

# The Hawai'i Archaeological Research Project (HARP): 2012 Fieldwork in Kohala, Hawaii Island

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NANI AND DON SVENDSEN, NIULI'I, HI**

**2012**

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## Introduction

This report describes archaeological field research in windward (northeastern) Kohala, Island of Hawai'i during the summer of 2012 conducted by the University of New Mexico under the direction of Dr. Michael Graves and graduate students from the Department of Anthropology. Fieldwork was conducted during three weeks in July, and was focused on the *ahupua'a* (traditional land division communities) of Niuli'i and Wai'āpuka. These *ahupua'a* are located on the eastern portion of windward Kohala that are defined by primary drainage valleys, and lie immediately to the west of the well-known Pololū Valley.

The Hawaiian Archaeological Research Project first began research in the summer of 2006 in the *ahupua'a* of 'Iole, Hālawā,, and Niuli'i, as part of a National Science Foundation grant. The following field seasons (seven in total) have added research to the *ahupua'a* or different sections of of Hālawā, Makapala, Niuli'i, Wai'āpuka, and Makanikahio.

The goals of this research have been to describe and reconstruct traditional and prehistoric agricultural practices within the primary drainages, secondary drainages, and adjacent ridge tops of windward Kohala. Oral traditions (Cachola Abad 2000) point to windward Kohala as a location where new practices for wetland or irrigated farming were tested and deployed in prehistory. Two archival maps, developed between 1870 and the early 1900s, have also been used to supplement field research. These maps depict remnant traditional field systems, as well as early sugar cane production areas. Most of the traditional field systems were converted to sugarcane, leaving these maps and sparse archaeological sites as the remaining evidence of the vast agricultural systems.

Some remnant agricultural field complexes can still be located by using various remote sensing techniques, surface configurations, and large-scale subsurface excavations. HARP field research has primarily focused on minimally-invasive methods, such as documentation of surface features and limited excavations. The excavations that have been conducted have been to recover charcoal samples from beneath field retaining walls for <sup>14</sup>C dating.

The following description of North Kohala's environment and previous archaeological work in Kohala are taken from the 2008 and 2011 HARP Field Reports. It is provided here for the sake of consistency. The reader is directed to these reports for more detailed information about previous fieldwork.

## Overview of Windward Kohala Archaeology

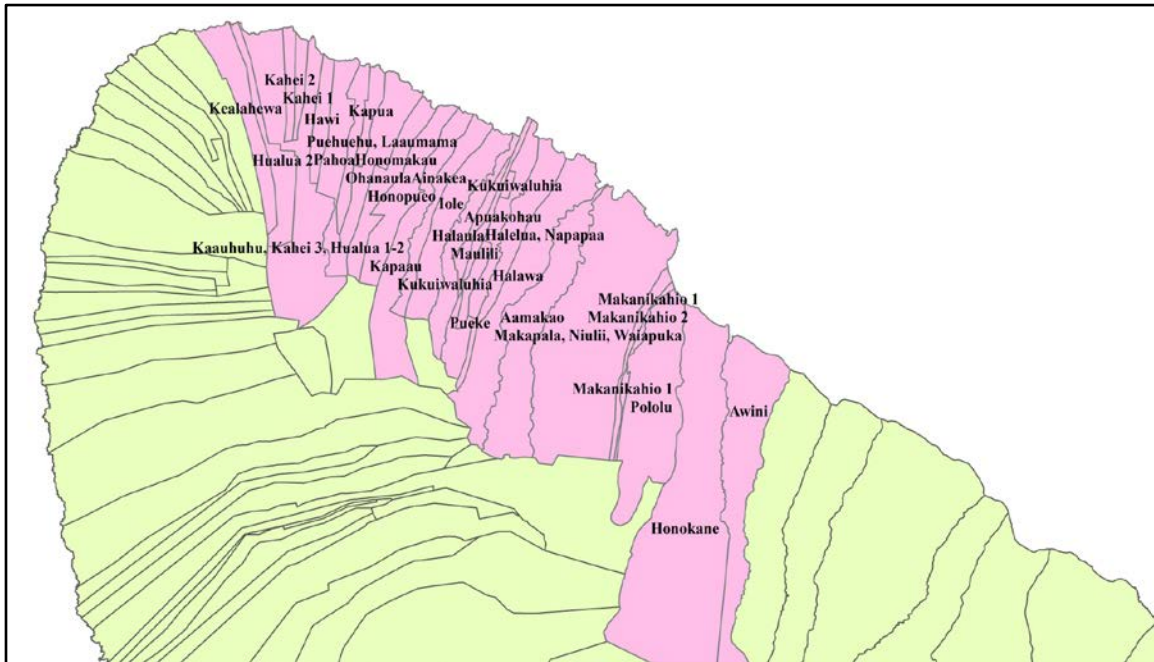
### Traditional Communities (*Ahupua'a*), Streams, and Bays of Windward Kohala

