic Site; Puako Petroglyph Archeological Preserve; Lapakahi State Historical Park; county parks and beaches, including the popular Hapuna Beach State Recreation Area; and more than 3,000 acres of State land holdings, including Pu'u Wa'a Wa'a State Wildlife Preserve.

Northwest Hawaii receives an average rainfall of 10 – 20 inches a year. Communities along the coast receive less than 10 inches of rain while higher elevations receive more precipitation. The coverage area is notoriously dry and at times can be extremely dry. Kawaihae holds the state record for the least amount of annual rainfall (0.19 inch in 1953) and Puako has the distinction of the lowest average annual rainfall (1987-2000) at 8.93 inches.



Ridge along the southern boundary of Pu'u Lani Ranch Estates subdivision. The ridge is a fire concern due to its steep slope and the high-intensity burning vegetation growing on the ridge.

Slope within the region varies by geography, although the overall terrain in the region naturally slopes from the mountains down to the sea. Gulches, as well as volcanic vents or hills several hundred feet in elevation, dot the countryside. Some subdivisions, such as Pu'u Lani Ranch Estates, have steep ridges bordering their community, others, such as Kohala by the Sea and Waikoloa; have gulches running through their communities. These ridges and gulches are covered with invasive grasses and shrubs that are high intensity burning fuels.

Vegetation zones, as depicted in Figure 4 below, vary within Northwest Hawaii between grasslands, mixed forest, high-intensity developed, scrub/shrub, bare land, estuarine shrub/scrub, and low-intensity developed, among others.

Communities and subdivisions in Northwest Hawaii are often separated by vast expanses of open grasslands containing high-intensity burning fire fuels, including grasses and shrubs. Large lava flows also dot the landscape, providing natural fuel breaks.

The dryland ecosystem in Northwest Hawaii was once referred to as the most diverse native dryland ecosystem in the state of Hawaii. Development, the lack of fine fuels mitigation, and continuous wildfires have caused the demise of much of these native forests, leaving pockets, or kipuka, of remnant plant communities dotting the countryside. Small kipukas of wili wili (*Erythrina sandwicensis*) and lama (*Diospyros sandwicensis*) trees in Waikoloa and along highway 190 are examples of these remnant forests. Attempts at reforestation are under way in Pu'u Wa'a Wa'a and Waikoloa. However, alien trees, shrubs, and grasses have invaded these kipuka. Many of the grasses, such as molasses grass (*Melinis minutiflora*) and fountain grass (*Pennisetum setaceum*), are fire-adapted and increase wildfire potential in areas they invade.



Lava flows dot the Northwest Hawaii landscape providing natural fire fuel breaks. However, invasive grasses, such as fountain grass (above) have spread across open lands and the lava flows reducing their effectiveness as fuel breaks.

The 1859 lava flow, which started from Mauna Loa and flowed westward to the sea, presently serves as a natural fuel break between the communities of Waikoloa and Pu'uana'hulu. To the south of Pu'uana'hulu, the 1801 lava flow traverses from the mountaintop of Hualalai to sea level in multiple areas. These flows, along with numerous smaller sparsely vegetated flows, serve as natural fuel breaks. However, the proliferation of fountain grass has compromised these fuel breaks. A prolific

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non-native species, fountain grass is colonizing lava flows at an alarming rate, and as a result, enabling fire to burn on the fuel break. Fountain grass is so prevalent in Northwest Hawaii that complete eradication of the plant is unfeasible.

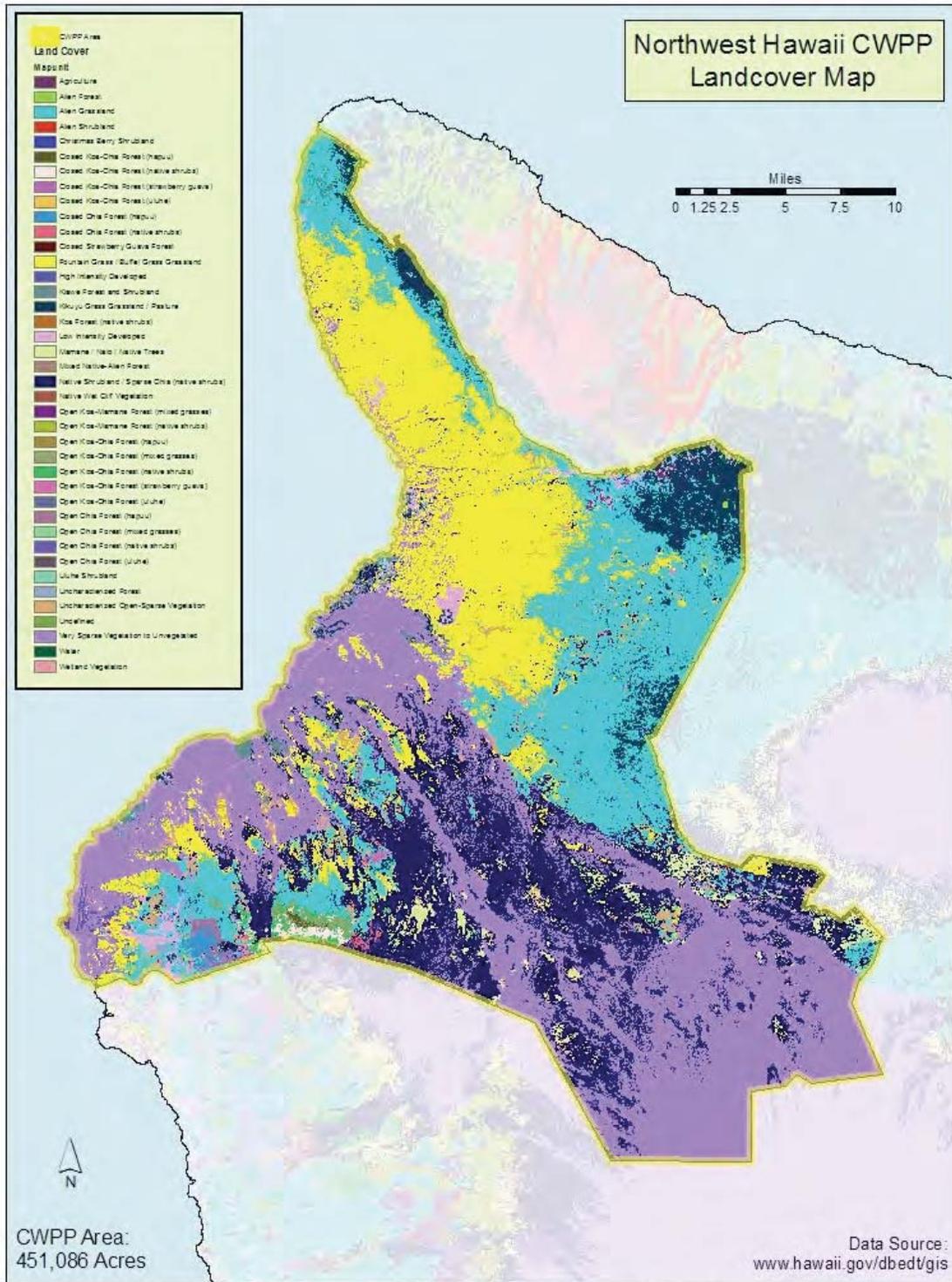


Figure 4: Land cover map of Northwest Hawaii depicting various vegetation zones. Yellow areas denote fountain grass, buffel grass, and/or grassland; purple denotes unvegetated or very sparse vegetation; light blue denotes alien grassland; and dark blue denotes native shrubland / sparse ohia (native shrubs).

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Northwest Hawaii is home to more than 54 federally-listed endangered and threatened plant and animal species, including the Hawaiian duck, (*Anas wyvilliana*), Hawaiian goose (*Branta sandvicensis*), Hawaiian hawk (*Buteo solitarius*), Palila (*Loxioides bailleui*), Akepa (*Loxops coccineus coccineus*), Hawaii creeper (*Oreomystis mana*), 'Ohai (*Sesbania tomentosa*), Hala pepe (*Pleomele hawaiiensis*), Po'e (*Portulaca sclerocarpa*), and Loulu (*Pritchardia affinis*). Figure 5 below shows a plant density map for endangered and threatened plants in Northwest Hawaii. Maps of native Hawaiian bird species locations and forest bird ranges in Northwest Hawaii can be found in Appendix A.

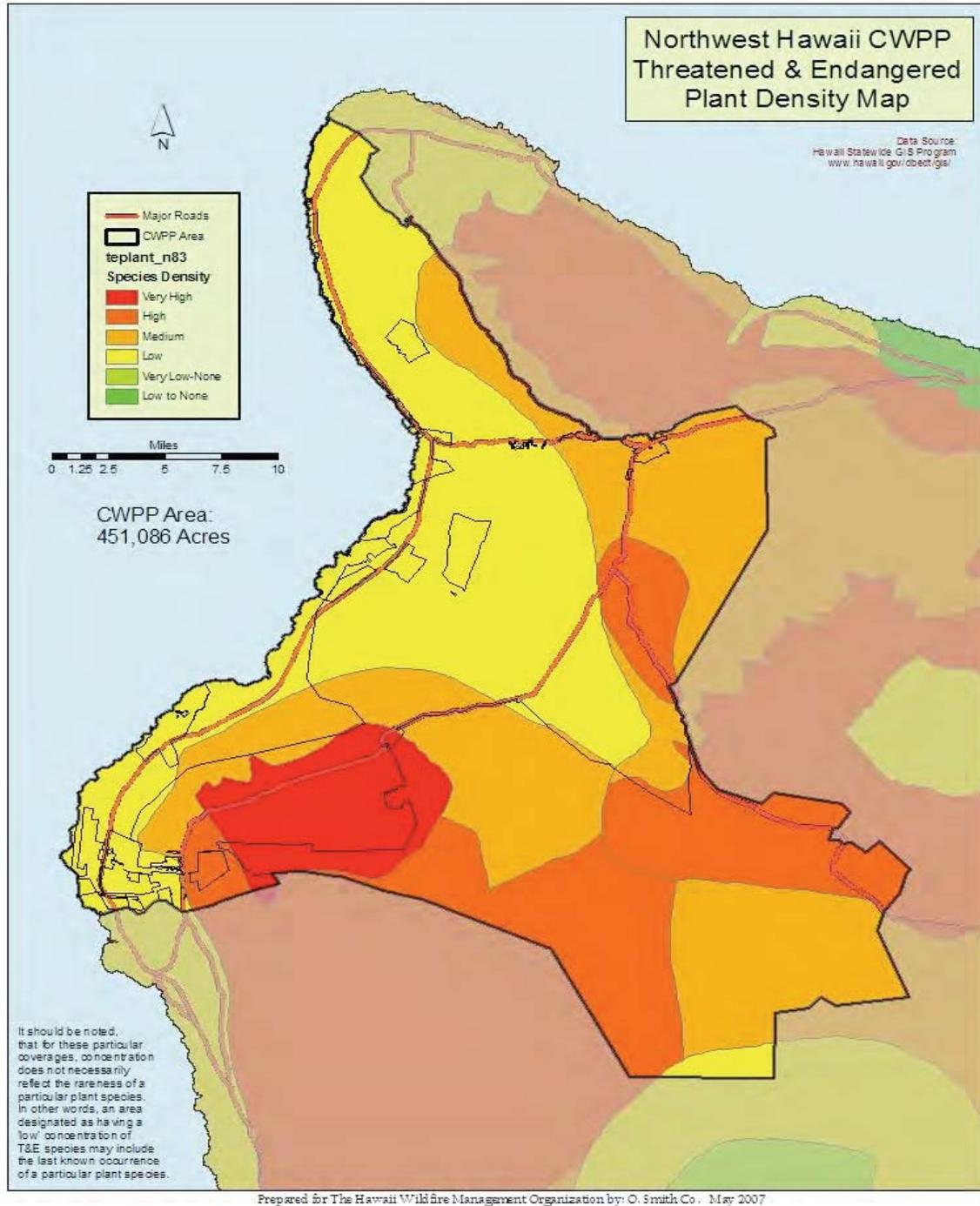


Figure 5: Map depicting endangered and threatened plant densities in Northwest Hawaii. Red zone denotes very high plant density, dark orange denotes high density, light orange is medium density, and yellow is low density of endangered plants.

Fire History:

Different agencies are responsible for fire suppression around the county, depending on fire location. Hawaii Fire Department is responsible for fire suppression in county residential areas while the State Division of Forestry and Wildlife is responsible for fire suppression on state lands. The Pohakuloa Training Area has an organized fire department that responds to fires on the Army's federal land while the National Park Service responds to fires on Park land. All of these agencies have a Memorandum of Understanding for mutual aid in fire suppression. Each organization maintains separate fire history statistics.



Figure 6, below, is a fire history map for West Hawaii spanning from 1954 – 2005 with graphs depicting fire size and frequency. The graphs within the map can be found in Appendix B.

An August 2005 wildfire that started along Kawaihae Road in Waimea consumed 25,000 acres in West Hawaii and burned south all the way to Waikoloa Village. (Photo Credit: Wayne Ching).



The fire history map also illustrates how fuels have been managed in the region. For example, grazing objectives in the Pu'u Wa'a Wa'a area are aimed at fine fuel reduction to minimize the wildfire threat. Wildfires in this area have been infrequent and small and as a result, damage to the dryland forest ecosystem has been less severe than in Pu'u'anahulu. Comparatively, grazing was removed in Pu'u Anahulu (adjacent to Pu'u Wa'a Wa'a and separated by a lava flow) in the 1960s and since then, this area has experienced numerous large catastrophic fires that have decimated much of the native dryland habitat.

While the Waikoloa fire (above right) was burning, a wildfire started by a roadside vehicle ignited grasslands north of Kohala Ranch and jumped the Akoni Pule Highway, burning more than 1,500 acres. (Photo Credit: Wayne Ching).

In the past decade Northwest Hawaii has experienced at least 39 wildfires with 13 of those burning more than 1,200 acres.

Average size for all wildland fires within the

CWPP coverage area during the past 50 years is 2,835 acres with a median size of 400 acres. However, northwest Hawaii has experienced some of the state's largest wildfires, including a 1969 fire that burned 45,000 acres and a 2005 wildfire that encompassed an area from Waimea to Waikoloa burning 25,000 acres. In 2005 there were two simultaneous wildfires burning just days apart. The first fire was the large 25,000-acre Waikoloa conflagration and the second fire was the Akoni Pule Highway wildfire that consumed 1,500 acres. These two large wildfires burning in the same region put a tremendous strain on firefighting



A March 2006 wildfire, caused by a lightning strike, burned more than 300 acres in Pu'u'anahulu and the state-owned Pu'u Wa'a Wa'a Forest Reserve. (Photo Credit: Wayne Ching).

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resources and in fact, resources from other islands were brought in to assist.

Wildfire ignition or fire starts are from various sources. Vehicular fire starts, such as the Akoni Pule Highway wildfire (where a vehicle was set on fire) are a common cause of fire starts. In many cases, catalytic converters and traffic accidents, account for most of the fire starts related to vehicles, including a 60-acre blaze just north of Pu'u Lani Ranch Estates that was started when a vehicle veered over a cliff and caught fire, igniting nearby brush. Human caused fire starts are also common. Agricultural escape burns, unauthorized residential burning, and arson are some examples of fires attributed to humans. The presence of an arsonist within the Waikoloa/Kohala area is a concern for local firefighters and the community. Hawaii County fire and police departments and the state Forestry and Wildlife Division have created a task force to apprehend the arsonist(s). While natural causes are the least likely sources of wildfire ignition, they do occur. A 300-acre fire in Pu'uuanahulu was started by a lightning strike. Below is a chart showing wildfires in the CWPP coverage area from 1954 to 2005. The Hawaii Wildfire Management Organization is currently updating its fire history data. As this report is being written there has been a rash of wildfires in Northwest Hawaii that officials believe were intentionally set. Between January and mid July 2007 more than 14,000 acres burned within the CWPP coverage area.

