



July 26, 2010

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**Subject: Botanical Survey Update  
Kamakana Villages at Keahuolu  
TMK (3) 7-4-021:020. 024, 025, 026 and 027**

Dear Dr. Meyerhoff,

In response to your letter of 12 March 2010 to Ms. B.J. Leithhead Todd of the County of Hawai'i Planning Department, Group 70 International, Inc. commissioned a new botanical survey to address your concerns. Dr. Art Whistler of Isle Botanica was engaged to conduct a 100% botanical survey of the parcel. The purpose of the updated survey was to determine to what extent, if any, the Candidate species *Bidens micrantha* ssp. *ctenophylla* occurs on the property. The fieldwork was conducted on 25 and 26 March 2010 under Dr. Whistler's direction. GPS equipment was used to determine exact position relative to the property boundaries. The final April 2010 botanical report is attached for your review.

During a botanical survey in 2007, Dr. Whistler identified a few individuals of this species near the northeastern corner of the study area. However, no individuals of *Bidens micrantha* ssp. *ctenophylla* were found at the study site during the present survey. The findings lead Dr. Whistler to conclude one of the following:

- a) the species was rare then but is now extirpated from the area;
- b) the species is present but is extremely rare, perhaps existing only as seeds in the soil; or
- c) the species was never found in the study area because of unclear boundaries during the earlier surveys in 2007.

Additional botanical surveys were conducted in 2008 on two parcels contiguous with the upper reaches of the present study area. These surveys reported the species in very small numbers. One of two parcels now appears to have been at least partially cleared to make a well site. The findings of the current survey (April 2010) support the third possibility above.

*Bidens micrantha* ssp. *ctenophylla* usually occurs on 'a'a lava at elevations above 500 ft. Where it does occur, it is usually in relatively undisturbed Hawaiian "dry forest" dominated by species such as 'ohi'a lehua, lama, and 'alaha'e. The upper reaches of the study area are instead covered with disturbed scrub forest

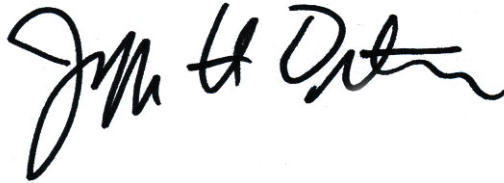
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dominated by Christmas berry and koa haole (both of them alien invasive species), along with the native 'alahe'e. Only the upper 8% of the subject property is above 500 ft elevation, and very little of this upper elevation area is covered with the suitable 'a'a lava flow habitat. Based on Dr. Whistler's current findings, the Candidate species *Bidens micrantha* ssp. *ctenophylla* is unlikely to exist on the property. The study further indicates that other Candidate, Threatened, or Endangered plant species are not present on the subject property.

We would appreciate your review of the attached report and concurrence with the findings. Please contact us if you require additional information.

Sincerely,

GROUP 70 INTERNATIONAL, INC.

A handwritten signature in black ink, appearing to read "Jeffrey H. Overton". The signature is fluid and cursive, with a large initial "J" and "O".

Jeffrey H. Overton, AICP, LEED AP  
Principal, Chief Environmental Planner

cc:

Ms. B.J. Leithhead Todd, Director  
County of Hawaii, Planning Department

**Botanical Survey**

**for**

***Bidens micrantha* subsp. *ctenophylla***

**at**

**Kamakana Villages:  
North Kona,  
Island of Hawai‘i**

**by**

**Art Whistler, Ph.D.  
Isle Botanica  
Honolulu, Hawai‘i**

**Report prepared for**

**Group 70  
Honolulu, Hawai‘i**

**April 2010**

## INTRODUCTION

The current study area encompasses about 273 acres located in North Kona on the island of Hawai‘i. It is on a property often designated on maps as Hawaiian Housing Finance and Development Corporation (HHFDC) land and is situated just northeast of Kailua-Kona town, and mauka (inland) of Ka‘ahumanu Highway. The irregularly shaped polygon (Fig. 1) is bordered on the southeast side by Palani Road, beginning at the point where Henry Street intersects it. The western boundary extends northwest from the intersection of Palani Road and Henry Street, and the northeast corner abuts Kealakehe. The area comprises lava flows of various ages that are covered mostly by an alien-dominated scrub vegetation that has been highly disturbed in the past.

Forest City Hawaii Kona, in collaboration with HHFDC, is proposing to develop a master-planned mixed-use affordable housing project on the site. Approval of the project required an up-to-date botanical survey, especially since there are federally listed threatened and endangered plant species occurring in the general vicinity. A botanical study was done on the area over 20 years ago (Char 1989), and a more recent one was completed three years ago (Whistler 2007). No federally listed species were encountered in those surveys, but one species reported from the area is now being considered for emergency listing under the Endangered Species Act of 1973. If it is listed, the project as now envisioned might be negatively impacted. Consequently, a new botanical study was initiated to determine if the species is still present, and if so, where may it occur.

The plant species in question is *Bidens micrantha*, one of 19 endemic species of the genus *Bidens* thought to have resulted from adaptive radiation from a single ancestor. More specifically, it is ssp. *ctenophylla* that is endemic to the island of Hawai‘i. Two other allopatric (non-overlapping in range) subspecies are recognized: *Bidens micrantha* ssp. *kalealaha*, which is restricted to Lana‘i and Maui, and is a Federally-listed Endangered Species; and ssp. *micrantha*, which is restricted to Maui, but is more common. These plants go by the Hawaiian name ko‘oko‘olau, which generally refers to all members of the genus.

