Appendix E

Botanical Surveys

BOTANICAL SURVEY OF HONUAʻULA (WAILEA 670), KĪHEI, MAUI

PREPARED FOR

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1.0 INTRODUCTION

1.1 Objectives

SWCA Environmental Consultants (SWCA) was tasked to conduct a botanical survey within the 271 ha (670 ac) Honua'ula (Wailea 670) Property (hereinafter referred to as the 'Property') in Kīhei, Maui. The objectives of the survey were to: 1) describe the vegetation on the Property; 2) document all the plant species found on the Property; and 3) identify and map the location(s) of native plants. This report documents the results of the botanical survey, offers conservation management recommendations, and provides mitigation alternatives to address the Phase I project district zoning conditions promulgated by the Maui County Council. The survey also supports the Environmental Impact Statement (EIS) being prepared for the project by PBR Hawaii, Inc. in accordance with Chapter 343 Hawaii Revised Statutes (HRS). A companion document addressing wildlife and plant-related wildlife issues was prepared by SWCA and is submitted under separate cover (SWCA 2009a). Further documentation will detail the conservation and stewardship plan for the Native Plant Preservation Area and an animal management plan as required by the Maui County Council (SWCA 2009b).

Botanical surveys conducted in support of EIS and environmental assessments (EA) under HRS Chapter 343 are typically qualitative descriptions of vegetation and lists of species observed during brief pedestrian surveys. They are characteristically limited to a single survey rather than repeated seasonal assessments, and rarely the result of rigorous, quantitative research. In the past, greater emphasis was placed upon individual species than the ecosystems in which they occurred. To better address concerns raised by the Maui County Council and members of the public over the presence of native plants within the southern portion of the Property, SWCA set out to conduct a thorough quantitative assessment of site vegetation in order to obtain the best possible understanding of vegetation types and plant species present within the Property.

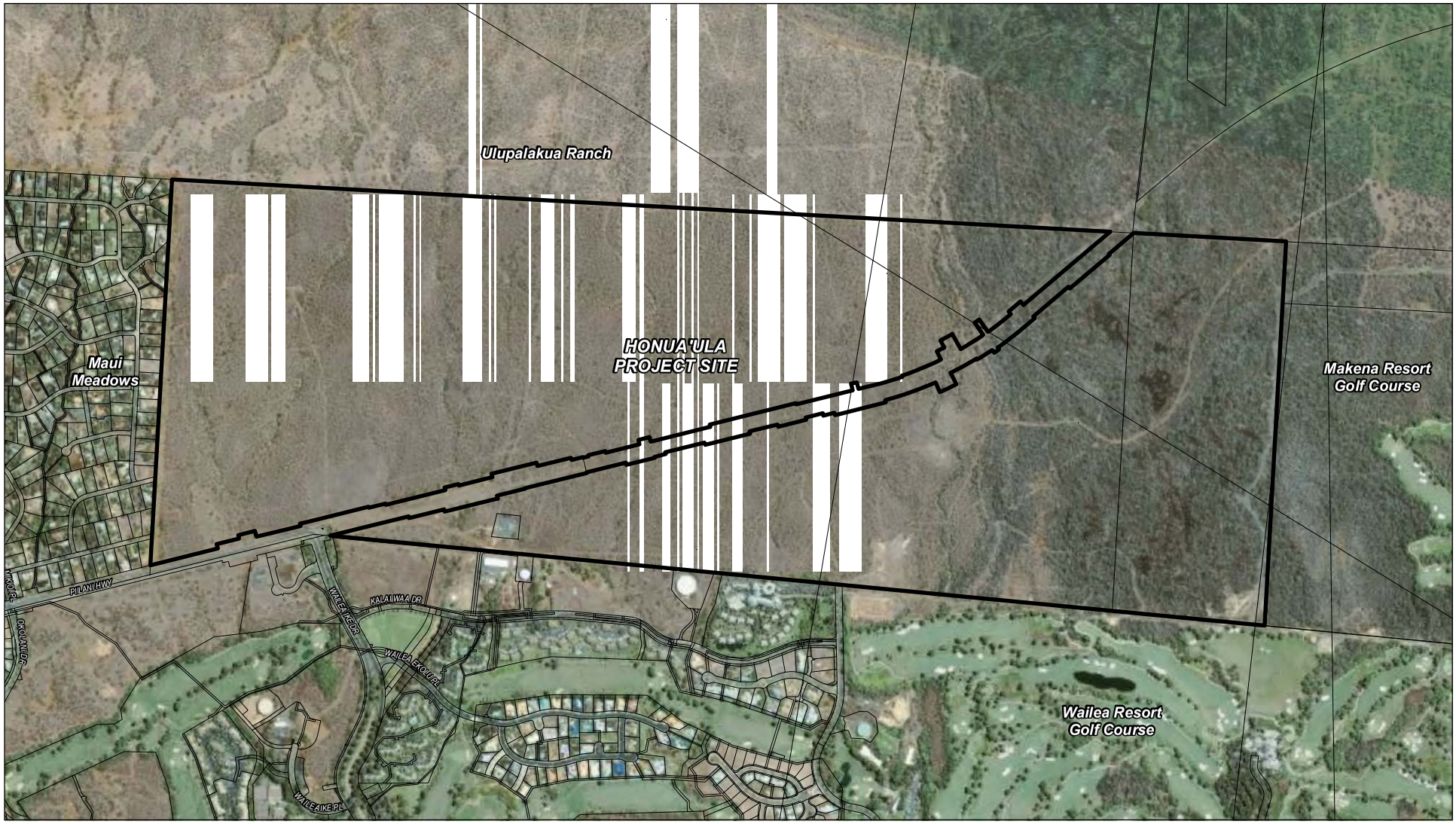
1.2 Project Summary

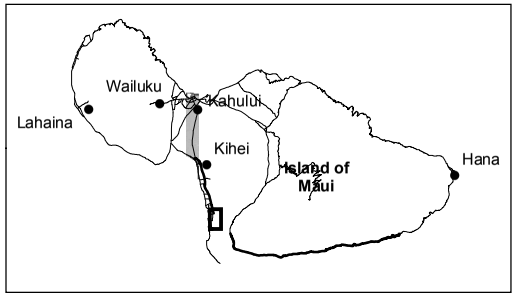
Honua'ula is a planned mixed-residential community encompassing a rectangular area of 271 ha (670 ac) east of, and adjacent to, the existing Wailea Resort in Kīhei, Maui. It is bounded by the Maui Meadows subdivision to the north, the Makena golf course to the south, the Wailea golf course to the west, and the 'Ulupalakua Ranch to the east (Figure 1). An EIS was first published for the development (then known as Wailea 670) in 1988 (PBR Hawaii 1988). Project district zoning was approved for the entire 271 ha in 1993, and approximately 170 ha (420 ac) was approved for golf course development and accessory uses. The following year, the State Land Use Commission issued a decision and order on urban land use designation. Since 1988, the project has had several owners.

After six years of project revisions by the present owner to accommodate community concerns, the Maui County Council approved Phase I conditional Project District Zoning for 271 ha allowing for residential, limited commercial, golf course, and open space zoning. With this approval, the Maui County Council issued several conditions regarding the conservation of natural resources. Their conditions included the creation of a Native Plant Preservation Area and stewardship plan for the propagation of native dry land forest plants within the Property. The conservation and stewardship plan (SWCA 2009b) incorporates findings, conclusions, and recommendations of this report and a sister report prepared by SWCA on the wildlife resources of the Property.

1.3 Physical Setting

Approximately 200 ha (495 ac) of land in the northern three-quarters of the Honua'ula Property within the Paeahu ahupua'a consists of older lava flows of the Kula Volcanic Series (Figure 2). Older Kula lavas range in age from 140,000 to 950,000 years old, while younger Kula lavas in the central portion of the parcel may be between 13,000 and 30,000 years old (USGS). Weathering of lavas led to the formation of a thin layer of soil over the northern portion. About 70 ha (173 ac) of younger Hana Volcanic Series flows within the Palauea ahupua'a make up the southern quarter of the Property. The southern lava flows are estimated to be between 5,000 and 13,000 years old (Figure 2) and have not undergone extensive weathering.





Legend

Honua'ula Project Boundary

TMK Parcels

Aerial Source: Microsoft 2009
Boundary and Parcel Source: PBR Hawaii

Figure 1
Aerial Photograph

0 250 500 1,000 ft

0 50 100 200 M

N

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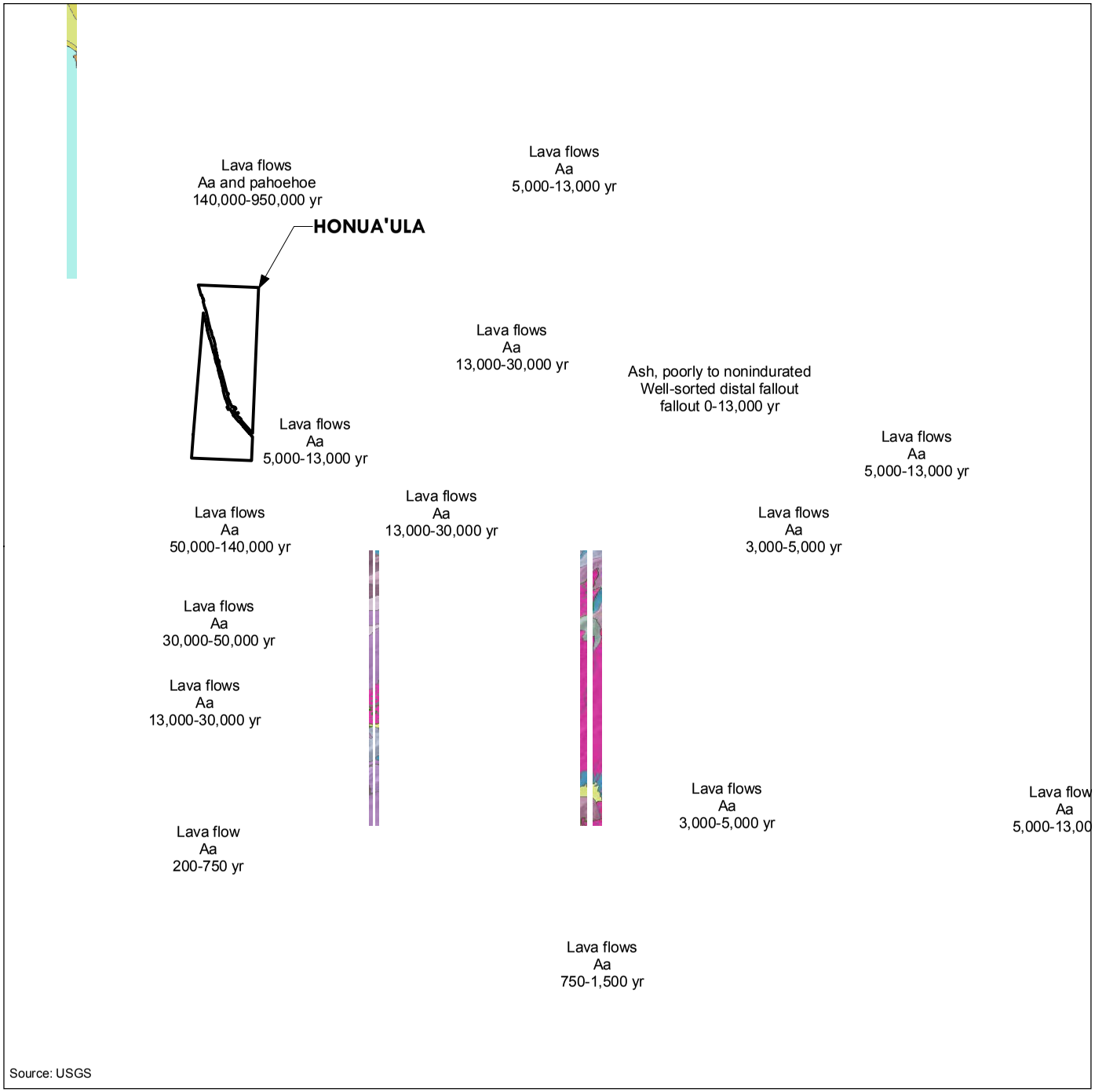

Source: USGS

Legend

Project Boundary

Geology

- Qa, Alluvium
- Qbd, Beach deposits
- Qdy, Younger dune deposits
- Qhn, Hana Volcanics
- Qhn0, Hana Volcanics
- Qhn1, Hana Volcanics
- Qhn2, Hana Volcanics
- Qhn2v, Hana Volcanics
- Qhn3, Hana Volcanics
- Qhn6, Hana Volcanics
- Qhne, Hana Volcanics
- Qhnt, Hana Volcanics
- Qhnv0, Hana Volcanics
- Qhnv1, Hana Volcanics
- Qhnv2, Hana Volcanics
- Qhnv3, Hana Volcanics
- Qhnv4, Hana Volcanics
- Qhnv5, Hana Volcanics
- Qhnv6, Hana Volcanics
- Qkui, Kula Volcanics
- Qkul, Kula Volcanics
- Qkul?, Kula Volcanics
- Qkuls, Kula Volcanics
- Qkuv, Kula Volcanics
- Qkuv?, Kula Volcanics
- Qls, Landslide deposits
- Qtc, Talus and colluvium

N

0 0.5 1 2 Km

0 0.5 1 2 Mi

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Figure 2
Geology Map

This area is characterized by an extremely rough surface composed of broken 'a'ā lava blocks called clinker with little or no soil accumulation (PBR Hawaii 1988). The terrain slopes gently at about 12% in an east to west direction across the Property. Steeply sloping ridges and gulches dissect the parcel, particularly in the north. The soils and lavas covering the Property, and the drainage gulches that run across the land, strongly influence the nature of the vegetation that grows there.

1.4 Literature Review

At one time, Rock (1913) suggested that lowland dry and mesic forests in Hawai'i had more native tree species than any other area in the state. Since then, however, native lowland dry forests have been degraded by non-native herbivores and invaded by alien shrubs and grasses (Wagner, et al. 1999). True native dry forests are acknowledged to be the rarest native plant community within the main Hawaiian Islands (Bruegmann 1996) and the nation (Noss and Peters 1995). Bruegmann (1996) estimated that over 90 percent of Hawai'i's native dry forest habitats have been severely fragmented and degraded. Williams (1990) and Cabin et al. (2000a, 2000b) summarized the causative factors of this loss citing pre-contact fire and deforestation, non-native ungulate grazing, alien species invasions, and conversion of forests for agricultural, urban, and military uses.

During the Second World War, the military used lands in Kīhei for training and maneuvers (P. Erdman, Ulupalakua Ranch, pers. comm.). Activities within and adjacent to the Property included a Navy Underwater Demolition Team (UDT) training base at Kamaole, an Army camp at Makena, and amphibious assault training exercises by the Marine Corps. Jeep roads were bulldozed inland and cross-country movement by armored vehicles and troops were conducted. Following 1945, the area was returned to open pasture. Periodic bulldozing of the highway easement connecting Kīhei to 'Ulupalakua by the State of Hawai'i, grazing pressure from axis deer (*Axis axis*) and feral goats (*Capra hircus*), and unauthorized *kiawe* (*Prosopis pallida*) logging have caused further disturbance to the area.

Char and Linney (1988) conducted the first botanical survey within the Property area. They observed 132 plant species in three distinct vegetation types: *kiawe* (*Prosopis pallida*)/buffelgrass (*Cenchrus ciliaris*) pasturelands, gully vegetation, and scrub vegetation. Twenty-one of the 132 plant species they observed are native to Hawai'i. The remaining 111 are non-native species. They found no threatened or endangered plant species within the Property. However, they identified one candidate species, *'āwikiwiki* (*Canavalia pubescens*), and several uncommon native species on the site including *nehe* (*Lipochaeta rockii*), *'ānunu* vine (*Sicyos hispidus*), *maiapilo* (*Capparis sandwichiana*), and *kolomona* (*Senna gaudichaudii*). Char and Linney (1988) recommended that a small area in the southwestern corner of the Property where they found *'āwikiwiki* (*C. pubescens*) and representatives of other uncommon native plants be left intact. However, sometime prior to 1996, unknown persons bulldozed the area and the plants were lost.

The *nehe* plants (*Lipochaeta rockii*) reported from the Property have a distinct leaf shape (A.C. Medeiros, USGS, pers. comm.); however, the current Manual of Flowering Plants of Hawaii (Wagner et al. 1999) did not find sufficient scientific evidence to recognize it as a distinct variety or subspecies. Herbst (Bishop Museum, pers. comm.) suggested that it might easily hybridize with other plants of the same species.

Recently, Altenberg (2007) drew attention to the southern portion of the Property which he claimed to be among the best examples of a remnant native lowland dry forest remaining on Maui. He suggested that Honua'ula "contains most of the 3rd largest contiguous area of *wiliwili* (*Erythrina sandwicensis*) habitat on Maui, approximately 110 acres in the southern 1/6 of the property" (Altenberg 2007). Altenberg recommended that an area of approximately 45 ha (110 ac) be preserved for its ecological significance. He found 20 native plant species (including 12 endemic species) concentrated in the southern one third of the Property. Four of the native species he observed - *pua kala* (*Argemone glauca*), *alena* (*Boerhavia herbstii*), *'akoko* (*Chamaecyse celastroides* var*. lorifolia*), and *'ānunu* (*Sicyos pachycarpus*) - had not been reported by Char and Linney (1988) or Char (1993, 2004). Char and Linney (1988) and Char (1993, 2004) reported five species within the Property that were not found by Altenberg (2007): maidenhair fern (*Adiantum capillus-veneris*), *pellaea* (*Pellaea ternifolia*), *kakonakona* (*Panicum torridum*), *Solanum americanum* (*popolo*) and *alena* (*Boerhavia repens*).

Gagne and Cuddihy (1999) noted that native dry forest communities occur on all of the main islands at 300-1,500 m (984-4,921 ft) in elevation, especially on leeward aspects or in the rain shadows of mountains. Precipitation is between 500-2,000 mm (17-79 in) annually, and is usually concentrated between November and March. Gagne and Cuddihy (1999) noted that lowland dry forests usually "grade into lowland dry grasslands or shrub lands below 300 m elevation…" The semi-arid Honua'ula Property lies between 90-245 m (295-804 ft) elevation, and is estimated to receive about 300 mm (12 in) of precipitation annually. Hence, the southern portion of the Property may be described more accurately as a highly disturbed, remnant native coastal dry shrubland (sensu Gagne and Cuddihy 1999) in which *wiliwili* (*Erythrina sandwicensis*) has become a common inhabitant. Medeiros (USGS, pers. comm.) suggested that mature *wiliwili* (*Erythrina sandwicensis*) trees may be found throughout southeastern Maui, often in abundance and greater densities than those encountered in the Property. Altenberg (2007) identified eight *wiliwili* (*E. sandwicensis*) forests in southeast Maui including Kanaio, Pu'u o Kali, Honua'ula / Wailea 670, Makena, La Perouse, Kaupo, Lualailua, and Waikapu.

The recent US Geological Survey GAP Analysis Program (Figure 3) maps classified landcover within the Property as largely "XT: open kiawe forest and shrubland (alien grasses)", "Y: uncharacterized open-sparse vegetation", with small patches of "XG: alien grassland" and "XT: alien forest". Price et al. (2007) recently developed methods using bioclimatic data to map habitat quality for and range of two widespread plant species including *wiliwili* (*Erythrina sandwicensis*) and two rare plant species throughout the Hawaiian Islands. The area encompassed by the Property appears on these maps as 'medium' to 'low' habitat quality for *wiliwili* (*E. sandwicensis*) (Price et al. 2007). However, numerous areas in southeastern Maui located between Pu'u Ola'i and Kaupo outside the Property did appear as having 'high' habitat characteristics on the maps prepared by Price et al (2007).

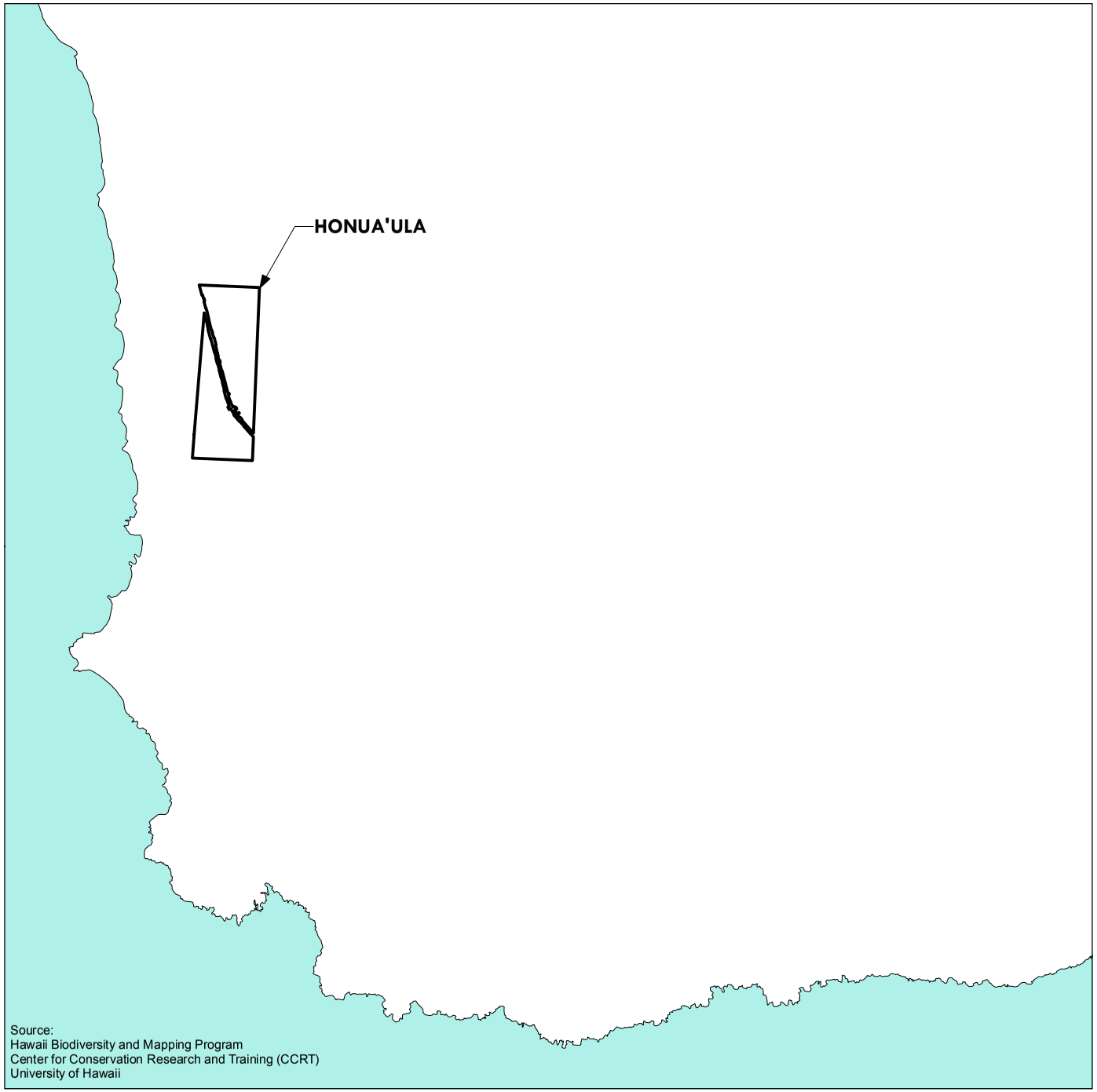
2.0 METHODS

Spatially explicit information on the composition and structure of plant communities within the Property is needed to meet the survey objectives, especially if data are to be used to make conservation, management and long-term monitoring and ecological research recommendations for the Property. However, the relatively small Property and the nature of the understory vegetation prevent the effective application of remote sensing technologies typically used in vegetation mapping. Therefore, SWCA botanists developed a sampling method to meet all three study objectives. High resolution field sampling techniques were designed based upon previous reconnaissance surveys conducted by SWCA, cooperating government, and other scientists on March 6-8, 13-15, 24-26, 2006; January 4-5, February 24-26, and October 18, 2007.