Windward Kohala consists of a relatively incised landscape comprising steep-sided, narrow gulches and a few true valleys with ridge tops between, and extending to the uplands where the Kohala Mountains form its western and northern boundaries. Rainfall is abundant in this part of Kohala, ranging from ca. 1200-1500 mm at the coast to more than 3000 mm in the mountains.



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The ridge tops separating the gulches on the western end of this area were mostly converted to sugarcane cultivation in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries to about 1200' above sea level. Streams can be found in the upper reaches of all drainages but may disappear before reaching the coast, particularly in the smaller gulches and in Pololū Valley where the stream reappears as a large marsh behind a coastal sand dune.



The naming of traditional communities, streams (and parts thereof), and the bays (into which the streams flow) in windward Kohala has produced a welter of Hawaiian terms. Because these names derive from no later than the historical, post-European contact period, they are treated as “archaeological”, that is, referring to places, territories, and streams that likely predate the arrival of Europeans to Hawai‘i in the late 18<sup>th</sup> century. An estimated 30 traditional Hawaiian communities are known for windward Kohala (Fig 1); these were recorded and mapped in the mid to late 19<sup>th</sup> century (and appear today on USGS topographic maps). Ahupua‘a and their associated territories are one of the building blocks of prehistoric and historic Hawaiian culture and society. Often depicted as containing all of the resources, especially foods, needed by Hawaiians to maintain themselves, they have been described as autonomous, endogamous, and sustainable units of organization (Handy and Pukui 1972; Hommon 1986). Recent research (Ladefoged and Graves 2006; Ladefoged et al. 2009), however, suggests these territories were dynamic with early communities established over larger areas that were in turn sub-divided into smaller areas. This pattern appears to hold for at least some of the windward Kohala ahupua‘a. In leeward Kohala, rain fed agricultural resources likely varied in their abundance and predictability across ahupua‘a and recent research suggests this variability affected demographic outcomes (Ladefoged et al. 2009). Windward communities also varied in terms of their access to and amount of irrigated and wetland agricultural resources, or differed in fields’ proximity to the coast, predictability of stream flow, and the extent of irrigation or other water

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control facilities. Boundaries for some ahupua'a cannot be identified with great precision and thus are estimated based on topography and drainages, and the locations of these named territories on early maps of the area.