The typical habitat for ssp. *ctenophylla* is “dry forest,” most of which has been destroyed in the Hawaiian Islands, and that which remains is highly degraded. According to the Hawai‘i Heritage Program (1992), the subspecies was known at that time (i.e., in 1992) from only four populations totaling approximately 3,000 individuals, the majority of which occurred in only two populations. They listed it as “Critically Imperiled,” which is defined as “6–20 occurrences and/or 1,000—10,000 individuals remaining; or more abundant but facing moderate threat range-wide.” Following categories developed by the IUCN (1994), Wagner et al. (1999b) listed it as “Vulnerable”, a category that includes plants likely to become endangered in the near future unless the threats to their survival are removed or reduced. In the Hawaiian Islands, most species in this category are threatened by extensive habitat destruction or modification or by other environmental disturbances. The Federal Government currently classifies it as a “Candidate” species for Endangered Species Act protection. The USFWS has recently (USFWS 2010a) estimated that the population has declined from 1,000 individuals in 2006 to 130 to 140 individuals in 2008 (USFWS 2010b).

Historically, ssp. *ctenophylla* probably had a wider range than it presently does on the slopes of Hualalali on the North Kona area, but it may now be restricted to an area of less than 10 square miles. Eleven herbarium species were located at the Bishop Museum Herbarium, and



Fig. 1. The study area at Kailua-Kona, Hawai'i.

those with specific data indicate the subspecies was collected on ‘a‘a lava flows between Pu‘uwa‘awa‘a and Hu‘ehu‘e, ranging from 500 to 3000 ft elevation. According to the USFWS (2010a), “one of the largest populations, totaling approximately 1,000 individuals, occurs on private land, representing one third of the known individuals. The remaining individuals occur on State-owned land. Land development for housing and commercial activities threatens ssp. *ctenophylla*. The two largest populations, one on private land and one on State land, are in the initial stages of development for residential and commercial purposes.”

A significant population of ssp. *ctenophylla* occurs in an area of “dry forest” at Kaloko above about 500 ft elevation, a few miles north of the present study site. It was recorded there during a transmission line botanical survey (CH2M Hill 1993) that passed through the area. A more comprehensive botanical survey (Whistler 2006) of the Kaloko “dry forest” documented the presence there of a seemingly healthy population of the subspecies. Another botanical survey just below the “dry forest” (Char 1993) extended up to 300 ft in elevation, but did not record the subspecies, showing that it is restricted to the upper portions of the ‘a‘a lava flow at Kaloko, probably always above 500 ft elevation.

The main objective of the current field study was to do a thorough field survey to see if any individuals of the plant in question are present. If they are, they were to be located using GPS coordinates. A second objective was to see if any other Threatened or Endangered plant species are found in the area.

## METHODOLOGY

A botanical field survey was conducted at the site by a four-person botanical team consisting of the PI (Art Whistler) and three field botanists on 25 to 26 March 2010. No roads lead into the property, so access was attained from Palani Road for the southern portions and from Kealakehe Drive for the eastern portion. A 100% survey was employed, in which parallel lines were walked by the field team members, with one of them flagging his survey line. When a boundary line was reached, the members turned around and the same procedure was carried out in the opposite direction. The lines were about 20 m apart, which is narrow enough for the team members to see the shrubby study plants. Particular care was taken on ‘a‘a lava flows, which is where most native species are found. Because the species has always been reported above 500 ft in elevation, the upper part of the property was treated with extra care. All plant species encountered during the survey were recorded. A checklist of all species found was also compiled (Appendix) and notes were taken on the vegetation, indicating the dominance and frequency of the plant species found there.

## THE VEGETATION

Four types of vegetation can be recognized at the study area: (1) Managed Land Vegetation; (2) *Prosopis* Woodland; (3) *Leucaena* Scrub; and (4) *Psydrax/Leucaena/Schinus* Scrub. The latter two blend into each other and no boundary lines between them can be drawn. The four types are briefly described below, and a more detailed description is found in Whistler (2007).

## (1) Managed Land Vegetation

This comprises the areas that are under periodic or frequent management, such as the edges of roads. This is a relatively minor component of the overall vegetation on the property, since only the roadsides of Palani Road are currently being managed. This vegetation rarely harbors threatened or endangered species, and was not sampled during the present survey.

## (2) *Prosopis* Woodland

This type of vegetation, which is dominated by the tall alien tree species kiawe (*Prosopis pallida*), is found only in an indistinct zone north of and paralleling Palani Road. It is an open woodland with few other tree species besides the koa haole (*Leucaena leucocephala*). The two other trees more common outside of this zone, the alien Christmas berry (*Schinus terebinthifolius*) and the native alahe'e (*Psyrdrax odoratum*), are uncommon here. Other than the alahe'e, few native species are found here, mostly because of the dominance of the kiawe.

## (3) *Leucaena* Scrub

This is the type of vegetation found on areas of older lava flows dominated by the alien scrubby tree koa haole (*Leucaena leucocephala*). It is not a homogeneous type of vegetation, since with increasing elevation going eastward up the slope, its density and the species associated with it change. On the lower and middle portions of the study area (Fig. 5), koa haole is mostly 1–3 m in height, scattered in an open-to-dense matrix of fountain grass (*Pennisetum setaceum*). Less common here is the native shrub or small tree alahe'e (*Psyrdrax odoratum*), which in some places is almost co-dominant. Several other trees and shrubs are found here, but in low numbers. This includes the alien tree Christmas berry (*Schinus terebinthifolius*) and the alien shrub klu (*Acacia farnesiana*). Fountain grass dominates most of the open areas having some soil, but a number of other herbaceous species are found in the shade of koa haole or on pahoehoe rocks free of fountain grass, particularly talinum (*Talinum triangulare*), air plant (*Kalanchoë pinnata*), lantana (*Lantana camara*), and carrion flower (*Stapelia gigantea*).

## (4) *Psyrdrax/Leucaena/Schinus* Scrub

This is the type of vegetation found on more recent lava flows at the highest elevations of the study area, particularly above 450 ft. elevation (Fig. 6). The main tree species dominating this community are the indigenous alahe'e (*Psyrdrax odoratum*), the alien koa haole (*Leucaena leucocephala*), and the alien Christmas berry (*Schinus terebinthifolius*). Other tree species found here include the endemic 'ohe (*Reynoldsia sandwicensis*), the endemic shrub mamane (*Sophora chrysophylla*), the indigenous shrub 'a'ali'i (*Dodonaea viscosa*), and the Polynesian-introduced noni (*Morinda citrifolia*). The most significant of these trees is ohe, since it is a stately endemic species. Only about five ohe were seen in the study area, including two in a cave formed from a collapsed lava tube.