2.1 Field Surveys

A modified one-dimensional line transect method of plot-less sampling (Barbour et al. 1987) was employed by SWCA botanists across the entire Property. Linear transects were established at regular 20 m (65.6 ft) intervals across the remnant mixed *kiawe-wiliwili* shrubland in the southern portion of the Property, and at regular 50 m (164 ft) intervals across the entire northern portion of the Property (Figure 4). Transects in the northern portion of the Property were placed 50 m apart because, compared to the southern rugged 'a'ā lava flow with scrub vegetation, the northern 200 ha (495 acres) of Property is open pastureland and is known to harbor fewer native plant species (Char and Linney, 1988 and Altenberg 2007). The advantages of plot-less sampling are: 1) a sample plot does not need to be established, saving time; and 2) elimination of subjective error associated with the sample plot boundaries. This method also allowed us to sweep the entire project site to record more native plants than would have been found through sample plots and/or quadrats.

Transects were pre-established on an 800 × 1200 m (0.5 × 0.75 mi) map-overlay with ARC GIS software developed by Environmental Science Research Insititute (ESRI), and pre-loaded into Trimble GeoXT (Pocket PC) Global Positioning System (GPS) units with Terrasync 2.4 GPS software. Field surveys for this study were conducted within the southern 70 ha (173 acres) of scrub vegetation on March 8-10, 2008 and March 29-31, 2008, by botanists Shahin Ansari, Ph.D., Maya LeGrande, M.S., Ane Bakutis, M.S., Hina Kneuble, M.S., Talia Portner, B.S., Tiffany Thair, (M.S. candidate), and GIS Analyst Ryan Taira, B.A.



Legend

Project Boundary

Landcover

- NG: Deschampsia Grassland
- NS: Bog Vegetation
- NS: Native Dry Cliff Vegetation
- NS: Native Shrubland (alien grasses)
- NS: Native Shrubland / Sparse Ohia (native shrubs)
- NS: Native Wet Cliff Vegetation
- NS: Uluhe Shrubland
- NT: Closed Hala Forest
- NT: Closed Koa-Ohia Forest (native shrubs)
- NT: Closed Koa-Ohia Forest (uluhe)
- NT: Closed Ohia Forest (native shrubs)
- NT: Closed Ohia Forest (uluhe)
- NT: Ohia Forest (native shrubs and uluhe)
- NT: Open Koa-Ohia Forest (native shrubs)
- NT: Open Ohia Forest (native shrubs)
- NT: Open Ohia Forest (uluhe)
- Undefined
- W: Water
- X Agriculture
- X: High Intensity Developed
- X: Low Intensity Developed
- XG: Alien Grassland
- XG: Kikuyu Grass Grassland / Pasture
- XS: Alien Shrubland
- XS: Alien Shrubs and Grasses
- XT: Alien Forest
- XT: Closed Kiawe - Koa Haole Forest and Shrubland
- XT: Kiawe Forest and Shrubland
- XT: Open Kiawe Forest and Shrubland (alien grasses)
- Y: Uncharacterized Forest
- Y: Uncharacterized Open-Sparse Vegetation
- Y: Uncharacterized Shrubland
- Z: Very Sparse Vegetation to Unvegetated

N

0 0.5 1 2 Km

0 0.5 1 2 Mi

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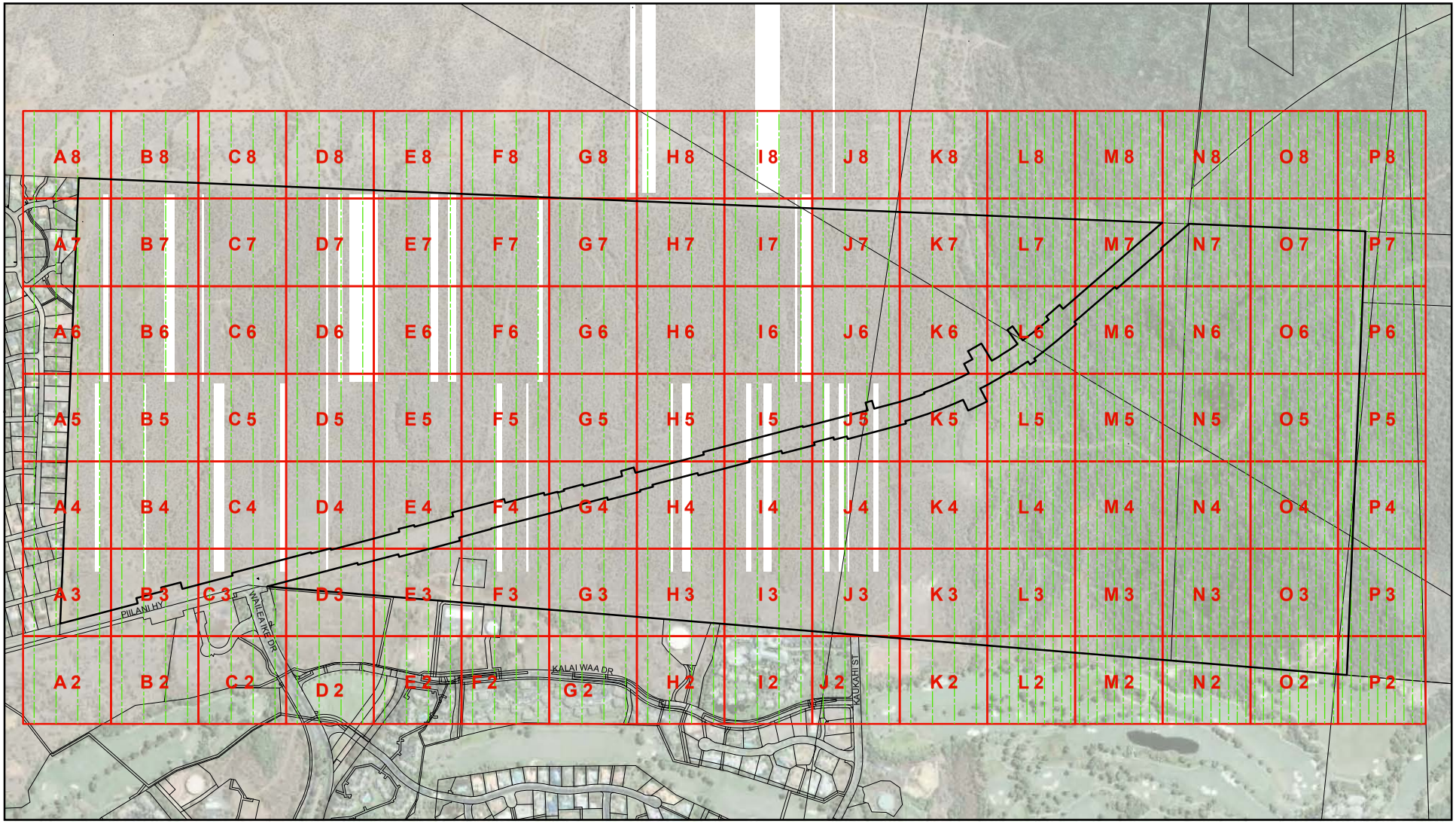
Figure 3
HI-GAP Landcover



Legend

- Transects
- Parcels
- Project Boundary
- 200 Meter Grid

Figure 4
Grid and Transects Map

0 250 500 1,000 ft

0 50 100 200 M

Parcel and Boundary Source: PBR Hawaii

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The northern portion of the Property was surveyed by the team on May 27- 29, 2008. Three two-person teams concurrently walked abreast along adjacent transects. Each team was responsible for locating and mapping native plants 10 m (33 ft) on either side of each transect. At each plant feature, 10 to 15 data points were collected and averaged to produce a single GPS point. GPS data was collected along transects using Wide Area Augmentation System (WAAS) for real time differential GPS (DGPS). At the end of each transect, the botanists moved to adjacent transects to continue their search until all transects were surveyed. Mapping was conducted at an approximate rate of 0.4 km/ hr (0.25 miles/ hr). Surveys commenced at the southeastern corner of the Property (grid P8) and proceeded to the south-west corner (grid P2; Figure 4). The entire length of each transect was surveyed, totaling 78,500 m (48.7 mi) across the Property.

A single GPS point was collected at the center of each discrete patch of vines, herbaceous and small shrub species. Herbs, shrubs, and vines less than 15 cm (6 inch) tall that were not flowering or fruiting were considered seedlings. For each patch, the botanists documented the phenology, number of individuals (seedlings and adults), aerial diameter of the patch (m), presence/ absence of signs of herbivory (such as chewed leaves or stems, scraping of the leaf surface), damage (broken off branches) and/or disease (wilting, yellowing of the whole or part of the plant). If patches were very large (> 5 m² or 54 ft²), a GPS point was collected every 5 m^2. Where multiple *wiliwili* trees (*E. sandwicensis*) were found with overlapping canopies, a single GPS point was collected at the approximate center of the grove of trees. Botanists also noted the aerial canopy diameter and the number of seedlings/ juveniles and adult plants within a grove. Large tree species with trunks less than 15 cm (6 inch) in diameter were regarded as juveniles.

Hoary abutilon (*Abutilon incanum), koali awahia* (*Ipomoea indica*)*, 'ilima (Sida fallax), popolo* (*Solanum americanum*), *'ilie'e* (*Plumbago zeylanica*), *alena* (*Boerhavia* spp.), and *'uhaloa* (*Waltheria indica*) were abundant and widespread indigenous (versus endemic) species common throughout the southern 'a'ā lava flow. Therefore, individuals of these species were not mapped. This is consistent with the methods of Altenberg (2007).

2.2 Mapping and Data Analysis

GPS field data was post-processed with GPS Pathfinder Office software and used to differentially correct to a Continuously Operating Reference Station (CORS). Most features were accurate to sub-meter precision. Data was exported in ESRI ArcGIS to shape file format in NAD 83 (Cors 96) UTM Zone 4 meters using WGS 84 to NAD 83_4 transformation. ESRI ArcView 9.2 software was used for digital mapping.

To better visualize the distribution of native plant species, a graduated circle map was created showing the distribution of all species based on the number of plants mapped at each location (GPS point). Circles of different color represent different species, the size of the circle reflects the number of individuals mapped at each location and assigned to one of six count classes; 1-5, 6-10, 11-15, 16-25, 26-60, and 61-110 individuals. While the graduated circle map is informative, a more effective way to find the greatest concentration of the native plant resources is to map the densities of each species.

Vegetation density maps were created using kernel density which is based on the quadratic kernel function described in Silverman (1986). The 26 native species known to occur in the Property were arranged in order of their relative importance by the project botanists and only the top eight endemic and indigenous plant species that are uncommon within the Property and elsewhere in the State were included in the GIS density analysis (Table 1). Density of these selected eight native plant species was evaluated as a means of identifying suitable boundaries for a Native Plant Preservation Area within a portion of the Property based upon their greatest concentration.

Using the ArcView GIS Spatial Analyst extension, SWCA converted species count classes of the eight species to density (number of species/acre) classes. These resulting density maps allow comparison of native plants on the same spatial scale. However, density maps for these species varied greatly from 0-57 plants per acre for *wiliwili* (*Erythrina sandwicensis*) to 0-1 plant per acre for *'āwikiwiki* (*Canavalia pubescens*). Therefore, the maps were further standardized by reclassifying the densities for the species to a common scale where nine (9) represented the highest density for each species and one (1) represented lowest. The reclassified density maps

were then overlaid with a percent weight assigned to each. Each species was assigned a different weight by the project botanists based on their relative botanical importance throughout the State and Property (Table 2). The density maps and the overlay analysis were developed using 100 m (328 ft) resolution to define specific and contiguous preservation areas that protect the greatest concentration of rare native plant species within the Property.

Table 1. Native plants reported from the Property arranged in order of their relative importance by project botanists. *Group 1 = endemic (E) and indigenous (I) plants uncommon within the Property as well as elsewhere in the State, and/or of significance to life stages of the endangered Blackburn sphinx moth (Manduca blackburni); Group 2 = relatively common endemic species throughout Hawai'i, Group 3 = relatively common native (indigenous) species throughout Hawai'i.*

Species	Status	Hawaiian Name	Family
GROUP 1			
Lipochaeta rockii	E	*nehe*	Asteraceae
Canavalia pubescens	E	*paunu*	Fabaceae
Erythrina sandwicensis	E	*wiliwili*	Fabaceae
Capparis sandwichiana	E	*maiapilo*	Capparaceae
Senna gaudichaudii	I	*kolomona*	Fabaceae
Sicyos hispidus	E	*'ānunu*	Cucurbitaceae
Sicyos pachycarpus	E	*'ānunu*	Cucurbitaceae
Chamaesyce celastroides var. *lorifolia**	E	*'akoko*	Euphorbiaceae
Argemone glauca	E	*pua kala*	Papaveraceae
GROUP 2			
Myoporum sandwicense	E	*naio*	Myoporaceae
Panicum torridum	E	*kakonakona*	Poaceae
Heteropogon contortus	E	*pili*	Poaceae
Ipomoea tuboides	E	*ipomea*	Convolvulaceae
Boerhavia herbstii	E	*alena*	Nyctaginaceae
Doryopteris decipiens	E	*'iwa'iwa*	Adiantaceae
Plumbago zeylanica	E	*'ilie'e*	Plumbaginaceae
GROUP 3			
Dodonaea viscosa	I	*'a'ali'i*	Sapindaceae
Sida fallax	I	*'ilima*	Malvaceae
Boerhavia spp.**	I	*alena*	Nyctaginaceae
Abutilon incanum	I	hoary abutilon	Malvaceae
Ipomoea indica	I	*koali awahia*	Convolvulaceae
Waltheria indica	I	*'uhaloa*	Sterculiaceae
Pellaea ternifolia	I	*pellaea*	Adiantaceae
Adiantum capillus-veneris	I	maidenhair fern	Pteridaceae
Solanum americanum	I	*popolo*	Solanaceae

** A single stunted akoko was found within the Property in 2006; however, the plant was found to be dead in the late summer of 2007, and was not found at all during the 2008 surveys. Therefore, it is not considered in further plant density analysis for the purpose of defining boundaries of the native plant preserve.*
*** Two indigenous species of Boerhavia (repens and acutifolia) were reported within the Property during the SWCA surveys. Char and Linney (1988) and Char (1993, 2004) also found B. repens within the Property.*

2.3 Regional Assessment of *Wiliwili* Abundance

A low-altitude qualitative aerial survey of southeast Maui was conducted by biologists Robert Kinzie, Ph.D., John Ford, M.S., and GIS Analyst Ryan Taira, B.A. on July 11, 2008 to identify and photograph other areas where *wiliwili* (*Erythrina sandvicensis*) is common. During summer months, *wiliwili* (*E. sandwicensis*) trees drop their leaves and are easy to identify from the air. The aerial survey began at Kahului International Airport and extended along the Kīhei coast over undeveloped lands between 300-450 m (980-1500 ft) elevation toward the southeast to Lualailua, at altitudes ranging from 15-150 m (50-500 ft) above ground level (AGL).

Still photos and videos of *wiliwili* (*E. sandwicensis*) were collected with a SONY DCR-SR100 digital video camera with a Carl Zeiss® Vario-Sonnar® T lens. Still photos were also taken with a Pentax Optio W30 digital camera with a Pentax 6.3mm lens. *Wiliwili* (*E. sandwicensis*) trees within the Pu'u O Kali Preserve, Honua'ula, adjacent 'Ulupalakua Ranch and Makena Resort lands, Makena State Park, lands east of Pu'u Olai, Ahihi-Kinau, Kanaio, and Lualailua were photographed.

Table 2. Percent weight assigned for the eight species selected for density analysis; *based on their relative botanical importance throughout the State and the Honua'ula Project site.*

Species	Common Name	Percent Weight
Lipochaeta rockii (E)	*nehe*	16
Canavalia pubescens (E)	*paunu*	15
Erythrina sandwicensis (E)	*wiliwili*	14
Capparis sandwichiana (E)	*maiapilo*	13
Senna gaudichaudii (I)	*kolomona*	12
Sicyos hispidus (E)	*'ānunu*	11
Sicyos pachycarpus (E)	*'ānunu*	10
Argemone glauca (E)	*pua kala*	9

3.0 RESULTS

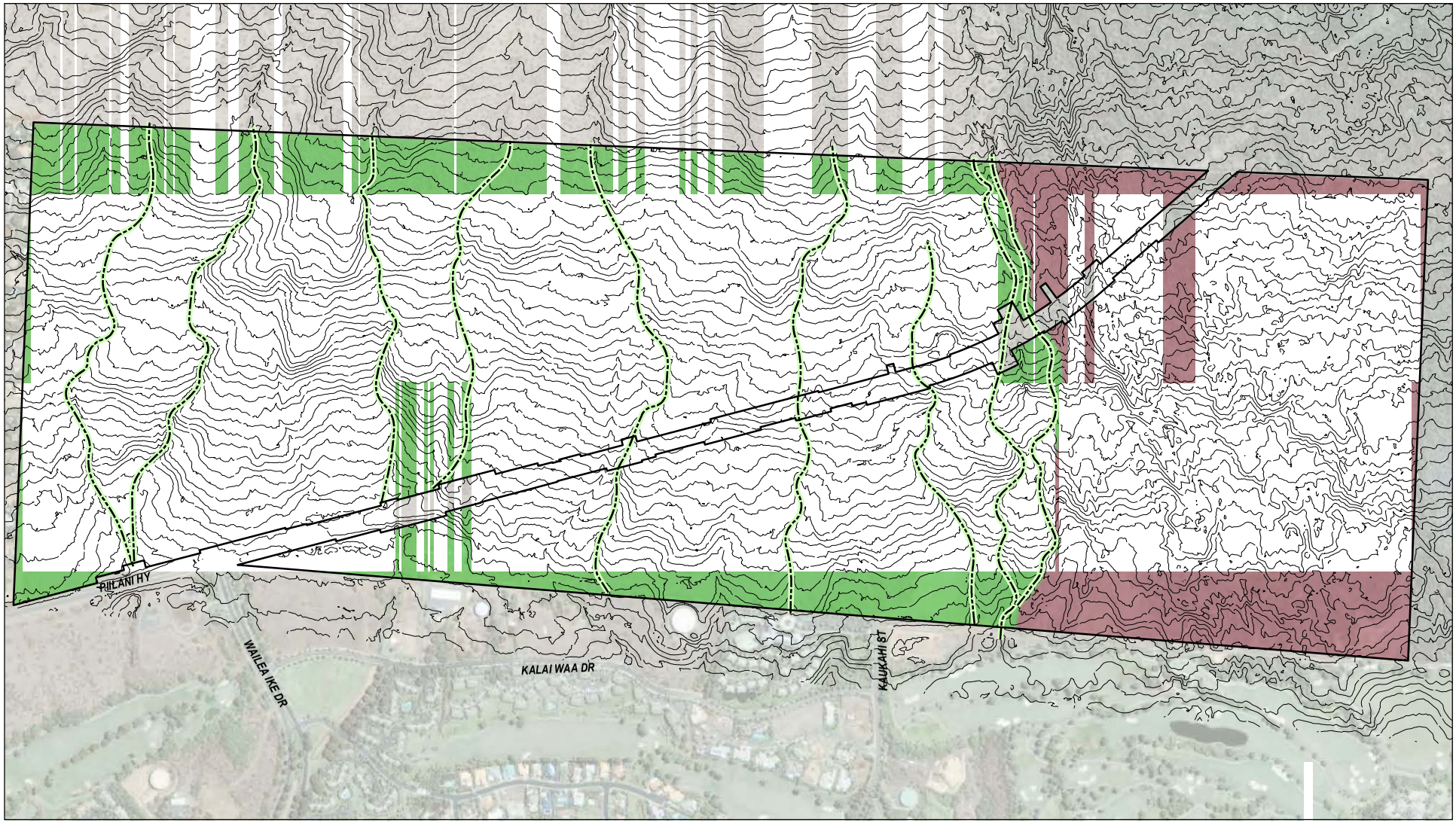
A complete list of all plants found within the site is provided in Appendix A. *Portulaca* sp. nov. was reported by Char and Linney (1988); however, it is not included in Appendix A because the species level was never determined and no known collections were made by Char and Linney (1988). All the native plant species described from the Property are known to occur elsewhere on Maui and the main Hawaiian Islands. Only the unique leaf form of Rock's *nehe* (*Lipochaeta rockii*) appears to be limited to the Property. Table 3 illustrates the occurrence of adult and seedling native plants within the Property.

Table 3. A comparison of the number of native plants and seedlings observed within the entire Honua'ula Property and the remnant mixed kiawe-wiliwili shrubland in the southern portion of the Property. *Prop = entire Honua'ula Property, KW = kiawe-wiliwili shrubland.*

Species (Hawaiian name)	Number of Points		Number of Seedlings		Number of Adults		Total Numbers Observed	
	KW	Prop	KW	Prop	KW	Prop	KW	Prop
Argemone glauca (pua kala)	26	26	247	247	165	165	412	412
Canavalia pubescens ('āwikiwiki)	5	5	0	0	5	5	5	5
Capparis sandwichiana (maiapilo)	311	312	14	14	548	549	562	563
Dodonea viscosa ('a'ali'i)	7	7	0	0	16	16	16	16
Doryopteris decipiens ('iwa'iwa)	2	14	0	2	7	52	7	54
Erythrina sandwicensis (wiliwili)	546	569	334	341	2105	2137	2439	2478
Heteropogon contortus (pili)	0	66	0	384	0	1109	0	1493
Ipomoea tuboides (ipomea)	5	5	0	0	5	5	5	5
Lipochaeta rockii (nehe)	24	24	56	56	45	45	101	101
Myoporum sandwicense (naio)	17	17	0	0	21	21	21	21
Senna gaudichaudii (kolomona)	28	32	1	5	36	38	37	43
Sicyos hispidus ('ānunu)	48	49	5	5	107	108	112	113
Sicyos pachycarpus ('ānunu)	101	102	313	313	289	290	602	603

3.1 Vegetation

Similar to the vegetation categories described by Char and Linney (1988), SWCA found three distinct vegetation types within the Property (see Figure 5). Each of these is described in the following paragraphs. Figure 6 illustrates the percent of introduced and native plants reported from each of the three predominant vegetation types.



Legend
- Project Boundary

Vegetation Types
- Kiawe-buffel Grass Grassland
- Kiawe-wiliwili Shrubland
- Gulch Vegetation

Figure 5
Vegetation Types

0 250 500 1,000 ft
0 50 100 200 M

Boundary Source: PBR Hawaii
Aerial Source: Microsoft 2009

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3.1.1 *Kiawe*-Buffelgrass Grassland

About 75% of the northern portion of the project parcel is characterized by an extensive grassland comprised primarily of *kiawe* (*Prosopis pallida*) *and* buffelgrass (*Cenchrus ciliaris*). There is scattered evidence that trespassers may be logging *kiawe* (*P. pallida*) trees for charcoal in this area. Guinea grass (*Urochloa maxima*), natal redtop (*Rhynchelytrum repens*), and sour grass (*Digitaria insularis*) are also scattered throughout the northern portion of the Property. Other plants found here include the invasive *koa haole* (*Leucaena leucocephala*), lantana (*Lantana camara*), partridge pea (*Chamaecrista nictitans*) and cow pea (*Macroptilium lathyroides*).