West Hawaii Fire Data 1954 - 2005

DATE	ACREAGE	CITY
12/12/05	25.00	Kailua-Kona
10/29/05	35.00	Kailua-Kona
8/4/05	2500.00	Hawi
8/3/05	25000.00	Waikoloa
8/2/05	2500.00	Kawaihae
8/1/05	6000.00	Kamuela
7/22/05	2500.00	Kamuela
7/12/05	150.00	Hawi
6/15/05	100.00	Kamuela
6/14/05	50.00	Kamuela
6/1/05	1.00	Hawi
5/24/05	400.00	Kamuela
5/18/05	150.00	Hawi
3/2/05	10.00	Kamuela
2/28/05	7.00	Kawaihae
11/27/04	2.50	Kapaau
9/20/04	1500.00	Kamuela
9/15/04	1200.00	Kamuela
9/12/04	1500.00	Kamuela
9/7/04	400.00	Waikoloa
9/6/04	350.00	Waikoloa
8/10/04	5.00	Kamuela
7/11/04	40.00	Hawi
7/8/04	40.00	Hawi
7/7/04	40.00	Hawi
7/6/04	100.00	Kawaihae
7/5/04	40.00	Hawi
7/3/04	20.00	Kamuela
7/15/00	1.70	Waiki'i
1/15/00	70.55	Saddle Road Junction
10/15/99	4553.44	Pu'uuanahulu

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10/15/99	4382.84	Waikoloa
7/15/99	429.93	Saddle Road Junction
7/15/99	595.49	Waiki'i
7/15/99	4.13	Saddle Road Junction
4/15/99	9758.00	Pu'uana'hulu
5/15/98	3287.52	Pu'uana'hulu
4/15/98	7463.78	Waikoloa
4/15/97	102.27	Hualalai
4/15/96	113.52	Hualalai
1/15/96	84.46	Pu'uana'hulu
10/15/95	196.84	Waiki'i
5/15/95	40.01	Waiki'i
3/15/95	1072.98	Hualalai
7/15/94	24714.92	Pu'uana'hulu
12/15/93	745.40	Pu'uana'hulu
6/15/93	107.61	Pu'uana'hulu
5/15/93	352.78	Hualalai
7/15/91	193.78	Puako
3/15/91	46.28	Pu'uana'hulu
9/15/90	98.00	Puako
8/15/90	1133.50	Waiki'i
10/15/89	13.17	Hualalai
7/15/89	2835.30	Kiholo Mauka
12/15/88	2.00	Hualalai
8/15/88	551.21	Pu'uana'hulu
7/15/88	1064.98	Waikoloa
3/15/88	1160.26	Hualalai
8/15/87	5234.00	Waikoloa
7/15/87	676.24	PTA
7/15/87	1963.48	Waikoloa
7/15/87	3530.81	Pu'uana'hulu
7/15/87	794.90	Puako
9/15/86	3486.01	Pu'uana'hulu
9/15/85	18291.33	Waikoloa
9/15/85	13993.35	Waikoloa
10/6/83	1309.11	Saddle Road Junction
10/6/83	1817.41	Waikoloa
4/15/78	3510.01	PTA
10/15/77	97.38	PTA
9/15/77	854.69	PTA
11/15/75	44.40	Waiki'i
8/15/75	233.26	Waiki'i
9/15/73	53.45	PTA
7/15/73	2211.32	Pu'uana'hulu
6/15/73	27.48	Pu'uana'hulu
6/15/73	53.37	Pu'uana'hulu
4/15/73	190.34	Hualalai
4/15/73	7.78	Hualalai
3/16/73	8120.77	Kawaihae
2/15/73	2800.04	Waiki'i
9/15/69	47974.79	Pu'uana'hulu
7/15/69	984.22	Pu'uana'hulu
9/15/68	8744.35	Pu'uana'hulu
11/15/54	4179.65	Waiki'i

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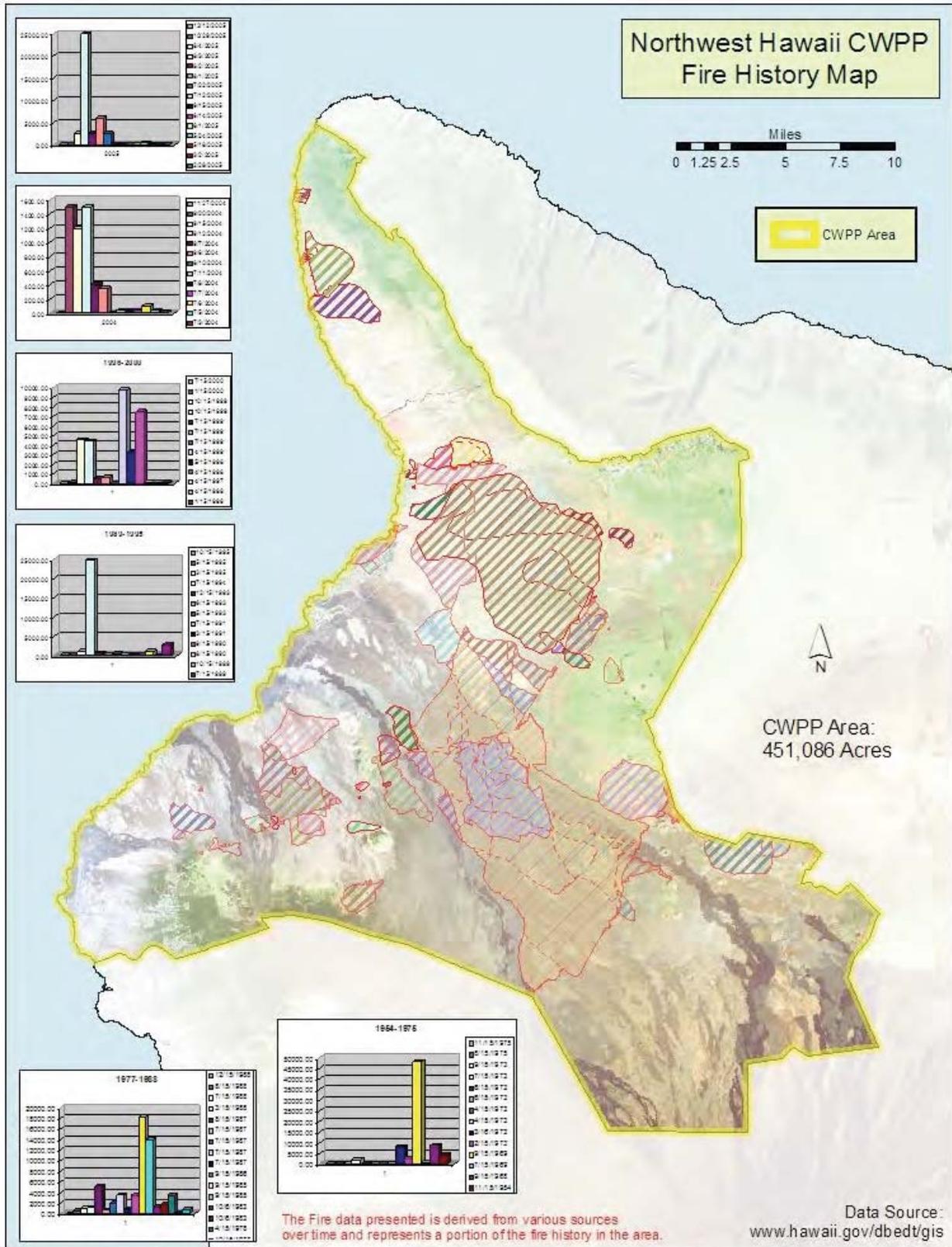


Figure 6: Fire history map of Northwest Hawaii, showing wildfires in the region from 1954 –2005. The imbedded graph charts depict fires in annual ranges by size and can be found in Appendix B.

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Stakeholders:

Stakeholders are individuals or groups who have a high level of interest in the protection of their assets from wildfire. The CWPP area encompasses lands managed by federal, state, county, and private entities. Contact information for principal government stakeholders is listed below.

Federal:

Pohakuloa Training Area (U.S. Army)

Eric Moller
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(808) 969-2441
mollereh@shafter.army.mil



Hawaii Volcanoes National Park

Joe Molhoek
Pacific Island Fire Mgmt. Officer
PO Box 52, HNP, HI 96718
(808) 985-6042
Joe_Molhoek@nps.gov



State:

Department of Land and Natural Resources: Division of Forestry and Wildlife

Wayne Ching
State Protection Forester
1151 Punchbowl St., Room 325, Honolulu, HI 96813
(808) 587-4173
Wayne.F.Ching@hawaii.gov



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Hawaii Fire Department

Fire Chief Darryl Oliveira
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(808) 981-8394
Hcfd1@co.hawaii.hi.us



County:

Hawaii County Civil Defense

Troy Kindred
Civil Defense Administrator
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(808) 961-8229
tkindred@co.hawaii.hi.us



Wildfire Risk Assessment for Northwest Hawaii:

In 2006, the Hawaii Wildfire Management Organization commissioned the Firewise coordinator to conduct a series of wildfire hazard assessments for a dozen West Hawaii communities, using the Hawaii Wildland Fire Risk and Hazard Severity Assessment based on the Assessment in Appendix A of NFPA 1144, *Standard for Protection of Life and Property from Wildland Fire*. These hazard assessments were conducted to identify the level of wildfire risk for the West Hawaii communities included in this CWPP.



HFD personnel, Dr. Kimbal of Puako Community Association, and Earl Spence (far right), a HWMO contractor, view a map of Puako before accompanying the Firewise coordinator in a wildfire hazard assessment of Puako.

Using a pre-established point system, the Hawaii Wildland Fire Risk and Hazard Severity Assessment is a tool used to determine the level of wildfire risk to a home or community. Points are given regarding overall terrain and location, road width, local area fire history, prevailing winds and seasonal weather, geographical contours, native vegetation, water availability, location of fire suppression resources, as well as the combustibility of building materials, including the roof, siding, and attached items, such as decks, fencing, or an unit. The combined points in all these categories are added together and the overall risk is determined by whether the score falls in the low-, medium-, high-, or extreme-risk point range. Given the ignitability of individual structures, preponderance of fuels in close proximity to structures, and lack of water, all the communities within Northwest Hawaii, with the exception of Pu'u Kapu, scored in the high-hazard range in the wildfire hazard assessment, while Pu'u Kapu scored in the medium-risk range.

While the Northwest Hawaii region as a whole shares certain common characteristics, the communities within it vary tremendously and deserve separate description in terms of slope, size, and water availability. Therefore short descriptions excerpted from the wildfire hazard assessments are provided below.

Kohala Ranch and Kohala Estates

Kohala Ranch is a developed subdivision in Kohala, Hawaii that spans from the Akoni Pule Highway, near sea level, up to Kohala Mountain Road at the 3,300-foot elevation. It is comprised of 4,000 deeded acres, with lots ranging in size from a half-acre to more than 10 acres. Kahua Ranch borders Kohala Ranch. Cattle and sheep from Kahua and Ponohele Ranches graze within the Kohala Ranch subdivision and help to reduce fuel load within the community.

The subdivision has underground utilities, paved roads, hydrants, and setbacks. There is one means of ingress and egress at the top and bottom of the subdivision (at Akoni Pule Highway and Kohala Mountain Road). Both entrances have a gate and guard shack with the Akoni Pule entrance staffed 24 hours a day and the Kohala Mountain Road entrance staffed 16 hours a day (unmanned from 10 pm – 6 am). Ala Kahua Road, a paved road on the south east side of the subdivision, leads to the neighboring subdivision of Kohala Estates but there is a locked gate separating the communities. A 12-foot wide equestrian trail with wood fencing on either side extends along the perimeter of the Heathers I section of the subdivision and the trail has been graded for 4-wheel drive vehicles. Several homes within the subdivision have locked gates blocking their driveways.

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Kohala Estates is a developed subdivision directly south of and adjacent to Kohala Ranch. Lots were originally sold in 20-acre parcels, but have since been subdivided into 3-acre lots. Kohala Estates, which also starts at Akoni Pule Highway, is ungated and side streets within the subdivision are off Ala Kahua Drive. Since Ala Kahua Drive is gated directly below the volunteer fire station, this leaves the community with one means of ingress and egress from the subdivision.



Kiawewai gulch separates Kohala Ranch and Kohala Estates.

Kohala Estates has paved roads, with hydrants spaced less than 1,000 feet apart. Some utilities are underground and some are above ground. Road signage is metal and reflectorized, however house numbers vary in size and color. There is no organized grazing of animals within Kohala Estates.

Slope within both subdivisions varies between 10 to 20+ percent. Kiawewai gulch runs along the southern boundary of the subdivision between Kohala Ranch and Kohala Estates. Property lines from both subdivisions extend to the middle of the gulch. Kiawewai gulch is a fire hazard due to the kiawe/buffel grass vegetation.

There is a 100,000-gallon water tank on the Kohala Ranch side of the gulch, which feeds all the fire hydrants within Kohala Ranch and Kohala Estates. The tank is pressurized and if there is a loss of electricity, the tank becomes gravity fed. Kohala Ranch and Kohala Estates are not part of the Hawaii County water system. Kohala Ranch Water Company controls and supplies the water for Kohala Ranch, Kohala Estates, Kohala By the Sea, and DHHL Hawaiian Homes Residence Lots subdivisions (the latter subdivisions are just south of Kohala Ranch and Kohala Estates).

Kohala by the Sea

Kohala By The Sea (KBTS) is a developed gated community directly south of Kohala Estates. KBTS covers approximately 77 acres and the general topography is a gentle slope of 9 percent. However, there is a large gulch that runs through the middle of the community. This gulch is a particular fire hazard because of the kiawe trees and haole koa brush within it.

There are 73 lots within the subdivision with 42 homes either built or under construction. The community has underground utilities, paved roads, hydrants, and setbacks, as well as one functional point of egress and ingress. There is a paved road on the north side that ties into the adjacent community of Kohala Estates, which can be used as an escape route in case of emergency.

The KBTS community is surrounded and intermixed by bunchgrass, which produces fast moving and intense fire conditions. The strong onshore winds that persist everyday make this community prone to wildfires.

Kohala by the Sea residents, concerned about the threat of wildfire to their community, went through the steps to become the first nationally recognized Firewise Community in Hawaii. They are the only community in Hawaii to earn this distinction and have maintained recognition status for three consecutive years.



Kohala by the Sea residents during a 2005 Firewise community workday. Collaborative mitigation efforts helped the community achieve national recognition as part of the Firewise Communities USA program.

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Kawaihae

Kawaihae is a community in the North Kohala district of Hawaii along the leeward coast. Akoni Pule Highway runs through the community, which includes a commercial harbor with a shipping terminal and fuel depot; Ka Ilima O Kawaihae Cultural Surf Park; Kawaihae Canoe Club and boat ramp; retail shopping centers and restaurants; Pu'ukohola National Heiau National Historic Site, an Industrial Park, Ke Hale O Kawaihae Transitional Housing, Kawaihae Village, Department of Hawaiian Home Lands Kawaihae Residence Lots, and Ke Hale O Kawaihae.

Ke Hale O Kawaihae is on the mauka side of Akoni Pule Highway, diagonally across from Pu'ukohola National Heiau National Historic Site just south of Kawaihae Harbor. The Kawaihae Industrial Park is three miles north of Ke Hale O Kawaihae, also on the mauka side of Akoni Pule Highway. The DHHL Kawaihae Makai Lots are on the makai side of Akoni Pule Highway across from the Industrial Park with the bulk of the Kawaihae Residence Lots just north of the Industrial Park on the mauka side of the highway.

Ke Hale o Kawaihae is a 24-unit facility that is part of Catholic Charities Transitional Housing Program. The program provides temporary housing to homeless families with children. There are no driveways or roads within this facility as the units are clustered around an unpaved parking lot directly off Akoni Pule Highway. Utilities are above ground along the highway. There is a power station directly south of the units on the same side of the highway. On either side and behind the units are open lands filled with grasses and brush, including fountain grass and kiawe. Units are of post and pier construction with combustible siding and non-combustible roofing.

Kawaihae Residence Lots are part of Hawaiian Home Lands. Congress created *The Hawaiian Homes Commission Act of 1920* as a land trust. The purpose of the Act was the rehabilitation of native Hawaiians, those individuals of not less than one-half Hawaiian blood. The program offered 99-year leases for residential, agricultural, and pastoral homesteads on the islands of Kauai, Oahu, Maui, Molokai, and the island of Hawaii. When Hawaii became the 50th state in the U.S., one of the conditions of statehood was that the State of Hawaii would administer this program.

The Makai Lots are directly north of the Kawaihae Canoe Club and across the highway from the Industrial Park. There are 22 house lots in the Makai Lots ranging from 15,000 to 23,489 square-feet. In the Makai Lots, one paved road, Honokoa Street, runs between Akoni Pule Highway and the ocean and accesses Akoni Pule Highway at either end. Utilities are above ground and there are hydrants along the road. Driveways are less than 100 feet long and at least 12 feet wide with 15-foot vertical clearance. There are thick groves of kiawe trees on the makai side of the highway. In addition to these Makai Lots there are 3 more house lots across from the harbor.

The 196 lots in the Residence Lots range between one-half acre to an acre in size. They have above ground utilities, paved roads, hydrants spaced less than 1,000 feet apart, and setbacks. Kalo'olo'o Drive, which starts at Akoni Pule Highway, is the main road in the Kawaihae Residence Lots, with side streets that dead end or loop around off of this main road. Road signage is metal and reflectorized, however individual house numbering is spotty to nonexistent. Driveway lengths vary in the Residence Lots, those that are shorter (less than 100 feet) tend to be paved with concrete, while longer driveways tend to be unpaved. Driveways are at least 12 feet wide with 15-foot vertical clearance. Only a few homes within the Residence Lots have locked gates blocking their driveways.

Slope in the community varies between 10 to 20+ percent. The Transitional Housing and Makai Lots are flat at or near sea level. The Industrial Park is on a slight hill above the Makai Lots. There are rolling hills throughout the Residence Lots with Kalo'olo'o Drive on a steep incline. There are gulches run to

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the north and south of the Residence Lots. These gulches are a fire hazard due to the grasses and kiawe trees growing within them.

The Residence Lots are not part of the Hawaii County water system. A single company controls the water for Kohala Ranch, Kohala Estates, Kohala By the Sea, and Hawaiian Home House lots.

Kawaihae Village is just mauka of the intersection of Queen Kaahumanu Highway and Kawaihae Road. The village complex includes rental housing used by Mauna Kea Observatories for their employees.

Much of the land area owned by Queen Emma Lands on the north side of the Kawaihae Road, although not highly suitable for grazing, was fenced and the Ranch grazes this area to reduce the amount of fire fuel that could enhance wildfires. This grazing project is a collaborative effort, including Mauna Kea Soils and Water Conservation Services, Parker Ranch, Queen Emma Lands, and the State Department of Health.

Anekona Estates and Kanehoa in Waimea

Anekona Estates and Kanehoa are developed adjoining subdivisions on the south side of Kawaihae Road at the 1,800-foot elevation in Waimea. The Kanehoa subdivision has 44 homes with two empty lots. Lots in Kanehoa were originally 5 acres in size, although some have been subdivided into 2.5-acre lots. Several lots have two houses on property, which are considered condominiums by the Kanehoa Homeowners Association. The majority of homes are owner occupied. Lots in Anekona Estates appear to be at least a half-acre to acre in size.