The ground cover underneath the trees is usually sparse in this type of vegetation, with scattered clumps of *Pennisetum setaceum* (fountain grass) found mostly in pockets of soil or pahoehoe, and perhaps being the most common species found here. Sometimes, however, it covers large patches where the trees are scarce. Second in ground cover importance is probably

Table 1. Native species found in the study area.

<i>Bidens micrantha</i> ssp. <i>ctenophylla</i> (Asteraceae)	ko'oko'olau	Endemic
<i>Capparis sandwichiana</i> (Capparaceae)	pua pilo	Endemic
<i>Cocculus trilobus</i> (Menispermaceae)	huehue	Indigenous
<i>Cuscuta sandwichiana</i> (Cuscutaceae)	dotter	Endemic
<i>Dodonaea viscosa</i> (Sapindaceae)	a'ali'i	Indigenous
<i>Erythrina sandwicensis</i> (Fabaceae)	wiliwili	Endemic
<i>Heteropogon contortus</i> (Poaceae)	pili grass	Indigenous
<i>Ipomoea indica</i> (Convolvulaceae)	koali-'awa	Indigenous
<i>Nephrolepis exaltata</i> (Nephrolepidaceae)	kupukupu	Indigenous
<i>Peperomia leptostachya</i> (Piperaceae)	'ala'ala-wai-nui	Indigenous
<i>Plectranthus parviflorus</i> (Lamiaceae)	spurflower	Indigenous
<i>Plumbago zeylanica</i> (Plumbaginaceae)	'ilie'e	Indigenous
<i>Psilotum nudum</i> (Psilotaceae)	moa	Indigenous
<i>Psydrax odoratum</i> (Rubiaceae)	alahe'e	Indigenous
<i>Reynoldsia sandwicensis</i> (Araliaceae)	'ohe	Endemic
<i>Sida fallax</i> (Malvaceae)	'ilima	Indigenous
<i>Sophora chrysophylla</i> (Fabaceae)	mamane	Endemic
<i>Waltheria indica</i> (Sterculiaceae)	'uhaloa	Indigenous

the alien air plant (*Kalanchoë pinnata*), which forms a dense undergrowth in some places (Fig. 7), but is entirely lacking in others.

Scattered throughout the site are near barren areas of 'a'a lava. At higher elevations in the study area, this is where ssp. *ctenophylla* would most likely be found. However, none were seen and the few plants occurring in this inhospitable habitat were mostly the fern kupukupu (*Nephrolepis exaltata*). Christmas berry typically surrounds and grows over the edges of these rubbly lava flows.

This vegetation type, like the *Leucaena* Scrub, is classified as disturbed, since fires periodically sweep through the area, and goats are known to be in the area (recent signs of goats were found during the survey). These scrubby types of vegetation somewhat match the description of the "Lowland Dry Shrublands" described in Wagner et al. (1999a), which is described as occurring in leeward situations on most of the main islands, at 330 to 2000 ft elevation, and being open and not exceeding 10 ft in height.

## THE FLORA

In all, 50 plant species were recorded during the present survey (see Appendix). This is considerably less than the 82 recorded for the same area during the previous survey (Whistler 2007). The difference can be attributed mostly to two main factors: (1) the roadsides along Palani Road, where many weedy species are found, were not sampled during the present survey; and (2) the recent drought conditions have caused many herbaceous species to die back or die out.



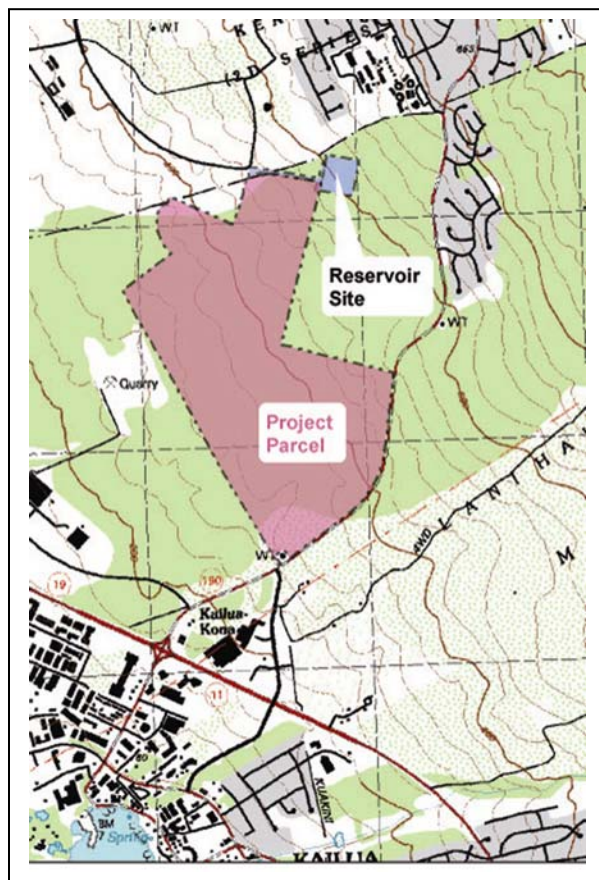


Fig. 2. Location of the well-site botanical survey (in blue).

Four species not found during the 2007 survey were found during the present survey, all but one of them alien weedy species. The addition of the four brings the total number of species recorded from the study area to 86.

Seventeen native species were recorded in the 2007 survey, four more than during the present work. Three of the missing native species, dotter (*Cuscuta sandwichiana*), pili grass (*Heteropogon contortus*), and moa (*Psilotum nudum*) are herbaceous, and the drought, along with the relative infrequency of the species, can account for their absence from the current survey. The fourth native species, wiliwili (*Erythrina sandwicensis*), was found during the 2007 survey only along Palani Road, probably planted as an ornamental. One native species recorded during the present survey, spurflower (*Plectranthus parviflora*), was not found during the original survey.