The area has been disturbed throughout by numerous jeep trails and unrestricted grazing by axis deer. Some open areas that appeared to be heavily grazed were devoid of buffelgrass (*Cenchrus ciliaris*), but contained the native shrubs *‘ilima* (*Sida fallax*) and hoary abutilon (*Abutilon incanum*), and the introduced golden crown beard (*Verbesina encelioides*).

3.1.2 Gulch Vegetation

The vast expanse of *kiawe*-buffelgrass in the northern three quarters of the Property is bisected from east to west by several gulches that carry flood waters to the sea (Figure 5). These intermittent gulches vary in depth and are characterized by patches of exposed bedrock. The gulches are shaded by their steep walls providing relatively cool and moist conditions. Three species of ferns including maidenhair fern (*Adiantum capillus-veneris*), sword fern (*Nephrolepis multiflora*), and the endemic *‘iwa‘iwa* fern (*Doryopteris decipiens*) were found in the shaded rocky outcrops and crevices within the gulches. Native *Pili* grass (*Heteropogon contortus*) was found in more open and sunny locations. Other species found within the gulches include tree tobacco (*Nicotiana glauca*), *wiliwili* (*Erythrina sandwicensis*), lantana (*Lantana camara*), partridge pea (*Chamaecrista nictitans*), golden crownbeard (*Verbesina encelioides*), *‘ilima* (*Sida fallax*), hoary abutilon (*Abutilon incanum*), *koa haole* (*Leucaena leucocephala*), indigo (*Indigofera suffruticosa*), *‘uhaloa* (*Waltheria indica*) and lion’s ear (*Leonotis nepetifolia*).

3.1.3 Mixed *Kiawe*-*Wiliwili* Shrubland

Remnant mixed *kiawe-wiliwili* shrubland was limited to the southern ‘a‘ā lava flow in the southern quarter of Property (Figure 5). Scattered groves of large-stature *wiliwili* (*Erythrina sandwicensis*) and *kiawe* trees co-dominated the upper story. Native shrubs, such as *‘ilima* (*Sida fallax*) and *maiapilo* (*Capparis sandwichiana*), and the native vine *‘ānunu* (*Sicyos pachycarpus*), were represented in the understory. Introduced shrubs, introduced grasses, and introduced vines and herbaceous species dominated the ground vegetation. Lantana (*Lantana camara*), found throughout the mixed *kiawe-wiliwili* shrubland, showed signs of dieback. Although abundant, the guinea grass (*Urochloa maxima*) found on the site was grazed to stubble, probably by axis deer.

3.2 Endangered, Threatened, and Candidate Endangered Species of Plants

No Federal or State of Hawai‘i listed threatened, or endangered plant species were found in the Property. Over a period of time, Altenberg (2007) collected roughly 15 GPS points for *‘āwikiwiki* vines (*Canavalia pubescens*) within the *kiawe-wiliwili* shrubland during his hikes across the Honua‘ula parcel. It is unknown how many of his GPS points represent duplicate occurrences of the same plant. The U.S. Fish and Wildlife Service (2009) reported “a few individuals at Palauea-Keahou” [including the Property] based upon information received from Altenburg (2007) and Hank Oppenheimer (Plant Extinction Prevention Program, pers. comm.). During this study, the project botanists found only five (5) individual *‘āwikiwiki* (*C. pubescens*) plants on the Property. All *‘āwikiwiki* (*C. pubescens*) were flowering and fruiting at the time of the survey; however, no seedlings were detected. The plants appeared to be healthy with no signs of damage or disease.

Figure 6. ***Percent of native and introduced plant species found in each of the three predominant vegetation types within the Property.*** *Data is pooled across all plant species (n= 146) observed by Char and Linney (1988), Altenberg (2007) and SWCA (this study). KB = Kiawe-buffelgrass grassland (n= 105, 9 natives and 96 introduced), MG = mixed gulch vegetation (n= 66, 11 natives and 55 introduced), KW = kiawe-wiliwili shrubland (n= 106, 26 natives and 80 introduced).*

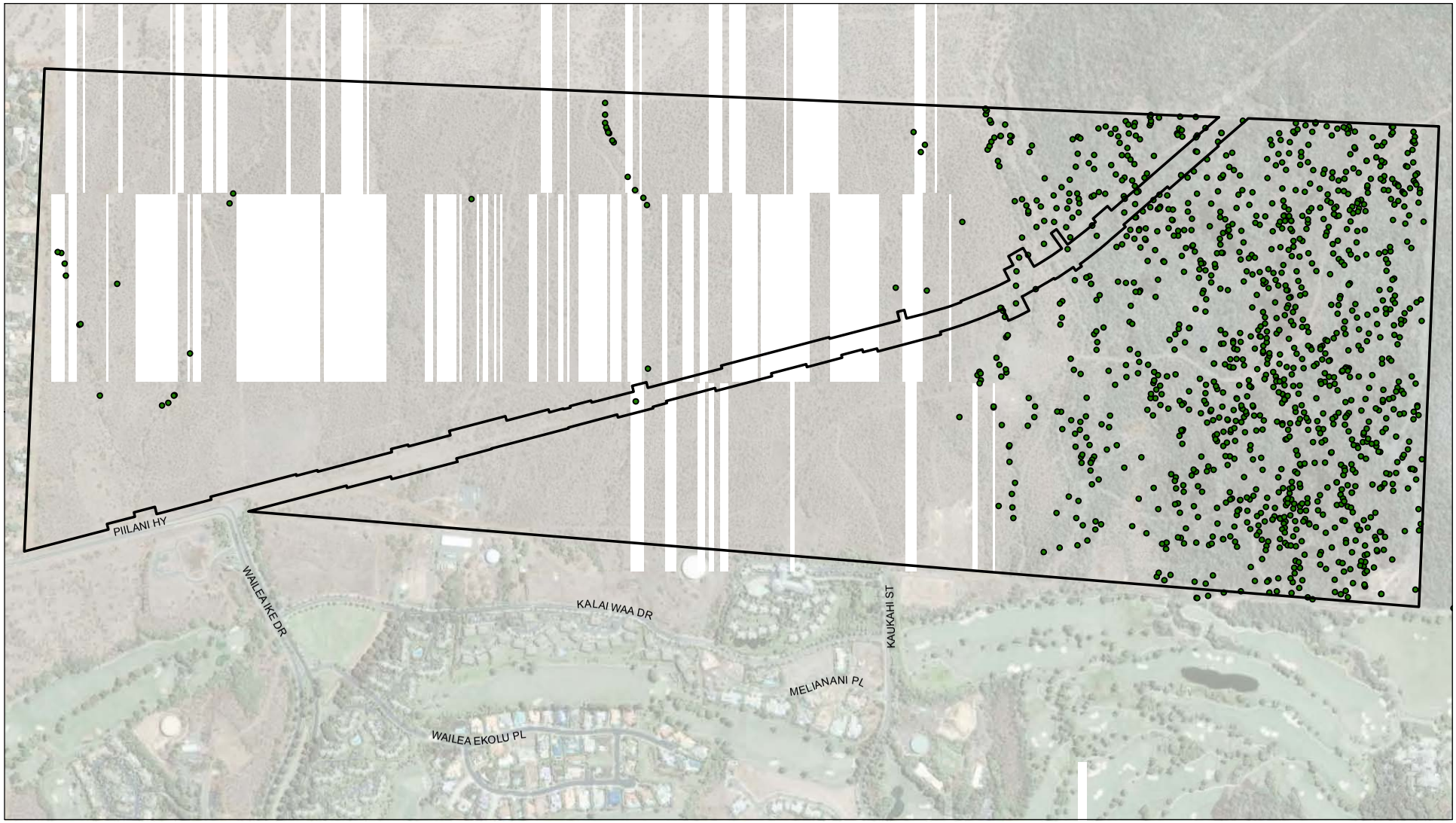
3.3 Distribution and Abundance of Native Plant Species

In all, 146 plant species have been identified within the Property, 26 of which are native, 14 of these endemic. The remaining 120 plant species are introduced non-native species. Of the 26 native species reported in previous surveys (Char and Linney 1988, Altenberg 2007), we found 21 during this study. We did not observe *Panicum torridum*, *Boerhavia herbstii*, *Adiantum capillus-veneris*, *Chamaesyce celastroides* and *Pallaea ternifolia* during our surveys. Figure 7 illustrates the location of native plants within the Property, and Figure 8 illustrates the distribution of native plant species within the Property by count.

As previously mentioned, hoary abutilon (*Abutilon incanum), koali awahia* (*Ipomoea indica*), *'ilima (Sida fallax), popolo* (*Solanum americanum*), *'ilie'e* (*Plumbago zeylanica*), *alena* (*Boerhavia* spp.), and *'uhaloa* (*Waltheria indica*) were abundant and widespread throughout the *kiawe-wiliwili* shrubland, and therefore were not mapped since it was not feasible to collect GPS data for each individual plant. Aside from these species and *'āwikiwiki* (*Canavalia pubescens*), which is discussed above and at length in Section 4.0, descriptions of the remaining native plants found on the Property appear below. Individual fact sheets, including photographs and distribution maps, of the native plants mapped by SWCA are found in Appendix B in alphabetical order by species name.

SWCA botanists found 412 *pua kala* (*Argemone glauca*) in 26 locations within the Property, all of which were limited to the southern 'a'ā portion of the Property (Table 3, Figure 8). Most clusters averaged 16 individuals, most of which were seedlings (60%). Clusters ranged from one to 39 m^2 with the average being 4 m^2 (n= 26 clusters). The majority of clusters occurred in the southwestern portion of the *kiawe-wiliwili* shrubland, usually in relatively open, sunny locations of the lava flow. All plants of this species we observed were flowering at the time of the surveys.

Maiapilo (*Capparis sandwichiana*) is a common shrub throughout the understory of the remnant mixed *kiawe-wiliwili* shrubland. We found 563 *maiapilo* during the survey and all but one individual was located in the southern 'a'ā portion of the Property (Table 3, Figure 8). Most clusters ranged from one to five individuals; 11 were larger, consisting of six to 10 individuals.



Legend

- Project Boundary
- Native Plant Points

Figure 7
Native Plant Occurrences

0 250 500 1,000 ft

0 50 100 200 M

Native Plant Source: Trimble GeoXT GPS
Boundary Source: PBR Hawaii
Aerial Source: Microsoft 2009

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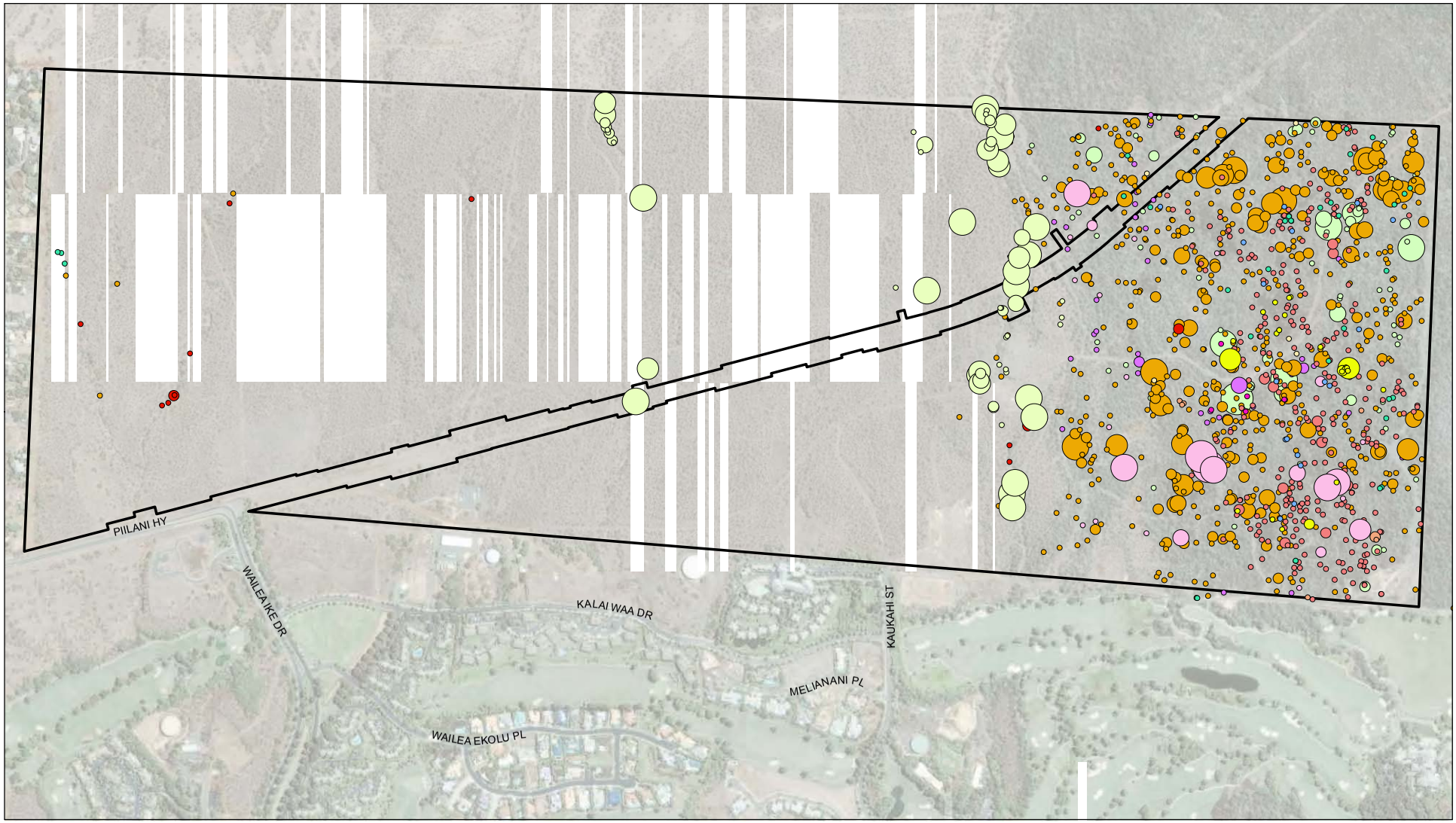

Native Plants by Species

- *Argemone glauca*
- *Canavalia pubescens*
- *Capparis sandwichiana*
- *Doryopteris decipiens*
- *Dodonea viscosa*
- *Erythrina sandwicensis*
- *Heteropogon contortus*
- *Ipomoea tuboides*
- *Lipochaeta rockii*
- *Myoporum sandwicense*
- *Senna gaudichaudii*
- *Sicyos hispidus*
- *Sicyos pachycarpus*

Native Plants by Count Classes

- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 25
- 26 - 60
- 61 - 110

Plant Source: Native Plants were mapped with GPS
Boundary Source: PBR Hawaii
Aerial Source: Microsoft 2009

Figure 8
Native Plant Count Classes

0 250 500 1,000 ft
0 50 100 200 M

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These large clusters were found primarily in the southern portion of the *kiawe-wiliwili* shrubland. The aerial cover of the largest cluster was 531 m^2, others ranged from one to 314 m^2 (average cover of 17 m^2). Several *maiapilo* clusters were flowering and fruiting, but the frequency of seedlings was low (2.5%). About 20% of the plants showed mild to heavy signs of insect herbivory where the epidermis (upper layer of the leaves) appeared to be scraped away.

We observed 16 *'a'ali'i* (*Dodonaea viscosa*) shrubs in seven locations, all limited to the southwestern corner of the *kiawe-wiliwili* shrubland (Figure 8). Six of the seven locations had one to four individuals while the largest cluster was comprised of six individuals. Average cover of *'a'ali'i* was about 26 m^2 where the aerial cover of two clusters were 79 m^2 each and the remaining five ranged from one to 20 m^2. One plant was observed fruiting and no seedlings were observed in the vicinity of the adult shrubs. All plants were healthy with no detectable signs of damage, disease, or herbivory.

Fifty-four *'iwa'iwa* (*Doryopteris decipiens*) ferns were distributed at about 14 locations within the Property (Figure 8). Of these, only seven individuals were found within the *kiawe-wiliwili* shrubland; the others occurred in the drainage gulches within the northern portion of the Property. The number of individuals within a cluster ranged from one to 16, the majority of which were adults (96%). Some plants showed signs of dehydration; most plants in the largest cluster (16 individuals) were very dry. Aerial cover of the largest cluster was approximately 7 m^2 while the others ranged from one to 3 m^2.

Wiliwili (*Erythrina sandwicensis*) was the most common native tree species in the southern 'a'ā lava flow (Table 3, Figure 8). We mapped 2,476 individuals distributed throughout the Property. The majority (2439 individuals) were limited to the *kiawe-wiliwili* shrubland in groves of various sizes. The largest groves (>15 individuals) tended to be located in the eastern portion of the *kiawe-wiliwili* shrubland. The number of adult *wiliwili* (*E. sandwicensis*) trees was greater (86%) than seedlings and juveniles (Table 3). Most *wiliwili* trees showed some form of damage, primarily from the Erythrina gall wasp (*Quadristichus erythrinae* Kim) and the seed eating bruchid beetle (*Specularius impressithorax* Pic). Additional information on the *wiliwili* (*E. sandwicensis*) within the Property can be found in Table 4.

Table 4. Number of wiliwili (Erythrina sandwicensis) groves on the project site. *Grove size is categorized by the number of individual trees in the grove. Range and average canopy cover is measured in m^2.*

Number of Trees in Grove	Number of Groves	Range in Grove Canopy Cover (min-max) (m^2)	Mean Canopy Cover of the Grove (m^2) (+/- 1 S.E.)	Median Grove Canopy Cover (m^2)
1 to 5	417	0.8 - 1589.6	94.1	38.5
6 to 10	107	28.3 – 2862	523.5	254.3
11 to 15	28	12.6 - 706.5	839.1	706.5
16 to 25	12	314 – 2862	1453.9	961.6
26 to 60	5	254.3 - 1962.5	1029.2	873.3

Pili grass (*Heteropogon contortus*) was the only native grass species found within the Property (Figure 8). *Pili* (*H. contortus*) was limited to gulches within the *kiawe*-buffelgrass grassland in the northern half of the Property (Table 3). We mapped 1,493 *pili* (*H. contortus*) plants in 66 locations within the Property. All plants were limited to gulches within the *kiawe*-buffelgrass grassland in the northern half of the Property. Most individuals occurred in the southern drainage gullies of the grassland, becoming less abundant to the north. Adult plants were flowering at the time of our surveys. We did not observe signs of superficial damage or disease.

Five endemic Hawaiian moon flower (*Ipomoea tuboides*) vines were observed within the Property; all of which are limited to the southern 'a'ā portion of the Property (Table 3, Figure 8). At the time of the survey all plants were flowering.

One hundred and one *nehe* (*Lipochaeta rockii*) were found distributed in 24 clusters across the Property (Figure 8). All were within the southern 'a'ā portion of the Property. Two large clusters

contained 22 and 23 individuals respectively and were located in the center of the mixed *kiawe-wiliwili* shrubland. Smaller clusters (< 10 individuals) were found from central to southwestern portion of the shrubland. Clusters ranged from < 1 m^2 to 78.5 m^2 in area.

Twenty-one *naio* (*Myoporum sandwicense*) shrubs/trees were observed in 17 locations distributed throughout the *kiawe-wiliwili* shrubland (Table 3, Figure 8). No *naio* (*M. sandwicense*) seedlings were found. Fifteen of the 17 locations were occupied by a single shrub/tree. Aerial cover ranged from < 1 m^2 to 78.5 m^2, the largest of which consisted of three shrubs/trees.

Forty-three *kolomona* (*Senna gaudichaudii*) trees were mapped at 32 locations within the Property (Figure 8). The majority (37 individuals) of the plants occurred in the southern portion of the mixed *kiawe-wiliwili* shrubland. The cluster size ranged from one to five individuals, and 24 of 29 mapped locations consisted of solitary plants. The areal extent ranged from < 1 m^2 to 19.6 m^2. Evidence of herbivory was observed at four of 29 locations. Many of the plants found were flowering and/ or fruiting at the time of our surveys.

We mapped 113 *'ānunu* (*Sicyos hispidus*) vines at 49 locations within the Property (Table 3, Figure 8). These vines occurred primarily in the central and northern edge of the 'a'ā lava flow. Larger clusters (> 5 individuals) tended to be located in the central portion of the *kiawe-wiliwili* shrubland. Seedlings were observed at only one location and no signs of damage or herbivory were detected.

A second species of *'ānunu* (*Sicyos pachycarpus*) was found within the Property (Figure 8). Six hundred and three *S. pachycarpus* were mapped in 102 locations. The size of clusters varied greatly and ranged from one to 110 plants per location. The majority of the larger clusters (> 15 individuals) were concentrated in the center of the *kiawe-wiliwili* shrubland. Approximately 52% of mapped plants were seedlings. Many adults were observed flowering and/ or fruiting. Most of the vines appeared to be healthy; only one plant showed signs of herbivory.

3.4 GIS Density Analysis

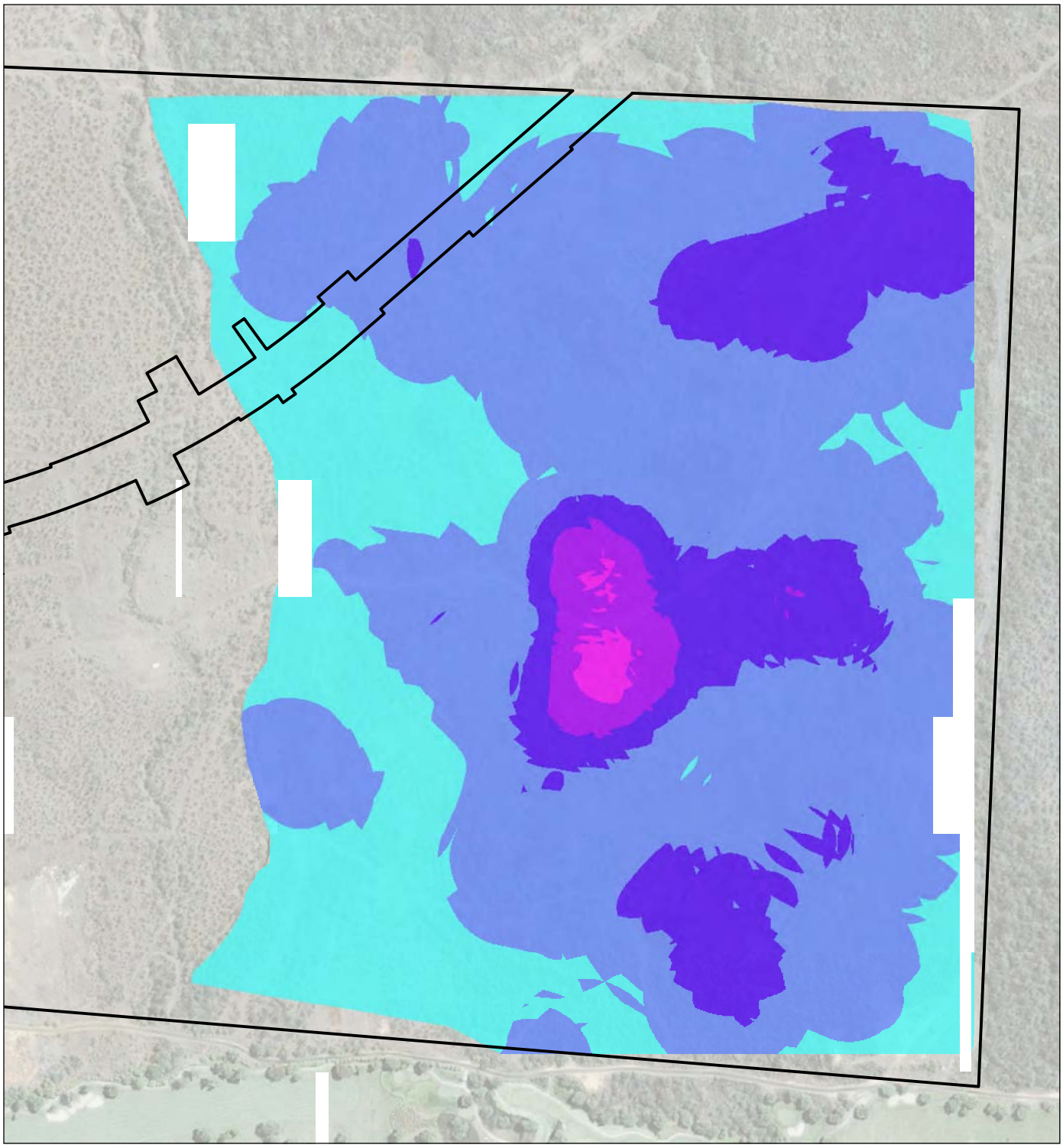
Table 2 illustrates how SWCA botanists weighted each species in Group 1 (from Table 1) for density analysis. The resulting density analysis, conducted at a resolution of 100 m (328 ft) illustrated the core areas occupied by the highest densities of the most significant plant species. Figure 9 illustrates the results of the weighted density analysis for the eight most important native plant species. The colors represent the weighted average of the densities of the eight species.