Anekona Estates and Kanehoa subdivisions have underground utilities, paved roads, hydrants, and setbacks. There is a drainage ditch that separates the Anekona Estates and Kanehoa subdivisions.

Road widths within Anekona Estates and Kanehoa are 20 feet within the subdivisions. Kanehoa Homeowners Association is responsible for mowing the road shoulders within its subdivision, and schedules mowing according to rainfall. The majority of driveways within Anekona Estates are paved and several are gated. House numbering within Anekona Estates is inconsistent: varying in size, some are rusty and would be difficult to see at night or in smoky conditions.

Ouli Street is the only road in the Kanehoa subdivision. Ungated, Ouli Street exits onto Kawaihae Road and dead ends at the Waimea end of the subdivision with a small turnaround. There are road shoulders on either side of Ouli Street. There are two means of egress from Anekona Estates: Kanehoa Street and Anekona Street. Kanehoa Street exits onto Kawaihae Road and dead ends with no turn around space at a road barrier blocking entrance to Ouli Ekahi subdivision. Anekona Street exits onto Kawaihae Road where there is a gate, and merges into Kanehoa Street at the other end. Several homes within Anekona and Kanehoa subdivisions have locked gates blocking their driveways. There is road signage in Kanehoa but there is no street signage for side roads in Anekona Estates. House numbers vary in size and color.

There are gently rolling hills within both subdivisions and slope varies between 0 to 10 percent. Some houses are built on the top of hills while others are on flat land. Behind the subdivision is open hilly grasslands extending for several miles to the south to Waikoloa. There are open areas within both subdivisions with tall grasses.

Hydrants, spaced 1,000-feet apart within both subdivisions, are supplied by the Hawaii County Department of Water Supply (DWS). A storage tank for the county water system is located on Kawaihae Road at the 1,800-foot elevation near the Kanehoa subdivision. The tank is maintained by the DWS. Kanehoa subdivision has its own agricultural water system for irrigation. Three reservoirs are

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located at the top of the subdivision and those residents that pay to use the reservoir can use this water. Residents within Kanehoa are oriented towards green growth for fire safety. There is a stream that runs through the subdivision through a series of ditches that runs sporadically and is available to all homeowners. This is in addition to the above-mentioned reservoirs.

Directly south of Anekona Estates is Ouli Ekahi, an affordable rental project of 33 units managed by the County of Hawaii (Housing and Community Development Corporation of Hawaii). There is a combination of houses and cottages. It has one road in and out of the subdivision with side streets at the end of the main entrance road. There are utilities above ground along the entrance road. Ouli Ekahi is separated from Anekona Estates by a road barrier. Lots are considerably smaller than Anekona or Kanehoa, averaging 10,000-square feet. Houses in Ouli Ekahi have metal roofing and combustible (wood) siding. Driveways are typically 12 feet wide with 15-foot vertical clearance. Several homes have fences, although the fences for the most part are non-combustible, i.e. of rock or metal with only one or two fences composed of wood. Most homes have defensible space because they lack vegetation.



House in Kanehoa subdivision. Built atop a slight hill, the front yard is covered in invasive grasses, a potential wildfire hazard.

In addition to area fuel load, strong winds, and minimal rainfall, there is an additional threat to these subdivisions. According to fire officials there is unexploded ordinance (UXO) in Waimea Anekona Estates, mostly small size mortar rounds and bullets. Some homes are built on unexploded ordinance. There have been explosions from UXO in residential areas during past wild fires. Per the Fire Chief's directive, no fire suppression field operations are allowed in designated UXO areas for safety reasons. It's believed there are UXO large enough to be fatal to dozer operators in the UXO areas.

Homes in all three subdivisions have Class A roofs, however some houses have wood siding and/or lanais, while others have non-combustible siding and/or lanais. Houses vary between post and pier and concrete slab construction. Some lots have defensible space around the house, while others have grasses growing right up to the house. Since Ouli Street is the only means of egress for many residents in Kanehoa, evacuation of residents and response by fire fighting personnel may be compromised if smoke or flames impede road access. According to Hawaii Fire Department personnel, some of the houses along the highway in Kanehoa are at risk because if a fire began along the highway, the wind would blow flames towards the houses.

Pu'u Kapu

Pu'u Kapu is a Department of Hawaiian Home Lands community in Waimea, on either side of Mamalahoa Highway in the South Kohala District covering an area of 11,949 acres. Pu'u Kapu I, on the Kona side of Mamalahoa Highway, is comprised of three distinct separate areas: Kuhio Village subdivision off Kamamalu Road, which contains 121 house lots; Farm lots, of which there are 75; and 204 Pastoral lots. Pu'u Kapu II is on the Kohala side of Mamalahoa Highway and borders the Kohala Forest. The information below focuses on Pu'u Kapu I.

House lots in Kuhio Village range from 10,000 square feet to an acre in size. Driveways in the subdivision are typically less than 100 feet, and few, if any, have turnarounds large enough for fire engine apparatus. Several driveways are gated or fenced. Driveways are typically at least 12 feet wide with 15 feet vertical clearance. House numbering is inconsistent and in many cases nonexistent. The majority of homes have metal roofs and wood siding. Roads are paved and there are multiple means to access Mamalahoa Highway, the main road through the Waimea community. Fire hydrants are spaced

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throughout Kuhio Village subdivision. Utilities are above ground. Hawaii County is responsible for the maintenance and repair of roadways and shoulders in Kuhio Village.

Pu'u Kapu Farm lots are between Kuhio Village House lots and the Pastoral lots and range from 1.5 acres to 30 acres in size. The majority of the road system is built to county standards, with the exception of the partially paved substandard area on Kahilu Road that merges into Mana Road. There is more than one road to access the farm lots from Mamalahoa Highway. Some of the roads in the Farm lots area are paved single lane roads and some are unpaved dirt roads. Hawaii County is responsible for the maintenance and repair of roadways and shoulders in the Farm lots. Driveways tend to be longer than 300 feet and several are gated or fenced. House numbering is inconsistent or nonexistent. As in Kuhio Village, houses in the Farm lots tend to be constructed with metal roofs and combustible siding. Vegetation is denser in the Farm lots than in Kuhio Village House lots and some properties have windbreaks of eucalyptus or pine trees. Several lot owners raise horses, sheep, and/or goats. Fire hydrants are spaced throughout the farm lots and utilities are above ground. There are several active commercial agricultural operations in the farm lots, which are well irrigated.

The first phase of the Pu'u Kapu I pastoral lot leases were awarded in 1952 with the second phase being awarded in 1990. These lots, which range from 10 – 300 acres in size, are furthest away from Mamalahoa Highway and the Waimea fire station. Fire Road 7, an unpaved dirt road less than 24 feet wide that has access off of Mana Road, and Poliahu Road, a paved road 20 feet wide, are the main access roads to the Pastoral lots, with several side roads connecting to Fire Road 7. Access to DHHL Pastoral lots is gated on both Poliahu Road, shortly after the gate the road changes from paved to unpaved, and at the intersection of Mana Road and Fire Road 7. At the present time the gates to the Pastoral lots are unlocked.

Several Pastoral lot owners raise horses, cattle, goats, and/or sheep. Driveways within Pastoral lots are typically longer than 300 feet with room to stage firefighting apparatus. House numbering is not common in the Pastoral lots. With the exception of a few of the 100-acre lots, most people do not have access to electricity with homesteaders relying on generator, solar, or wind power. DHHL, via Sandwich Isle Communications, installed an underground fiber optic system with the capability of running underground lines should electricity become available. DHHL is responsible for maintaining the roads in the Pastoral lots. The agency does not mow the road shoulders.



Landowners in the Pu'u Kapu Pastoral lots graze cattle, goats, sheep, and/or horses, which helps to reduce fire fuel load (photo on right). However, not all lot owners manage their grazing to reduce fuels (photo on left).

There are no fire hydrants in Pu'u Kapu Pastoral lots. County potable water is available to a limited number of lots via a 4-inch main line. All lots awarded in 1952 have water via this 4-inch line. There is a Department of Water Supply 12,000-gallon tank on Fire Road 11 specifically for fire department use.

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The Pu'u Kapu Pastoral Water Group has a 10,000-gallon tank opposite the 12,000-gallon tank near lot #78. There are two water meters near lots #15 and #20 that supply water to various homesteads. About 40 lots have their own water tanks that are fed through these meters with the tanks serving as the main source to individual lots and for fire protection. The majority of the lots issued in 1990 rely on catchment water. HWMO has installed a 5,000-gallon helicopter dip tank for the Pu'u Kapu community to serve as an additional water source for firefighting suppression.

For the most part, the community is on flat land, graded at less than 5 percent. The community experiences offshore winds in the morning and onshore winds in the afternoon. Normal trade winds blow north to south, although the area experiences strong, dry winds.

Puako

Puako is a developed community on the makai side of Queen Kaahumanu Highway in the South Kohala District. There are 150 homes in the Puako community with a mix of older (30-50 years old) and newer homes, incorporating varying degrees of fire-resistant construction materials. For instance, some of the older homes have wood shake roofs. Roughly one-third of the homes are owner occupied, one-third are long-term rentals, and one-third are vacation rentals. Driveways in Puako are typically less than 300 feet, and few, if any, have turnarounds large enough for fire engine apparatus. House numbering within Puako is inconsistent. While some homes have fire-resistant roofing and siding, others have wood shake roofs and wood siding. Many homes do not have defensible space around their property.



Homes in Puako range from older cottages to new, much larger models.

One road, Puako Beach Road, is a paved road less than 24 feet in width and is the main means of ingress and egress from the community. A secondary emergency access road, which is unpaved and can handle two-wheel drive vehicles traveling 25 miles per hour, is located behind the Catholic Church on the mauka side of Puako Beach Road and is locked and gated. Fire hydrants in Puako are less than 1,000 feet apart.

For the most part the community is on flat land, graded at less than 5 percent, although the terrain is at a slope at the transfer station and at the main entrance to Puako at Queen Kaahumanu Highway.

There is a kiawe forest running along the mauka boundary of the community from Queen Kaahumanu Highway down towards the community.

The community experiences offshore winds in the morning and onshore winds in the afternoon. Normal trade winds blow north to south, although the area experiences strong, dry winds.

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The 100-foot fuel break on the mauka side of the Puako community created in 2003.

In 2003, the Hawaii Wildfire Management Organization provided technical assistance in the planning and creation of a 100-foot wide fuel break, which runs along the mauka side of the community from Hokuloa Church to the end of the subdivision lots. In 2004, HWMO worked with the Puako Community Association (PCA) to reimburse them for maintenance of the fuel break. PCA and the Puako community is working on several wildfire mitigation measures, including the maintenance of access lanes between private lots to enhance fire suppression efforts, increasing the width of the community fuel break to 300 feet and maintaining it annually, establishing a secondary emergency access routes from community through the Maui Lani resort, creating buffer zone around petroglyph areas, and enhancing defensible space around individual properties.

Waikoloa

Waikoloa Village is a developed community encompassing four square miles or 2,560 acres, between Queen Kaahumanu Highway and Mamalahoa Highway on Hawaii County's leeward coast. Waikoloa Village contains more than 2,700 homes, condominiums, and apartment units; a 122-acre golf course; a recreational complex; tennis courts and swimming pool; schools; churches; a shopping center and offices; as well as two small community parks. Waikoloa Village is surrounded by miles of open land filled with non-native vegetation, such as fountain grass.

There has been a sizable increase in development in recent years, with additional condominium complexes and subdivisions built within the community. For example, in 2006, developers Castle and Cook broke ground for the first phase of constructing 54 single-family homes and 175 condos and plans to develop another 520 additional condos and homes in the future. There are also plans for 1,200 affordable housing units to be built, in addition to numerous empty lots within the Village that may be built upon at any time. House lot sizes in Waikoloa Village range from 12,000-square-foot to 18,000-square-foot, with the 12,000-square-foot size being the norm. Driveways are less than 100 feet long with no turnaround space for fire apparatus, and several are less than 12 feet wide with 15-foot vertical clearance. The majority of homes are owner-occupied although some are used as vacation rentals. Road signage within the Village is metal and reflectorized. House numbers are displayed on mailboxes and painted on curbsides in front of homes.

The community has underground utilities, paved roads, hydrants, and setbacks. Waikoloa Road, which runs east west from Queen Kaahumanu Highway at sea level up to Mamalahoa Highway, is the main means of ingress and egress to the community. Waikoloa Road is a two-lane paved road greater than 24 feet wide. Roads within the Village are paved with some as much as 40 feet wide. Paniolo Avenue, a major thoroughfare through the community, is four lanes wide. During previous fires, the community had only one

means of ingress and egress, which severely impacted the evacuation of thousands of residents. To address this concern, an emergency access road was recently built providing the community with an alternative means of egress



An emergency access road leading from Waikoloa Village to Queen Kaahumanu Highway was recently built to provide additional egress during wildfire emergencies.

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in case of wildfire. The unpaved road, composed of compacted gravel, runs from Hulu Street, in a newly built part of western Waikoloa Village down to Queen Kaahumanu Highway. The road is gated and the fire department has an emergency access key.

Slope within the community varies between 0 to 20+ percent with rolling hills throughout the Village. There are gulches within the community filled with kiawe trees. Gulches can channel fire and kiawe trees are known to carry fire and create embers that can be easily carried onto residential properties. During a 2003 fire, the gulch next to the Baptist church carried fire through the community.

Water to fire hydrants, as well as residential and commercial properties within the Village is supplied by Hawaii County Department of Water Supply.

Pu'u'anahulu

Pu'u'anahulu is a community in the North Kona District, along the Mamalahoa Highway at the 2,200-foot elevation 18 miles north of Kona and 19 miles south of Waimea. The only road through the community, Mamalahoa Highway, runs northeast from Kona to Waimea. The community is composed of several houses along the highway; a church; a community complex, including a community center, equestrian ring, and volunteer fire station; a golf course, and the gated community of Pu'u Lani Ranch Estates (PLRE). The Baptist church is considered a historical landmark. Pu'u Wa'a Wa'a Ranch is directly south of the community.

The Pu'u Wa'a Wa'a ahupua'a, directly south of Pu'u'anahulu, contains more than 36,000 acres of state land and is an area rich in native Hawaiian plants and animals. At one time it was a Native Hawaiian dryland forest, but wildfires and grazing have destroyed much of the forest.

Houses along the highway have been established for at least 100 years. Pu'u Lani Ranch Estates is a gated community developed within the past 20 years. When approaching Pu'u'anahulu from Kona on Mamalahoa Highway, there is a steep curve at the base of the ridge by Pu'u Wa'a Wa'a Ranch with the road winding around curves until the top of the hill at which is the entrance to PLRE and the Big Island Country Club. All the above-mentioned homes and enterprises are between the base of the ridge and the top of the hill.

Homes along the highway have above ground utilities, hydrants and setbacks. Mamalahoa Highway is the only means of ingress and egress from the community. The Big Island Country Club is behind the homes on the makai side of the highway and PLRE is behind the homes on the mauka side of the highway. Some landowners along the highway graze goats and/or horses on their property.

Pu'u Lani Ranch Estates is a developed subdivision, the entrance of which is on Mamalahoa Highway. Built in phases since 1986, there are more than 146 lots in



The Baptist Church in Pu'u'anahulu, on Mamalahoa Highway, is considered a historical landmark.



Typical house in Pu'u Lani Ranch Estates. This house has defensible space, although not all homes in the subdivision do.

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the subdivision, and as of February 2007 there were 72 houses built. Lots are a minimum of one-acre parcels, with some lots being two acres in size. Within Pu'u Lani Ranch Estates there are several vacant lots with overgrown brush, many owned by mainland or international investors. Within PLRE there is a community clubhouse, tennis courts, and an equestrian facilities. The subdivision has underground utilities, paved roads greater than 20 feet in width, hydrants, and setbacks. There is one road for ingress and egress from the subdivision, which is gated. Several homes within the subdivision have locked gates blocking their driveways. Road signage is metal and reflectorized, however house numbers vary in size and color.

Driveways in PLRE must be paved using asphalt or concrete, or crushed. Driveways in PLRE tend to be less than 100 feet long, while driveways of homes along the highway tend to be longer and curved.

Diagonally across the highway from PLRE (on the makai side) is the Big Island Country Club, which includes a golf course, clubhouse, and undeveloped areas. Lynch Investments owns 400 acres and The Big Island Country Club owns the golf course, which is more than 100 acres.

There is one main road in and out of the golf course. A dirt road runs along the backside or makai boundary of the golf course, through the maintenance area connecting to Mamalahoa Highway. This road could be used as a secondary means of egress in case of emergency. Beyond the boundary of the golf course are grass filled rolling hills containing more than 3,000 acres of state land.

The unmaintained areas within the golf course contain 105 house lots that are slated for high-end residential construction. Lynch Investments owns these house lots and is moving forward in the construction permit process.

Within the PLRE subdivision slope is less than 20 percent. However those homes along the ridge are at a much higher risk from wildfire since the slope is nearly 100 percent in some places and is covered with high intensity fuels. Homes along the ridge are set back more than 30 feet from the slope. The steep ridge is covered with fountain grass, a high-intensity burning fuel, as well as silver oak, which is easily ignitable due to oily resins, and kiawe, which is known for having a long burn time. Firewise community workdays have been held in the past to decrease the fuel load at the base of the ridge to reduce wildfire risk from vehicle accidents.

Pu'uanaulu, including PLRE, is not part of the Hawaii County water system. The community came together several years ago to purchase the water system supplying the area and formed their own water company, Napu'u Water Inc. Two wells supply the community: one well at the PLRE clubhouse and one well at Pu'u Wa'a Wa'a ranch. Area residents must pay for this water, which is expensive. Because Napu'u Water Inc.'s predecessor supplied subsidized water for grazing in the area; grazers now pay premium prices for water. This may impact the viability of grazing, which will have an impact on reducing fuels in the area.