Beginning at the north and west and continuing eastward on the Kohala peninsula the ahupua'a are: Hāwī, Pāhoa, Honomaka'u, Kapu'a, Pūehuehu, Lā'umama, Hana'ula, Honopueo, Kapa'au, 'Āinakea, 'Iole, Hala'ula, Ma'ulili, Pueke, Kukuiwaluhia, 'Āpuakaohau, Halelua, Napapa'a, Hālawa, 'A'amakāō, Makapala, Niuli'i (NIU), Wai'āpuka (WAI), Mekanikahio 2 (MAA), Mekanikahio 1 (MAA), Pololū, Honokāne, and 'Āwini. There are two "capping" inland ahupua'a, Nunulu Iki and Nunulu Nui. They cap several windward communities whose boundaries extend down to the coast: Honopueo, Kapa'au, 'Āinakea, and 'Iole. The boundaries separating ahupua'a were also mapped but are best considered to be rough proxies for the originals. The boundaries separating the easternmost communities of Hālawa and 'A'amakāō, the communities of Makapala, Niuli'i, and Wai'āpuka, and Mekanikahio 1 and Pololū are not completely known, suggesting these each may have functioned as a single community prior to their naming. In the case of Mekanikahio 1 and Pololū, the former extending to the west of the Valley proper, this would suggest the original boundary for Pololū extended onto the western ridge lands. Other evidence such as points where boundaries intersect in the uplands (e.g., below the uppermost boundary) and territory duplicated names (e.g., Mekanikahio 2 and Mekanikahio 1) suggest the partitioning of windward ahupua'a in fashion similar to what has been inferred for the leeward side of Kohala (Ladefoged and Graves 2008, 2009).

The association of gulches and streams with ahupua'a in windward Kohala is more complex. While there are three communities (Kukuiwaluhia, Ma'ulili and Napapa'a) that do not appear to have overlapped with **any** named drainages many ahupua'a extend across or incorporate multiple independent or branching drainages. In several instances, where a named gulch branches in the uplands, names were associated with each branch. Table 1 lists the ahupua'a and the named drainages with which they are associated. The various independent gulches or valleys vary in their size, catchment area, and the amount of water flowing in the main drainage stream. Stream flow is a function of rainfall and catchment, which increases from west to east in windward Kohala. Generally, gulches are shorter in total extent (from coast to uplands) to the west (e.g., Lipoa in Hāwī), and longer to the east (e.g., Waikama in Wai'āpuka) where there is more likely to be perennial stream flow to the coast. Some gulches support stream flow only at higher elevations. Springs, which are poorly documented, do appear to be distributed unevenly throughout the gulches. They occur in East Hālawa and in secondary drainages to Waiakala'e, 'Ōpaepilau, and Waikama. Two gulches, Waiakala'e and Kapaloa, on the far eastern boundary of Mekanikahio 1 and Pololū flow into Pololū Valley rather than to the coast. The upper branches of several gulches originate in the uppermost portions of leeward Kohala ahupua'a (e.g., Puakāne, and Wai'āpuka in Kehena 2). Note that in many cases gulches incorporated multiple windward communities and this may also indicate that formerly these communities functioned as one. Such historical linkages may also be the basis for resource sharing across

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communities, including the diversion of water out of one gulch and onto adjoining tablelands and into secondary drainages and back into a main gulch drainage.

Different versions of maps of windward Kohala show slight variants in gulch names. Most importantly for this work, the branch of Waikama Stream known as 'Āwini Puali'i, is mis-identified on modern topographic maps. On the 1930 topographic map of the Hawi section, 'Āwini Puali'i is placed as a west branch of Wai'āpuka Gulch at about 2000' asl; more recent topographic maps place 'Āwini Puali'i much lower in elevation and as an eastern branch of Waikama Stream, just to the west of Waiakala'e Stream. This stream should actually be known as 'Ōpaepilau Gulch. We will follow this convention throughout this report. And it should be noted that in the report (Graves et al. 2012) from the 2010 and 2011 fieldwork 'Ōpaepilau was mis-identified as 'Āwini Puali'i.

There are seven major bays located in windward Kohala, from the north and west to the east and south, they are: Keawaeli ('Iole ahupua'a, Pali Akamoia and Waianaia Gulches); Hapu'u (Hālawa ahupua'a and Hālawa Gulch); Kapanaiia or Kapana ('A'amakāō and possibly Makapala ahupua'a, Walaohia and 'A'amakāō Gulches); Kēōkea (Niuli'i and Makapala ahupua'a, Waikani, and Niuli'i Gulches), Neue or Naue (Wai'āpuka and Niuli'i ahupua'a, Waikama Gulch); Pololū (Pololū ahupua'a, Pololū Stream), and Honokāne (Honokāne ahupua'a, Honokāne Iki Stream, Honokāne Nui Stream).