Of the 18 native species found during the two surveys (Table 1), six are endemic. Indigenous plants are species that are native to a region or place, but are also found elsewhere. Endemic plants are species restricted to a single region or area, i.e., in the case of Hawai'i, they are found only in Hawai'i. In biodiversity terms, the endemic status is the more important of the two categories, since if a species belonging to it is endangered or threatened in Hawai'i, it would likewise be classified globally. Indigenous species, however, can be rare in Hawai'i, but may be common elsewhere in the Pacific. Over 90% of the native plants in Hawai'i are endemic, one of

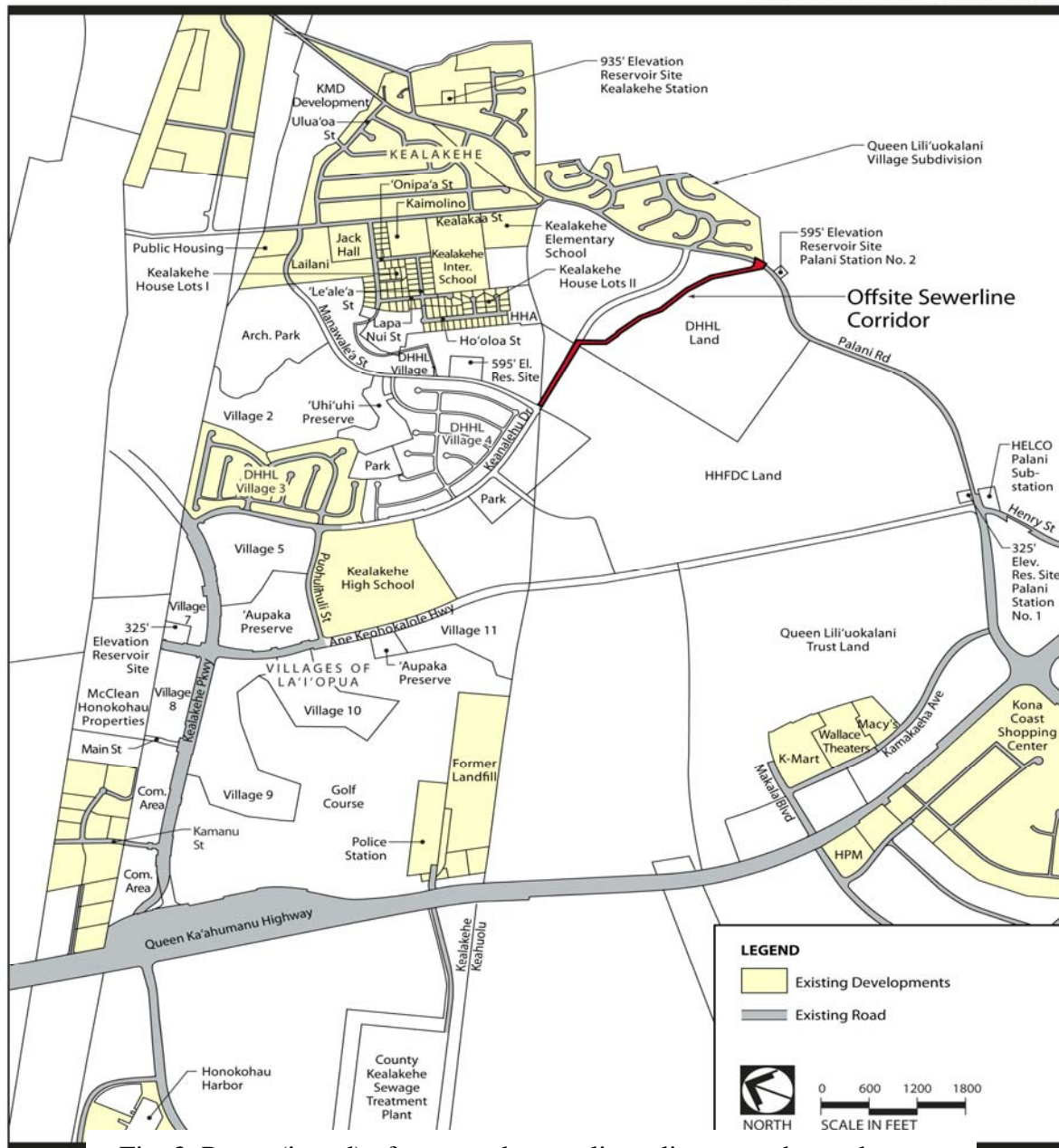


Fig. 3. Route (in red) of proposed sewer line adjacent to the study area.

the highest rates in the world. Only one of the species recorded during the two surveys is of particular concern, the ssp. *ctenophylla*, discussed earlier and the main basis for the present survey. One other endemic species, pua pilo (*Capparis sandwicensis*), is sometimes a cause of concern, but this spreading shrub is rare in the study area.

## DISCUSSION

The target species, ssp. *ctenophylla* was not found during the present survey in the study area. It was, however, reported there during the 2007 survey. According to that latter report, it