At the Big Island Country Club the hydrants within the golf course are not active (hydrants are the responsibility of Lynch Investments). Of Big Island Country Club's two wells, one is working and one is currently under repair.

North Kona: Hina Lani, Kona Palisades, Kealakehe

There are several miles of open grass lands south of Pu'uanaulu and north of Kona. The subdivisions of Kealakehe, Kona Palisades, and Hina Lani are south of the grasslands and increase in proximity to the urban center of Kailua-Kona. While the wildfire risk is slightly lower in this region, due to increased industrial and residential development, it is still in the wildland urban interface. The area was originally

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dryland forest, and there is still native flora in the area, in addition to cultural sites, including refuge caves. The above communities span between Mamalahoa Highway and Queen Kaahumanu Highway.

Winds are typically north to north east trade winds averaging 5 – 15 mph, although the area does experience strong south winds on occasion. While homes in these subdivisions are generally built on flat land, the communities themselves are built on steep grade, particularly Kona Palisades, which runs from 1,500 foot elevation to sea level in the span of less than four miles.

House lots are smaller in size (10,000 – 15,000 square feet) than the more rural areas to the north. Driveways are also shorter, generally only 50 to 100 feet in length, with no turnaround. Driveways are typically 12 feet wide with 15 feet of vertical clearance. Almost all homes in these subdivisions have non combustible roofing, although many have combustible siding and/or lanais. Houses vary in level of defensible space, with many homes using gravel and landscaping to create defensible space. However, those homes closest to undeveloped areas have kiawe growing in close proximity to the homes.



Houses in subdivisions in North Kona, such as the ones in Kealakehe, above, tend to be closer together than other communities.

Community Assets at Risk:

Assets at risk are valued resources that can be damaged or destroyed by wildfire. In addition to ensuring firefighter safety and protecting residents and visitors, the following assets warrant consideration in pre-incident planning: watersheds; forest reserves; wildlife; scenic, cultural, and archeological sites; ranchlands; and structures. The following were identified as valued resources within Northwest Hawaii that would be adversely affected by wildfire.

Commercial / community resources:

Resorts, shopping centers, schools, community centers, churches, restaurants, industrial parks, and retail establishments.

Natural / Cultural Resources:

Pu'ukohola Heiau National Historic Site, Puako Petroglyph Archeological Preserve, Lapakahi State Historical Park, county parks and beaches including Hapuna Beach State Recreation Area, Wailea Bay, Spencer Beach Park, Pu'u Wa'a Wa'a State Wildlife Preserve, as well as native dryland forest, rare and endangered plants and animals, and cultural and archeological features, such as refuge caves. Importantly, the North Kohala coastline has the most numerous intact archeological sites in the state.

Houses and residences are at risk to wildfire in Northwest Hawaii. Overgrown vegetation close to homes and an increase of non-native high-intensity plants was found in every northwest Hawaii community. Northwest Hawaii as a whole has experienced tremendous development in recent years. Waikoloa Village already contains 2,700 single-family houses, condominiums, and apartment units and there are plans for nearly 2,000 additional homes and condominiums. New subdivisions are being built on either side of Hina Lani in North Kona. Many new residents are from other parts of the United States and unfamiliar with the wildfire risks of Hawaii communities.

The majority of homes within residential areas in Northwest Hawaii have Class A roofing, however, several homes can be found in almost every subdivision with wood shake roofs. Many homes in West

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side communities also have combustible siding and/or lanais (decks). Homes vary widely in defensible space regardless of socio-economic background, with lava serving as a natural fuel break on some lots and vegetation growing close to the home on other lots. Few driveways have turnaround access for emergency vehicles.

Community Concerns for West Hawaii:

Community meetings specifically on the CWPP process held in May 2007 with community members and fire agencies identified the most pressing fire concerns in Northwest Hawaii. They include, in order of priority:

1. Insufficient water infrastructure to adequately and quickly suppress wildfires;
2. Inadequate fire suppression resources, such as vehicles;
3. Fuel load along roadsides, in community open areas, and individual homes;
4. Regional and local planning and development standards that do not require communities' and subdivision designs to consider and/or mitigate fire risk
 - 4 a. Structures' design, materials, and placement and landscaping that promotes or does not mitigate fire risk;
5. Community egress and firefighting vehicle ingress during a wildfire;
 - 5a. Identification of evacuation route roads within subdivisions;
6. Lack of emergency access staging areas within subdivisions for evacuation purposes;
7. Need to reduce and/or control invasive species that possess inherent fire or ignition properties;
8. Arson;
7. Need to Increase/integrate communication equipment between state, federal, and county agencies; and
9. Lack of public awareness of the wildfire threat;
 - 9a. Need for awareness regarding restricting vehicle access and/or those vehicles with catalytic converters.

Recommended Actions for Northwest Hawaii:

Based on identified community concerns, the following recommendations are made to reduce the wildfire threat in Northwest Hawaii. The implementation of a multi-modal approach will increase firefighting efficiency, reduce fire fuels, and improve community and firefighter safety. Mitigation measures to reduce wildfire risk and/or impact in Northwest Hawaii include in order of priority:

1. Installation of pre-staged static water and helicopter dip tanks;
2. Acquisition of adequate resources for first responders, including off road tankers;
3. Reduction of fuel load and/or appropriate conversion of fuels along road sides, in community open areas, and individual homes. Appropriate conversion would include transition to vegetation with low ignition potential and low ability to carry fire, especially native plants;
4. Creation of development standards and community planning that requires the mitigation of wildfire risks at the regional, community/subdivision, and individual structure levels;
5. Creation/improvement of secondary access roads for those communities with only one means of ingress/egress; identification of evacuation route roads within subdivisions;
6. Development of emergency staging areas within communities and promoting awareness of such areas within the community, including holding mock disaster drills;
7. Reduction and/or control of invasive species that increase fire risk and, where appropriate, conversion to vegetation as described in priority number three;

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8. Continued fire prevention education and outreach; including arson prevention education and the development of a fire danger rating system.
9. Integration of current and future communication equipment utilized by federal, state, and county fire suppression personnel to increase effective firefighting response.

Based on the results of the community risk assessment, priority ratings have been selected for Northwest Hawaii and areas of community importance. The community recommendations for the type and method of treatment for the surrounding vegetation are listed in the following table.

Community, structure or area at risk	Type of Treatment	Method of Treatment	Overall Priority
Kawaihae	Mechanical	Need for additional pre-staged static water and helicopter dip tanks	Very High
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uuanahulu, North Kona	Mechanical / Chemical / Hand Labor	Reduction of fuel load along roadsides, community open areas, and individual homes	Very High
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uuanahulu, North Kona	Mechanical	Acquisition of adequate resources for first responders, including off road tankers	High
Kohala by the Sea, Waimea Anekona, Puako, Pu'u Lani Ranch Estates	Mechanical / Chemical / Hand Labor	Creation of secondary emergency ingress/egress roads	High
Kohala, Pu'u Kapu, Waikoloa, Pu'u Lani Ranch Estates	Mechanical	Street signage identifying evacuation routes	High
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uuanahulu, North Kona	Mechanical	Development of emergency staging areas within communities, promoting awareness of such areas within the community, including holding mock disaster drills	High
Kohala, Kawaihae, Pu'u Kapu, Waimea,	Mechanical / Chemical / Hand Labor	Reduction and/or control of invasive species	High

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Puako, Waikoloa, Pu'uanahulu, North Kona			
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uanahulu, North Kona	Public Education and Outreach	Continued fire prevention education and outreach, including arson prevention education	Medium
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uanahulu, North Kona	Mechanical / Political	Increase effective integrated communication between federal, state, and county fire suppression agencies	Medium

Community organizations, federal agencies, and private landowners in Northwest Hawaii were invited to submit projects that provide protection and reduce wildfire risk. The following table displays a list of projects based on recommendations from community and fire-related organizations. HWMO intends to assess the progress annually and invite agencies and landowners to submit projects that provide community protection.

Community, structure, or area at risk	Project	Agency	Funding Needs	Timetable	Community Recommendation
Kawaihae, leeward N Kohala coast, Pu'uanahulu; S Waimea, Pu'u Wa'a Wa'a, Waikoloa	Installation of pre-staged static water and helicopter dip tanks	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$128,000	2008 - 2009	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uanahulu, North Kona	Reduction and/or conversion of fuel load along roadsides, community open areas, and individual homes	Multiple Agencies: county	Cooperative Funding \$850,000	2008 - 20012	Yes
All communities and areas in the CWPP planning	Creation of development standards and community planning that	Multiple Agencies: county and state	Cooperative Funding \$150,000 for outreach, any needed	2008-2009	

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planning area	planning that requires the mitigation of wildfire risks		impact studies and education		
Kohala by the Sea, Waimea Anekona, Puako, Pu'u Lani Ranch Estates	Creation of secondary emergency ingress/egress roads	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$750,000 if environmental assessments required	2008 - 2010	Yes
Kohala, Pu'u Kapu, Waikoloa, Pu'u Lani Ranch Estates	Street signage identifying evacuation routes	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$50,000	2008 - 2012	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uuanahulu, North Kona	Development of emergency staging areas within communities, promoting awareness of such areas within the community, including holding mock disaster drills	Multiple agencies: private	Cooperative Funding \$33,000 for planning and outreach	2008 - 20010	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uuanahulu, North Kona	Reduction, control, and or conversion of invasive species	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$1,500,000 includes maintenance, grazing, and conversion projects	2008 - 2012	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uuanahulu, North Kona	Continued fire prevention education and outreach, including arson prevention education	Multiple agencies: federal, state, county, and private	Cooperative Funding \$30,000	2008 - 2012	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uuanahulu, North Kona	Increased effective integrated communication between federal, state,	Multiple agencies	Cooperative Funding	2008 - 20011	Yes

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Waikoloa, Pu'uana'hulu, North Kona	and county fire suppression agencies				
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Installation of pre-staged static water and helicopter dip tanks

Lack of water for fire suppression was identified as one of the most important challenges facing Northwest Hawaii communities. Pre-staged static water and helicopter dip tanks will greatly increase effective fire suppression and firefighting efficiency.

Acquisition of adequate fire suppression resources

Acquisition of additional fire suppression vehicles, particularly smaller off-road vehicles, may help fire fighting personnel reach remote fires quicker.

Reduction and/or appropriate conversion of fuel load

Reducing vegetation or appropriately converting fuels to species with low ignition potential in the vicinity of valued resources (houses, churches, community centers, cultural resources), in community common areas, and along road sides and fuel breaks will decrease fire risk to important resources and improve fire suppression capabilities. Whenever possible, fuels conversion should incorporate native plants.

Development standards and community planning that requires the mitigation of wildfire risks

Adopting development standards and community plans that mitigate wildfire risk will prevent many of the problems that set the stage for loss during fires and will greatly assist in suppression efforts and maximizing responder safety.

Creation / improvement of secondary access roads

Creation or improvement of secondary access roads to provide emergency egress should be pursued, secured, and improved where appropriate. Other secondary roads that may be used for fire suppression activities should be clearly signed and maintained.

In order to remain effective, the secondary emergency egress roads must be maintained on a regular basis. Funding should be secured to ensure that the roads are maintained at least twice a year. The organization that is determined to be responsible for the access roads may want to consider the purchase of a dozer or other equipment to maintain the roads.

Also, evacuation routes should be clearly identified within Northwest Hawaii subdivisions with signage posted marking these roads for express egress in case of emergency.

Development of emergency staging areas within communities

Recognizing that evacuation may not always be possible during a wildfire, community association and/or neighborhood groups may want to develop emergency staging areas within their community for times when evacuation is not possible. Once these staging areas are identified, communities should promote awareness of such areas within the community, as well as hold periodic mock disaster drills.

Reduction, control, and/or conversion of invasive species

Invasive grasses, such as molasses grass and fountain grass are high-intensity burning fuels that carry fire to other fuels. The ability of fountain grass to establish on barren lava flows compromises natural fire breaks for use by fire agencies. Proactive measures should be taken to mitigate the growth of fire fuels on these natural fuel breaks. Current strategies to address fine fuel build-up along roadsides should be continued, including developing vegetated fuel break corridors consisting of plants less likely to ignite or carry fire with an emphasis on native plants. It is recommended that community associations

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in Northwest Hawaii adopt CCRs that address fire fuels build-up within their community. It is also strongly recommended that outreach efforts include alerting residents and developers to the wildfire risk caused by invasive grasses and ways to prevent their spread. Periodic inspection of the each home site and sanitation strategies should be suggested by the homeowners associations. Landscaping with fire resistant plant species and especially native plant species should be recommended by the homeowners associations.

Continued fire prevention education

Fire agencies in Hawaii County and the Hawaii Wildfire Management Organization have partnered with Firewise to promote community wildland fire awareness in wildland urban interface communities. The objective is to increase overall awareness of fire hazard issues that affect residents within the wildland urban interface. While a Firewise coordinator has provided much needed outreach in the community, funding for such a position has been intermittent. Stable funding for an outreach coordinator should be developed to ensure consistent fire prevention outreach. With a continued influx of residents from other parts of the United States who are unaware of Northwest Hawaii's unique fire risks, it is crucial to continue a comprehensive fire education and outreach campaign. This program should consist of the following:

- a. Continued development and coordination of community meetings and outreach events. Coordination with other community groups, such as the local disaster preparedness committee and civic organizations, to provide wildland fire safety information on defensible space and fire-resistant Firewise building materials. Provide outreach at community events.
- b. Develop educational materials specific to community fire threat and continue outreach in local publications. Continued outreach is needed with large numbers of new residents moving into the area.
- c. Development of fire prevention outreach materials, including TV and radio public service announcements, posters, and handouts.
- d. Development of arson prevention outreach materials, including TV and radio public service announcements, posters, and handouts.
- e. Creation and promotion of a systematic fire danger rating system. Such a system has been in development for a couple of years and when finalized the fire danger rating system should be promoted in Northwest Hawaii, so residents know when fire hazards within their community are at their highest.

Increased effective communication between emergency personnel agencies during disaster

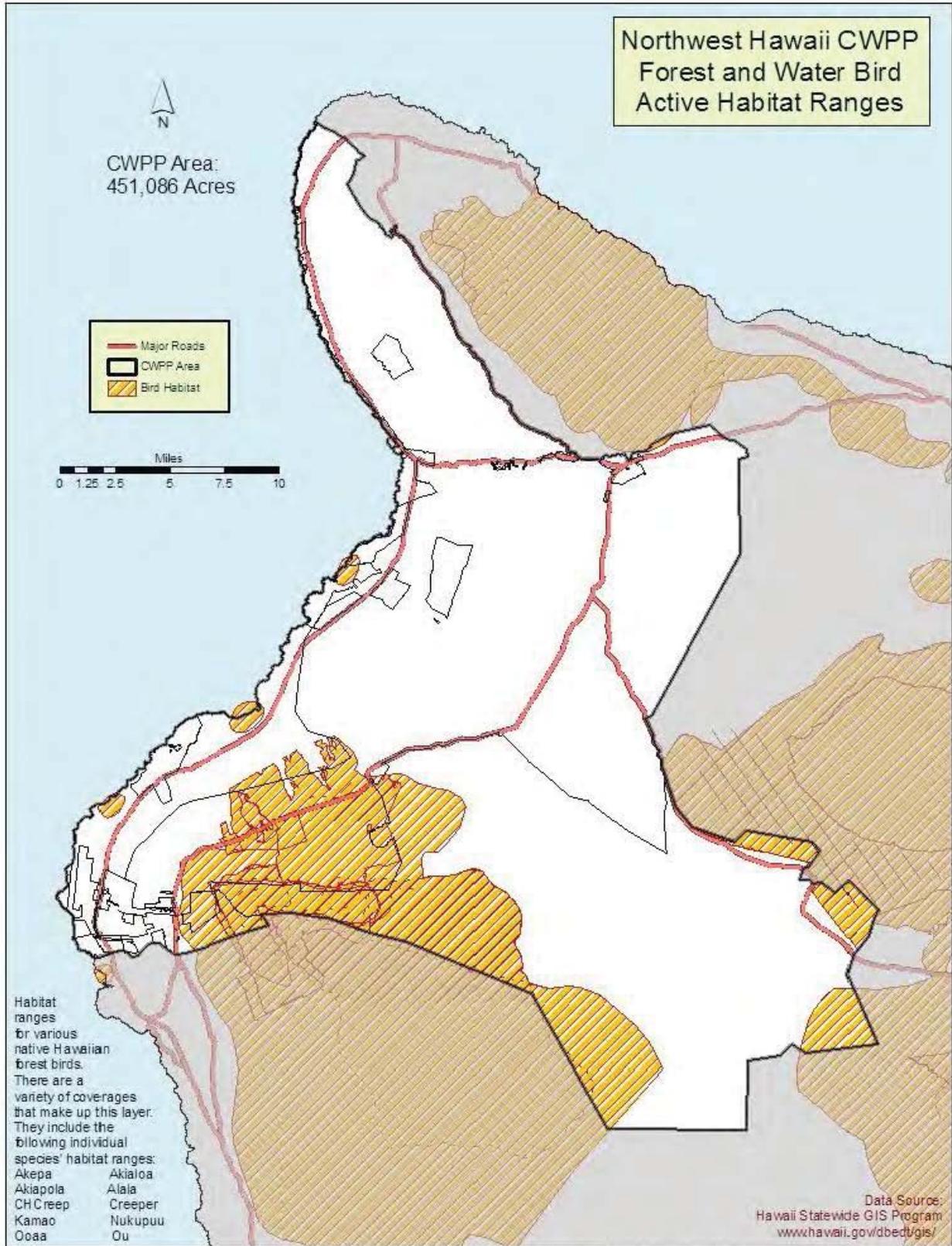
Fires, earthquakes, and hurricanes are among the risks that threaten Northwest Hawaii communities. It is imperative that current and future communication equipment utilized by federal, state, and county fire suppression agencies are integrated to increase effective firefighting response.