HARP field research has focused on the easternmost gulches and ahupua'a of windward Kohala: Hālawa, 'A'amakāō, Makapala, Niuli'i, Wai'āpuka, Makanikahio 2, and Makanikahio 1. Sugar cane plantation agriculture was assumed to have destroyed much of the prehistoric archaeology and traditional Hawaiian sites in the area. Fortunately, within the gulches and side drainages and especially above the area where sugar cane was planted a considerable and generally well-preserved array of archaeological sites was found. For the most, these are agricultural complexes that include terraces, irrigation ditches, and other water control features, and less often habitation and ritual sites.

### Previous Archaeological Research

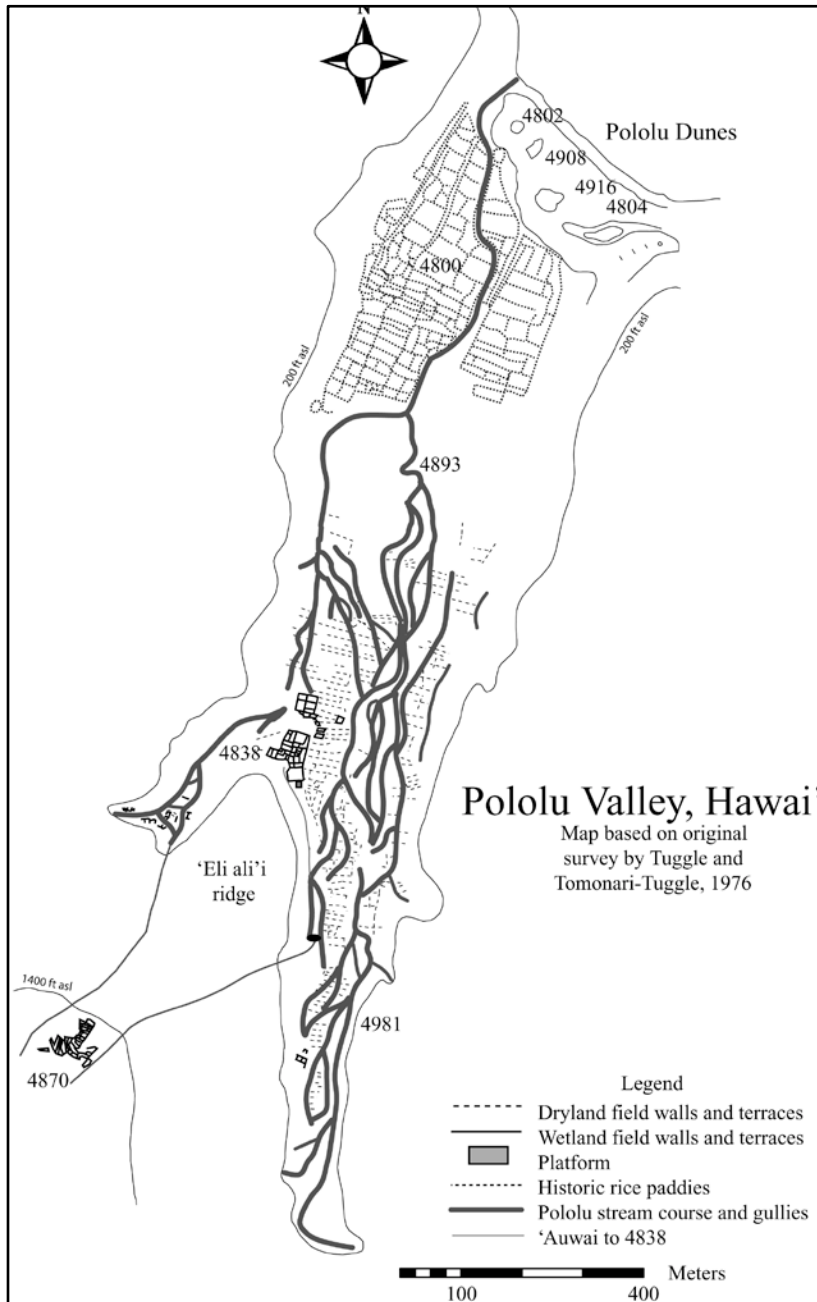
The first archaeological field research in windward Kohala began with H. David Tuggle's work in Pololū and, Honokāne Iki, and 'Āwini Valleys (Tuggle, 1976; Tuggle and Tominari-Tuggle 1980), as a complement to work that had taken place at Lapakahi on the leeward (dry, western) side of Kohala.