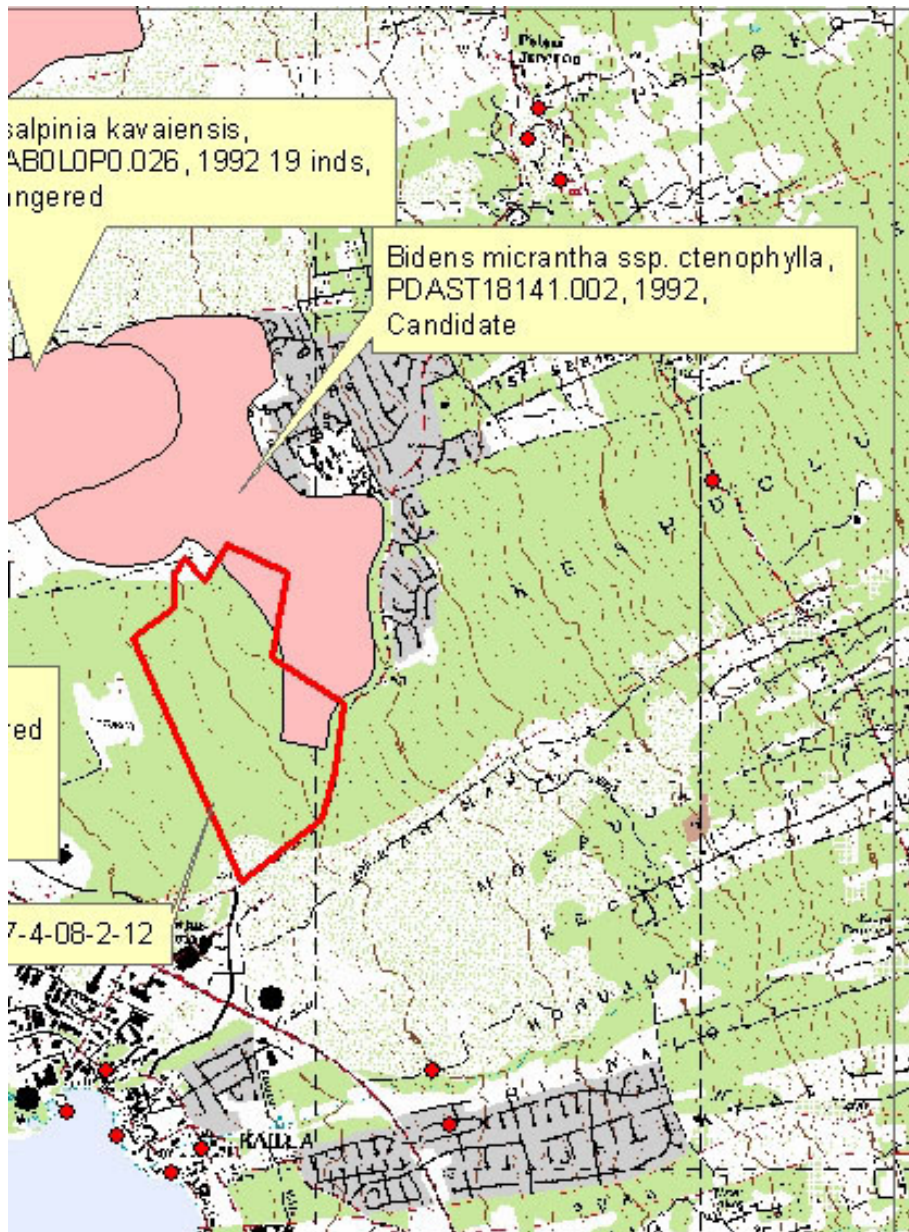


Fig. 4. Area of *Bidens micrantha ssp. ctenophylla* in relation to the study site (based on data from the Hawaiian Heritage Program).

“was found during the present study, but it has not been listed as Threatened or Endangered, and thus has no official status.” At that time, it was found only in the northeast corner above 500 ft elevation at that time. A botanical survey for a proposed well site (Whistler 2008a) just outside the northeast corner of the study site (Fig. 2) recorded the presence of the species there. That report noted that it “is shown in the Hawai‘i Natural Heritage Program Database map as occupying the area of the reservoir site, and this was found to be true.” It was, however,

Table 2. Comparison between the floras of Kaloko and the present study area.

<i>Species</i>	Common Name	Kaloko	Study Area
<b>Endemic Species</b>			
<i>Argemone glauca</i>	pua kala	X	--
<i>Bidens micrantha</i> ssp. <i>ctenophylla</i>	ko'oko'olau	X	--
<i>Capparis sandwichiana</i>	pua pilo	X	X
<i>Chamaesyce celastroides</i>	'atoto	X	--
<i>Cuscuta sandwichiana</i>	dotter	--	X
<i>Diospyros sandwicensis</i>	lama	X	--
<i>Doryopteris decipiens</i>	kumuniu	X	--
<i>Lipochaeta subcordata</i>	-----	X	--
<i>Metrosideros polymorpha</i>	'ohi'a lehua	X	--
<i>Pleomele hawaiiensis</i>	halapepe	X	--
<i>Reynoldsia sandwicensis</i>	'ohe	X	X
<i>Sophora chrysophylla</i>	mamane	X	X
<b>Indigenous Species</b>			
<i>Cocculus trilobus</i>	huehue	X	X
<i>Dodonaea viscosa</i>	'a'ali'i	X	X
<i>Heteropogon contortus</i>	pili grass	X	X
<i>Ipomoea indica</i>	koali-'awa	X	X
<i>Myoporum sandwicense</i>	naio	X	--
<i>Nephrolepis exaltata</i>	kupukupu	X	X
<i>Osteomeles anthyllidifolia</i>	'ulei	X	--
<i>Peperomia leptostachya</i>	'ala'ala-wai-nui	X	X
<i>Plectranthus parviflorus</i>	spurflower	X	X
<i>Plumbago zeylanica</i>	'ilie'e	--	X
<i>Psilotum nudum</i>	moa	X	X
<i>Psydrax odoratum</i>	alahe'e	X	X
<i>Scaevola taccada</i>	naupaka	X	--
<i>Senna gaudichaudii</i>	kolomona	X	--
<i>Sida fallax</i>	'ilima	X	X
<i>Waltheria indica</i>	'uhaloa	X	X

uncommon at the site. Another survey conducted on DHHL (Department of Hawaiian Home Lands) property adjacent to the present study along a proposed sewer line route from the present study area to Palani Road (Whistler 2008b) noted "The endemic subshrub *Bidens micrantha* ssp. *ctenophylla* was also present, but is very uncommon in the corridor." The only other indication that the species occurs in the study area is based upon the Hawaiian Heritage Program map that shows the species is found in the present study area (Fig. 4). It is not clear, however, how accurate this map is.