Reducing Structural Ignitability:

Individuals and community associations can reduce structural ignitability throughout their community by taking the following measures recommended by the Firewise program.

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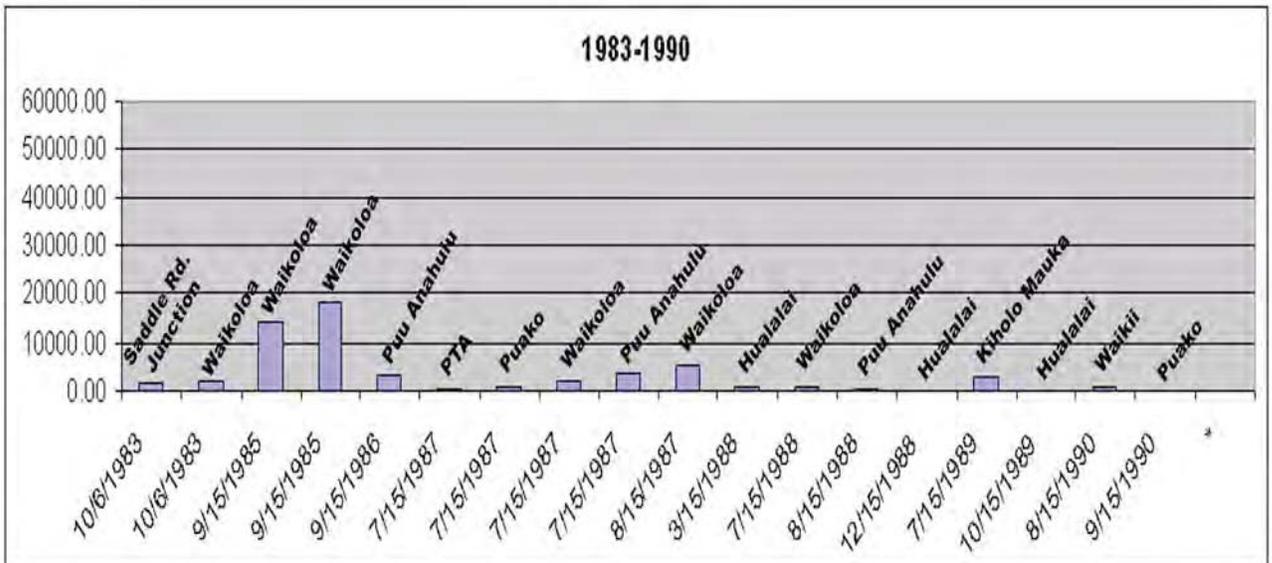
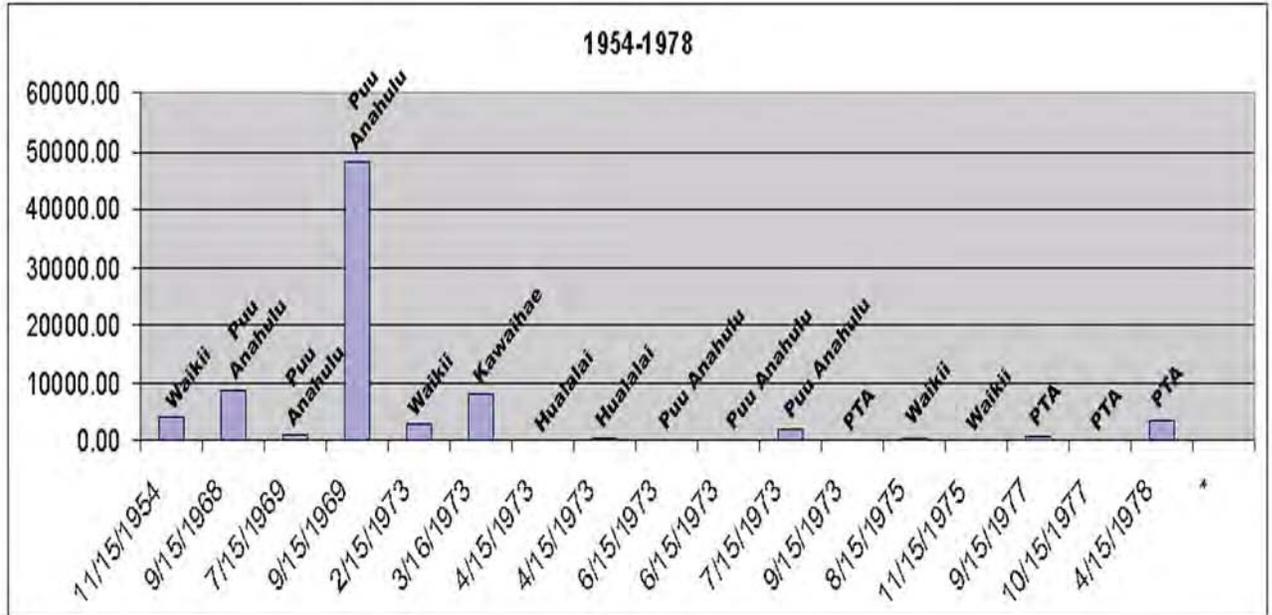
- Create a buffer zone of defensible space around a property of at least 30 feet or to the property line if the house has less than 30 feet of yard. Remove flammable vegetation and combustible growth within 30 feet of the house.
- Prune tree limbs 6 – 10 feet above the ground.
- Space trees and shrubs ten feet apart in the yard.
- Make sure that plants closest to the house are low-lying. And whenever possible use native Hawaiian or succulent plants.
- Routinely remove dead leaves and other organic matter from the yard.
- Sweep and/or clean gutters, eaves, and roofs regularly to prevent the build-up of leaves and other matter.
- Use fire-resistant building materials for the roof, siding, and decks, such as metal, stucco, tile, brick, and cement.

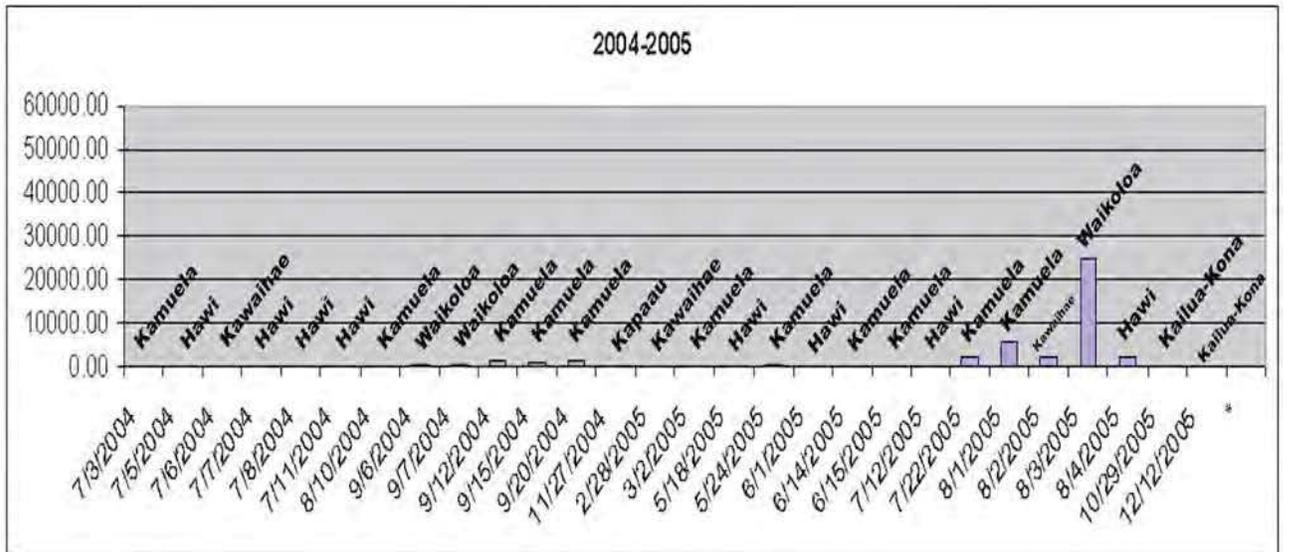
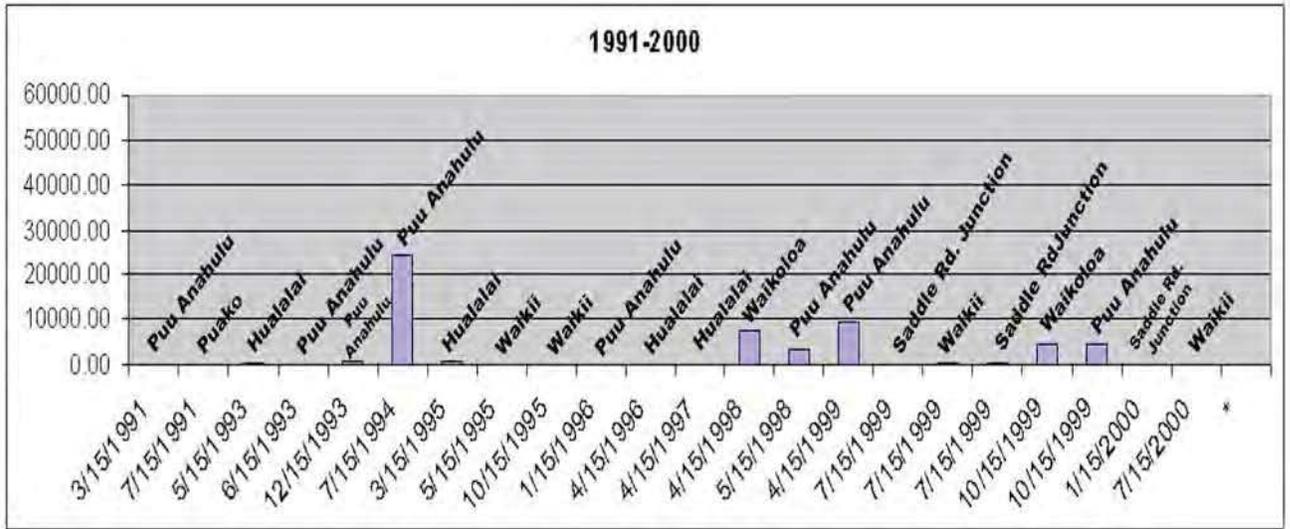


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Appendix B: Fire History Graphs for Major Fires 1954 - 2005

Graphs from Northwest Hawaii Fire History map depict fire size for different periods of time. Data unavailable for the period 1978-1983.





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Appendix C: Updated Project List 2009-2012

Federal agencies and private landowners in Northwest Hawaii were invited to submit projects that provide wildfire protection and reduce risk. The following table displays a list of recommended projects.

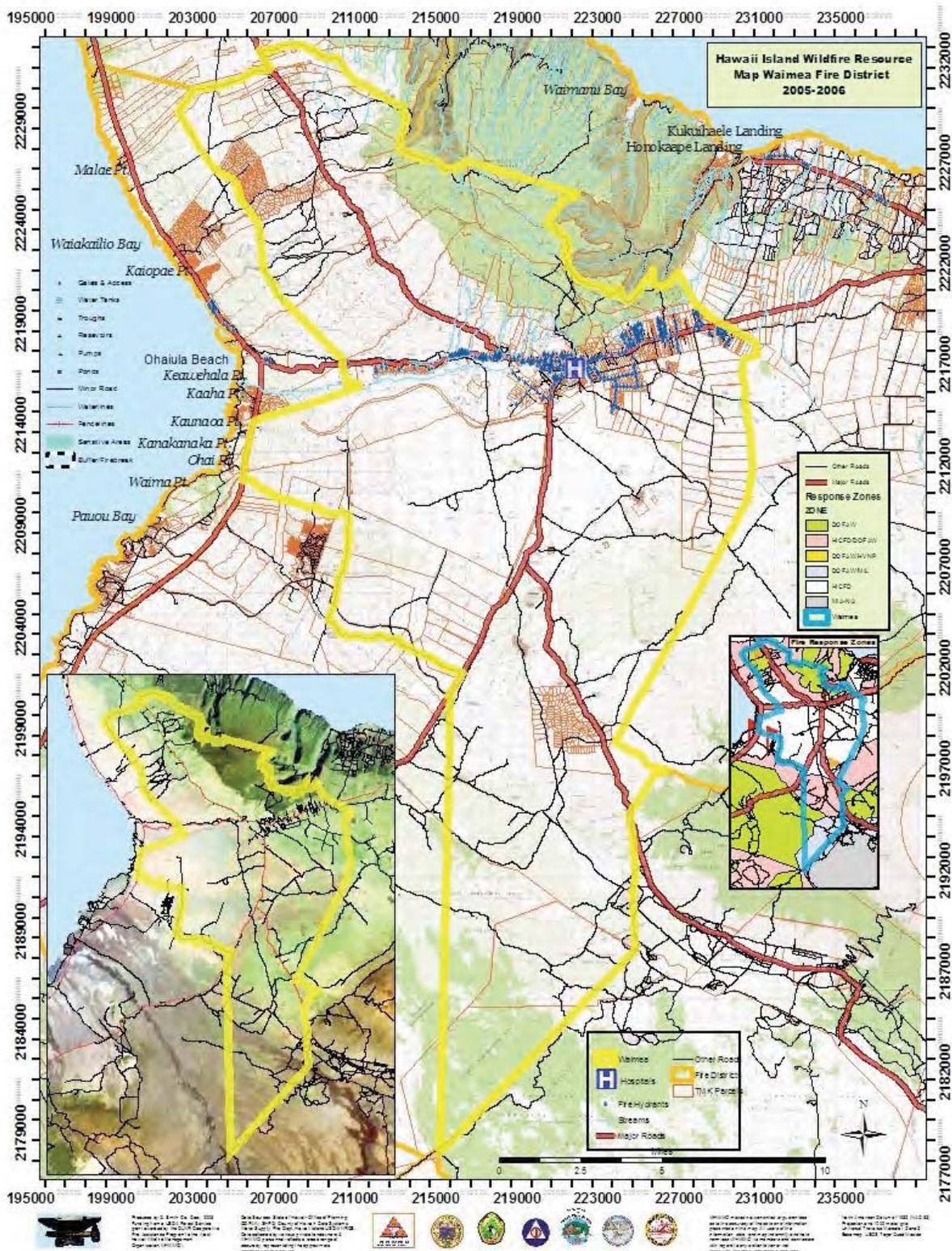
Community, structure, or area at risk	Project	Agency	Funding Needs	Timetable	Community Recommendation
Kawaihae, leeward N Kohala coast, Pu'uanaulu; S Waimea, Pu'u Wa'a Wa'a, Waikoloa	Installation of pre-staged static water and helicopter dip tanks	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$128,000	2008 - 2009	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uanaulu, North Kona	Reduction and/or conversion of fuel load along roadsides, community open areas, and individual homes	Multiple Agencies: county	Cooperative Funding \$850,000	2008 - 20012	Yes
All communities and areas in the CWPP planning area	Creation of development standards and community planning that requires the mitigation of wildfire risks	Multiple Agencies: county and state	Cooperative Funding \$150,000 for outreach, any needed impact studies and education	2008-2009	
Kohala by the Sea, Waimea Anekona, Puako, Pu'u Lani Ranch Estates	Creation of secondary emergency ingress/egress roads	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$750,000 if environmental assessments required	2008 - 2010	Yes
Kohala, Pu'u Kapu, Waikoloa, Pu'u Lani Ranch Estates	Street signage identifying evacuation routes	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$50,000	2008 - 2012	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea	Development of emergency staging areas within	Multiple agencies: private	Cooperative Funding \$33,000 for planning	2008 - 20010	Yes