3.5 Aerial Reconnaissance Survey

Wiliwili (*E. sandwicensis*) and *kiawe* (*P. pallida*) trees were the most distinctive tree species observed from aerial surveys. In contrast, understory was difficult if not impossible to identify from the air. Dense stands of *wiliwili* trees (*E. sandwicensis*) were found in several areas adjacent to, and well outside of, the Property (Figure 10). This includes a large geographical area of approximately 400 ha (1,000 ac) east of Pu'u Olai (Figure 11), stretching from the southern boundary of the Property into the Makena property and Ahihi-Kinau Natural Area Reserve in the south, and from the Makena Resorts southeast of Honua'ula toward the 'Ulupalakua Ranch. Our aerial reconnaissance confirmed input from others (A.C. Medeiros, USGS, pers. comm.; Altenberg 2007) suggesting that several additional high density *wiliwili* (*E. sandwicensis*) groves may be found near Pu'u Olai, Kanaio, Pu'u O Kali, Makena (Figure 12), La Perouse, Kaupo, and Lualailua.

4.0 DISCUSSION

The Property was viewed by Char and Linney (1988) and Char (1993, 2004) as having unremarkable vegetation. Until SWCA (2006) and Altenberg (2007), there had been no recognition of the remnant mixed *kiawe-wiliwili* shrubland as an area worthy of special recognition. Similarly, there have been no previous efforts by any Federal, State, local government agency, or conservation Non-governmental organizations (NGOs) to acquire and protect any portion of the Property.



Weighted Average

- 5 - Highest Weighted Average
- 4
- 3
- 2
- 1 - Lowest Weighted Average

Figure 9
Visual Representation of Weighted Density Analysis of the Eight Most Important Plant Species within the Project Area

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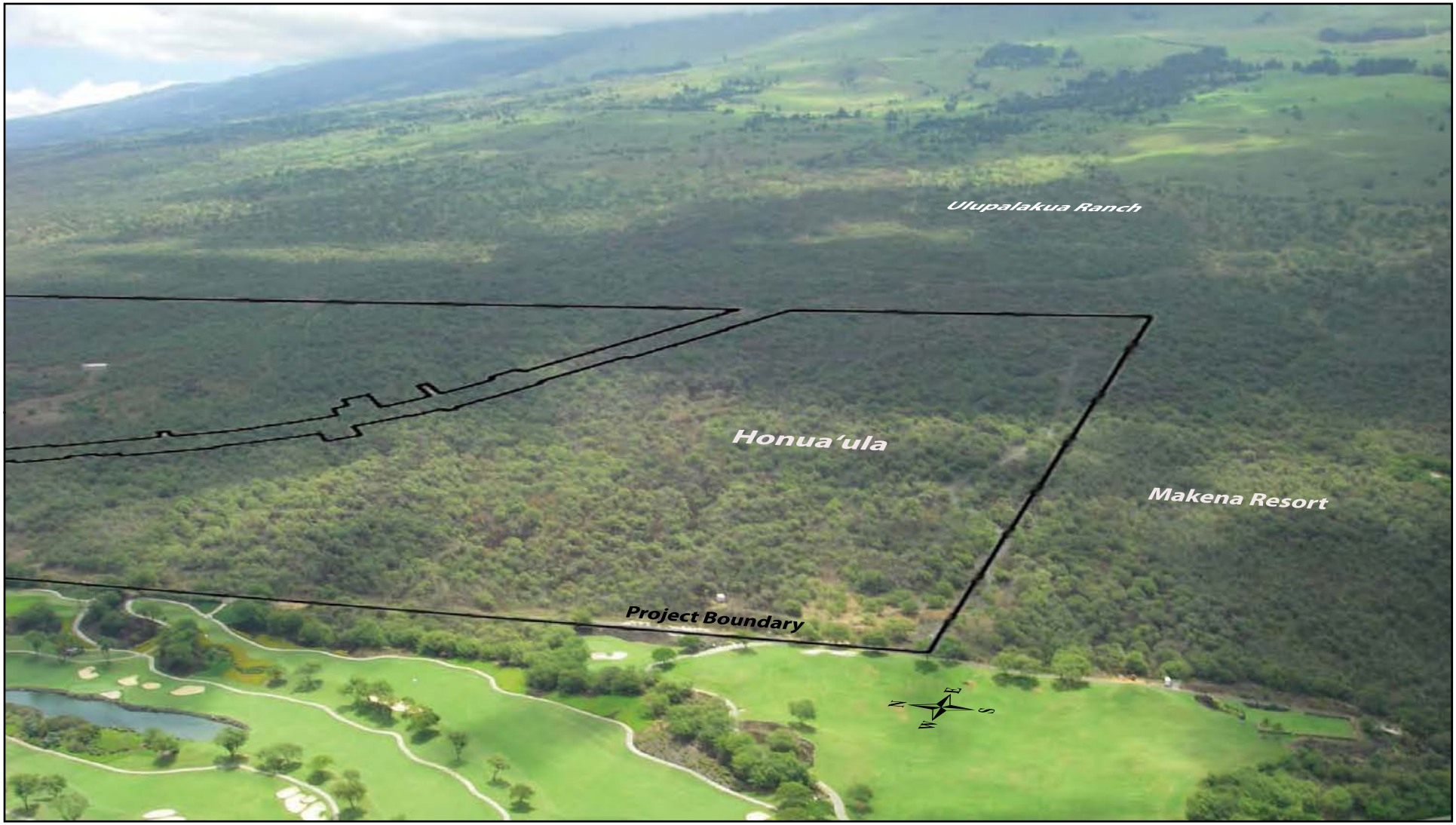


Figure 10 - An east-northeasterly aerial view of the remnant mixed kiawe-wiliwili shrubland within and adjacent to the southern and southeastern boundaries of Honua'ula, on Makena Resort and Ulupalakua Ranch lands, respectively.

Figure 11 - A westerly aerial view of the dense remnant mixed kiawe-wiliwili shrublands adjacent to Pu'u Olai.

Figure 12. An easterly aerial view of dense remnant mixed kiawe-wiliwili shrublands surrounding the Makena Sewage Treatment Facility.

The remnant native vegetation in the remnant mixed *kiawe-wiliwili* shrubland represents a highly degraded lowland dry shrubland in which *wiliwili* trees (*E. sandwicensis*) are a natural component. High density *wiliwili* (*E. sandwicensis*) stands occur in other locations throughout the region. Altenberg (2007) identified eight areas in southeast Maui, including the Property, where *wiliwili* (*E. sandwicensis*) groves are found. In this study, we also found dense *wiliwili* (*E. sandwicensis*) groves east of Pu'u Olai.

Far from being pristine, this dry shrubland has been degraded by human activities including unrestricted grazing by ungulates, cattle grazing, invasive plant species, road works, *kiawe* (*P. pallida*) logging, and military activities. Only 26 of the 146 species reported from the parcel are native, 14 of these are endemic, and 120 are introduced non-native species (Figure 6).

Canavalia pubescens Hook. & Arnott is "…uncommon in open dry sites such as lava fields, kiawe thickets, and dry forest, 15-540m, on Ni'ihau, Kaua'i (Nāpali Coast), Lāna'i, and leeward East Maui" (Wagner et al. 1999). In 1997, the species was added as a candidate species by the U.S. Fish and Wildlife Service (USFWS). The most recent USFWS (2009) information on the species includes the following:

> *"Canavalia pubescens is found on dry, open lava fields and in dryland forest. On Kauai, C. pubescens was found in open, moist forest and in dry scrub forest at elevations between 180 to 2,900 feet (ft) (55 to 884 meters (m)). On Niihau, this species was last seen growing on an exposed basalt ledge at 300 ft (91 m) in elevation. On Lanai, C. pubescens was observed growing among sun-scorched lava rocks along a coastal trail at 50 ft (15 m) elevation with Cordia subcordata (kou) (H. Oppenheimer, PEP Program, pers. comm. 2007). On Maui, C. pubescens is found on recent lava flows in Erythrina (wiliwili) lowland dryland forest and shrubland with the following native species: Capparis sandwichiana (maiapilo), Chamaesyce celastroides var. lorifolia (akoko), Dodonaea viscosa (aalii), Ipomoea spp. (no common name), Morinda spp. (noni), Sida fallax (ilima), Rauvolfia sandwicensis (hao), and Waltheria indica (uhaloa); at elevations between 80 to 400 ft (24 to 122 m) (Wagner and Herbst 1999, p. 654; Hawaii Biodiversity and Mapping Program (HBMP) 2008)."*
>
> *"Currently, Canavalia pubescens is found on the island of Maui (HBMP 2008; H. Oppenheimer, Plant Extinction Prevention Program, pers. comm. 2006; F. Starr, U.S. Geological Survey, Biological Resources Discipline (USGS-BRD), pers. comm. 2006). No plants were observed at the last known location of this species on Lanai in 2007; however, it could possibly be found there again (H. Oppenheimer, pers. comm. 2007). There were a few individuals at Palauea-Keahou, but this area is currently undergoing development (Altenburg 2007, pp. 12-13; H. Oppenheimer, pers. comm. 2007)."*
>
> *"Five populations are known on Maui: Keokea and Puu o Kali with "hundreds" observed; southwest Kalua o Lapa with two individuals; Papaka Kai with six individuals; Ahihi-Kinau with a few individuals; and southeast Pohakea, with at least one individual (HBMP 2008; F. Starr, pers. comm. 2006; H. Oppenheimer, pers. comms. 2006, 2007). These populations total a little over 200 individuals, with the majority ("hundreds") in one population (Puu o Kali)."*

Altenberg (2007), F. Starr (pers. comm.), and H. Oppenheimer (pers. comm.) apparently presumed that the remaining *'āwikiwiki* (*C. pubescens*) at Palauea-Keahou [Honua'ula] have "… likely been destroyed by development" (as cited in USFWS 2008a and 2009). Contrary to this pessimistic outlook, all five individual on the Honua'ula Property continue to thrive. No construction or other development related activity other than recent fence building to keep cattle from the *kiawe-wiliwili* shrubland has been conducted in that area. Honua'ula Partners, LLC is committed to the Maui County Council as early as March 2006 to insure that all five *'āwikiwiki* (*C. pubescens*) plants within the Property are protected and managed to help ensure their conservation.

The Species Assessment and Listing Priority Assignment Form (USFWS 2009) notes that the USFWS has "promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed" and determined that the species "does not appear to be appropriate for emergency listing at this time because the immediacy of

the threats is not so great as to imperil a significant proportion of the taxon within the time frame of the routine listing process."

Nehe (*Lipochaeta rockii* Sherff) occurs in scattered locations on Maui, but is primarily known from Moloka'i and Kaho'olawe where it is scattered to common in coastal sites to dry forests, and along the margins of lava flows (Wagner et al. 1999). As noted above, *nehe* (*L. rockii*) within the Property have a distinct leaf shape; the leaves are less dissected compared to specimens at other Maui locations. However, it is not recognized as a separate subspecies or variety by botanical authorities (Wagner et al. 1999) and is suggested to easily hybridize with other plants of the same species (Herbst, Bishop Museum, pers. comm.). It is also not given statutory protection by State or Federal laws.

4.1 Comparison to Adjacent Hawaiian Dry Forests and Conservation Efforts

As stated above, there have been no previous efforts to acquire and protect any portion of the Property. Instead, government conservation efforts for native dry forest ecosystems have been focused on better examples of relatively intact ecosystems such as Pu'u o Kali, 'Auwahi, and similar areas. Figure 13 illustrates existing areas on southeastern Maui where remnant dry forest and shrubland communities are being protected by various entities.

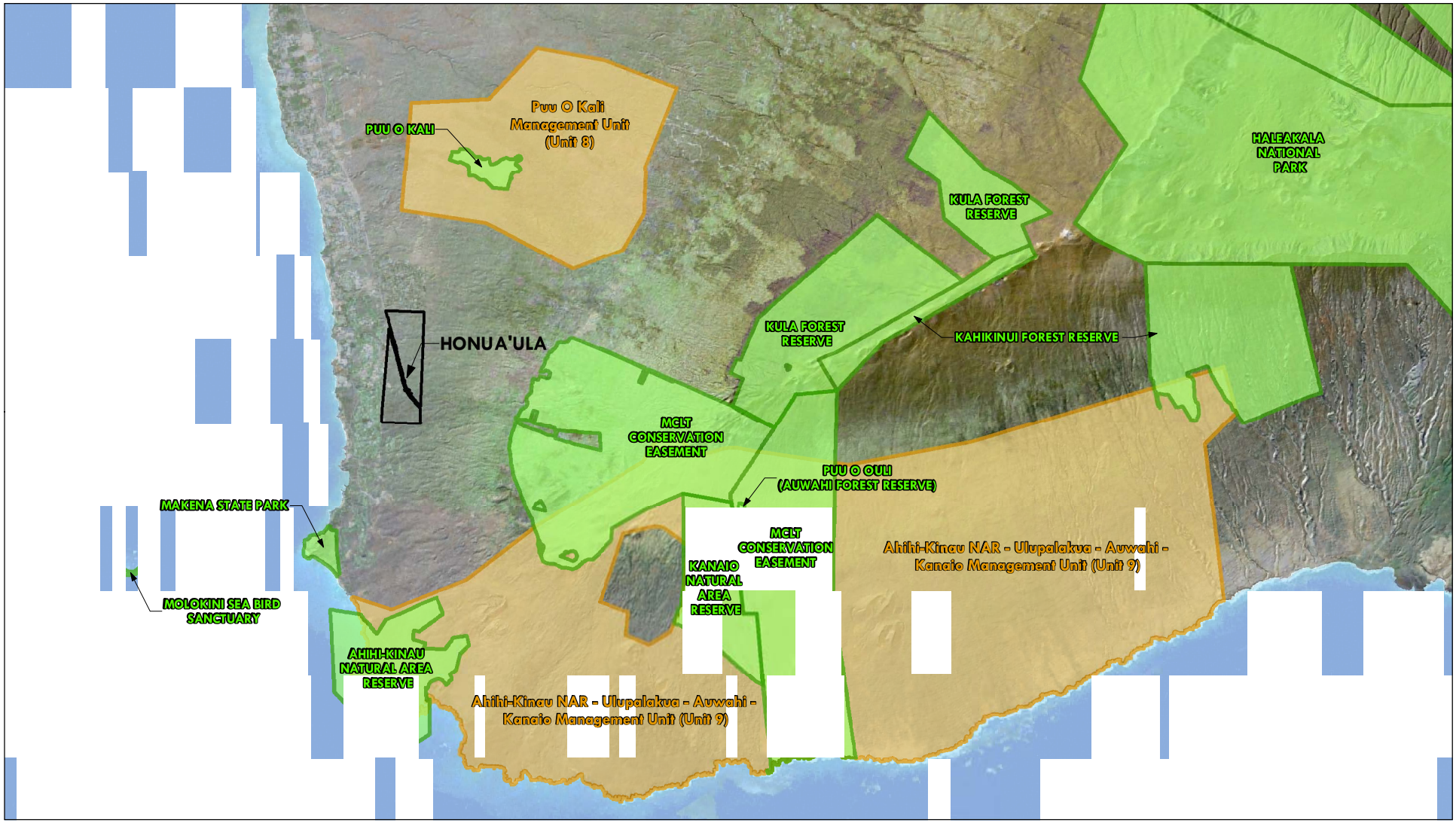
'Auwahi Forest Reserve (Medeiros 2006) is a four hectare (10 ac) remnant native dry forest on the south slope of East Maui at 1,200 m (3,937 ft) elevation (Figure 13). This site has been undergoing restoration since 1997 under a partnership between landowners, government agencies and scientists. 'Auwahi has a rich plant diversity including 50 native tree species, at least five of which are endangered (Medeiros 2006).

Pu'u O Kali Forest Reserve is a remnant *wiliwili* (*E. sandwicensis*) forest on the slopes of east Maui above Kīhei. It is among the most diverse and intact lowland dry forests on Maui which also supports endangered flora. As Monson (2005) quoted A.C. Medeiros, "*Pu'u-O-Kali* is the only place on this whole side that looks like it did in ancient times… It's the only place where a Hawaiian from long ago would look around and say, 'Oh, I know where I am.' They wouldn't recognize the rest of South Maui."

Kanaio Natural Area Reserve located to the south of the Property encompasses 354 ha (876 ac), portions of which include *wiliwili* (*E. sandwicensis*). Nearly 38% of the vegetation in Kanaio is native with about 14% indigenous and 24% endemic. Twenty-two species of Hawaiian dry land forest trees are found in Kanaio, over 35% of the total number of native species in the area (Medeiros et al. 1993).

A relatively pristine remnant native dry forest occurs at Palamanui, a 293 ha (725 ac) mixed use residential and commercial development in Kona, Hawai'i. Sixty two plant species have been described from the native forest there, of which 27 are native and 35 are introduced (Hart 2003). Roughly seven percent of the total Palamanui development parcel consists of a *lama-alahe'e-'iliahi* (*Diospyros-Psydrax-Santalum*) dry forest that has "apparently never received any major disturbance" (Hart 2003, Group 70 International 2004). Three federally listed endangered plant species are found at Palamanui: *uhi-uhi* (*Caesalpinia kavaiensis*), *aiea* (*Nothocestrum breviflorum*) and *halapepe* (*Pleomele hawaiiensis*). Several large 'akoko (*Chamaesyce multiformis*), many of which are larger than have ever been seen before, have been described from Palamanui (Group 70 International 2004).

Another plant mitigation and preserve restoration plan has been developed for construction of The Villages at La'iōpua in Kealakehe, North Kona on the Island of Hawai'i for the Department of Hawaiian Home Lands (Leonard Bisell Associates LLC and Geometrician Associates, 2008). Originally conceived in 1999, the plan addresses the protection of two listed endangered plants: *aupaka* (*Isodendrion pyrifolium*) and *uhiuhi* (*Caesalpinia kavaiensis*) and 19 associated endemic and indigenous plants. Fifty-five species of introduced plant species have been recorded within or near the proposed preserves at La'iōpua. The several small preserves are planned for La'iōpua, the largest of which is 26.6 acres in area. The other preserves are 11 and 4 acres in size, with additional 'mini-preserves' proposed to protect individual trees. As with the proposed Native Plant Preservation Area at Honua'ula, the La'iōpua preserves also incorporate archaeological features, and include specific conservation principals, management objectives, and physical plans.



Legend

- Project Boundary
- Reserves
- Proposed Management Units for the Blackburn's Shpinx Moth

Figure 13
Vicinity Conservation Efforts

N

0 0.5 1 2 Miles

0 1 2 4 Km

Image Source: State of Hawaii (LANDSAT)
Reserves and Management Units Source: State of Hawaii
Boundary Source: PBR Hawaii

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Protection of at least 22 ha (55 ac) of the dry forest remnant at Palamanui is an integral part of the overall development proposal. Significant elements of the proposed preserve management plan for Palamanui (Hart 2003; J. Price, UH Hilo, pers. comm.) are directly relevant to management of the proposed native plant preserve at Honua'ula and have been incorporated into our recommendations.

4.2 Relevant Dry Forest Research in Hawai'i

In their research studies conducted at Ka'upulehu dry forest on Hawai'i Island, Cabin et al. (2000a) found that excluding ungulates with fencing is effective in helping the recruitment of some native tree species. However, fencing alone was insufficient to restore native dry forests. In another study at Ka'upulehu, Cabin et al. (2002a) experimentally manipulated micro-site conditions (canopy vs. no canopy), water (ambient vs. supplemental), and weeding (removal vs. non-removal). They also added seeds of six native species in 64 1m² plots to investigate the regeneration of native dry forest species. The authors suggest that it is possible to restore degraded dry forests in Hawai'i by manipulating the ecological conditions particularly for the fast growing understory species which then create micro-sites more favorable for the establishment of native trees. Cabin et al. (2002b) investigated how light availability (full vs. 50% shade), alien grass control (bulldoze, herbicide, plastic mulch and trim treatments), and out-planting vs. direct seeding affected the establishment of native plants and suppression of invasive grasses. Their results highlight the fact that restoration can be site specific and hence it is important to examine species and treatment specific responses to these species before attempting large scale conservation efforts. They also suggest that relatively simple techniques can be used to simultaneously suppress invasive grasses and establish populations of vigorous native understory species even at larger scales.

These and other related studies (Allen 2000, Blackmore and Vitousek 2000, Cabin et al. 2000a, 2000b, 2001; Chang 2000, Chimera 2004, Cordell et al. 2001, 2002; D'Antonio et al. 1998, Henderson et al. 2001, Litton et al. 2004, Merlin and Juvik 1992, Sandquist et al. 2004, Stratton 1998, and Tunison 1992) give hope that even small restoration efforts consisting of a few hectares can help provide habitat for rare native dry forest species and can subsequently serve as urgently-needed sources of propagules. This hope is reinforced by the numerous sources on information on successful propagation of rare native Hawaiian plants specifically for landscaping (e.g., Tamimi 1999, Friday 2000, Wong 2003, Bornhorst and Rauch 2003, CTAHR 2006).

5.0 PROPOSED MITIGATION MEASURES

The Maui County Council promulgated 28 specific conditions in granting a Phase I project district zoning approval. Specific conditions related to vegetation within the Property appear in the following paragraphs.

> *"7. That Honua'ula Partners, LLC, its successors and permitted assigns, shall prepare an animal management plan that shall be submitted during Project District Phase II processing and approved by the Department of Land and Natural Resources prior to submittal of Project District Phase III processing. Said plan shall include procedures for the management of animal intrusions including, but not limited to, construction of boundary or perimeter fencing, wildlife control permits, and rodent and feral cat control. Honua'ula Partners, LLC, its successors and permitted assigns, shall implement the approved animal management plan. The Department of Land and Natural Resources may require periodic updates of the plan.*
>
> *27. That Honua'ula Partners, LLC, its successors and permitted assigns, shall provide the report "Remnant Wiliwili Forest Habitat at Wailea 670, Maui, Hawaii by Lee Altenberg, Ph.D.", along with a preservation/mitigation plan, to the State Department of Land and Natural Resources, the United States Fish and Wildlife Service, and the United States Corps of Engineers for review and recommendations prior to Project District Phase 11 approval. The Maui Planning Commission shall consider adoption of the plan prior to Project District Phase II approval.*
>
> *Such plan shall include a minimum preservation standard as follows: That Honua'ula Partners, LLC, its successors and permitted assigns, shall establish in perpetuity a*

Conservation Easement (the "Easement"), entitled "Native Plant Preservation Area", for the conservation of native Hawaiian plants and significant cultural sites in Kīhei-Makena Project District 9 as shown on the attached map. The Easement shall comprise the portion of the property south of latitude 20°40′l 5.00"N, excluding any portions that the State Department of Land and Natural Resources, the United States Fish and Wildlife Service, and the United States Corps of Engineers find do not merit preservation, but shall not be less than 18 acres and shall not exceed 130 acres.