One factor that makes the current occurrence of *ssp. ctenophylla* on the property doubtful is lack of the appropriate habitat. It is usually found on 'a'a lava, but the major occurrences of this substrate in the study area are too low in elevation to have the species. It has not been reported below 500 ft elevation, probably because of the increasing aridity with decreasing elevation. Smaller patches of 'a'a occur in the northeast corner (Fig. 8), but no *ssp. ctenophylla* individuals were encountered there during the present survey.

A comparison of the present study area with the Kaloko "dry forest" where a significant population of *ssp. ctenophylla* occurs, shows some major differences in species composition between the two areas (Table 2). This table shows 26 native species in the "dry forest," and only 18 in the present study area. Most of the trees and shrubs in the Kaloko "dry forest" are native species, mainly 'ohi'a lehua (*Metrosideros polymorpha*), lama (*Diospyros sandwicensis*), 'alahe'e (*Psydrax odoratum*), pua pilo (*Capparis sandwichiana*), 'akoko (*Chamaesyce celastroides*), and mamane (*Sophora chrysophylla*). Less common native species are 'ohe (*Reynoldsia sandwicensis*), naio (*Myoporum sandwicensis*), and 'a'ali'i (*Dodonaea viscosa*). These species, with the exception of 'alahe'e, are either absent or uncommon in the present study area. They are replaced by a dense scrub of the native 'alahe'e, along with the two alien trees, koa haole and Christmas berry. So the species composition as well as the 'a'a substrate both indicate that the study area is not good habitat for *ssp. ctenophylla*.

There are several possible reasons why *ssp. ctenophylla* was once recorded in the study area but appears to no longer be there. It is possible that the plant was not actually found on the property due to errors in delineating the boundary during previous surveys. But if it was on the property, it was probably only a small remnant population. The plant may have died back because of the current drought. This is quite likely, since many of other herbaceous species found during the 2007 survey of the study area were also missing during the present survey. Or, the individuals may have died naturally and not reproduced themselves because of competition from fountain grass and other species.

In addition to development, there are three main threats to *ssp. ctenophylla* and other rare native plants in the general area: (1) fire; (2) grazing animals; and (3) invasive weeds. Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity and from occasional lightning strikes, they are not adapted to recurring fire regimes and do not quickly recover following a fire. Alien plants are often better adapted to fire, and some fire-adapted grasses have become widespread in Hawai'i. Native shrubland and "dry forest" can thus be converted to land dominated by alien grasses, especially fountain grass (*Pennisetum setaceum*) by means of recurring fires. Fire can destroy dormant seeds as well as plants, even in steep or inaccessible areas. Fountain grass is a fire-adapted bunch grass that has spread rapidly over bare lava flows and open areas on the island of Hawaii since its introduction in the early 1900s. Fountain grass is particularly detrimental to Hawaii's "dry forests" because it is able to invade areas once dominated by native plants, where it interferes with plant regeneration, carries fires into areas not usually prone to fires, and increases the likelihood of fires (Cuddihy and Stone 1990).

Grazing animals are the second threat to rare native species in Hawai'i. Goats are known to be in the study area, and they like to graze on tasty plants. Native plants tend to be tasty, since in the absence of native grazers they have not developed chemicals to inhibit herbivory. Consequently, native plants like *ssp. ctenophylla* are probably negatively impacted by grazing from goats. Sheep and cattle are also harmful to native plants, but these two species probably do not occur in the study area.

The third threat to rare native plants is introduction of competing species. The original native flora of Hawai‘i consisted of about 1,000 species, 89 percent of which were endemic. Of the total native and naturalized Hawaiian flora of 1,817 taxa, 47 percent were introduced from other parts of the world and nearly 100 species have become pests (Wagner et al. 1999a). Naturalized alien species compete with native plants for space, light, water, and nutrients (Cuddihy and Stone 1990). Several species of introduced plants threaten *spp. ctenophylla*, most notably fountain grass, koa haole, and Christmas berry.

### **Other Threatened or Endangered Species**

Several threatened or endangered species have been reported in the general area. Uhiuhi (*Caesalpinia kavaiensis*) was recorded in the vicinity just north of the present study area, but it was not found during the present or in the earlier (2007) survey of the study area, nor in the larger survey area surveyed by Char (1989). There is a single record of hala pepe (*Pleomele hawaiiensis*) collected in the uhiuhi area northwest of the study area in 1992, but it was not seen by Char in the larger area south of this population nor during the present study. There is, however, a relatively large population at Kaloko a few miles north of the current study area (Whistler 2006). ‘Aaea (*Nothoestrum brevifolium*) was found in 1992 near the record of hala pepe, but it was not seen by Char in the larger area south of this population, nor during the present study. At about the same point, a population of about 50 to 60 individuals of aupaka (*Isodendron pyriformum*) was found in 1992, but this shrub was not seen by Char in the larger area south of this population, nor during the present study. Consequently, none of these species has been reported in the study area, nor are they likely to occur there because of the lack of appropriate habitat.

### **Culturally Significant Species**

In a Cultural Impact Assessment (CIA) of the site (Rosendahl 2007), H. Wong-Smith noted several plants found at the site were mentioned by informants as being culturally significant—pili grass (*Heteropogon contortus*), pilo (*Capparis sandwichiana*), alahe‘e (*Psydrax odoratum*), kauila (two trees go by this name, *Alphitonia ponderosa* and *Colubrina oppositifolia*, and it is not clear which one is meant; the latter is a federally listed endangered species), and uhiuhi (*Caesalpinia kavaiensis*). Pili grass was reportedly harvested on the site “sometime in the past” [for thatch?], but this grass is now uncommon at the site because of the dominance of invasive plants, and was not found during the present survey. Pilo, reportedly still harvested in the area for medicinal purposes, is very infrequent in the study area, but is much more common in the Kaloko dry forest to the north. Kauila and uhiuhi are rare species, but neither was found in the study area during the present survey. Alahe‘e is very common at the site, as it is in much of Hawai‘i. The report made no mention of preserving these species, even if they were found in the area.