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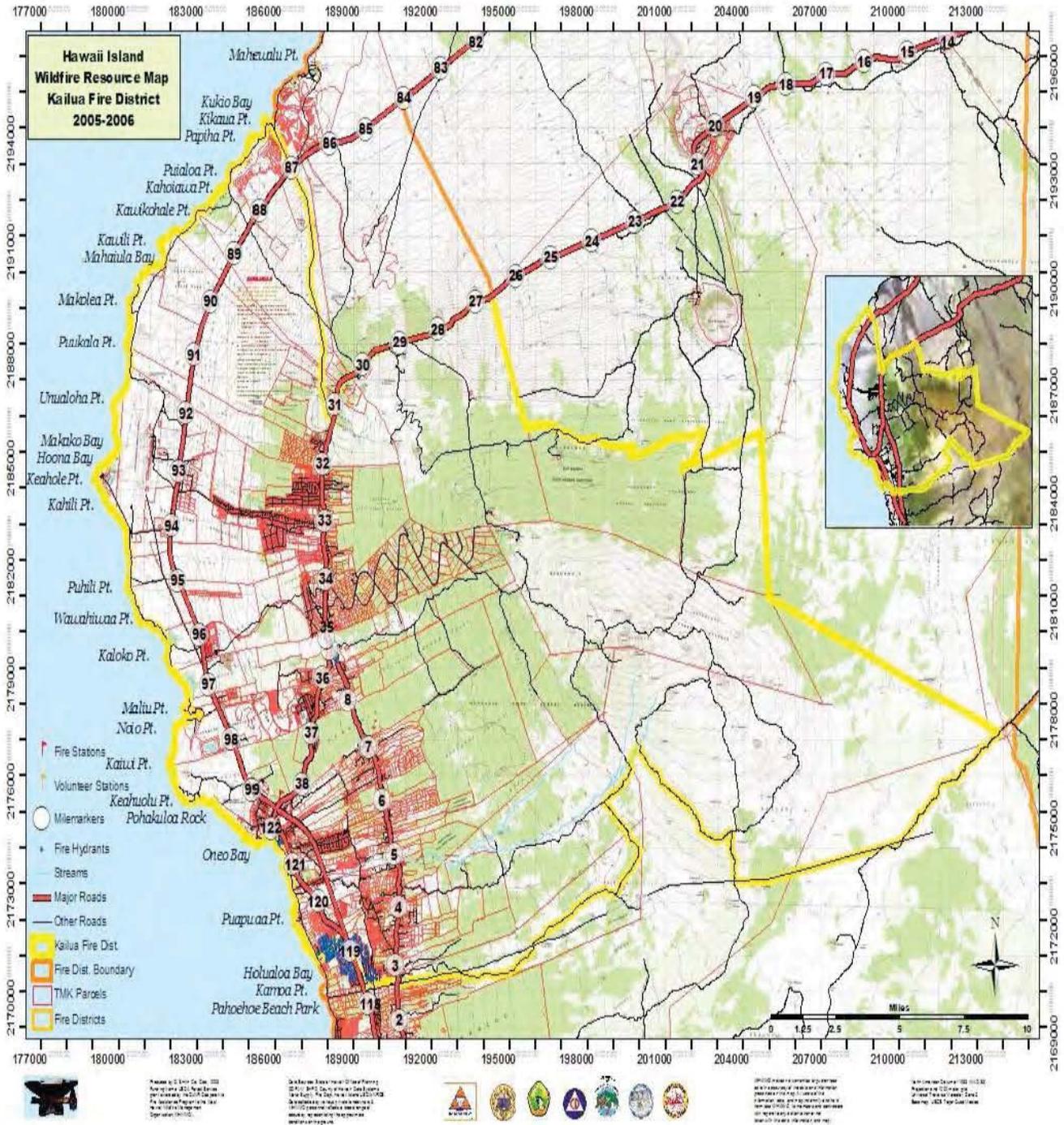
Waimea, Puako, Waikoloa, Pu'uanaulu, North Kona	communities, promoting awareness of such areas within the community, including holding mock disaster drills		and outreach		
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uanaulu, North Kona	Reduction, control, and or conversion of invasive species	Multiple Agencies: federal, state, county, and private	Cooperative Funding \$1,500,000 includes maintenanc e, grazing, and conversion projects	2008 - 2012	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uanaulu, North Kona	Continued fire prevention education and outreach, including arson prevention education	Multiple agencies: federal, state, county, and private	Cooperative Funding \$30,000	2008 - 2012	Yes
Kohala, Kawaihae, Pu'u Kapu, Waimea, Puako, Waikoloa, Pu'uanaulu, North Kona	Increased effective integrated communication between federal, state, and county fire suppression agencies	Multiple agencies	Cooperative Funding	2008 - 20011	Yes

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Appendix D: Fire Resource Maps for Northwest Hawaii, Hawaii
Maps courtesy of Hawaii Wildfire Management Organization.



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Appendix E: List of Potential Grant Resources

Below is a list of potential grant sources to help fund mitigation projects described within this CWPP. The list below is by no means exhaustive and potential community groups should also research grant funding sources available to them.

Grant Program	Deadline	Contact Information	Matching Funds Required?
<p>State Fire Assistance Grants. Funds target hazard mitigation in the Wildland Urban Interface for mitigating risks of hazardous fire conditions through hazardous fuels reduction, information and education, and homeowner and community defensible space treatments.</p>	September 7, 2007 for 2008-2009 competitive funding	Division of Forestry and Wildlife Attn: Wayne Ching, 1151 Punchbowl St., Rm. # 325 Honolulu, HI 96813 http://www.state.hi.us/dlnr/dofaw/fmp/wui0809.htm	Yes: 50/50 match
<p>Rural Fire Assistance Grants (RFA) The Dept. of the Interior receives an appropriated budget each year for a rural fire assistance (RFA) grant program. This funding will enhance the fire protection capabilities of rural and volunteer fire departments through training, equipment purchases, and fire prevention work on a cost-shared basis. This program is primarily for rural departments serving populations under 10,000 and which have responsibilities to provide mutual aid to Dept. of Interior lands (e.g., Tribal, National Parks etc.) The DOI assistance program targets rural and volunteer fire departments that routinely help fight fire on or near DOI lands.</p>	Varies by state	Hawaii Volcanoes National Park Joe Molhoek Pacific Island Fire Mgmt. Officer PO Box 52, HNP, HI 96718 (808) 985-6042 Joe_Molhoek@nps.gov	The maximum award is \$20,000. This year RFA grants will require 90/10 cost-share.

<p>One of these four agencies administers those lands: Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), U.S. Fish and Wildlife Service (FWS) and the National Park Service (NPS).</p>			
<p>Volunteer Fire Assistance Grant (VFA): The VFA program, formerly known as the Rural Community Fire Protection program, is administered by state forestry agencies through 50-50 cost-sharing grants to local fire depts. in rural communities. The program's main goal is to provide federal financial, technical, and other assistance in the organization, training, and equipping of fire departments in rural areas with a population of 10,000 or less. Congressionally appropriated VFA funds are provided to the State forestry agencies through the USDA Forest Service. The State forestry agencies pass this money on to needful fire departments within their states. Any fire agency or volunteer fire department that serves a community of 10,000 or less may apply.</p>		<p>Wayne Ching Division of Forestry and Wildlife 1151 Punchbowl St., Rm. # 325 Honolulu, HI 96813 (808) 587-4173 Fax: (808) 587-0160 wayne.f.ching@hawaii.gov</p>	<p>50/50 cost share.</p>

Of note, Hawaii County Civil Defense is acquiring firefighting apparatus through a Department of Homeland Security grant, however, these grants are only available to government agencies.

Appendix B—Biological Resources Survey Report

Appendix B

Appendix B contains the biological survey report, dated April 2013, by Geometrician Associates, LLC, for the proposed fuel break and dip tank sites on the Island of Hawaii. The report describes the results of a botanical and faunal habitat survey of the sites on the west side of Hawaii Island that would be modified for the construction of dip tanks and fuel breaks. The report concludes that the proposed action would substantially protect rare and threatened & endangered plants and habitat for threatened & endangered fauna and is not expected to adversely modify proposed critical habitat if and when it is designated. This description applies to the next 24 pages.

***Biological Survey
Hawai'i Wildfire Management Organization
Firebreak and Diptank Sites, Island of Hawai'i
FEMA-1640-DR-HI, HMGP 1640-7***

**By Ron Terry, Ph.D. Geometrician Associates, LLC
Prepared for CDM Smith
On Behalf of FEMA
Contract HSFEHQ-09-D-1128, Task Order HSFE60-12-J-0005
April 2013**

Introduction

This report describes the results of a botanical and faunal habitat survey of seven sites on the west side of Hawai'i Island that will be modified for construction of dip tanks and firebreaks. The Hawai'i Wildfire Management Organization (HWMO) is proposing to use U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) funding to reduce wildfire hazards and improve wildfire suppression capabilities for several communities in West Hawai'i. The proposed measures and locations for implementing those measures were identified based on historic fire patterns, location of hazardous fuel loads, and current availability of fire suppression resources.

Figure 1 depicts the regional location of the sites, which comprise seven areas scattered in the dry country between North Kohala and North Kona at elevations between sea level and about 2,200 feet above sea level. Figures 2-8 are individual maps of each site. Table 1 provides information on the details of the action on each site. The scope of the surveys was as follows:

- Conduct a botanical survey of the affected areas, with a focus on rare, threatened or endangered (T E) species, including in particular *Mezoneuron kawaiense* (*uhiuhi*), *Pleomele hawaiiensis* (*halapepe*), *Portulaca sclerocarpa*, *Lipochaeta venosa*, *Vigna o-wahuensis* and *Abutilon menziesii* (*red ilima*) (which have been found in nearby areas), providing a full list of plant species observed and flagging or GPS (as practical) any individuals or populations of rare, threatened or endangered plant species.
- Provide a narrative with field-based observations concerning habitat for T E faunal species in and near the affected area, including GPS coordinates for any areas of concern.

I visited each site between one and three times in October and November 2012 and April 2013, fully covering the entire surface of each site. Species were identified in the field and, as necessary, collected and keyed out in the laboratory. Special attention was given to the possible presence of any federally (USFWS 2013) listed or proposed threatened or endangered plant or wildlife species and designated or proposed critical habitat.

Vegetational Influences

The geologic substrate in all of these areas are late Pleistocene-era and Holocene era lava flows from Hualalai, Mauna Loa, Mauna Kea and Kohala volcanoes (Wolfe and Morris 1996). The surface is both ‘a‘a (clinkery lava) and pahoehoe (smooth or ropy lava), often heavily weathered to a more rounded surface and covered in many areas with soil formed in-situ or through wind-blown deposits. Soil types are variable, but there is minimal in several locations (U.S. Soil Conservation Service 1973). Rainfall is low, less than 500 mm (~19 inches) annually at all sites (Giambelluca et al 2012). Based on the low cloud cover and fairly clear atmospheric conditions, solar radiation and temperatures are both very high, leading to potential evapotranspiration that far exceeds precipitation, and thus very arid conditions.

The vegetation at all sites is naturally dry, but prior to human contact, it was not particularly pyrophytic (fire-adapted) because of the relatively low frequency of natural fires in Hawai‘i. It is difficult to speculate on the pre-human vegetation of the area, since the introduction of certain grasses, grazing animals and fire have changed the soil and microclimate of the area. Gagne and Cuddihy (1990) described the vegetation in areas with a similar geology and range of elevation as Lowland Dry Forest, Lowland Dry Shrubland, Lowland Dry Grasslands, or Coastal Dry Shrublands. Much of the area may have once been dominated by *pili* grass (*Heteropogon contortus*) and shrubs such as *ilima* (*Sida fallax*), *pā‘ū-o-Hi‘iaka* (*Jacquemontia ovalifolia*), and ‘*uhaloa* (*Waltheria indica* – which is still common). At higher elevations, there was perhaps diverse but fairly sparse cover of native dry-forest trees and shrubs including ‘*āweoweo* (*Chenopodium oahuense*), ‘*akia* (*Wikstroemia* spp.), ‘*a‘ali‘i* (*Dodonaea viscosa*), with trees such as sandalwood (*Santalum ellipticum*), *lama* (*Diospyros sandwicensis*) and *alahe‘e* (*Psydrax odoratum*) in the upper elevations, along with now rare trees such as *wiliwili* (*Erythrina sandwicensis*), and *uhiuhi*.

Current Vegetation

In modern times, wildfire has come to pose a grave threat to Hawaiian ecosystems by converting native habitats into grasslands dominated by nonnative species. As in many other tropical areas, fires in Hawai‘i are usually caused by human activity. Because few native Hawaiian animals or plants are adapted to wildfires, they generally perish when exposed to fire. Native shrubs and trees may recover from fire to some degree, but native plant communities are often overwhelmed by more aggressive alien species after fires. Many nonnative species, such as fountain grass (*Cenchrus setaceus*), are pyrophytic and thrive in the aftermath of fires. Unlike native shrubs and trees, many alien grasses recover quickly, increasing in ground cover and biomass after a fire. Fires encourage fountain grass by stimulating growth from the base of clumps and encouraging seed production. The establishment of pyrophytic grasses increases the threat of additional fires. Fire represents a major disturbance, which encourages conversion of native dominated communities into alien dominated plant communities (see Figure 10a).

Despite the variation in elevation and substrate among the seven subject sites, all have a high frequency of fire, and the vegetation at each is now dominated by fire-adapted invasive species including fountain grass, buffel grass (*Cenchrus ciliaris*), *kiawe* (*Prosopis pallida*) and *koa haole* (*Leucaena leucocephala*). The Puako Firebreak site is surrounded by a dense forest comprised of

kiawe; this vegetation is highly flammable, supporting extremely high temperatures, very long flame lengths, and rapid rates of fire spread. The Waikoloa Diptank and Firebreak sites are surrounded by hazardous fuels, including fountain grass and *koa haole*. The Ponohele Diptank site has *kiawe* and buffel grass, and the two Diptank sites in the Pu‘uanahulu area are in areas dominated by fountain grass. The intense fire hazard is of course the reason for the proposed project.

All of the sites have also experienced various other forms of disturbance, including wood removal, cattle grazing and associated walls and fence construction, crop agriculture, grazing and browsing by goats (Figure 10b), and grading for construction or for firebreaks. The site with the heaviest disturbance is the Kuainiho Diptank, which has been completely graded by a bulldozer and is maintained in a vegetation-free state through herbicide, and the Puako Firebreak, most of which appears to have been cut and graded, although due to deep soil and the presence of groundwater, vegetation readily regrows.

Flora

A full list of plant species found in the surveyed areas is contained in Tables 2a-g, below. Of the species found on the seven sites, nine are indigenous (found in Hawai‘i as well as elsewhere) and two are endemic (found in Hawai‘i and nowhere else). All these native species are common in the region and in other areas of the Hawaiian Islands, and no rare, threatened or endangered species were detected.

A brief description of the flora and vegetation at each site follows, accompanied by species tables and photo figures:

Waikoloa Firebreak Site

The Waikoloa Firebreak site is highly disturbed because of its proximity to a road and an apartment complex (Figure 2). Dumping, windblown trash, remnants of former structures, and grading are all present. The extreme southern end of the proposed firebreak borders but does not intrude into Auwaiakeakua Gulch, a deeply incised but highly intermittent stream. The gulch vegetation in this area was explored as part of this project, and in a much longer section area downstream in a previous botanical survey by our firm (Geometrician Associates 2010), and no sensitive species were detected. A variety of weeds and a few common natives are present.

Puako Firebreak Site

This elongated site had the largest number of species and the greatest number of natives (Figure 3). If there was no management, the vegetation would be a dense monoculture of *kiawe* trees with buffel grass in any unshaded areas, as it is directly *mauka*. The site has been intensively managed as a firebreak through heavy equipment, tree trimming and removal, and mulching. In addition, residents often dump yard waste in the area. These disturbed conditions promote a high number of weeds, but they also promote open conditions that preclude full coverage by *kiawe* and allow several coastal natives to thrive, particularly the low-lying areas where there is root access to groundwater in the deep, somewhat salty soil (Figure 10c). As discussed in more detail

in the *Impacts and Mitigation* section below, a cluster of *Nicotiana glauca*, cited by the U.S. Fish and Wildlife Service as an occasional host for an endangered moth, had sprouted in a *kiawe* wood pushpile.

Kuainiho Dip Tank Site

This site (Figure 4) functions as a marshaling yard for fire-fighting, is maintained in a vegetation-free state through herbicide. At the time of the botany survey in October 2011 contained just one species, the weed balloon plant (*Asclepias physocarpa*) (Table 2e).

1859 Lava Flow Dip Tank Site

This proposed diptank site, along with the existing access road and adjacent areas for the pipeline to supply the tank (Figure 5), contains low, shrubby vegetation completely composed of invasive grasses, herbs and shrubs (Table 2f).

Waikoloa Dry Forest Preserve Site

The site is directly adjacent to the main access track within the preserve (Figure 6). It was selected by the preserve managers in consultation with the HWMO team because it balanced needs for access, water pressure and avoiding sensitive resources within the preserve, especially *wiliwili* and *uhiuhi* trees. The proposed site has almost no vegetation (Table 2g). It is important to note that individuals of both *uhiuhi* and *Nicotiana glauca* are present very near the proposed site (Figure 10d), but neither will be adversely affected by the tank.

Ponoholo Ranch Dip Tank Site

This heavily grazed proposed diptank site, access road and the roughly mile-long route for the pipeline (Figure 7), contained only four species, one native (*ilima*), and three non-native (*kiawe*, *koa haole* and buffel grass) (Table 2c).

Lalamilo Dip Tank Site

This site (Figure 8), which consists of an existing access road and a proposed diptank site and pipeline route, is also heavily grazed, but due to somewhat greater rainfall and lower temperatures, it has a more diverse assemblage of weeds and one common native plant (Table 2d).

Faunal Habitat

Although feral mammals and introduced reptiles, birds and amphibians are present, all are deleterious to native flora and fauna. They are not considered to be concern to conserve in Hawai'i, and they are not discussed here.

The species of birds likely to be present in these disturbed lowland habitats are almost exclusively non-native species. No bird surveys were conducted as part of this assessment, but

those opportunistically detected during the survey were typical of those found in this lowland disturbed habitat that have been well documented by ornithologists (see David 1996a, 1996b, 1999 and 2000), who generally find that avian diversity and densities here are very low. Native species are generally unusual, although the migratory and very common Pacific-Golden Plover or Kolea (*Pluvialis fulva*) can often be seen seasonally in flat, grassy areas. The endemic Short-eared Owl or Pueo (*Asio flammeus sandwichensis*) is a diurnal bird of prey regularly seen within the grasslands of North and South Kohala. This species is currently widespread and does not have special protective status under either the State or federal endangered species statutes on the Island of Hawai‘i.

Native forest birds are almost never present due to the arid grassland habitat. The likelihood of encountering an endangered bird species at any of the sites is low, but Hawaiian Stilt or ‘A‘eo (*Himantopus mexicanus knudseni*) have been observed in the lower Waikoloa area (R. David, unpublished survey 2003, pers. comm. to R. Terry), but there is no habitat for this bird in any of the sites. Nene or Hawaiian Goose (*Branta sandvicensis*) can be seen occasionally at some of the sites, as they are attracted by water features at golf courses. Nene prefer areas with young grass shoots, and none of the firebreak or diptank sites offers truly suitable habitat.