The scope of the Easement shall be set forth in an agreement between Honua'ula Partners, LLC and the County that shall include:

a. A commitment from Honua'ula Partners, LLC, its successors and permitted assigns, to protect and preserve the Easement for the protection of native Hawaiian plants and significant cultural sites worthy of preservation, restoration, and interpretation for public education and enrichment consistent with a Conservation Plan for the Easement developed by Honua'ula Partners, LLC and approved by the State Department of Land and Natural Resources, the United States Geological Survey, and the United States Fish and Wildlife Service; and with a Cultural Resource Preservation Plan, which includes the management and maintenance of the Easement, developed by Honua'ula Partners, LLC and approved by the State Department of Land and Natural Resources (collectively, the "Conservation/Preservation Plans").

b. That Honua'ula Partners, LLC, its successors and permitted assigns, shall agree to confine use of the Easement to activities consistent with the purpose and intent of the Easement.

c. That Honua'ula Partners, LLC, its successors and permitted assigns, shall be prohibited from development in the Easement other than erecting fences, enhancing trails, and constructing structures for the maintenance needed for the area, in accordance with the Conservation/Preservation Plans.

d. That title to the Easement shall be held by Honua'ula Partners, LLC, its successors and permitted assigns, or conveyed to a land trust that holds other conservation easements. Access to the Easement shall be permitted pursuant to an established schedule specified in the Conservation/Preservation Plans to organizations on Maui dedicated to the preservation of native plants, to help restore and perpetuate native species and to engage in needed research activities. These organizations may enter the Easement at reasonable times for cultural and educational purposes only.
e. Honua'ula Partners, LLC, its successors and permitted assigns, shall be allowed to receive all tax benefits allowable under tax laws applicable to the Easement at the time that said Easement is established in Kīhei Makena Project District 9, which will be evidenced by the recordation of the Easement in the Bureau of Conveyances, State of Hawaii."

Active conservation management of any area to be conserved is integral to the long term success of a mitigation effort. Whether the protected area is 80 ha (200 ac) or 5.3 ha (13 ac), there is no guarantee that the best possible conservation efforts and best management practices will perpetually protect all plant species in the same numbers currently found within the Property. However, the immediate concerns for the preserve on the site should be: 1) elimination of browsing, grazing, and trampling pressure on native plants by feral ungulates, 2) removal of noxious invasive plant and animal species, 3) protection against wildland fires. Honua‘ula Partners, LLC is proposing to implement the following measures to conserve elements of the remnant *kiawe-wiliwili* shrubland and protect native plants and animals on the Property.

- A conservation easement, hereinafter referred to as "Native Plant Preservation Area", encompassing a contiguous area within the remnant mixed *kiawe-wiliwili* shrubland will be dedicated in perpetuity to protect as much of the remnant native lowland dry shrubland plant community as possible. The protected area will meet the 7.3-52.6 ha (18-130 ac) directive imposed by the Maui County Council, and will ultimately be subject to approval by the Council. The Native Plant Preservation Area will encompass the highest densities of the rarest elements of the native vegetation within the project parcel.

- The development will conserve as many of the *wiliwili* trees (*Erythrina sandwicensis*) as possible outside the Native Plant Preservation Area and elsewhere within the remnant mixed *kiawe-wiliwili* shrubland as possible.

- The entire perimeter of the Property has already been fenced to discourage feral ungulates from entering the *kiawe-wiliwili* shrubland; however, the fence is porous. Fencing requirements will be reviewed and updated as establishment of the Native Plant Preservation Area and site construction begin. An animal management plan will be implemented as soon as possible to ensure that goats, deer, pigs, and stray cattle are removed i*n a humane man*ner from the Property.

- A Natural Resource Manager will be employed by Honua'ula Partners, LLC to help develop and implement specific conservation programs to help ensure the protection of native plants and animals within the Native Plant Preservation Area and other areas designated for native plant protection throughout the Property.

- Honua'ula Partners, LLC will implement a program to control and eradicate invasive grasses, weeds, and other non-native plants from Native Plant Preservation Area ***with the exception of*** the non-native tree tobacco (*Nicotiana glauca*), which is a recognized host plant for the endangered Blackburn's sphinx moth (*Manduca blackburni*).

- Honua'ula Partners, LLC will implement a native plant propagation program for landscaping with plants and seed naturally occurring on the Property. All plants native to the geographic area will be considered as potential species for use in landscaping.

- Honua'ula Partners, LLC will implement a seed predator control program to control rats, mice, and other seed predators within the Native Plant Preservation Area.

- Honua'ula Partners, LLC will implement a fire control program to help protect the Native Plant Preservation Area to help insure the success of plant propagation and conservation efforts.

- Honua'ula Partners, LLC will implement an education and outreach program open to the public at large, and sponsor service groups to assist with implementation of the management programs in the Native Plant Preservation Area and other areas designated for native plant protection.

- Honua'ula Partners, LLC will apply for additional program support offered by the State of Hawai'i (Natural Area Partnership Program and Hawaii Forest Stewardship Program) and U.S. Fish and Wildlife Service to promote sound management of the natural resources on the Property.

- All copies of all SWCA reports prepared for this project, including the Conservation and Stewardship Plan, along with Altenberg (2007) will be submitted to the Department of Land and Natural Resources (DLNR), USFWS, U.S. Geological Survey, and U.S. Army Corps of Engineers for review and comment.

- Long-term vegetation monitoring during wet and dry seasons will be continued to evaluate the health of native plants, and to support the development of the conservation and stewardship plan for the Native Plant Preservation Area and other areas designated for native plant protection.

- Finally, a multi-species Habitat Conservation Plan (HCP), to include the candidate endangered *'āwikiwiki* (*Canavalia pubescens*) is being prepared under Section 10(a)(1)(B) of the Endangered Species Act and in collaboration with DLNR and USFWS.

Taken together with the mitigation measures identified for wildlife (SWCA 2009), these actions fully satisfy the objectives and the intent of the special Project District Phase I conditions promulgated by the Maui County Council and recommendations of State and Federal resources agencies.

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APPENDIX A

CHECKLIST OF PLANTS REPORTED FROM HONUA'ULA

Checklist includes plants reported from Honua'ula by Char and Linney (1988), Char (1993, 2004), Altenberg (2007), and SWCA (this study). Plant names appear alphabetically by family and then by species into each of three groups: Ferns and Fern Allies (Pteridophytes), Monocots, and Dicots. The taxonomy and nomenclature of the flowering plants are based on Wagner et al. (1999), Wagner and Herbst (1999), and Staples and Herbst (2005). Recent name changes are those recorded in the Hawaii Biological Survey series (Evenhuis and Eldredge, eds, 1999-2002). The list includes scientific name with author citation, common English and/or Hawaiian name(s), biogeographic status, and location within the three dominant vegetation types at Honua'ula.

KEY to biographic status:

E = endemic (occurring only in the Hawaiian Islands);
I = indigenous (native to the Hawaiian Islands and elsewhere);
X = introduced or alien (all those plants brought to the Hawaiian Islands after 1778).

KEY to vegetation types:

KB = *kiawe*-buffelgrass grassland;
MG = mixed gulch-vegetation;
KW = mixed *kiawe-wiliwili* shrubland.

KEY to surveys:

C = Char and Linney (1988), Char (1993), Char (2004);
A = Altenberg (2007);
S = SWCA (2008 - this study).

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
PTERIDOPHYTES						
Adiantaceae						
Adiantum capillus-veneris L.	maiden-hair fern	I	C		*	
Doryopteris decipiens (Hook.) J. Sm.	*'iwa'iwa*	E	C, A, S	*	*	*
Pellaea ternifolia (Cav.) Link	*pellaea*	I	C		*	*

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Aspleniaceae						
Nephrolepis multiflora (Roxb.) F.M. Jarrett ex. C.V. Morton	sword fern	X	C	*		*
MONOCOTS						
Agavaceae						
Furcraea foetida (L.) Haw.	*malina*	X	S			*
Cannaceae						
Canna indica L.	indian shot	X	C	*		
Commelineaceae						
Commelina benghalensis L.	hairy *honohono*	X	C, S	*	*	*
Commelina diffusa N.L. Burm.	blue day flower	X	C	*	*	
Liliaceae						
Crinum sp.	crinum	X	C	*		
Yucca sp.	yucca	X	C	*		
Poaceae						
Bothriochloa pertusa (L.) A. Camus	hurricane grass	X	C	*	*	
Brachiara subqudripa (Trin.) A.S. Hitchc	brachiara	X	C	*		
Cenchrus ciliaris L.	buffelgrass	X	C, S			*
Cenchrus echinatus L.	sandbur	X	C	*		

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Chloris barbata (L.) Sw.	swollen finger grass	X	C, S	*	*	*
Chloris radiata (L.) Sw.	plush finger grass	X	C	*	*	*
Cynodon dactylon (L.) Pers	*manienie*	X	C, S	*		*
Digitaria ciliaris (Retz.) Koeler	Henry's crab grass	X	C	*		
Digitaria insularis (L.) Mez ex Ekman	sour grass	X	C, S	*	*	*
Digitaria radicosa (Presl.) Miq.	digitaria	X	C	*		
Digitaria sp.	crab grass	X	C	*		
Eleusine indica (L.) Gaertn.	goose grass	X	C	*	*	*
Eragrostis cilianensis (All.) Vign. ex Janchen	stink grass	X	C	*	*	
Eragrostis tenella (L.) Beauv. ex R. & S.	love grass	X	C	*		
Eragrostis sp.	eragrostis	X	C	*		
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	*pili* grass	E	C, A, S	*	*	*
Panicum maximum L.	guinea grass	X	C, S	*	*	*
Panicum torridum Gaud.	*kakonakona*	E	C			*
Rhynchelytrum repens (Willd.) Hubb.	natal red top	X	C, S			*
Setaria verticillata (L.) P. Beauv.	*mauʻu pilipili*	X	C	*	*	*
Tragus berteronianus J.A. Schultes	goat grass	X	C	*	*	*
Urochloa subquadripara (Trin.) R. Webster	signal grass	X	C	*		

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Zoysia sp.	zoysia	X	C	*		
DICOTS						
Amaranthaceae						
Amaranthus spinosus L.	spiny amaranth	X	C, S	*	*	*
Asclepiadaceae						
Asclepias physocarpa (E.Mey.) Schltr.	balloon plant	X	C, S	*		*
Stapelia gigantea (N.E. Brown)	zulu giant	X	S			*
Asteraceae						
Ageratum conyzoides L.	*maile hohono*	X	C, S	*	*	*
Bidens cynapiifolia Kunth	beggar tick	X	C, S	*	*	*
Bidens pilosa L.	Spanish needle	X	C, S	*	*	*
Calyptocarpus vialis Less.	straggler daisy	X	C, S			*
Centaura melitensis L.	star thistle	X	S			*
Cirsium vulgare (Savi) Ten.	bull thistle	X	S			*
Conyza bonariensis (L.) Cronq.	hairy horseweed	X	C	*		
Conyza canadensis (L.) Cronq.	horseweed	X	C, S	*		*
Crassocephalum crepidioides (Benth.) S.Moore		X	C, S	*	*	*
Emilia fosbergii Nicolson	red *pualele*	X	C	*		*

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Galinsoga parviflora Cav.		X	C	*	*	
Gnaphalium cf. *japonicum* Thunb.	cudweed	X	C	*	*	
Hypochoeris sp. L.	cat's ear	X	C	*	*	*
Lactuca serriola L.	prickly lettuce	X	C, S			*
Lipochaeta rockii Sherff	*nehe*	E	C, A, S			*
Parthenium hysterophorus L.	false ragweed	X	S			*
Sigesbeckia orientalis L.		X	C	*	*	
Sonchus asper (L.) J. Hill	spiny snowthistle	X	C	*	*	*
Sonchus oleraceus L.	*pualele*	X	C, S	*	*	*
Sphagneticola trilobata (L.) Pruski	wedelia	X	S			*
Synedrella nodiflora (L.) Gaertn.	node weed	X	C	*	*	*
Tridax procumbens L.	coat buttons	X	C, S	*	*	*
Verbesina encelioides (Cav.) Benth. & Hook	golden crown beard	X	C, S	*	*	*
Xanthium strumarium L. var. *canadense* (Miller)	cocklebur	X	C	*	*	*
Zinnia peruviana (L.) L.	wild zinnia	X	C, S	*	*	*
Brassicaceae						
Cornopus didymus (L.) Sm.	wart cress	X	C	*		

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Cactaceae						
Opuntia ficus-indica (L.) Mill.	*panini*	X	C, S	*	*	*
Pilocereus royenii (L.) Byles & Rowley	Royen's tree cactus	X	S			*
Capparaceae						
Capparis sandwichiana DC.	*maiapilo*	E	C, A, S			*
Cleome gynandra L.	spider flower	X	C	*		*
Caryophyllaceae						
Polycarpon tetraphyllum (L.) L.		X	C	*	*	
Chenopodiaceae						
Chenopodium carinatum R.Br.		X	C, S	*	*	*
Chenopodium murale L.	*aheahea*	X	C, S	*	*	*
Convolvulaceae						
Dichondria repens J. R. & G. Forst.		X	C	*		
Ipomoea indica (J. Burm.) Merr.	*koali awahia*	I	C, A, S	*	*	*
Ipomoea obscura (L.) Ker Gawl.	yellow bindweed	X	C, S	*		
Ipomoea tuboides (Degener & Ooststr.)	Hawaiian moon flower	E	C, A, S			*
Merremia aegyptia (L.) Urb.		X	C, S	*	*	*

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Cucurbitaceae						
Cucumis dipsaceus (Ehrenb. ex Spach	wild cucumber	X	C, S	*		*
Momordica charantia L.	bitter melon	X	C, S	*	*	*
Sicyos hispidus Hillebr.	*ʻanunu*	E	C, A, S			*
Sicyos pachycarpus Hook. & Arnott	*ʻanunu*	E	A, S			*
Euphorbiaceae						
Chamaesyce celastroides var. lorifolia (A. Gray) Degener & I. Degener	*ʻakoko*	E	A			*
Chamaesyce hirta (L.) Millsp.	hairy spurge	X	C, S	*	*	*
Chamaesyce hypercifolia (L.) Millsp.	graceful spurge	X	C	*		
Euphorbia heterophylla L.	*kaliko*	X	C, S	*	*	*
Phyllanthus tenellus Roxb.		X	C, S	*		
Ricinus communis L.	castor bean	X	C, S	*	*	*
Fabaceae						
Acacia farnesiana (L.) Willd.	klu	X	C, S		*	*
Bauhinia blakeana Dunn	orchid tree	X	C	*		
Calopogonium mucunoides Desv.		X	C			*
Canavalia pubescens Hook. & Arnott	*ʻāwikiwiki*	E	C, A, S			*
Cassia fistula L.	golden shower	X	C	*		

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Chamaecrista nictitans (L.) Moench	partridge pea	X	C, S	*		*
Crotalaria incana L.	fuzzy rattlepod	X	C	*		
Crotalaria pallida Aiton	smooth rattlepod	X	C	*		
Desmanthus virgatus (L.) Willd.	virgate mimosa	X	C, S	*		*
Desmodium tortuosum (Sw.) DC.	beggar weed	X	C			*
Erythrina sandwicensis O.Deg.	*wiliwili*	E	C, A, S	*	*	*
Indigofera suffritocosa Mill.	*iniko*	X	C, S	*		*
Leucaena leucocephala (Lam.) de Wit	*koa haole*	X	C, S	*	*	*
Macroptilium lathyroides (L.) Urb.	wild bean	X	C, S	*		*
Prosopis pallida (Humb. & Bonpl. Ex Willd.) Kunth	*kiawe*	X	C, S	*	*	*
Samanea saman (Jacq.) Merr	monkey pod	X	C	*		
Senna alata (L.) Roxb	candle bush	X	C	*		
Senna gaudichaudii (Hook. & Arn.) H.S.Irwin & Barneby	*kolomona*	I	C, A, S		*	*
Senna occidentalis (L.) Link	coffee senna	X	C			*
Lamiaceae						
Ocimum basilicum L.	sweet basil	X	C, S	*		*
Ocimum gratissimum L.	basil	X	C, S	*	*	*
Leonotis nepetifolia (L.) R. Br.	lion’s ear	X	S			*

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Stachys arvensis L.	stagger weed	X	C	*	*	*
Malvaceae						
Abutilon grandifolium (Willd.) Sweet	*ma'o*	X	C, S	*	*	*
Abutilon incanum (Link.) Sweet	hoary abutilon	I	C, A, S	*	*	*
Malva parviflora L.	cheese weed	X	C, S	*	*	*
Malvastrum coromandelianum (L.) Garcke	false mallow	X	C	*	*	*
Sida fallax Walp.	*'ilima*	I	C, A, S	*	*	*
Sida rhombifolia L.		X	C	*		
Meliaceae						
Melia azedarach L.	Chinaberry	X	S			*
Moraceae						
Ficus elastica Roxb.ex Hornem	rubber tree	X	C	*		
Ficus microcarpa L. f.	Chinese banyan	X	C, S	*	*	
Myoporaceae						
Myoporum sandwicensis A. Gray	*naio*	E	C, A, S			*
Myrtaceae						
Psidium guajava L.	guava	X	C	*		

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Nyctaginaceae						
Boerhavia coccinea Mill.		X	C	*		
Boerhavia acutifolia (Choisy) J.W.Moore	*alena*	I	S			*
Boerhavia herbstii Fosb.	*alena*	E	A			*
Boerhavia repens L.	*alena*	I	C, S			*
Mirabilis jalapa L.	four-o' clock	X	C			*
Oxalidaceae						
Oxalis corniculata L.	wood sorrel	X	C, S	*	*	
Papavaraceae						
Argemone glauca (Nutt. Ex Prain (Pope)	*pua kala*	E	A, S			*
Argemone mexicana L.	prickly poppy	X	C, S			*
Bocconia frutescens L.		X	S			*
Eschscholzia californica Cham.	California poppy	X	S			*
Passifloraceae						
Passiflora foetida L.	love-in-a-mist	X	C	*		*
Passiflora subpeltata Ort.	passion flower	X	C, S			*
Plumbaginaceae						
Plumbago zeylanica L.	*ʻilieʻe*	I	C, A, S	*	*	*

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Polygonaceae						
Antigonon leptopus H. & A.	coral vine	X	C	*		
Portulacaceae						
Portulaca oleracea L.	pigweed	X	C, S	*	*	*
Portulaca pilosa L.	*ʻakulikuli*	X	C, S	*	*	*
Primulaceae						
Anagallis viscosa L.	scarlet pimpernel	X	C	*	*	*
Sapindaceae						
Dodonaea viscosa Jacq.	*ʻaʻaliʻi*	I	C, A, S			*
Solanaceae						
Capsicum annum L.	chili pepper	X	C, S	*		
Datura stramonium L.	jimson weed	X	C	*	*	*
Lycopersicon pimpinellifolium (Jusl.)	currant tomato	X	C, S	*	*	*
Nicandra physalodes (L.) Gaertn.	apple of Peru	X	C	*	*	*
Nicotiana glauca R.C. Graham	tree tobacco	X	C, S	*	*	*
Solanum americanum Mill.	*popolo*	I	C, S	*	*	*
Solanum seaforthianum Andrews		X	S			*

Scientific Name	Common Name	Status	Source Survey	Vegetation Type		
				KB	MG	KW
Sterculiaceae						
Waltheria indica L.	*ʻuhaloa*	I	C, A, S	*	*	*
Tiliaceae						
Triumfetta semitriloba Jacq.	Sacramento bur	X	C, S			*
Verbenaceae						
Lantana camara L.	Sacramento bur	X	C, A, S	*	*	*

Appendix B

Native Plant Information Sheets

Argemone glauca (Nutt. ex Prain) Pope (Papaveraceae)

Hawaiian Name: *Pua kala*
Status: Endemic

Ecological and Cultural Significance: "Scattered to locally common in coastal dry forest and subalpine forest, 0-1,900 m, on the leeward sides of all of the main islands" (Wagner et al 1999). "Early Hawaiians used the seeds and sap of the stalk as a narcotic and analgesic for toothaches, neuralgia, and ulcers; the sap was used to treat warts" (Wagner et al 1999).

Honua'ula Photos: The majority of *pua kala* clusters occurred in the southwestern portion of the *kiawe-wiliwili* shrubland, usually in relatively open sunny locations of the lava flow. All plants we observed were flowering at the time of the surveys.

Distribution and Density at Honua'ula: We found 412 *pua kala* (*Argemone glauca*) in 26 locations within the Property. Most clusters averaged 16 individuals, most of which were seedlings (60%). Canopy cover of *pua kala* clusters ranged from one to 39 m^2 with the average being 4 m^2 (n= 26 clusters).

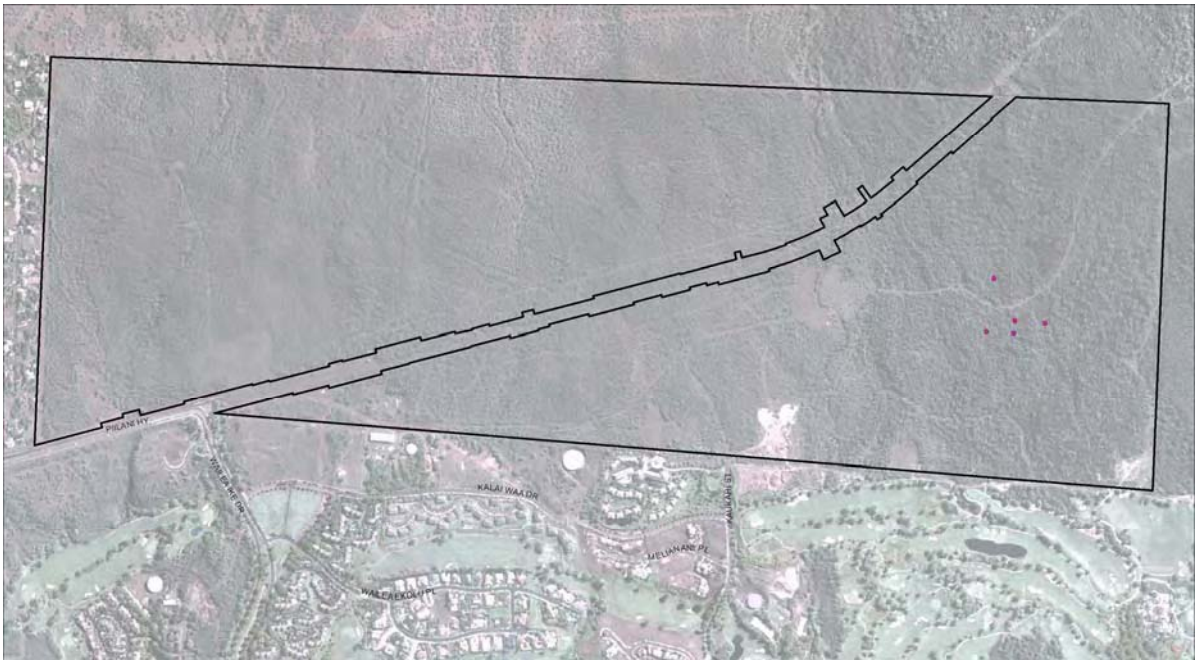
Canavalia pubescens Hook. & Arnott (Fabaceae)

Hawaiian Name: *'Āwikiwiki*
Status: Endemic (Candidate Endangered Species)

Ecological and Cultural Significance: "Presently uncommon in open dry sites such as lava fields, kiawe thickets, and dry forest, 15-540m, on Ni'ihau, Kaua'i (Nāpali Coast), Lāna'i, and leeward East Maui" (Wagner et al 1999). "Five populations are known on Maui: Keokea and Puu o Kali with "hundreds" observed, southwest Kalua o Lapa with two individuals, Papaka Kai with six individuals, Ahihi-Kinau with a few individuals, and southeast Pohakea, with at least one individual (HBMP 2008; F. Starr, pers. comm. 2006; H. Oppenheimer, pers. comm. 2006, 2008). These populations total a little over 200 individuals, with the majority ("hundreds") in one population (Puu o Kali)" (USFWS 2009).