## **CONCLUSIONS**

The “Candidate” species *Bidens micrantha* ssp. *ctenophylla* was reported once in the study area, but only at the highest, northeast corner of the property, where it was very uncommon. Botanical surveys of two areas adjacent to this corner turned up small numbers of the species just

outside the study area boundary. The species was not found during the present study and was either extirpated from the area, or is now present only in the seed bank. This disappearance may be due to recent droughts in the area, to fire (but not recently), to competition with alien species, or to inability to reproduce. Suitable habitat, like that found in the “dry forest” at Kaloko, is not found in the study area. Consequently, there is no indication that development of the area as now planned will adversely affect ssp. *ctenophylla*. It will also have no effect on any other Threatened, Endangered, or Candidate plant species in Hawai‘i, nor on any culturally significant Hawaiian plants.

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## APPENDIX. CHECKLIST OF PLANT SPECIES

The following is a checklist of the vascular plants inventoried during the field studies on the Hawaii Housing Finance and Development Corporation's Keahuolu Affordable Housing project parcel. The plants are divided into three groups, Ferns (including fern allies), Monocots, and Dicots. Within these groups, the species are presented taxonomically by family, with each family and each species in the family in alphabetical order. The taxonomy and nomenclature of the ferns follow Palmer 2003 and the flowering plants (Monocots and Dicots) follow Wagner *et al.* (1990). In most cases, common English and/or Hawaiian names listed here have been taken from St. John (1973) or Porter (1972).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name, when known.
3. Biogeographic status. The following symbols are used.
  - E = endemic (found only in Hawai'i).
  - I = indigenous (native to Hawai'i as well as other geographic areas).
  - P = Polynesian introduction (introduced to Hawai'i by Polynesians before the advent of the Europeans).
  - X = Introduced or alien (not native, introduced to Hawai'i, either accidentally or intentionally, after the advent of the Europeans).

Species	Common Names	Status	
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FERNS AND FERN ALLIES			
NEPHROLEPIDACEAE (Sword Fern Family)			
<i>Nephrolepis exaltata</i> (L.) Schott	kupukupu	I	
POLYPODIACEAE (Common Fern Family)			
<i>Phymatosorus grossus</i> (Langsd. & Fisch.) Brownlie	laua'e	X	
PSILOTACEAE (Psilotum Family)			
<i>Psilotum nudum</i> L.	moa	I	Not found 2010
MONOCOTS			
COMMELINACEAE (Spiderwort Family)			
<i>Rhoeo spathacea</i> (Sw.) Stearn	oyster plant	X	
POACEAE (Grass Family)			
<i>Chloris barbata</i> (L.) Sw.	swollen fingergrass	X	Not found 2010
<i>Heteropogon contortus</i> (L.) P. Beauv. ex Roem. & Schult.	pili grass	I?	Not found 2010
<i>Panicum maximum</i> Jacq.	Guinea grass	X	
<i>Pennisetum setaceum</i> (Forssk.) Chiov.	fountain grass	X	
<i>Rhynchelytrum repens</i> (Willd.) C.E. Hubb.	Natal redtop	X	

Species	Common Names	Status	
DICOTS			
ACANTHACEAE (Acanthus Family)			
<i>Barleria cristata</i> L.	Philippine violet	X	
ANACARDIACEAE (Mango Family)			
<i>Schinus terebinthifolius</i> Raddi	Christmas berry	X	
APOCYNACEAE (Periwinkle Family)			
<i>Catharanthus roseus</i> (L.) G. Don	Madagascar periwinkle	X	
ARALIACEAE			
<i>Reynoldsia sandwicensis</i> A. Gray	'ohe	E	
<i>Schefflera actinophylla</i> (Endl.) Harms	octopus tree	X	
ARISTOLOCHACEAE (Dutchman's Pipe Family)			
<i>Aristolochia littoralis</i> Parodi	pelican flower	X	Not found 2010
ASCLEPIADACEAE (Milkweed Family)			
<i>Stapelia gigantea</i> N.E. Brown	carrion flower	X	
ASTERACEAE (Sunflower Family)			
<i>Bidens cynapiifolia</i> Kunth	West Indian beggar's-tick	X	Not found 2010
<i>Bidens micrantha</i> Gaud. subsp. <i>ctenophylla</i> (Sherff) Nagatga & Ganders	-----	E	Not found 2010
<i>Bidens pilosa</i> L.	beggar's-tick	X	Not found 2010
<i>Emilia sonchifolia</i> (L.) DC.	pualele, emilia	X	Not found 2010
<i>Pluchea carolinensis</i> (Jacq.) G. Don	pluchea	X	Not found 2010
<i>Tridax procumbens</i> L.	coat buttons	X	
BIGNONIACEAE (Bignonia Family)			
<i>Jacaranda mimosifolia</i> D. Don	jacaranda	X	
<i>Spathodea campanulata</i> P. Beauv.	African tulip tree	X	Not found 2010
BUDDLEIACEAE (Butterfly-bush Family)			
<i>Buddleia asiatica</i> Lour.	dogtail, heulo'ilio	X	Not found 2010
CACTACEAE (Cactus Family)			
<i>Opuntia ficus-indica</i> (L.) Mill.	prickly pear, panini	X	
CANNABACEAE (Marijuana Family)			
<i>Cannabis sativa</i> L.	pakalolo, marijuana	X	Not found 2010
CAPPARACEAE (Caper Family)			
<i>Capparis sandwichiana</i> DC	pua pilo	E	
<i>Cleome gynandra</i> L.	African spider flower	X	Not found 2010
CARICACEAE (Papaya Family)			
<i>Carica papaya</i> L.	papaya	X	Not found 2010
CLUSIACEAE (Mangosteen Family)			
<i>Clusia rosea</i> Jacq.	autograph tree	X	
CONVOLVULACEAE (Morning-Glory Family)			
<i>Ipomoea indica</i> (J. Burm.) Merr.	koali-'awa	I	
<i>Ipomoea obscura</i> (L.) Ker-Gawl.	bindweed	X	