Additionally, it is possible that small numbers of the endangered endemic Hawaiian Petrel (*Pterodroma sandwichensis*) and the threatened Newell’s Shearwater (*Puffinus auricularis newelli*) over-fly the project area between the months of May and November. The Hawaiian Petrel was formerly common on the Island of Hawai‘i. This pelagic seabird reportedly nested in large numbers on the slopes of Mauna Loa and in the saddle area between Mauna Loa and Mauna Kea, as well as at the mid-to-high elevations of Hualālai. It has within recent historic times been reduced to relict breeding colonies located at high elevations on Mauna Loa and, possibly, Hualālai. Hawaiian Petrels were first listed as an endangered species by the USFWS in 1967 and by the State of Hawai‘i in 1973. Newell’s Shearwaters were also once common on the Island of Hawai‘i. This species breeds on Kaua‘i, Hawai‘i, and Moloka‘i. Newell’s Shearwater populations have dropped precipitously since the 1880s (Banko 1980, Day et al., 2003). This pelagic species nests high in the mountains in burrows excavated under thick vegetation, especially *uluhe* (*Dicranopteris linearis*) fern. Newell’s Shearwater was listed as a threatened species by the USFWS in 1975 and by the State of Hawai‘i in 1973.

The primary cause of mortality in both Hawaiian Petrels and Newell’s Shearwaters is thought to be predation by alien mammalian species at the nesting colonies. Collision with man-made structures is considered to be the second most significant cause of mortality of these seabird species in Hawai‘i. Nocturnally flying seabirds, especially fledglings on their way to sea in the summer and fall, can become disoriented by exterior lighting. When disoriented, seabirds often collide with manmade structures, and if they are not killed outright, the dazed or injured birds are easy targets of opportunity for feral mammals. There is no suitable nesting habitat within or close to any of the seven sites for either of these pelagic seabird species.

Although not detected in any of the surveys, which took place in full daylight, the only native Hawaiian land mammal, the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*), may also be present. The bat is present in many areas on the island of Hawai‘i and has been observed in *kiawe* scrub vegetation in Kona. They may forage for flying insects over the sites on a seasonal

basis, though the xeric nature of the habitat and the lack of dense vegetation provides little in the way of attractive food resources for a bat. Bats roost in trees or shrubs taller than 15 feet and can be vulnerable during the pupping season from June 1 to September 15 each year. Outside of the Puako Firebreak site, no such trees or shrubs are present.

Finally, there is an endangered insect, Blackburn's sphinx moth (*Manduca blackburnii*), that may be present as eggs, pupae or larvae on annual or semi-perennial plants at some sites. This close relative of the tomato hornworm of North America was formerly common on all Hawaiian Islands. Its populations were drastically reduced because of the decline of its principal natural host plant, the native tree 'aiea (*Nothocestrum* spp.). Blackburn's sphinx moth has since been found to occasionally utilize non-native host plants including: *Nicotiana glauca* (tree tobacco), *N. tabacum* (commercial tobacco), *Solanum melongena* (eggplant), *Lycopersicon esculentum* (tomato), and possibly *Datura stramonium* (Jimson weed). According to the U.S. Fish and Wildlife Service, the full range of the taxa that Blackburn's sphinx moth larvae may feed on is not known. However, larvae of a close relative of Blackburn's sphinx moth, *Manduca sexta*, feed on a wide variety of taxa in the Solanaceae family including: *Capsicum* (sweet and chili pepper), *Cestrum* (ornamental plants), *Cymphomandra* (tomatillo), *Datura* (Jimson weed, loco weed), *Lycium* (ornamental plants used for Chinese herbal medicines), *Lycopersicum* (tomato), *Petunia* (petunia), *Physalis* (tomatillo and ground cherry), *Solandra* (ornamental vines) and *Solanum* (potato, eggplant, Christmas cherry, nightshade).

These weedy members of the Solanaceae family are found widely distributed throughout the Hawaiian Islands. The only individuals observed within the proposed footprints of disturbance for any of the sites were within a small cluster of *Nicotiana glauca* at the Puako Firebreak, as discussed below. However, *N. glauca* is widely distributed and sometimes is the dominant shrub in the higher elevations of Pu'uuanahulu, where the 1859 Lava Flow and Kuainiho Diptank sites are located.

Impacts and Mitigation Measures

Project activities include vegetation removal at six of the all seven sites (the Kuainiho Diptank site, which also functions as a marshaling yard for fire-fighting, is maintained in a vegetation-free state through herbicide).

The vegetation at all sites except Puako is overwhelmingly non-native, and no threatened or endangered plant species are present in the area to be modified. Rare species and endangered plant species cited by USFWS, including *wiliwili* and *uhiuhi*, are present very near the proposed Waikoloa Dry Forest Diptank site. These species are carefully managed within this fenced preserve by professional managers, and the proposed project will only benefit them by providing an immediately available source of water for fighting wildfires that could threaten these populations.

Individuals of *Nicotiana glauca*, a weed which often emerges after land clearing, particularly on 'a'a surfaces, have been known to be present near five of the seven sites. During inspection, no *N. glauca* (or any other hypothesized *Manduca blackburnii* hosts) were present at any sites, but a patch of *N. glauca* had emerged within a pushpile of dead kiawe awaiting removal at the Puako

firebreak (Figure 10e). *N. glauca* may persist for years but often dies in unfavorable environments, and it is uncertain if these plants will persist in this unusual context.

To minimize impacts to the endangered Hawaiian hoary bat from tree removal that will occur at the Puako Firebreak, we recommend that woody plants greater than 15 feet will not be removed or trimmed during the bat birthing and pup rearing season (May 15 through August 15). Very few such trees are present, most within the gulch.

It is assumed that the project will involve no outdoor lighting and will thus not attract Hawaiian Petrels and Newell's Shearwaters, which may become disoriented by the lighting, resulting in birds being downed. If for any reason night lighting is required, it should be shielded in conformance with the Hawai'i County Outdoor Lighting Ordinance (Hawai'i County Code Chapter 9, Article 14).

HWMO's implementation of fuel break management and dip tank measures will reduce hazardous vegetation in designated wildland-urban interface areas will slow the spread of fire toward in the West Hawai'i communities. It will also reduce fire risk and assist in fighting wildfires in areas of mauka Kona and Kohala that are fuel gateways towards intact native vegetation located more *mauka* that is habitat for dozens of endangered species. As such, the action will significantly protect rare and T&E plants and habitat for T & E fauna.

None of the action areas are located within currently designated critical habitat. However, on October 17, 2012, the USFWS published a proposed rule in the Federal Register (77 FR 63928) to list 15 species as endangered. In addition, the proposed rule would designate critical habitat on Hawai'i Island for one of the proposed plant species – *ko'oko'olau* (*Bidens micrantha* ssp. *ctenophylla*) - and for two previously listed plant species - *uhiuhi* and *wahine noho kula* (*Isodendron pyriform*). One of the units of the proposed critical habitat (Unit 32, see Figure 9) is located in the area in which the Waikoloa diptank is proposed. As the surface alteration necessary for the installation of the diptank is minimal, and surveys have been undertaken to ensure that it does not directly affect these or other listed species, the action would not alter the characteristics of the land in a way that degrades the primary constituent elements that make it suitable as critical habitat, and the action will help to protect the habitat from wildfire. Therefore, the action is not expected to adversely modify the proposed critical habitat, if and when it is designated.

Limitations

No botanical survey of a large area can claim to have detected every species present. Some species are cryptic in juvenile or even mature stages of their life cycle. Dry conditions can render almost undetectable plants that extended rainfall may later invigorate and make obvious. The survey took place within the space of about four months, and the picture of flora and vegetation is thus to some degree limited. A season of heavy rain would produce much greater species richness on the uplands, particularly for non-native herbs. Although rare natives might also appear, they would generally soon be eliminated by grazing mammals in these pasture environments, which is part of the reason for their rarity. The findings of this survey must

therefore be interpreted with proper caution; in particular, there is no warranty as to the absence of any particular species.

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Table 1.
Summary of Proposed Fuel Break Management and Dip Tank Measures

Proposed Site	Proposed Activity	Tax Map Key (TMK)	Landowner	Local Partner
Waikoloa Fuel Break	Trim existing vegetation with weed-whackers and/or hand tools within 0.5-mile-long fuel break (~30 feet wide), with new fuel break tying into existing fuel break around apartment complex on Pua Melia Street; maintain trimmed vegetation within both new and existing fuel break	368003030, 368003037, 368003029, 368003028, 368002016, 368002051	Waikoloa Village Association	Waikoloa Village Association
Puako Fuel Break	Clear vegetation, grade, and place mulch in western half of existing 2-mile-long fuel break (~100 feet wide); work has already been completed by others within eastern half; maintain cleared vegetation within entire fuel break	369001017, 369001015, 369002027, 369002023	State of Hawaii	Puako Homeowner Association
Kuainiho Diptank Site	Install 12-foot diameter dip tank within existing staging area used for fire suppression activities; tank to be filled with water delivered via water truck	371004001	State of Hawaii	DOFAW
1859 Flow Diptank Site	Clear and grade area along existing access road (approx. 20'x20'); install 12-foot diameter dip tank; install 1-2" diameter aboveground pipeline along existing access road to deliver water to tank from nearby cattle trough	371004018	State of Hawaii (leased by private rancher)	DOFAW (in coordination with private rancher)
Waikoloa Diptank Site	Clear and grade area along existing access road (approx. 20'x20'); install 12-foot diameter dip tank; tank to be filled using existing water line	368002015	Waikoloa Village Association	Waikoloa Dryland Forest Initiative
Ponoholo Diptank Site	Clear and grade area (approx. 20'x20'); smooth grade along approx. 500-foot-long dirt access road; install 12-foot diameter dip tank; install 1-2" diameter pipeline along 1.0 mile-long route to deliver water from existing water line	359003004	Private landowner	Ponoholo Ranch
Lalamilo Diptank Site	Grade area (approx. 20'x20'); smooth grade along 0.5-mile-long dirt access road; install 12-foot diameter dip tank; install 1-2" diameter aboveground pipeline to deliver water to tank from adjacent property	366001002	State of Hawaii (leased by private rancher)	Private rancher

Table 2a. Puako Firebreak Plant Species List (see end of Table 2g for Status key)

Scientific Name	Family	Common Name	Life Form	Status
<i>Atriplex semibaccata</i>	Chenopodiaceae	Australian saltbush	Shrub	A
<i>Boerhavia repens</i>	Nyctaginaceae	Alena	Herb	I
<i>Cenchrus ciliaris</i>	Poaceae	Buffel grass	Herb	A
<i>Cenchrus setaceus</i>	Poaceae	Fountain grass	Herb	A
<i>Calotropis gigantea</i>	Asclepidaceae	Crown flower	Shrub	A
<i>Coccoloba uvifera</i>	Polygonaceae	Sea grape	Tree	A
<i>Cyperus javanicus</i>	Cyperaceae	Ahuawa	Herb	I
<i>Heliotropium currasavicum</i>	Boraginaceae	Nena	Herb	I
<i>Ipomoea alba</i>	Convolvulaceae	Moonflower	Vine	A
<i>Ipomoea indica</i>	Convolvulaceae	Morning glory	Vine	I
<i>Ipomoea pes-caprae</i>	Convolvulaceae	Beach morning glory	Vine	I
<i>Leucaena leucocephala</i>	Fabaceae	Koa haole	Shrub	A
<i>Malvastrum coromandelianum</i>	Malvaceae	False mallow	Herb	A
<i>Momordica charantia</i>	Cucurbitaceae	Bitter gourd	Vine	A
<i>Nicotiana glauca</i>	Solanaceae	Tree tobacco	Shrub	A
<i>Paspalum vaginatum</i>	Poaceae	Seashore paspalum	Herb	A
<i>Pluchea indica</i>	Asteraceae	Indian pluchea	Herb	A
<i>Pluchea symphytifolia</i>	Asteraceae	Sourbush	Shrub	A
<i>Prosopis pallida</i>	Fabaceae	Kiawe	Tree	A
<i>Scaevola taccada</i>	Goodenaceae	naupaka	Shrub	I
<i>Sida fallax</i>	Malvaceae	‘Ilima	Shrub	I
<i>Thespesia populnea</i>	Malvaceae	Milo	Tree	I
<i>Tridax procumbens</i>	Asteraceae	Coat buttons	Herb	A
<i>Waltheria indica</i>	Sterculiaceae	‘Uhaloa	Herb	I

Table 2b. Waikoloa Firebreak Plant Species List

Scientific Name	Family	Common Name	Life Form	Status
<i>Cenchrus ciliaris</i>	Poaceae	Buffel grass	Herb	A
<i>Cenchrus setaceus</i>	Poaceae	Fountain grass	Herb	A
<i>Chenopodium murale</i>	Chenopodiaceae	Chenopodium	Shrub	A
<i>Chenopodium oahuense</i>	Chenopodiaceae	Āweoweo	Shrub	E
<i>Leucaena leucocephala</i>	Fabaceae	Haole koa	Shrub	A
<i>Macroptilium atropurpureum</i>	Fabaceae	Phaseolus	Vine	A
<i>Malvastrum coromandelianum</i>	Malvaceae	False mallow	Herb	A
<i>Parthenium hysterophorus</i>	Asteraceae	False ragweed	Herb	A
<i>Prosopis pallida</i>	Fabaceae	Kiawe	Tree	A
<i>Sida fallax</i>	Malvaceae	‘Ilima	Shrub	I
<i>Tridax procumbens</i>	Asteraceae	Coat buttons	Herb	A
<i>Waltheria indica</i>	Sterculiaceae	‘Uhaloa	Herb	I

Table 2c. Ponoholo Ranch Dip Tank Site Plant Species List (includes access road/pipeline)

Scientific Name	Family	Common Name	Life Form	Status
<i>Cenchrus ciliaris</i>	Poaceae	Fountain grass	Herb	A
<i>Leucaena leucocephala</i>	Fabaceae	Koa haole	Shrub	A
<i>Prosopis pallida</i>	Fabaceae	Kiawe	Tree	A
<i>Waltheria indica</i>	Sterculiaceae	‘Uhaloa	Herb	I

Table 2d. Lalamilo Dip Tank Site Plant Species List (includes access road/pipeline)

Scientific Name	Family	Common Name	Life Form	Status
<i>Achillea millefolium</i>	Asteraceae	Common yarrow	Herb	A
<i>Amaranthus viridis</i>	Amaranthaceae	Slender amaranth	Herb	A
<i>Cenchrus ciliaris</i>	Poaceae	Buffel grass	Herb	A
<i>Cenchrus clandestinus</i>	Poaceae	Kikuyu grass	Grass	A
<i>Cenchrus setaceus</i>	Poaceae	Fountain grass	Herb	A
<i>Furcraea foetida</i>	Agavaceae	Mauritius hemp	Tree	A
<i>Lantana camara</i>	Verbenaceae	Lantana	Shrub	A
<i>Lepidium bonariense</i>	Brassicaceae	Lepidium	Herb	A
<i>Malvastrum coromandelianum</i>	Malvaceae	False mallow	Herb	A
<i>Neonotonia wightii</i>	Fabaceae	Glycine	Herb	A
<i>Opuntia ficus-indica</i>	Cactaceae	Panini	Shrub	A
<i>Portulaca pilosa</i>	Portulacaceae	Pigweed	Herb	A
<i>Senecio madagascariensis</i>	Asteraceae	Fireweed	Herb	A
<i>Sida fallax</i>	Malvaceae	‘Ilima	Shrub	I
<i>Solanum sodomium</i>	Solanaceae	Sodom apple	Shrub	A
<i>Waltheria indica</i>	Sterculiaceae	‘Uhaloa	Herb	I

Table 2e. Kuainiho Dip Tank Site Plant Species List*

Scientific Name	Family	Common Name	Life Form	Status
<i>Asclepias physocarpa</i>	Asclepiadaceae	Balloon plant	Shrub	A

*area is managed with herbicides

Table 2f. 1859 Lava Flow Dip Tank Site Plant Species List

Scientific Name	Family	Common Name	Life Form	Status
<i>Cenchrus clandestinus</i>	Poaceae	Kikuyu grass	Grass	A
<i>Cenchrus setaceus</i>	Poaceae	Fountain grass	Herb	A
<i>Indigofera suffruticosa</i>	Fabaceae	Indigo	Shrub	A
<i>Kalanchoe tubiflora</i>	Crassulaceae	Chandelier plant	Herb	A
<i>Lantana camara</i>	Verbenaceae	Lantana	Shrub	A
<i>Neonotonia wightii</i>	Fabaceae	Glycine	Herb	A
<i>Opuntia ficus-indica</i>	Cactaceae	Panini	Shrub	A

Table 2g. Waikoloa Dry Forest Preserve Dip Tank Site Plant Species List

Scientific Name	Family	Common Name	Life Form	Status
<i>Cenchrus setaceus</i>	Poaceae	Fountain grass	Herb	A

A=Alien E=Endemic I Indigenous END Federal and State Listed Endangered



Vicinity Map

LEGEND

- Dip Tank Location
- Fuel Break

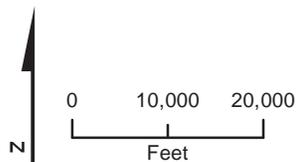
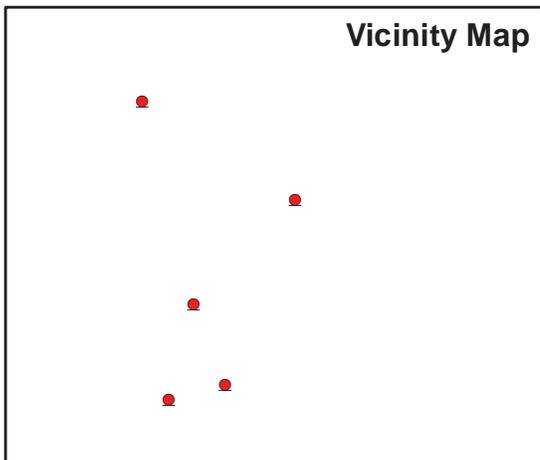