Honua'ula Photos: All five *'āwikiwiki* were flowering and fruiting at the time of the survey; however, no seedlings were detected. The plants appeared to be healthy with no signs of damage or disease.

Distribution and Density at Honua'ula: Altenberg (2007) illustrated GPS points for some 15 plants within the development. During this intensive field survey, however, SWCA's project botanists found only five *'āwikiwiki* plants.



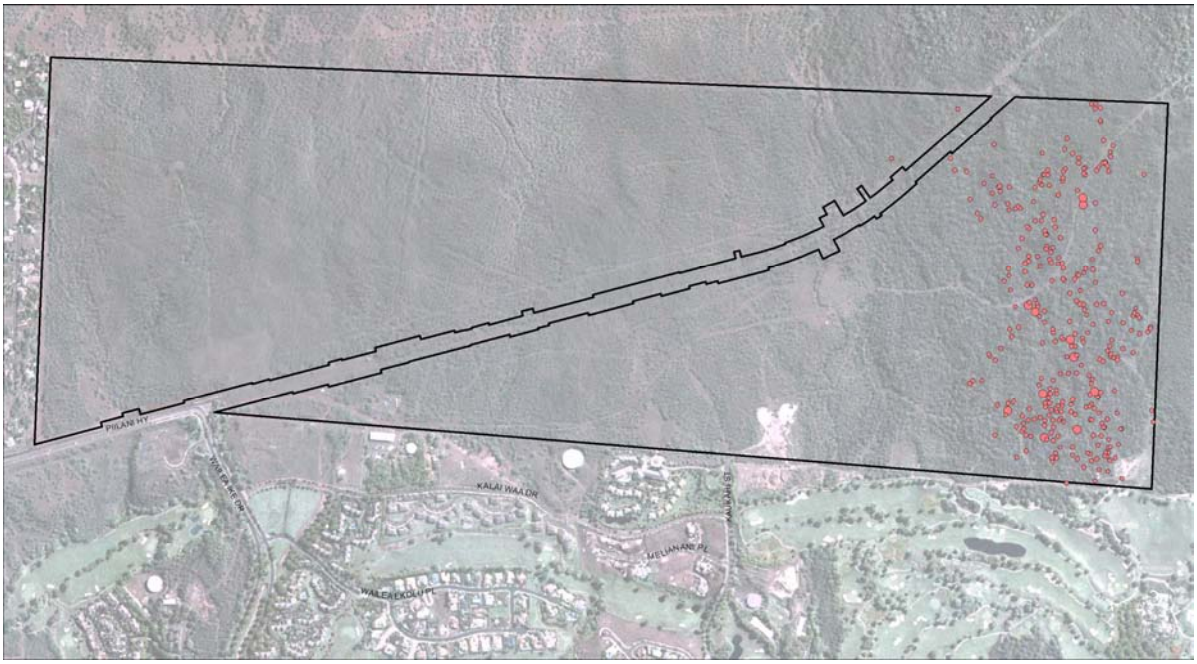
Capparis sandwichiana DC (Capparaceae)

Hawaiian Name: *Maiapilo*
Status: Endemic

Ecological and Cultural Significance: "Scattered on coral, basaltic rocks, or in soil along the coast or somewhat inland, 0-100 (-575) m, on Midway Atoll, Pearl and Hermes Atoll, Laysan, and all of the main islands" (Wagner et al 1999).

Honua'ula Photos: Several *maiapilo* clusters were flowering and fruiting but the frequency of seedlings was low (2.5%). About 20% of the plants showed mild to heavy signs of insect herbivory where the epidermis (upper layer of the leaves) appeared to be scrapped away.

Distribution and Density at Honua'ula: *Maiapilo* (*Capparis sandwichiana*) is a common shrub throughout the understory of mixed *kiawe-wiliwili* shrubland. We found 563 *maiapilo* during the survey and all but one individual was limited to the southern 'a'ā lava flow. Most clusters ranged from one to five individuals; 11 were larger, consisting of six to 10 individuals. The aerial cover of the largest cluster was 531 m^2, others ranged from one to 314 m^2 (average cover of 17 m^2).



Dodonaea viscosa Jacq. (Sapindaceae)

Hawaiian Name: *'A'ali'i*
Status: Indigenous

Ecological and Cultural Significance: "Pantropical; in Hawaii scattered to dominant, often in open sites such as ridges and lava fields, sometimes successional on lava or in pastures, ranging from coastal dunes, low elevation shrubland communities to dry, mesic, and wet forest, also subalpine shrubland, 3-2,350 m, on all of the main islands except Kaho'olawe" (Wagner et al 1999). "An extremely polymorphic species…Both the breeding system and morphological features of the *Dodonaea viscosa* complex are polymorphic" (Wagner et al 1999). "The fruit and leaves of *Dodonaea* are popular in lei making" (Wagner at al 1999).

Photos: One *'a'ali'i* plant was observed fruiting, and no seedlings were observed in the vicinity of the adult shrubs. All plants were healthy with no detectable signs of damage, disease or herbivory.

Both photos by Forest & Kim Starr (www.hear.org)

Left: *'a'ali'i flowers from Kanaio, Maui*

Right: 'a'ali'i near Auwahi, Maui

Distribution and Density at Honua'ula: We observed 16 *'a'ali'i* in seven locations, all limited to the south western corner of the *kiawe-wiliwili* shrubland. Six of the seven locations had one to four individuals while the largest cluster comprised of six individuals. Average cover of *'a'ali'i* is about 26 m^2 where the aerial cover of two clusters were 79 m^2 each and the remaining five ranged from one to 20 m^2.

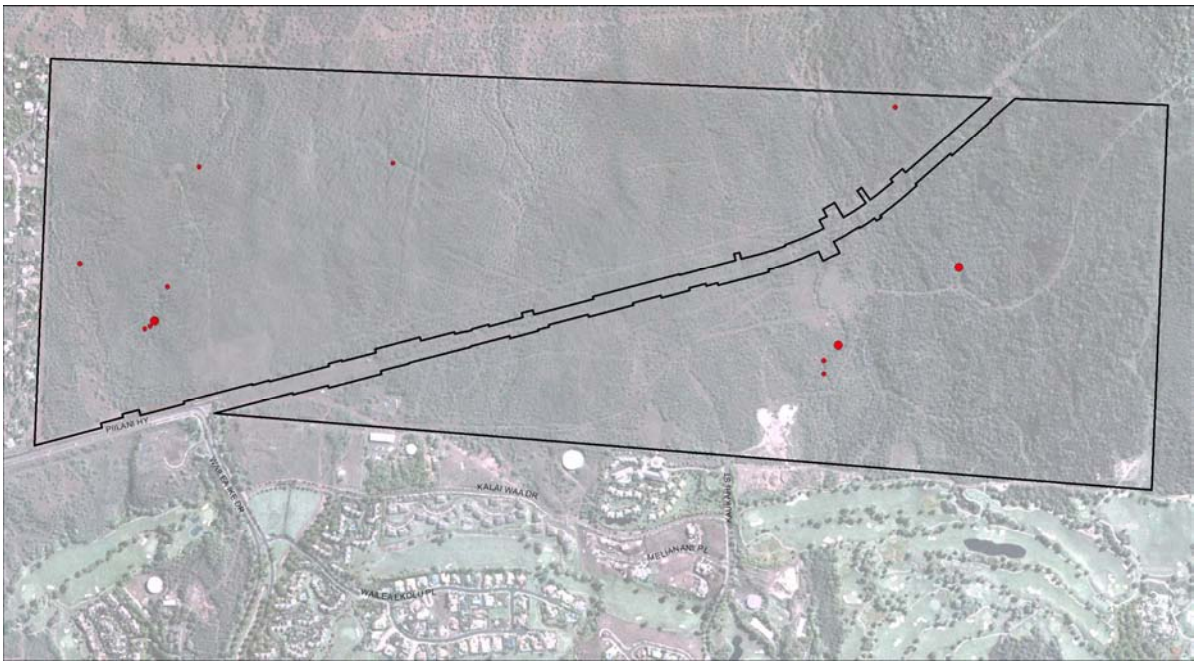
Doryopteris decipiens (Hook.) J. Sm. (Pteridaceae)

Hawaiian Name: *Iwaiwa*
Status: Endemic

Ecological and Cultural Significance: Reported from all major Hawaiian Islands and Ni'ihau, Lehua, and Kaho'olawe" (Palmer 2003). "Common in dry shrublands, grasslands and forests, often growing on exposed basalt, 30-915 m" (Palmer 2003).

Honua'ula Photos: Some iwaiwa plants within the development area showed signs of dehydration; most plants in the largest cluster (16 individuals) were very dry.

Distribution and Density at Honua'ula: Fifty-four *Iwaiwa* (*Doryopteris decipiens*) ferns were distributed at about 14 locations within the Property. Of these seven ferns were found within the *kiawe-wiliwili* shrubland, the others in the drainage gulches within in the northern portion of the site. The number of individuals within a cluster ranged from one to 16, the majority of which were adults (96%). Aerial cover of the largest cluster was approximately 7 m^2 while the others ranged from one to 3 m^2.



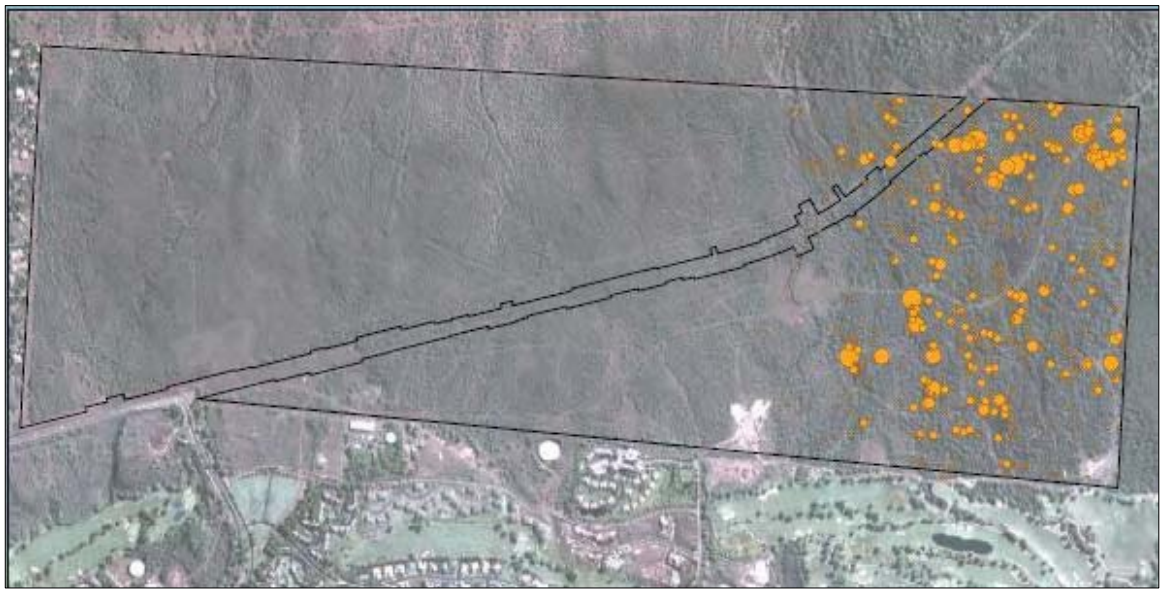
Erythrina sandwicensis Degener (Fabaceae)

Hawaiian Name: *Wiliwili*
Status: Endemic

Ecological and Cultural Significance: "Locally common in dry forest, up to 600m, on leeward slopes of all the main islands". "The soft, light wood was and still is used for the outriggers of traditional Hawaiian canoes. It also was formerly used for fishnet floats and surfboards. The seeds are strung into lei." Wagner et al (1999)

Honua'ula Photos: Most wiliwili trees showed some form of damage, primarily from the Erythrina gall wasp (*Quadristichus erythrinae* Kim) and the seed eating bruchid beetle (*Specularius impressithorax* Pic). Many trees were flush with new leaves following heavy rains in the spring of 2008, suggesting recovery from gall wasp damage.

Distribution and Density at Honua'ula: Wiliwili (*Erythrina sandwicensis*) is the most common native tree species in the *kiawe-wiliwili* shrubland. We mapped a total of 2478 individuals of which 2439 occurred in the southern 'a'ā portion of the Property in groves of various sizes. The largest groves (>15 individuals) tended to be located in the eastern portion of the kiawe-wiliwili shrubland. The frequency of adult wiliwili trees was greater (86%) than seedlings and juveniles.



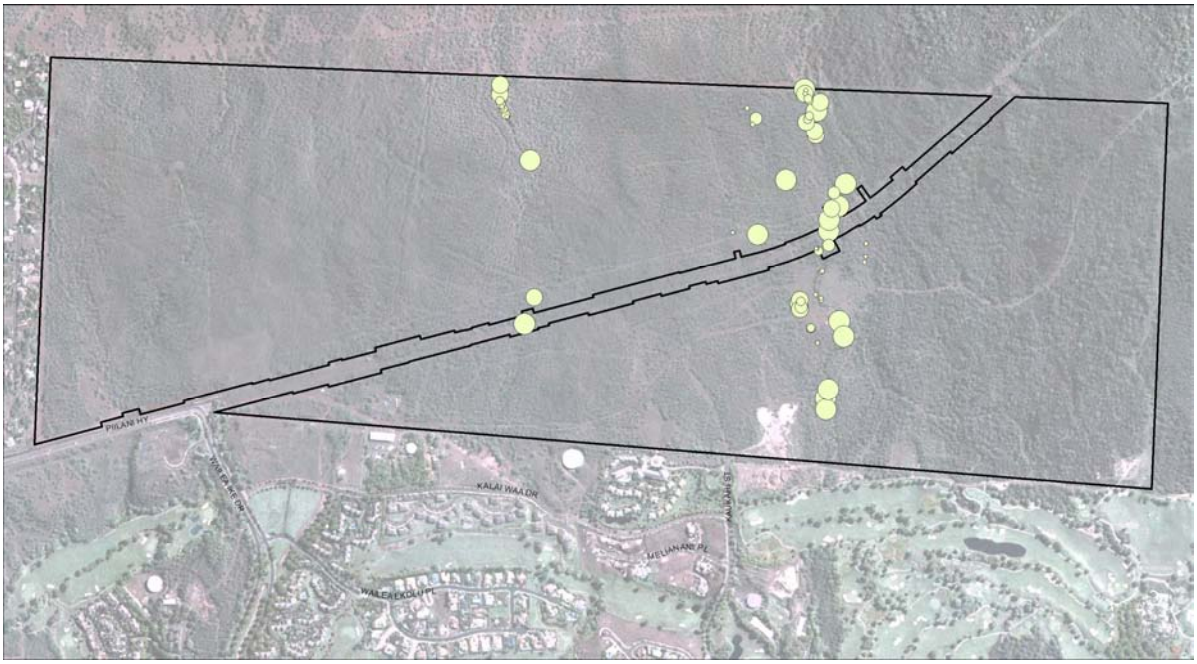
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult. (Poaceae)

Hawaiian Name: *Pili* grass
Status: Indigenous

Ecological and Cultural Significance: "Widely distributed throughout the tropics; in Hawai'i indigenous or possibly a Polynesian introduction, occurring on dry rocky cliffs, ledges, or slopes close to ocean exposure, 0-700 m, on all the main islands" (Wagner et al 1999). In dryer places, *pili* was favored for thatching material because of its pleasant odor, and was often used under a finishing thatch of *tī*, *hala*, or *kō* (Abbott 1992).

Honua'ula Photos: *Pili* grass (*Heteropogon contortus*) was the only native grass species found within the project area. Adult plants were flowering at the time of our surveys. We did not observe signs of superficial damage or disease.

Distribution and Density at Honua'ula: *Pili* grass was limited to gulches within the kiawe-buffel grass grassland in the northern half of the Project site. Most of *pili* grass occurred in the southern drainage gullies of the grassland, becoming less abundant to the north. We mapped 1493 *pili* grass plants in 66 locations within the Property.



Ipomoea tuboides Degener & Ooststr. (Convolvulaceae)

Hawaiian Name: Hawaiian Moon Flower
Status: Endemic

Ecological and Cultural Significance: "Occurring on arid rocky talus slopes or aa lava, 0-610 m, on all of the main islands" (Wagner et al 1999).

Honua'ula Photos: At the time of the SWCA 2008 surveys, all the Hawaiian moon flower plants within the development were flowering.

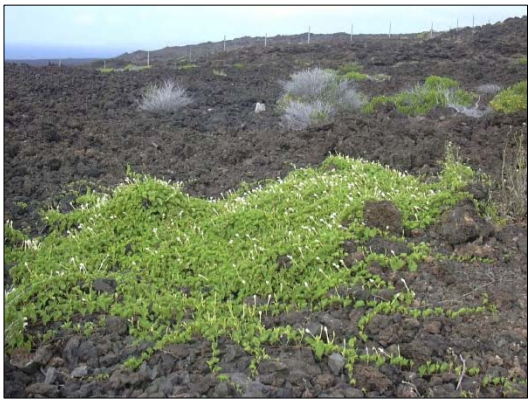
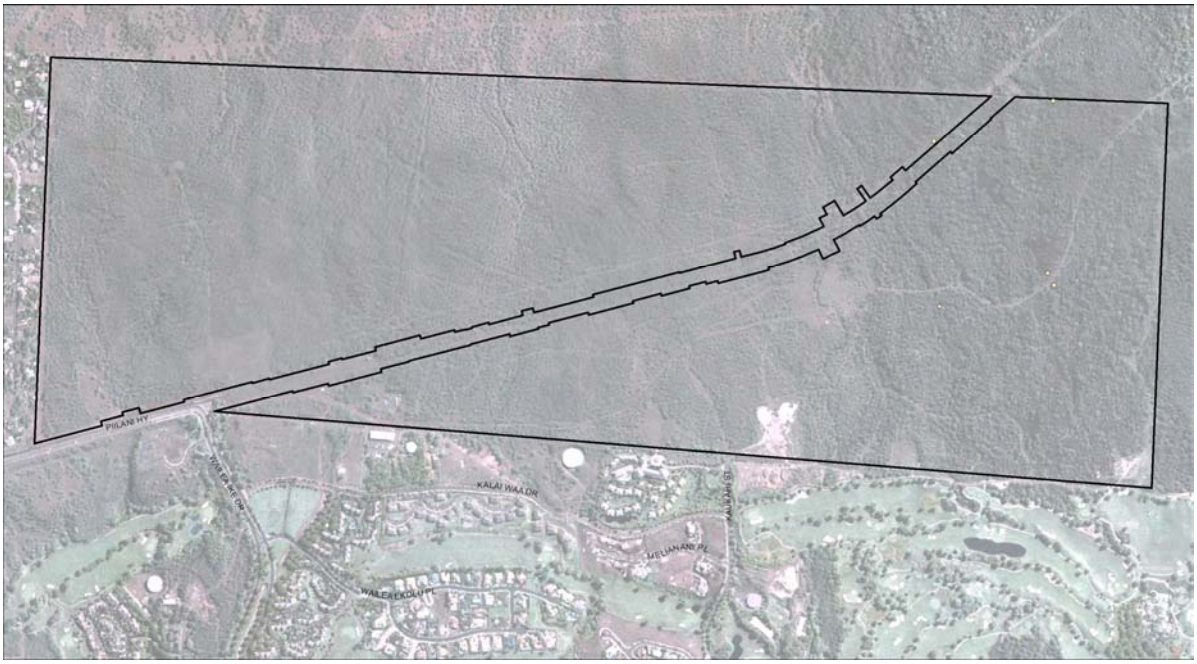


Photo above by Forest & Kim Starr of *Ipomoea tuboides* at Kanaio, Maui. (www.hear.org).

Distribution and Density at Honua'ula: Five Hawaiian moon flower (*Ipomoea tuboides*) vines were observed within the southern 'a'ā portion of the Property .



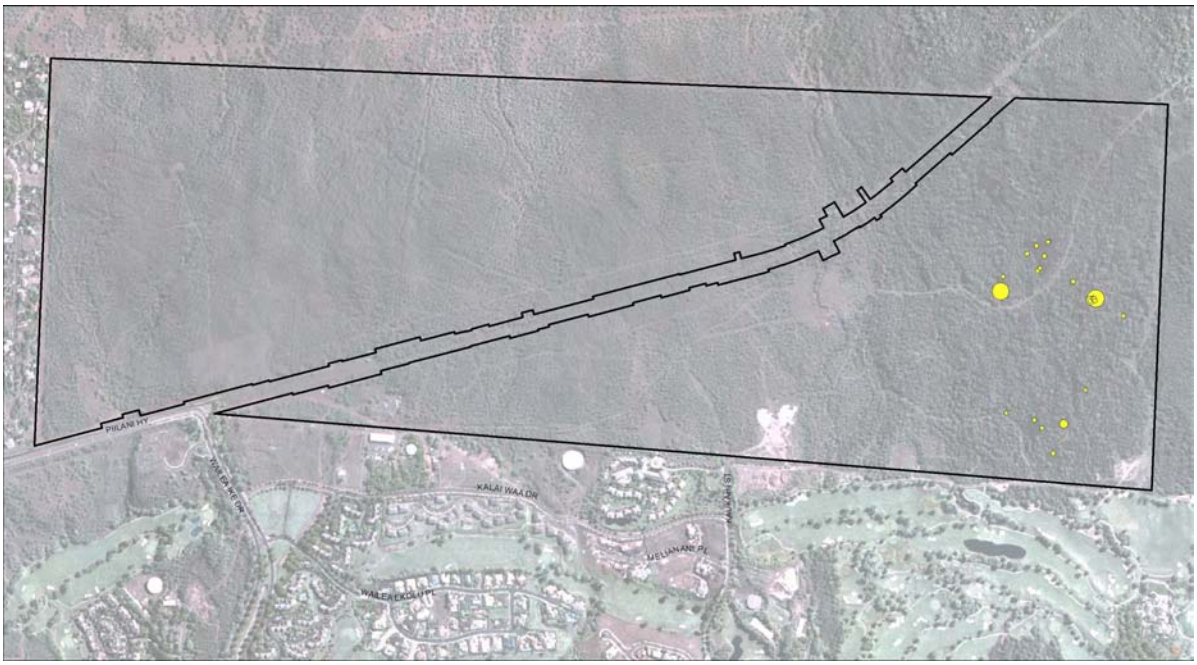
Lipochaeta rockii Sherff (Asteraceae)

Hawaiian Name: *Nehe*
Status: Endemic

Ecological and Cultural Significance: "Scattered to common in coastal sites to dry forest, often in disturbed areas and margins of lava flows, 15-550m, on Moloka'i, from scattered localities on Maui, common the coast on Kaho'olawe, also a single collection presumably from Hawai'i" (Wagner et al 1999). Synonymous with *L. lobata* (Gaud.) DC var. *makenensis* Degener & Sherff, *L. rockii* today is not recognized as a separate variety or subspecies (Herbst, Bishop Museum, pers. comm.)