Species	Common Names	Status	
CRASSULACEAE (Stonecrop Family)			
<i>Kalanchoë pinnata</i> (Lam.) Pers.	air plant	X	
<i>Kalanchoë tubiflora</i> (Haw.) Raym.-Hamet	chandelier plant	X	Not found 2010
CUCURBITACEAE (Gourd Family)			
<i>Coccinea grandis</i> (L.) Voigt	ivy gourd	X	Not found 2010
<i>Momordica charantia</i> L.	wild bittermelon	X	
CUSCUTACEAE (Dodder Family)			
<i>Cuscuta sandwichiana</i> (Cuscutaceae)	kauna 'oa	E	Not found 2010
EUPHORBIACEAE (Spurge Family)			
<i>Aleurites moluccana</i> (L.) Willd.	candlenut, kukui	P	Not found 2010
<i>Chamaesyce hirta</i> (L.) Millsp.	garden spurge	X	Not found 2010
<i>Euphorbia heterophylla</i> L.	kaliko	X	Not found 2010
<i>Phyllanthus debilis</i> Klein ex Willd.	phyllanthus weed	X	
<i>Ricinus communis</i> L.	castor bean	X	
FABACEAE (Pea Family)			
<i>Abrus precatorius</i> L.	rosary pea	X	
<i>Acacia farnesiana</i> (L.) Willd.	klu	X	
<i>Chamaecrista nictitans</i> (L.) Moench	partridge pea, lau-ki	X	
<i>Crotalaria pallida</i> Aiton	smooth rattlepod	X	Not found 2010
* <i>Desmanthus pernambucanus</i> (L.) Thellung	virgate mimosa	X	
<i>Desmodium tortuosum</i> (Sw.) DC.	Florida beggarweed	X	Not found 2010
<i>Erythrina sandwicensis</i>	wiliwili	E	Not found 2010
<i>Indigofera suffruticosa</i> Mill.	indigo, 'iniko	X	
<i>Leucaena leucocephala</i> (Lam.) de Wit	koa haole	X	
<i>Macroptilium lathyroides</i> (L.) Urb.	cow pea	X	Not found 2010
<i>Pithecellobium dulce</i> (Roxb.) Benth.	'opiuma, Manila tamarind	X	
<i>Prosopis pallida</i> (Humb. & Bonpl. ex Willd.) Kunth	kiawe, mesquite	X	
<i>Samanea saman</i> (Jacq.) Merr.	monkeypod	X	
<i>Senna occidentalis</i> (L.) Link	coffee senna	X	Not found 2010
<i>Sophora chrysophylla</i> (Salisb.) Seem.	mamane	E	
LAMIACEAE (Mint Family)			
<i>Hyptis pectinata</i> (L.) Poir.	comb hyptis	X	Not found 2010
* <i>Plectranthus parviflorus</i> Willd.	spurflower	I	
MALVACEAE (Mallow Family)			
* <i>Abutilon grandifolium</i> (Willd.) Sweet	hairy abutilon	X	
<i>Malvastrum coromandelianum</i> (L.) Garcke	false mallow	X	Not found 2010
<i>Sida fallax</i> Walp.	'ilima	I	
<i>Sida spinosa</i> L.	prickly sida	X	Not found 2010
MENISPERMACEAE (Moonseed Family)			
<i>Cocculus trilobus</i> (Thunb.) DC.	huehue	I	

Species	Common Names	Status	
MORACEAE (Mulberry Family)			
<i>Ficus microcarpa</i> L. f.	Chinese banyan	X	
<i>Ficus rubiginosa</i> Desf.	Port Jackson fig	X	Not found 2010
<i>Morus alba</i> L.	mulberry	X	Not found 2010
MYRTACEAE (Myrtle Family)			
<i>Psidium guajava</i> L.	guava	X	
* <i>Psidium cattleianum</i> Sabine	strawberry guava	X	
NYCTAGINACEAE (Four-o'-Clock Family)			
<i>Boerhavia coccinea</i> Mill.	-----	X	Not found 2010
<i>Bougainvillea glabra</i> Choisy	bougainvillea	X	
PASSIFLORACEAE (Passionflower Family)			
<i>Passiflora foetida</i> L.	love-in-a-mist	X	Not found 2010
PHYTOLACCACEAE (Pokeweed Family)			
<i>Rivina humilis</i> L.	rouge plant	X	
PIPERACEAE (Pepper Family)			
<i>Peperomia leptostachya</i> Hooker & Arnott	'ala'ala-wai-nui	I	
PLUMBAGINACEAE (Leadwort Family)			
<i>Plumbago zeylanica</i> L.	'ilie'e	I	
PORTULACACEAE (Purslane Family)			
<i>Portulaca oleracea</i> L.	common purslane	X	Not found 2010
<i>Portulaca pilosa</i> L.	'ihi	X	Not found 2010
<i>Talinum triangulare</i> (Jacq.) Willd.	talinum	X	
PROTACEAE (Protea Family)			
<i>Macadamia ternifolia</i> F. Muell.	macadamia	X	Not found 2010
RUBIACEAE (Coffee Family)			
<i>Morinda citrifolia</i> L.	Indian mulberry, noni	P	
<i>Psydrax odoratum</i> (Forst. f.) A. C. Sm. & S. Darwin	alahe'e	I	
SAPINDACEAE (Soapberry Family)			
<i>Dodonaea viscosa</i> Jacq.	'a'ali'i	I	
STERCULIACEAE (Cacao Family)			
<i>Waltheria indica</i> L.	'uhaloa	I	
VERBENACEAE (Verbena Family)			
<i>Lantana camara</i> L.	lantana	X	
<i>Stachytarpheta cayennensis</i> (Rich.) Vahl	blue rat's-tail	X	Not found 2010

\*Species not found during the 2007 survey.



Fig. 5. Matrix of fountain grass and koa haole in the middle of the study area.



Fig. 6. Scrub forest dominated by 'alahe'e, koa haole, and Christmas berry.



Fig. 7. Air plant dominating ground cover in scrub forest on upper portion of study area.



Fig. 8. Nearly barren 'a'a flow on upper portion of the study area.