(Tominari-Tuggle, 1988) also completed an overview of the cultural and historical resources of North Kohala that is the most comprehensive review of the area's history and archaeology. At the time, the main archaeological study was that of H. David Tuggle in the valleys of Pololū Honokāne Nui, Honokāne Iki, and 'Āwini. For Pololū, Tuggle documented a number of habitation loci across the back face of the large sand dune that reaches nearly across the entire mouth of the Valley at the Coast. Other habitation features, both prehistoric and historic, are located in the lower portion of the Valley usually adjacent to the lower slopes. Tuggle's work also provides



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the most completely documented array of agricultural features in Hawaii. He mapped the extensive dryland agricultural terraces and alignments in Pololū, along with the smaller array of irrigated terraces. Tominari-Tuggle identified an historic map of the rice fields in the marsh behind the large sand dune, which likely correspond to where taro was traditionally grown in the valley. In Honokāne, Tuggle mapped numerous smaller irrigated agricultural terrace complexes, extending several kilometers into the main valley of Honokāne Nui.



Since Tuggle's work in the 1970s, HARP has completed the most fieldwork in windward Kohala. This began in 2006 with research in Niuli'i (at Kēōkea Bay), in 'Iole (along the banks of upper

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Waiania Stream), and in lower and upper Hālawā Stream (Field and Graves 2008a, 2008b). At the same time, we conducted archival research on Tuggle's materials mapped and excavated in Pololū, including radiocarbon dating, computerized mapping of Site 4838, an dry land and irrigated agricultural complex, and inventorying the historic materials from Tuggle's excavations. Elsewhere, Mark Oxley (2007) re-analyzed basalt artifacts from various sites in Pololū to determine their possible source areas. In 2007, fieldwork focused on upper Hālawā, including both the east and west branches of the drainage, and lower Hālawā adjacent to Hapu'u Bay and farther upstream near the confluence of the two branches, and in the upper part of Niuli'i - Waikane Stream that extends into Makapala ahupua'a (McCoy and Graves 2007). In 2008, we returned to lower Hālawā to complete excavations at the deeply buried, stratified agricultural complex near the coast and began new field research in Wai'āpuka, along the east bank of Waikama Stream on the ridge top lands to the east of the gulch, and on the top of the cliff near the coast (McCoy and Graves 2008). In 2009, fieldwork concentrated on Wai'āpuka ahupua'a, primarily in a secondary drainage of Waikama where an extensive barrage terrace complex had been identified previously (Graves 2010). In January 2010, a small group from UNM conducted about 3 weeks of fieldwork focused on documenting irrigated agricultural complexes adjacent to lower Waikama Stream and additional fieldwork on the large barrage terrace complex in upper Wai'āpuka (Graves et al. 2012). During August 2011 graduate students from UNM joined Michael Graves to explore an agricultural complex at the end of the former sugar cane lands in Makanikahio and in the process discovered an intact irrigation ditch visible on the surface in the forested area just upslope of this complex, which led back to Waiakala'e Stream (Graves et al. 2012). This in turn led to a number of agricultural features and complexes in the forest area that had not been impacted by sugar cane cultivation. These complexes extended upslope to more than 1600' asl and tapped water from Waiakala'e and a series of secondary drainages to the east that flowed into Pololū Valley. In addition, two heiau complexes were mapped one in lower Waikama and the other on the boundary between Wai'āpuka and Makanikahio *ahupua'a*.