Honua'ula Photos: The population of nehe within the Honua'ula project area has a unique leaf shape.

Distribution and Density at Honua'ula: One hundred and one *nehe* (*Lipochaeta rockii*) were found distributed in 24 locations. Two large clusters contained 22 and 23 individuals respectively and were located in the center of the mixed *kiawe-wiliwili* shrubland. Smaller clusters (< 10 individuals) were found from central to southwestern portion of the shrubland. The aerial cover of clusters ranged from < 1 m^2 to 78.5 m^2.



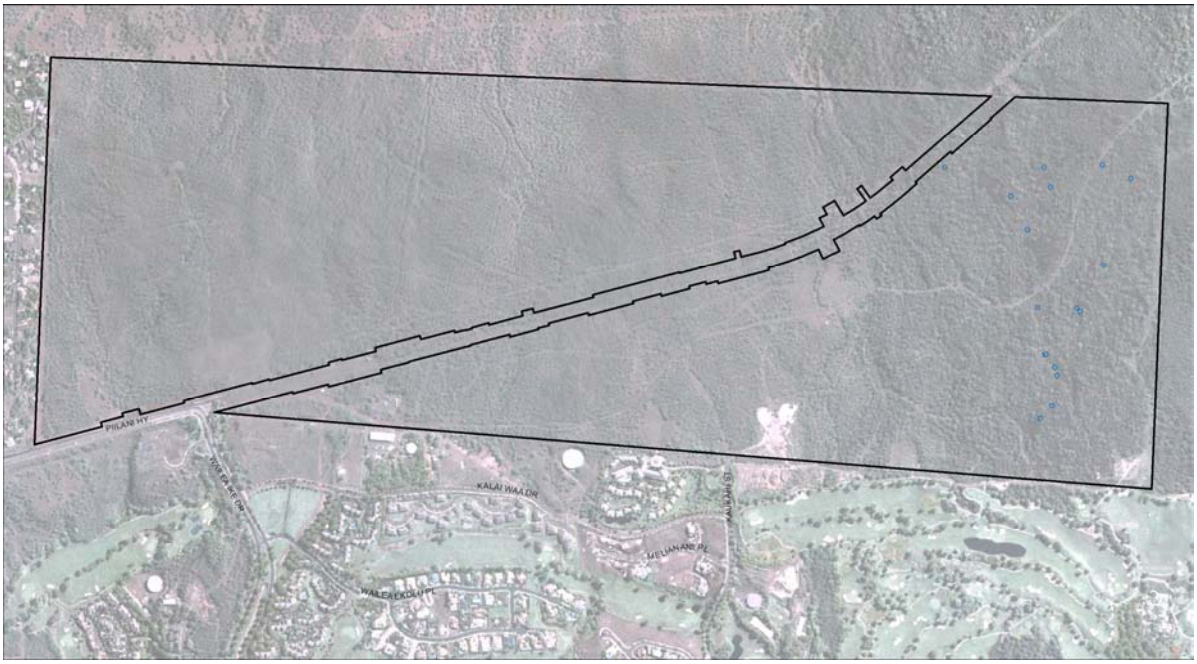
Myoporum sandwicense A. Gray (Myoporaceae)

Hawaiian Name: *Naio*
Status: Indigenous

Ecological and Cultural Significance: "Occurring on Mangaia in the Cook Islands and Hawai'i; in Hawai'i, occasional to common in strand vegetation, dry forest, 'a'ā lava, mesic to wet forest, and a dominant element of subalpine forest, 0-2,380 m, probably on all of the main islands but not documented from Kaho'olawe" (Wagner et al 1999). "The wood, while drying or burning, has an odor similar to that of sandalwood. It was once shipped to China as a substitute after the local sandalwood supply was exhausted, but it was not accepted. Also,it formerly was a preferred wood for house frames" (Wagner et al 1999).

Honua'ula Photos:

Distribution and Density at Honua'ula: Twenty one *naio* (*Myoporum sandwicense*) trees were observed in 17 locations distributed throughout the southern portion of the *kiawe-wiliwili* shrubland. No *naio* seedlings were found. Fifteen of the 17 locations were occupied by a single tree. Aerial cover ranged from < 1 m^2 to 78.5 m^2, the largest of which consisted of three trees.



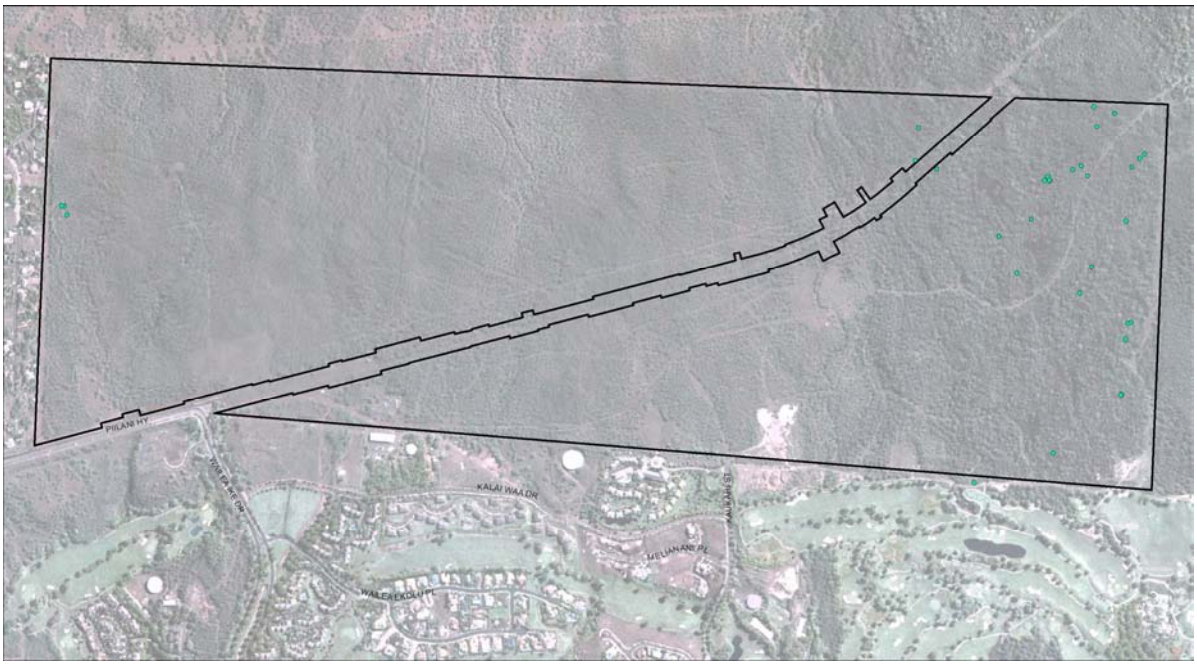
Senna gaudichaudii (Hook. & Arnott) H. Irwin & Barneby (Fabaceae)

Hawaiian Name: *Kolomona, uhiuhi*
Status: Indigenous

Ecological and Cultural Significance: "Occurring in the Pacific Basin, including the New Hebrides, Austral Islands, Rapa, Henderson Island, Fiji, Hawai'i, and perhaps New Caledonia and Tahiti; in Hawai'i primarily occurring in leeward sites usually on talus slopes, lava flows, or rocky sites in coastal *Leucaena-Prosopis* shrubland, disturbed hala forest, dry forest, and occasionally lower portions of mesic forest, 5-920 m, documented from all of the main islands except Ni'ihau and Kaho'olawe" (Wagner et al 1999).

Honua'ula Photos: Evidence of herbivory was observed at four of 32 locations. Many of the plants found were flowering and / or fruiting at the time of our surveys.

Distribution and Density at Honua'ula: Thirty-nine *kolomona* (*Senna gaudichaudii*) trees were mapped at 32 locations within the Property. Most were distributed in the southern portion of the mixed *kiawe-wiliwili* shrubland. The cluster size ranged from one to five individuals, and 24 of 32 mapped locations consisted of solitary plants. The aerial cover ranged from < 1 m^2 to 19.6 m^2.



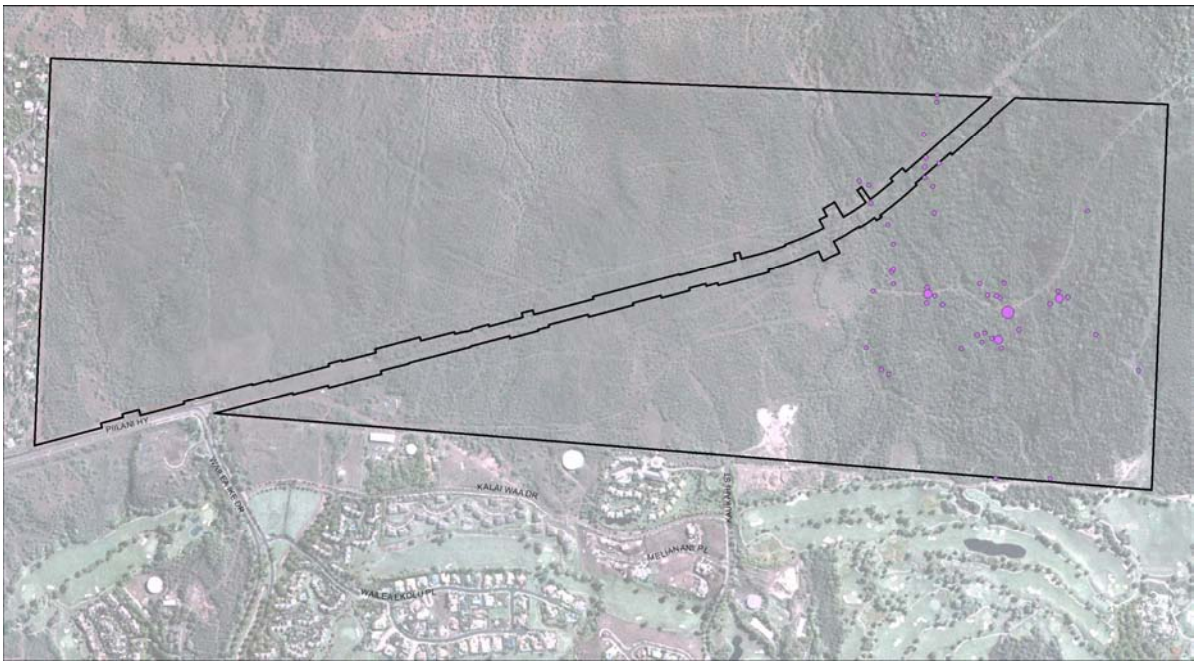
Sicyos hispidus Hillebr. (Cucurbitaceae)

Hawaiian Name: *ʻĀnunu*
Status: Endemic

Ecological and Cultural Significance: "Occurring in dry forest or alien vegetation, from near sea level up to 800 m, on Molokaʻi, Lānaʻi, Maui in the valley area from Kahului and Kīhei, and Hawaiʻi in the North Kona area" (Wagner et al 1999).

Honuaʻula Photos: *ʻĀnunu* vines within the Property did not show any signs of damage or herbivory.

Distribution and Density at Honuaʻula: We mapped 113 *ʻānunu* (*Sicyos hispidus*) vines at 49 locations within the Property. *ʻĀnunu* occurred primarily in the central and northern edge of the *kiawe-wiliwili* shrubland. Larger clusters (> 5 individuals) tended to be located in the central portion of the *kiawe-wiliwili* shrubland.



Sicyos pachycarpus Hook. & Arnott (Cucurbitaceae)

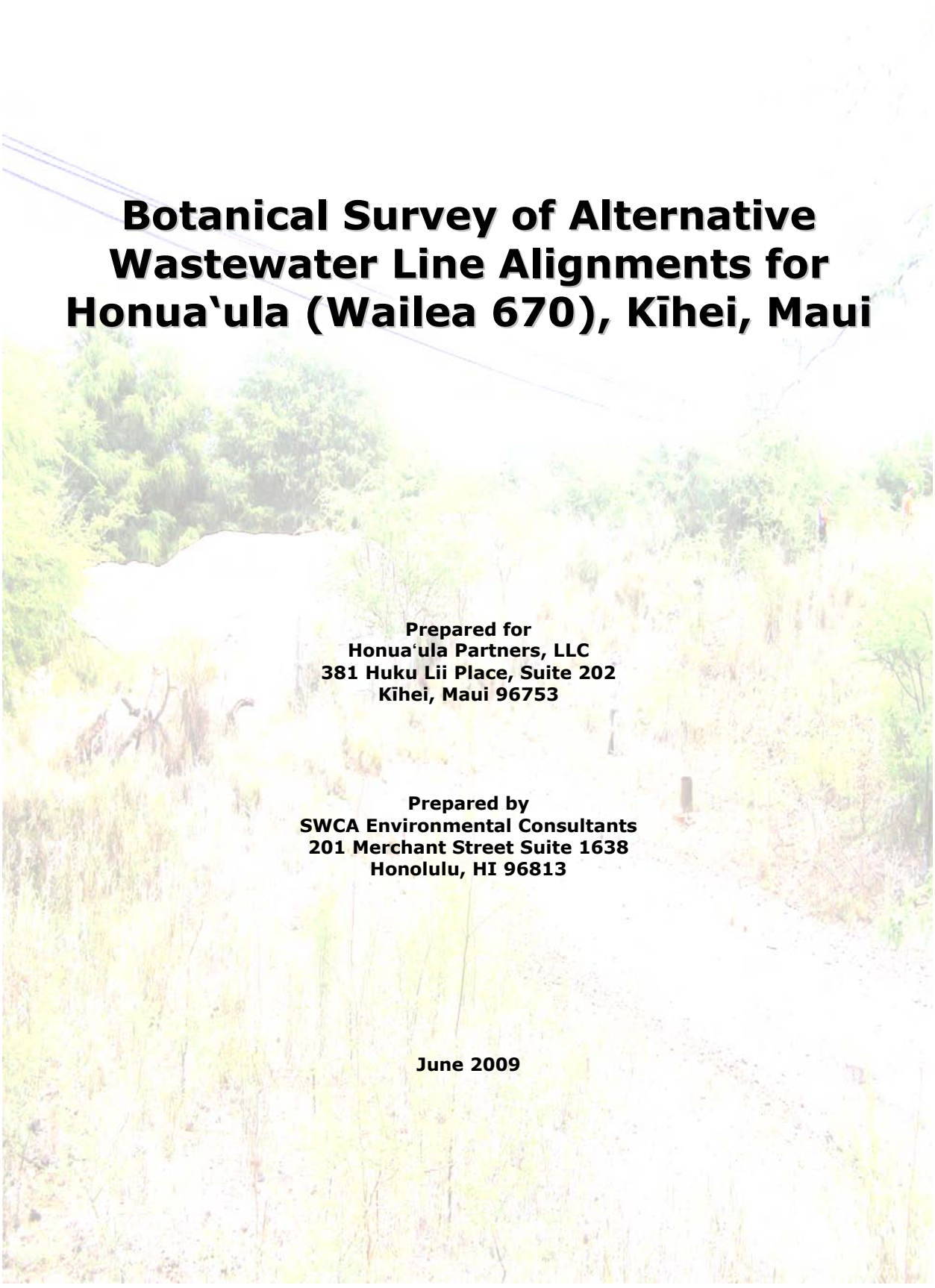
Hawaiian Name: *'ānunu*
Status: Endemic

Ecological and Cultural Significance: "Widespread in herb or shrubland coastal communities, dry forest, and alien vegetation such as *Leucaena* or *Prosopis* shrubland, on coral sand and clay loam, 0-900 m, primarily on the lower leeward slopes of all the main islands; also on the Northwestern Hawaiian Islands where collected from Laysan and Nihoa" (Wagner et al 1999).

Honua'ula Photos: Approximately 52% of mapped plants were seedlings. Many adults were observed flowering and/ or fruiting. Most of the *'ānunu* vines appeared to be healthy with only one plant showing some signs of herbivory.

Distribution and Density at Honua'ula: Six hundred and three *S. pachycarpus* were mapped in 102 locations. The size of clusters varied greatly and ranged from one to 110 plants per location. The majority of the larger clusters (> 15 individuals) were concentrated in the south and central portions of the *kiawe-wiliwili* shrubland.

Botanical Survey of Alternative Wastewater Line Alignments for Honua'ula (Wailea 670), Kīhei, Maui



Prepared for
Honuaʻula Partners, LLC
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1.0 INTRODUCTION

This report summarizes the findings of a botanical survey conducted by SWCA Environmental Consultants (SWCA) in August 2008 along three proposed alternative routes, for the conveyance of wastewater from the Honuaʻula Project site to the Makena Wastewater Reclamation Facility located on the Makena Resort property.

Honuaʻula is located in the Wailea area of Kihei, Maui (Figure 1). In April 2008, R.M. Towill Corporation conducted a feasibility study for conveyance of wastewater from Honuaʻula to the existing Makena Resort Wastewater Reclamation Facility (MRWRF), for treatment and disposal. This study by R. M. Towill investigated the following four alternative wastewater conveyance routes from Honuaʻula to MWWRF on the Makena property.

Alternative A – pump directly to MWWRF
Alternative B – pump to a high point and gravity flow to MWWRF
Alternative C – gravity flow to MWWRF
Alternative D- gravity flow to the Makena Wastewater Pump Station (MWWPS) "MU"

R. M. Towill Corporation determined that alternative C was infeasible because the elevation difference did not allow for gravity flow from the Project Site to the MRWRF (R. M. Towill Technical Memorandum, 2008). SWCA conducted botanical surveys along the three feasible alternative routes A, B and D (Figure 2) between the Project site and MRWRF for the conveyance of wastewater and the return of treated water for non-potable re-use at Honuaʻula.

The objectives of the botanical survey are:

- To identify and document the vegetation and all plant species within a 20 m-wide corridor along the three alternative wastewater line alignments;
- To map any State or Federally listed candidate, threatened or endangered plant species, species of concern and/ or rare (either locally or Statewide) plants within the study area.
- To recommend mitigation measures as appropriate to minimize impacts to native plants.

2.0 METHODS OF STUDY

Botanists Shahin Ansari Ph.D., Tiffany Thair (M.S. candidate), Maya Legrande M.S., and Talia Portner B.S. conducted plant surveys along each of the three alternative wastewater line alignments on August 8, 2008. A Trimble GeoXT mapping-grade GPS unit preloaded with the study transects was used to guide the survey and collect point data on native plants. The botanists walked the transects at 5-meter intervals to cover a 20-meter wide corridor along each of the three wastewater line alignments. The botanists thoroughly scanned each 5-m wide corridor and documented all plant species observed. We did not survey a portion of alternative route B that runs along the southern boundary of the Honuaʻula project Site, because this section was previously surveyed by SWCA in March of 2008 as part of the botanical survey for the Wailea 670 parcel (SWCA 2008).

3.0 RESULTS

The botanists observed 84 plant species, including eight native species two of which are endemic and six are indigenous (Appendix 1). No federally listed threatened, endangered, or candidate plants were detected along any of the alternative wastewater line alignments.

Previous botanical surveys of Honuaʻula (Char and Linney 1988, 1993, 2004; SWCA 2009) reported that the vegetation along the southern border of the Honuaʻula property is kiawe-wiliwili shrubland with scattered wiliwili, anuanu (*Sicyos pachycarpus*) and alena (*Boerhavia sp.*) (Figure 3). In this survey, all remaining areas surveyed consist of kiawe shrubland. Kiawe (*Prosopis pallida*) was the dominant canopy species along all three alternative routes (Figure 4). Some of the common herbs and shrubs included golden crown beard (*Verbesina encelioides*), *Bidens* species, false ragweed (*Parthenium hysterophorus*), klu (*Acacia farnesiana*), sweet basil (*Ocimum basilicum*), koa haole (*Leucena leucocephala*) and tree tobacco (*Nicotiana glauca*). Common

grasses found across the alternative conveyance routes include buffel grass (*Cenchrus ciliaris*), guinea grass (*Panicum maximum*), natal red top (*Melinus repens*) and sour grass (*Digitaria insularis*).

Alternative route 'A' extends for a length of 1940 linear m (6366 linear ft). About 753 m (2470 ft) of this route is adjacent to a paved road on the Makena property while the remaining 1187 m (3896 ft) runs through the kiawe shrubland and parts of the golf course on the Makena property (Figure 3). Alternative route 'A' requires the construction of a pump station (pump A, Figure 2) (Towill 2008) which would be located in the kiawe-wiliwili shrubland on the Honua'ula property (SWCA 2008) in the southwestern corner of the Honua'ula project site. Alternative route 'A' overlaps with route 'D' for 753 m (2470 ft) (Figure 3). Along the section where alternative routes 'A' and 'D' overlap, we found three native species, wiliwili (*Erythrina sandwicensis,* n=5), uhiuhi (*Senna gaudichaudii, n*=1) and maiapilo (*Capparis sandwichiana,* n=2). We also mapped thirty-three wiliwili trees at five locations towards the southern end of alternative route A (Figure 3 and 5).

Alternative route 'B' is 3212 linear m (10,538 linear ft) in length. Route 'B' would require the construction of two pump stations; pump A, and an additional pump station B (Figure 2) about 107 m (350 ft) to the east of pump A (Towill 2008). Location of pump B and the 856 m (2807 ft) stretch of route 'B' (Figure 2) runs through the kiawe-wiliwili shrubland (SWCA 2009) on the Honua'ula project site which inhabits the native species of wiliwili, anuanu (*Sicyos pachycarpus*) and alena (*Boerhavia sp.*) (Figure 3). The remaining 2356 m (7731 ft) of route B passes through the kiawe shrubland vegetation and parts of the golf course greens on the Makena property (Figure 2). Botanists found 14 wiliwili trees along the section of route 'B' that runs along the property line between Makena and the Lokelani Resort properties (Figure 3 and 6). They also found a clump of 11 to 15 individuals of hoary abutilon on Route B near the MRWRF (Figure 3).

Alternative route 'D' is 2027 linear m (6650 linear ft) in length. Similar to route 'A', the initial 753 m (2470 ft) of route 'D' also runs adjacent to a paved road on the Makena property. The remainder of 1274 m (4180 ft) of route 'D' runs through the kiawe shrubland and parts of the golf course before terminating at the 'MU' wastewater pump station (Figure 2 and 7). On the section of route 'D' that does not overlap with route 'A', we found one wiliwili tree and a clump of about 11 to 15 individuals of hoary abutilon (*Abutilon incanum*) close to the wastewater treatment plant (Figure 3 and 8).

4.0 DISCUSSION AND RECOMMENDATIONS

The construction and operation of any of the three alternative wastewater lines is not likely to have a major impact either on the vegetation or terrestrial ecosystems on either the Honua'ula or Makena parcels. The native species of plants found within the alternative wastewater line alignments are common throughout Maui and the other islands in the State. Ninety percent (90%) of the plants found on all three alternative alignments are introduced species.

Only a portion of alternative Route 'B' passes through the kiawe-wiliwili vegetation. This alternative requires the construction of two pump stations A and B, also within the kiawe-wiliwili vegetation. Construction of alternative Route 'A' is likely to disturb a greater number of native plant species. Alternative Route D is likely to have the least impact on the vegetation in general and on the native plants in particular.

- The the extent possible, as many wilwiliw trees as possible should remain undisturbed by construction. Where no alternative exists to removal of individual wiliwili trees, saplings can be propagated in areas adjacent to the wastewater lines, as appropriate.