FIGURE 1

Project Location
 FEMA HMGP Diptank and
 Fuel Break Project, Hawaii



LEGEND

 Fuel Break

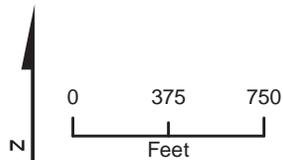
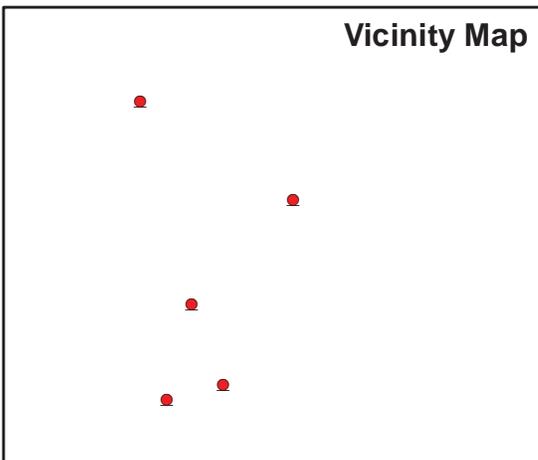


FIGURE 2

Waikoloa Fuel Break
 FEMA HMGP Diptank and
 Fuel Break Project, Hawaii



LEGEND

- Fuel Break (Eastern Portion)
- Fuel Break (Western Portion)

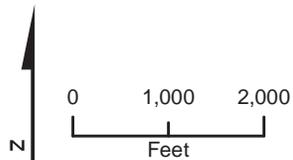
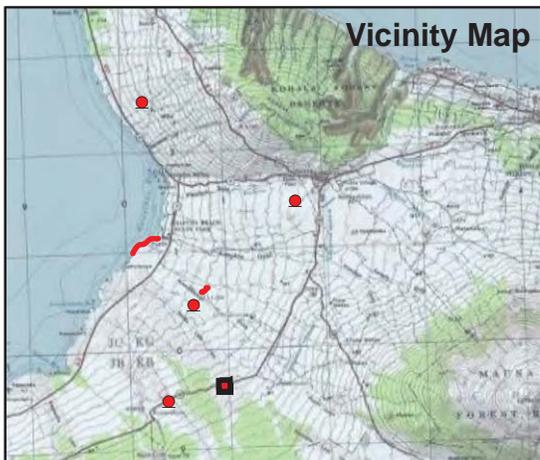
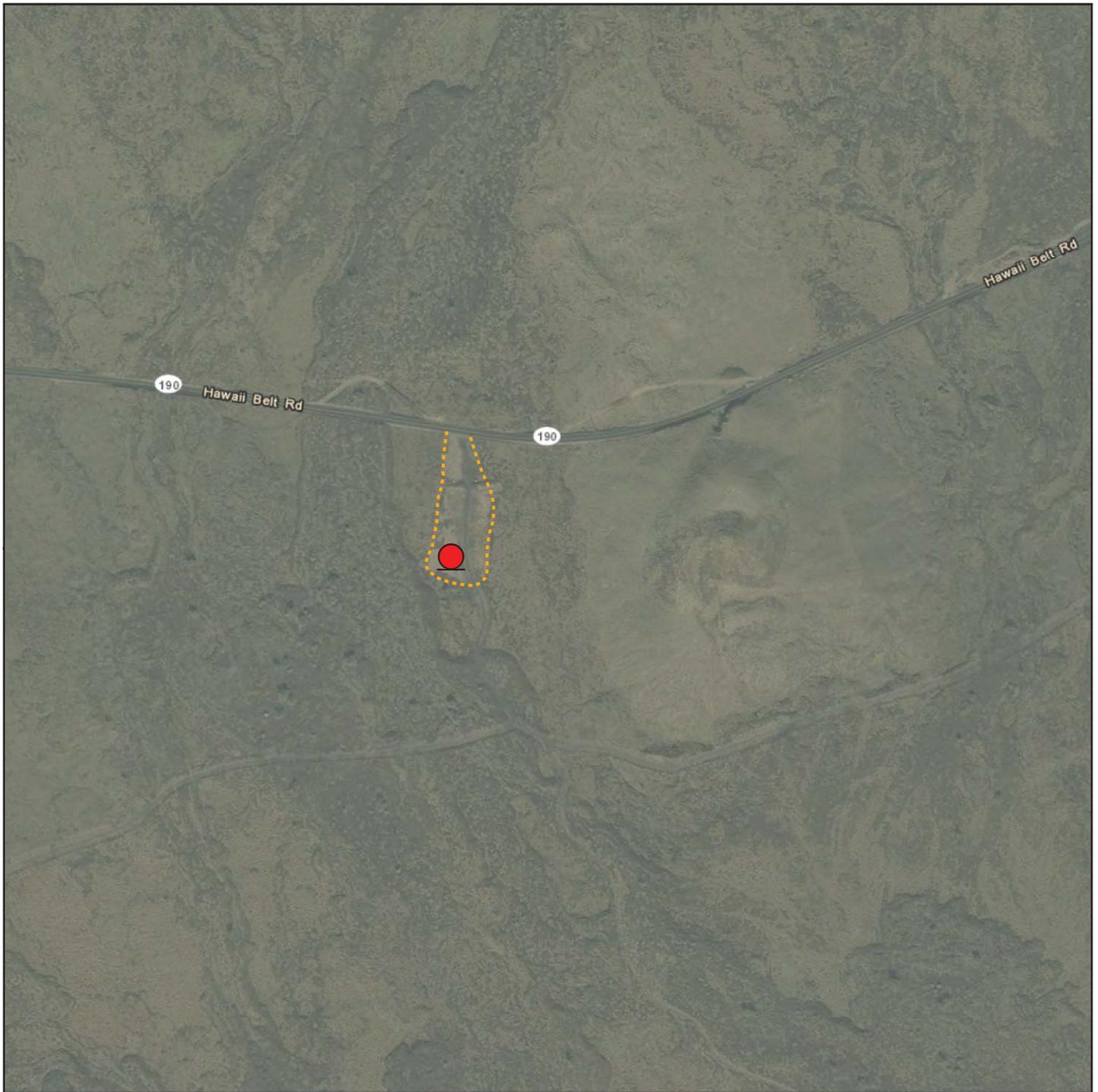
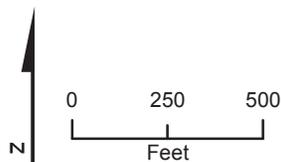


FIGURE 3
 Puako Fuel Break
 FEMA HMGP Diptank and
 Fuel Break Project, Hawaii



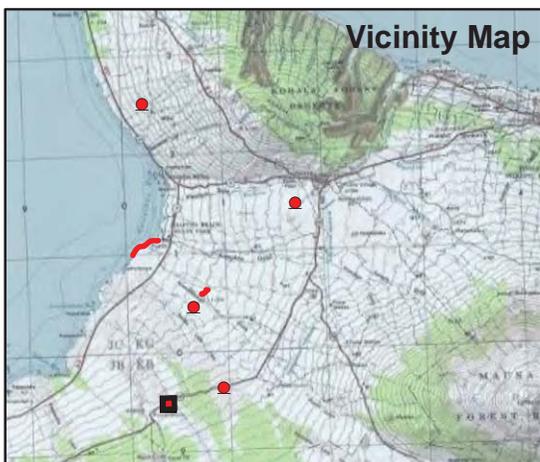
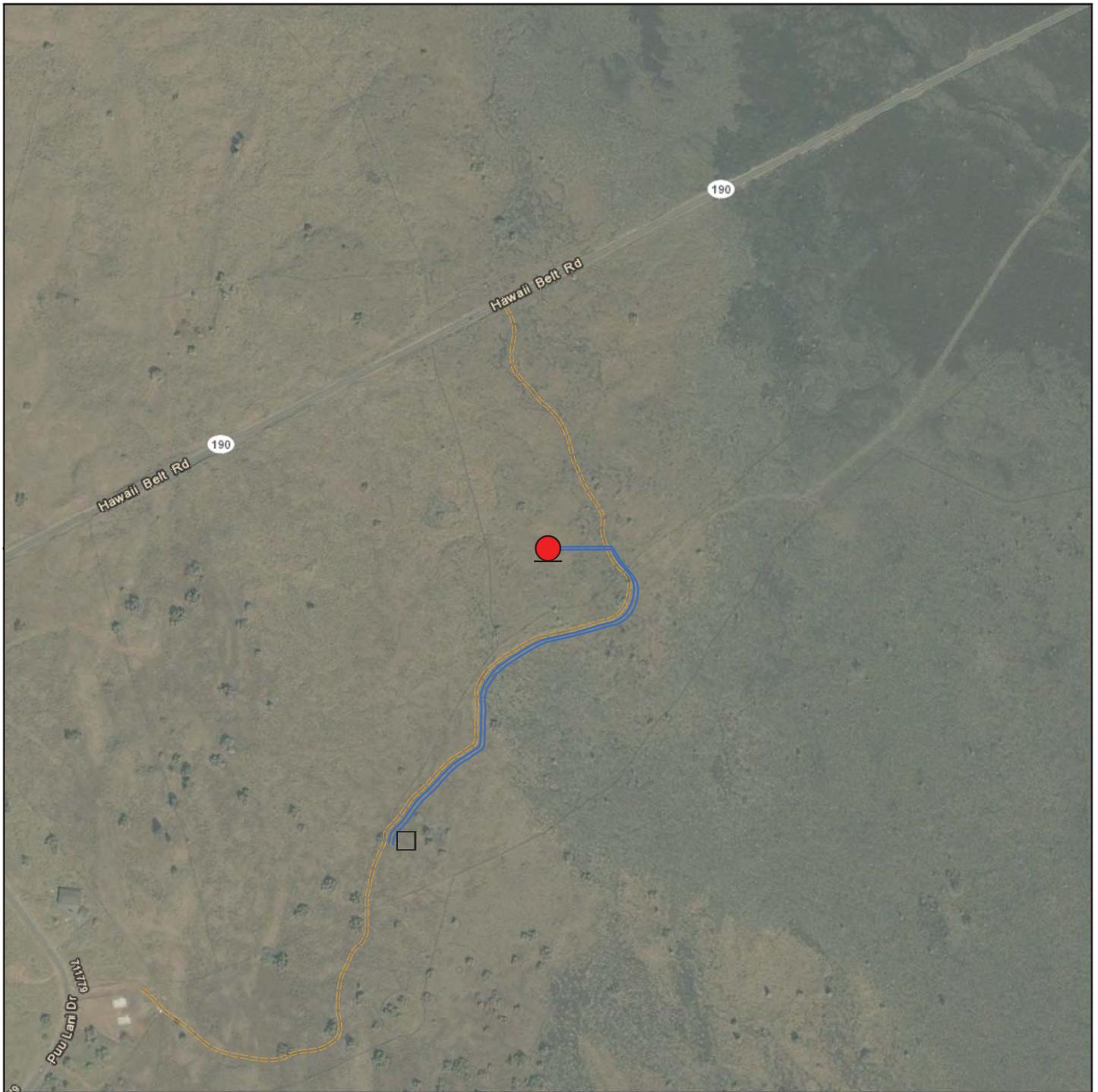
LEGEND

- Dip Tank
- - - Existing Staging Area



Note:
 Water to fill the dip tank will be delivered via a water truck; therefore, a new pipeline will not be installed at the site.

FIGURE 4
 Kuainiho Dip Tank
 FEMA HMGP Diptank and
 Fuel Break Project, Hawaii



LEGEND

-  Dip Tank
-  Existing Access Road
-  Existing Water Source for Filling Dip Tank
-  Corridor for Pipeline (along existing access road)
(1-2" Diameter HDPE)

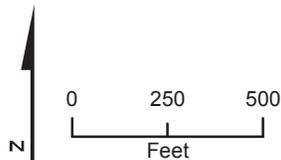
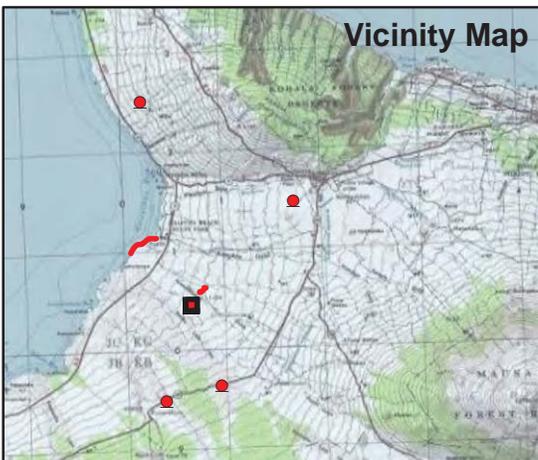


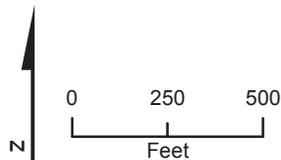
FIGURE 5

1859 Flow Dip Tank
 FEMA HMGP Diptank and
 Fuel Break Project, Hawaii



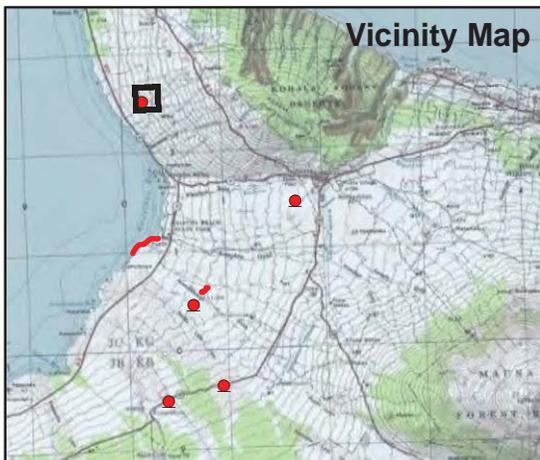
LEGEND

-  Dip Tank
-  Existing Access Road



Note:
Water to fill the dip tank will be delivered via an existing water line; therefore, a new pipeline will not be installed at the site.

FIGURE 6
Waikoloa Dip Tank
FEMA HMGP Dip Tank and
Fuel Break Project, Hawaii



LEGEND

-  Dip Tank
-  Existing Access Road
-  Existing Water Source for Filling Dip Tank
-  Corridor for Pipeline (1-2" Diameter HDPE)

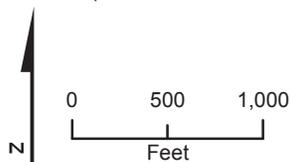
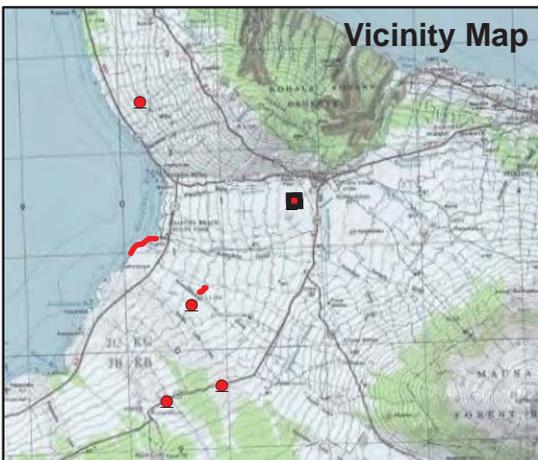


FIGURE 7

Ponoholo Dip Tank
 FEMA HMGP Driptank and
 Fuel Break Project, Hawaii



LEGEND

-  Dip Tank
-  Existing Access Road
-  Corridor for Pipeline (1-2" Diameter HDPE)

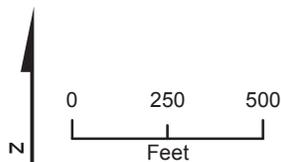
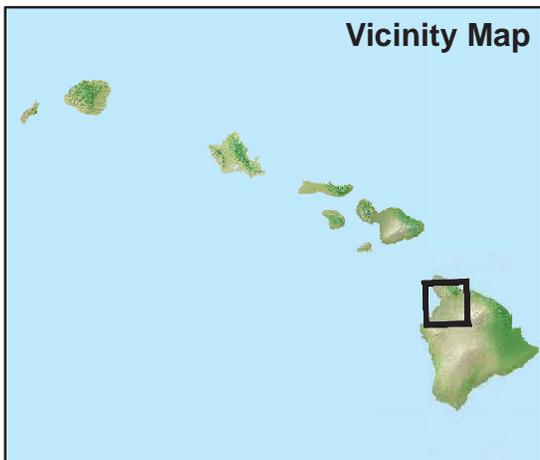


FIGURE 8

Lalamilo Dip Tank
 FEMA HMGP Diptank and
 Fuel Break Project, Hawaii



LEGEND

- Dip Tank
- Fuel Break
- Critical Habitat Unit 32

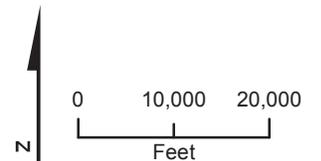


FIGURE 9

Critical Habitat Unit 32
 FEMA HMGP Diptank and
 Fuel Break Project, Hawaii

Figure 10a. Area Burned by Range Fire



Figure 10b. Goats Managing Fuel and Removing Native Species



Figure 10c. Low Elevation Vegetation at Puako Firebreak



Figure 10d. Uhiuhi at Waikoloa Dry Forest Preserve



Figure 10e. *N. glauca* Within Pushpile of Dead kiawe at Puako Firebreak