This fieldwork has been reported in a series of articles and book chapters, as well as reports and presentations. The Pololū <sup>14</sup>C dates established the earliest occupation of the valley at about AD 1200 (Field and Graves 2008c), as well as the late (post AD 1650) conversion from dryland to irrigated agriculture at the Site 4838 complex. Dry land agricultural features in Pololū were also dated to AD 1450-1600 by association with habitation features in the vicinity of this site. While <sup>14</sup>C dates from excavations elsewhere in windward Kohala have been reported (McCoy et al. 2010, McCoy and Graves 2010), no complete listing of such dates has been reported for this area. A manuscript is under preparation (Oxley et al. n.d.) to describe and review the more than 50 <sup>14</sup>C dates to develop chronology for windward Kohala.

Expanding soil nutrient analyses into windward areas, the impoverished nature of most alluvial and ridge top soils has been documented (Palmer et al. 2009) as has the role of irrigation or flood water in maintaining some components of agricultural productivity in this region (McCoy et al. 2012). Innovations in irrigated agricultural practices in windward Kohala (McCoy and Graves 2010) that included the construction of ditches into and along the slopes of secondary

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drainages and the use of ridge top irrigation complexes have been documented in Wai'āpuka and Niuli'i. Long term irrigated agricultural development, beginning as early as AD 1300, has been documented for Hālawa and is presumed to characterize much of windward Kohala (McCoy et al. 2010, 2012; McCoy and Graves 2012). This has been expanded by the more recent research showing ditch construction through bedrock and extending over distances as much as 500 m, transporting water from higher to lower elevations in the easternmost small valleys and ahupua'a of windward Kohala (Graves et al. 2011, 2012). A paper (Morehouse et al. n.d.) is in preparation to document the cut bedrock irrigation ditch technology of windward Kohala and to assess its likely dating. Morehouse (2010) developed a preliminary GIS model for the hydrology (and water flow) across the ridge top lands (tablelands) of Wai'āpuka. GIS and LiDAR based models of the total agricultural potential for the smaller valleys of windward Kohala has been compared (McCoy et al. 2011). The LiDAR imagery is currently under development to create a high resolution topographic map for this area, designed to expand the hydrological modeling and to locate possible barrage ditch complexes within secondary drainages. Nonetheless, from current and previous research we know that cumulatively, windward Kohala would have supported a larger area for irrigated agriculture than has conventionally been assumed.

### Archaeological Field Research: 2012

HARP represents a field research and training program in Hawaii sponsored by the University of New Mexico. Graduate and undergraduate students from UNM and a number of other institutions (e.g., University of Hawaii, University of California, University of Chicago) have participated in HARP field programs in windward Kohala, Hawai'i Island since 2006. These training programs have emphasized the conservation of cultural and historic properties as part of field archaeology. We use field methods that are generally non-invasive and attempt to change the perspective of archaeology as "excavation". Consultation with local experts and the integration of historical information are key aspects of this program. Documentation of archaeological sites is also employed, particularly in the creation of map and image based databases for these sites. Since its beginning students in the program have undertaken independent research and reported their research at professional meetings and conferences. This report reflects this same philosophy. Four of the five co-authors on it are graduate students who participated in the 2012 Summer HARP program. Two of the students are former participants of the NSF REU Site Grant in windward Kohala.

In 2012, HARP surveyed new areas not previously considered optimal for preservation of archaeological sites, areas along either bank of 'Ōpaepilau and Waikama, and re-surveyed several locations adjacent to these streams. This included forested uplands of windward Kohala, in areas not converted to sugar cane cultivation. At these higher elevations, when first explored in 2011, we expected to find little in the way of archaeological resources. Instead, we discovered an array of prehistoric and historic agricultural-related and habitation features and artifacts preserved in this environment. These include some of the most extensive traditional water