- Non-native tree tobacco (*Nicotiana glauca*) trees, which occur along all three alternative wastewater line alignments, are host plants for the listed endangered Blackburn sphinx moth (*Manduca blackburni*). *M. blackburni* has been found on tree tobacco plants elsewhere in Kīhei and within Honua'ula (SWCA 2009). To help insure against the accidental take of individual sphinx moths, a qualified wildlife biologist should first screen each tree tobacco plant, prior to any land clearing. If sphinx moths or signs of sphinx moths (frass, cut stems or leaves,

caterpillars, pupae, or adults) are found on any tree, that tree should be marked and protected against disturbance, and the US Fish and Wildlife Service and Maui Office of the Department of Land and Natural Resources, Division of Forestry and Wildlife should be consulted.

- Landscaping following construction should focus on the use of native plant species normally found on adjacent lands. Suitable species may include, 'ilima (*Sida fallax*), ilie'e (*Plumbago zeylanica*), maiapilo (*Capparis sandwichiana*), uhiuhi (*Senna gaudichaudii*) and naio (*Myoporum sandwicensis*). Seeds or seedlings for these native plants may be obtained from various native plant nurseries on Maui such as Ho'olawa Farms or Native Nursery LLC.

5.0 LITERATURE CITED

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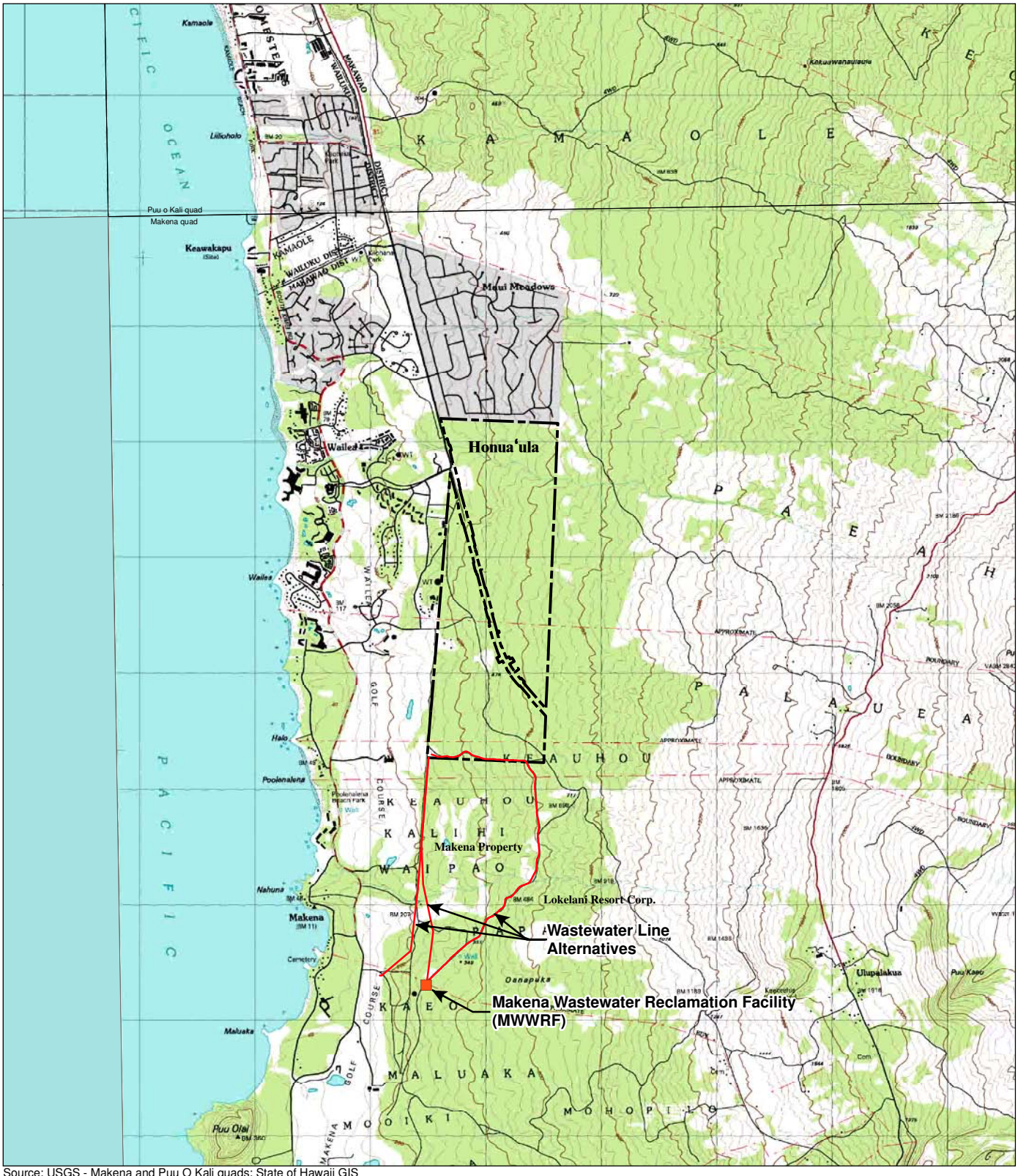
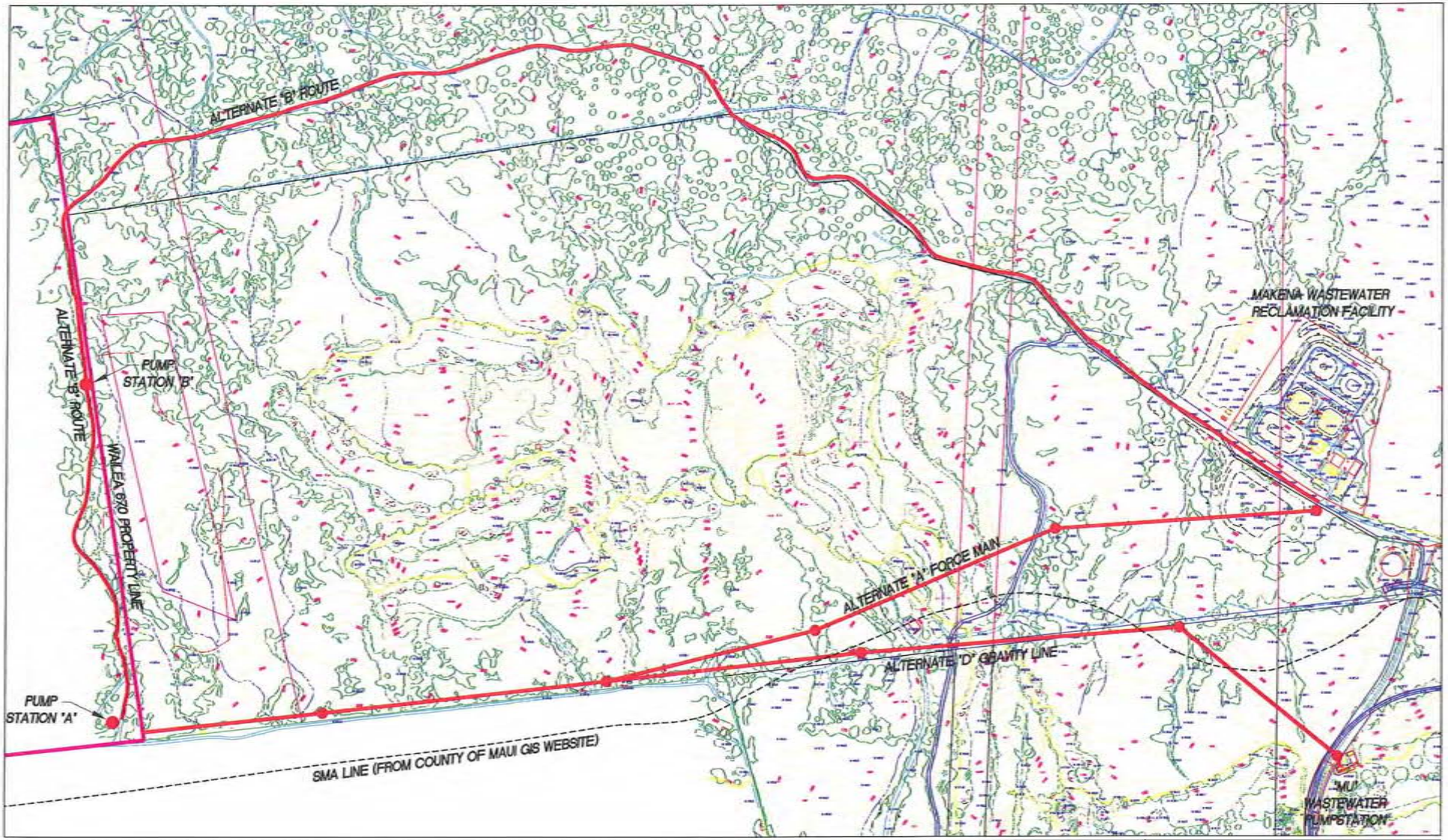


Source: USGS - Makena and Puu O Kali quads; State of Hawaii GIS

Figure 1
Location of Honua'ula Project Site



Planning – Engineering – Environmental Services – Photogrammetry – Surveying – Construction Management
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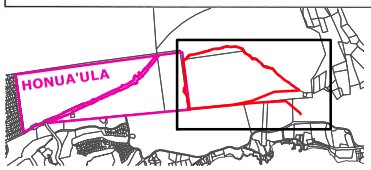
NOTES:
1. SCALE: 1"=200'.
2. CONTOUR INTERVAL: 2' & 5'.
3. VERTICAL DATUM: MEAN SEA LEVEL.
4. ORIGIN OF COORDINATES: HAWAIIAN PLANE COORDINATE SYSTEM (ZONE 2).
5. COMPILED FROM PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY DATED 4-3-07 AT AN AVERAGE OF 3,850' ABOVE MEAN TERRAIN.
6. ALL CONTOURS IN AREAS WHERE THE HEIGHT OF VEGETATION EXCEEDS FIVE FEET ARE TO BE INTERPRETED AS FORM LINES ONLY AND AS SUCH MAY BE SUBSTANDARD.

LEGEND
BUILDING
FENCED ROAD
UNPAVED ROAD
FENCE
WALL
POWER POLE
SEWER LINE
ACCESS SHAFT
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR
DRAIN LINE
SPOT ELEVATION
TREE, BUILDING, SCRUB
PALM TREE

GRAPHIC SCALE
200 0 100 200 400

Figure 2
Offsite Wastewater Line Alternatives Map



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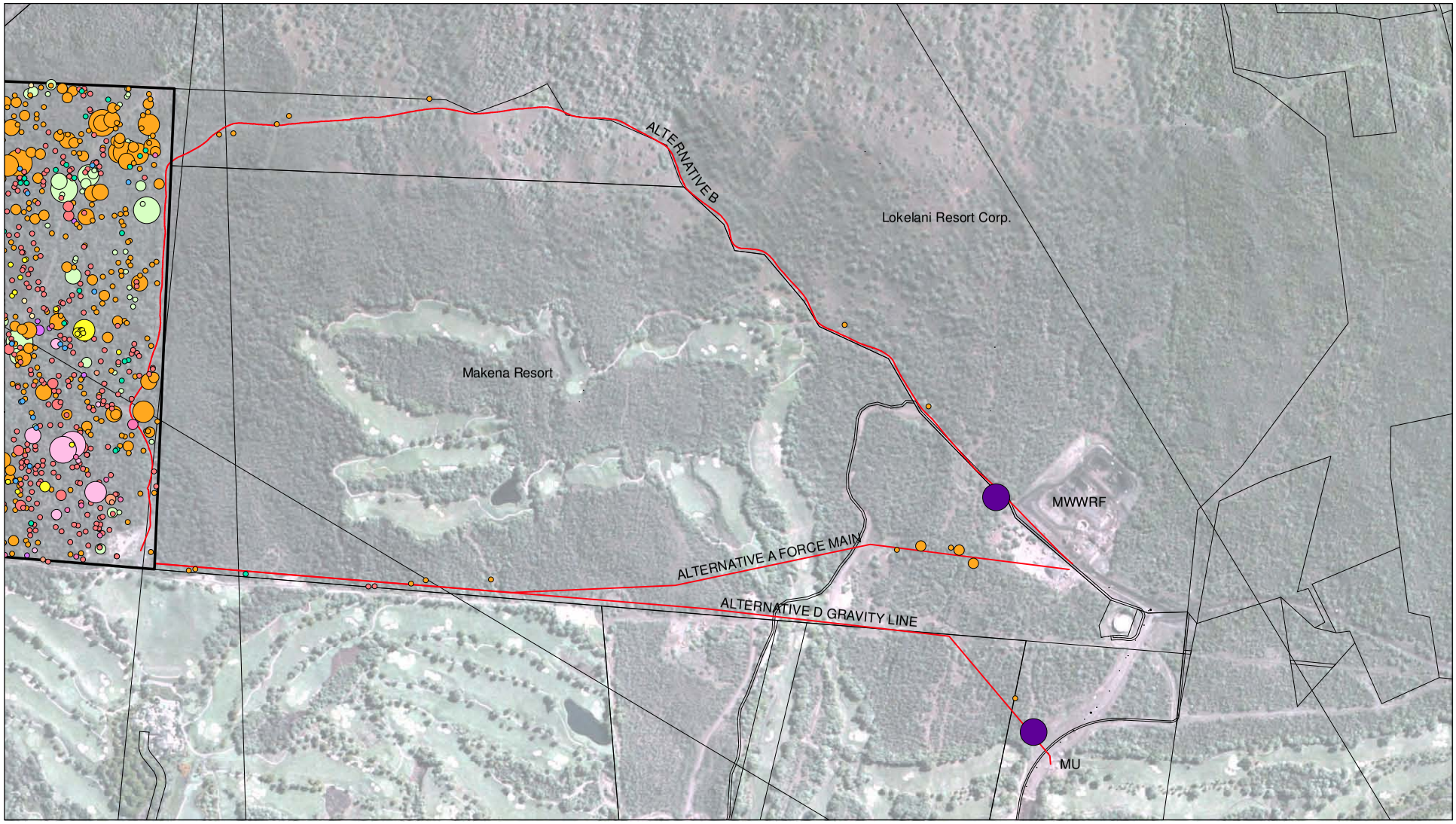

Native Plants by Species

- *Argemone glauca*
- *Abutilon incanum*
- *Boerhavia sp.*
- *Canavalia pubescens*
- *Capparis sandwichiana*
- *Doryopteris decipiens*
- *Dodonea viscosa*
- *Erythrina sandwicensis*
- *Heteropogon contortus*
- *Ipomoea tuboides*
- *Lipochaeta rockii*
- *Myoporum sandwicense*
- *Senna gaudichaudii*
- *Sicyos hispidus*
- *Sicyos pachycarpus*

Native Plants by Count Classes

- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 25
- 26 - 60
- 61 - 110

Plant Source: Native Plants were mapped with GPS
Boundary Source: PBR Hawaii
Aerial Source: PDC (Pacific Disaster Center)

Figure 3
Locations of Native Plants

N

0 250 500 1,000 ft

0 50 100 200 M

SWCA ENVIRONMENTAL CONSULTANTS

Figure 4. Kiawe shrubland was the typical vegetation type along route 'A' (above) and the other wastewater conveyance routes 'B' and 'D'.

A

B

Figure 5. Maiapilo (*Capparis sandwichiana*) (A) and uhiuhi (*Senna gaudiachaudii*) (B) adjacent to the paved road along the section where routes 'A' and 'D' overlap.

Figure 6. Grove of wiliwili (*Erythrina sandwicensis*) trees along wastewater conveyance route 'B'.

Figure 7. Vegetation along alternative wastewater conveyance route 'D' overlooking the waste water pump station.

Figure 8. Hoary abutilon (*Abutilon incanum*) on route 'D'.

APPENDIX 1. LIST OF PLANTS OBSERVED ON ALTERNATIVE WASTEWATER LINE ALIGNMENTS.

The taxonomy and nomenclature of the flowering plants are in accordance with Wagner et al. (1999), Wagner and Herbst (1999), and Staples and Herbst (2005). Recent name changes are those recorded in the Hawaii Biological Survey series (Evenhuis and Eldredge, eds, 1999-2002). (✓) indicated species presence.

The following symbols are used:

E = endemic = native only to the Hawaiian Islands.
I = indigenous = native to the Hawaiian Islands and elsewhere.
X = introduced or alien = all those plants brought to the Hawaiian Islands by humans, intentionally or accidentally, after 1778.

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
AGAVACEAE					
Furcraea foetida (L.) Haw.	mauritius hemp, malina	X		✓	
ALOEACEAE					
Aloe vera (L.) N.L.Burm.	aloe	X	✓	✓	
COMMELINACEAE					
Commelina benghalensis L.	hairy honohono, dayflower	X		✓	
POACEAE					
Axonopus fissifolius (Raddi)Kuhlm.	narrow-leaved carpetgrass	X	✓		
Brachiaria mutica (Forssk.) Stapf	California grass	X		✓	
Cenchrus ciliaris L.	buffelgrass	X	✓	✓	✓

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
Chloris barbata (L.) Sw.	swollen fingergrass	X	✓	✓	✓
Cynodon dactylon (L.) Pers	manienie	X	✓	✓	✓
Digitaria insularis (L.) Mez exEkman	sourgrass	X	✓	✓	✓
Melinus repens (Willd.) Zizka	natal redtop	X	✓	✓	✓
Panicum maximum L.	guinea grass	X	✓	✓	
Setaria verticillata (L.) P.Beauv.	bristly foxtail, mau'u pilipili	X	✓	✓	✓
ACANTHACEAE					
Asystasia gangetica (L.) T.Anderson	chinese violet	X		✓	
AMARANTHACEAE					
Alternanthera pungens Kunth	khaki weed	X	✓	✓	✓
Amaranthus spinosus L.	spiny amaranth	X	✓		
Amaranthus viridis L.	slender amaranth	X		✓	✓
ASCLEPIADACEAE					
Asclepias physocarpa (E.Mey.)Schltr.	balloon plant	X	✓	✓	✓
ASTERACEAE					

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
Ageratum conyzoides L.	maile hohono, maile	X		✓	
Bidens cynapiifolia Kunth	Spanish needle, beggartick	X	✓	✓	✓
Bidens pilosa L.	Spanish needle	X	✓	✓	✓
Conyza bonariensis (L.) Cronq.	hairy horseweed	X	✓	✓	✓
Crassocephalum crepidioides(Benth.) S.Moore	crassocephalum	X		✓	
Emilia fosbergii Nicolson	red pualele	X	✓	✓	
Lactuca serriola L.	prickly lettuce	X		✓	
Parthenium hysterophorus L.	false ragweed, Santa Maria	X	✓	✓	✓
Pluchea carolinensis (Jacq.) G.Don	sourbush	X	✓	✓	
Pluchea indica (L.) Less.	Indian fleabane	X		✓	
Pluchea x *fosbergii* Coopper. &Galang	fleabane	X		✓	
Sonchus oleraceus L.	pualele	X	✓		
Sphagneticola trilobata (L.)Pruski	wedelia	X		✓	
Tridax procumbens (L.)	coat buttons	X	✓	✓	✓
Verbesina encelioides (Cav.)Benth. & Hook	golden crown-beard	X	✓	✓	✓

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
Xanthium strumarium L. var.*canadense* (Miller)	kikania	**X**	✓	✓	
BORAGINACEAE					
Heliotropium procumbens Mill. var. *depressum* (Cham.) Fosberg		**X**	✓		
CACTACEAE					
Opuntia ficus-indica (L.) Mill.	panini	**X**	✓	✓	✓
CAPPARACEAE					
Capparis sandwichiana DC.	maiapilo	**E**		✓	
Cleome gynandra L.	wild spider flower	**X**	✓	✓	
CHENOPODIACEAE					
Atriplex semibaccata R.Br.	Australian saltbush	**X**	✓	✓	✓
Chenopodium murale L.	aheahea	**X**	✓		
CONVOLVULACEAE					
Ipomoea obscura (L.) Ker Gawl.		**X**	✓	✓	✓
Merremia aegyptia (L.) Urb.	hairy merremia	**X**	✓	✓	✓
CUCURBITACEAE					

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
Coccinea grandis (L.) Voigt	ivy gourd	X	✓	✓	✓
Momordica charantia L.	balsam pear	X		✓	
EUPHORBIACEAE					
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	✓	✓	✓
Chamaesyce hypercifolia (L.)Millsp.	graceful spurge	X		✓	
Chamaesyce hyssopifolia (L.)Small		X	✓		
Euphorbia heterophylla L.	kaliko	X		✓	
Ricinus communis L.	castor bean	X	✓	✓	✓
FABACEAE					
Acacia farnesiana (L.) Willd.	klu, aroma, kolu	X	✓	✓	✓
Chamaecrista nictitans (L.)Moench	partridge pea	X	✓	✓	✓
Crotalaria incana L.	fuzzy rattlepod	X	✓		
Crotalaria pallida Aiton	smooth rattlepod	X	✓	✓	
Desmanthus pernambucanus(L.) Thell.	slender or virgate mimosa	X	✓	✓	✓
*Erythrina sandwicensis*O.Deg.	wiliwili	E	✓		

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
Indigofera suffritocosa Mill.	iniko	X	✓	✓	✓
Leucaena leucocephala (Lam.) de Wit	koa haole	X	✓	✓	✓
Macroptilium lathyroides (L.)Urb.	wild bean	X	✓	✓	
Pithecellobium dulce (Roxb.)Benth.	opiuma	X		✓	
Prosopis pallida (Humb. &Bonpl. Ex Willd.) Kunth	kiawe, algaroba	X	✓	✓	✓
Samanea saman (Jacq.) Merr.	monkeypod	X		✓	
Senna occidentalis (L.) Link	coffee senna	X		✓	
Senna gaudichaudii (Hook. &Arn.) H.S.Irwin & Barneby	kolomona, uhiuhi	I		✓	
LAMIACEAE					
Hyptis pectinata (L.) Poit.	comb hyptis	X	✓		
Leonotis nepetifolia (L.) R.Br.	lion's ear	X	✓	✓	✓
Ocimum basilicum L.	sweet basil	X	✓	✓	✓
MALVACEAE					
Abutilon grandifolium (Willd.)Sweet	hairy abutilon	X	✓	✓	✓
Abutilon incanum (Link.)Sweet	hoary abutilon	I	✓	✓	✓

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
Malva parviflora L.	cheese weed	X	✓	✓	✓
Malvastrum coromandelianum(L.) Garcke	false mallow	X	✓	✓	✓
Sida fallax Walp.	ʻilima	I	✓	✓	✓
Sida spinosa L.	prickly sida	X	✓	✓	✓
NYCTAGINACEAE					
Boerhavia coccinea Mill.		X	✓	✓	✓
PASSIFLORACEAE					
Passiflora foetida L.	love-in-a-mist	X		✓	
PLUMBAGINACEAE					
Plumbago zeylanica L.	ʻilieʻe	I		✓	
PORTULACACEAE					
Portulaca oleracea L.	pigweed	X	✓	✓	✓
SOLANACEAE					
Datura stramonium L.	jimson weed	X	✓		
Nicandra physalodes (L.)Gaertn.	apple of Peru	X		✓	

Scientific Name	Common Name	Status	Alt B	Alt A	Alt D
Nicotiana glauca R.C. Graham	tree tobacco	X	✓	✓	✓
Solanum americanum Mill.	glossy nightshade, popolo	I		✓	
Solanum lycopersicum L. var.*cerasiforme* (Dunal)Spooner, G.J. Anderson &R.K. Jansen	cherry tomato	X	✓	✓	✓
*Solanum seaforthianum*Andrews		X	✓	✓	
STERCULIACEAE					
Waltheria indica L.	'uhaloa	I	✓	✓	✓
TILIACEAE					
Triumfetta semitriloba Jacq.	Sacramento bur	X	✓	✓	✓
Verbenaceae					
Lantana camara L.	lākana	X	✓	✓	