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transport features (i.e., ditches) documented for the region. In some cases, these ditches begin at relatively high elevation (1800-2000' asl), and transport water for more than 500 m downslope into different drainages or back into the original drainage, and in some instances, into the territories of different traditional communities. These features were in use through a portion of the historic period (based on the occurrence of Euroamerican artifacts), but some also likely date to the period prior to European contact in the late 18<sup>th</sup> century. They deploy traditional technology but do so in ways unanticipated by our prior experience. Ditches were not only dug to divert water from streams to agricultural terraces, but these ditches sometimes connected distinct agricultural complexes, were dug into slopes and through bedrock, and traversed the ridge tops (or tablelands) between streams and secondary drainages. Shorter ditches, particularly those associated with secondary drainages, transported water off of ridge tops and may have collected slope wash water from rainfall. We have documented the use of secondary drainages to transport water down slope in lieu of ditches, feeding primary streams, irrigating barrage and other terraces within the secondary drainages, and on occasion linking with other irrigation complexes. These agricultural features are a testament to the ingenuity, creativity, innovation, and technical abilities of Hawaiians to solve resource procurement, extraction, and production challenges. They clearly anticipate what scientists have only recently understood: tropical soils in Hawaiian are not necessarily rich in nutrients and in fact, with higher rainfall levels, soil nutrients are depleted, making irrigation the only successful long-term strategy for growing crops in these contexts. In Kohala, however, such contexts are limited in area and so Hawaiians had to be resourceful in innovating and adapting their traditional practices to new lands. In some cases the conversion of lands on ridge tops and in secondary drainages likely exceeded lands converted to agricultural production within the primary stream drainages. There were substantial outlays of labor involved in these efforts to divert water into these new areas, but also apparently there were good returns to their efforts.

We have also discovered the value of thinking in terms of models of agricultural practices that can be used to predict or anticipate locations where evidence of such practices might be preserved. The use of secondary drainages for barrage terrace irrigated agriculture is just one such outcome. Many of these drainages have been filled during the time the land was graded for sugar cane production. But others have not been completely obliterated, and on Lydgate's 1881 historical map of Kohala, the presence of such terraces is suggested for a number of instances likely to represent secondary drainages. New LiDAR imagery developed for windward Kohala holds considerable promise to show the locations of many more secondary drainages including those that were subsequently filled in by sugar cane cultivation.

Finally, we should acknowledge efforts to understand traditional Hawaiian irrigation agriculture by putting former lo'i terraces back into production. Even when these efforts cannot be sustained, important information can be learned (e.g., about the impact of changing or variable precipitation at different elevations). Where restored lo'i are sustained, insights can be gained regarding secondary crops that might have been cultivated in nearby areas, nearer to streams or on the slopes below irrigation ditches. Taro production records can also be verified through

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restoration efforts at former lo'i. We also are inspired by the work and dedication of those who restore former cultivated lo'i and 'auwai, and their associated stream waters, and forested lands.

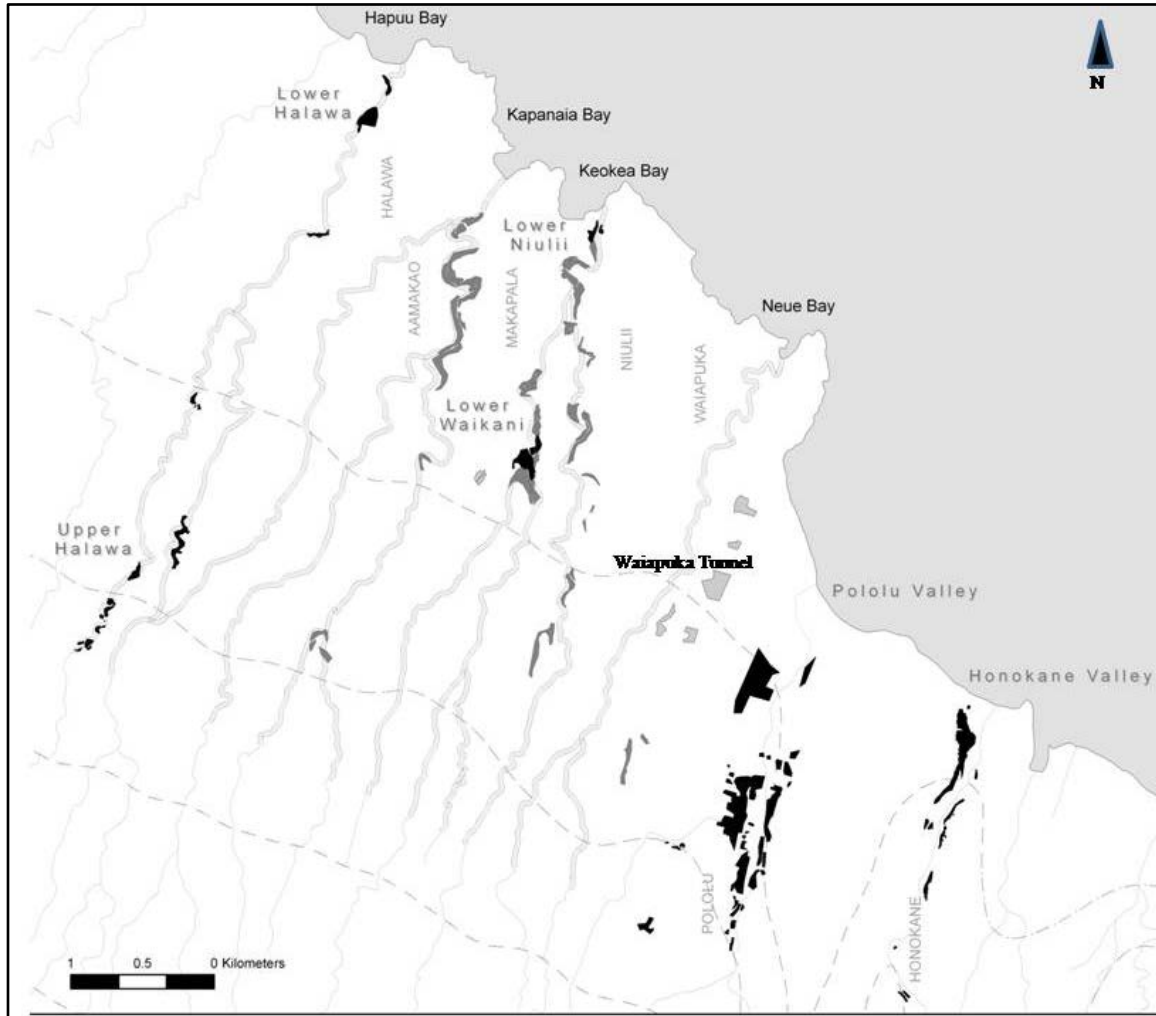
The archaeologists from the University of New Mexico (and prior to that, the University of Hawai'i at Mānoa) have conducted fieldwork in Wai'āpuka, Makanikahio, and Niuli'i during the field seasons of 2006, 2008, 2009, 2010, 2011, and 2012. As with this research, the work focused on the documentation and mapping of agricultural features and archival mapping, resulting in extensive maps of the archaeology of the three ahupua'a.

### Wai'āpuka (WAI) Study Area

The ahupua'a of Wai'āpuka is located on the windward side of the District of Kohala, adjacent to the ahupua'a of Niuli'i (to the north and west) and Makanikahio (to the east), and Pololū Valley less than 1 km away. The distance from the coastline to the mountain border is approximately 7 km. This area receives ample rainfall each year, with Waikama Stream serving as the major drainage for the ahupua'a. A second stream, "Ōpaepilau, flows into upper Waikama from the east. At higher elevations the Waikama branches into Wai'āpuka and Awini Pualli Gulches. They provide a constant flow of water in the upper portion of this drainage. This fieldwork was conducted in the mountainous area of Wai'āpuka, at approximately 850 feet to 1750 feet in elevation. Most of this land is currently owned by Kamehameha Schools, with areas being leased and in the care of Hawaii Forest and Trail on either side of Waikama-Ōpaepilau Streams both above and below the Kohala Ditch.

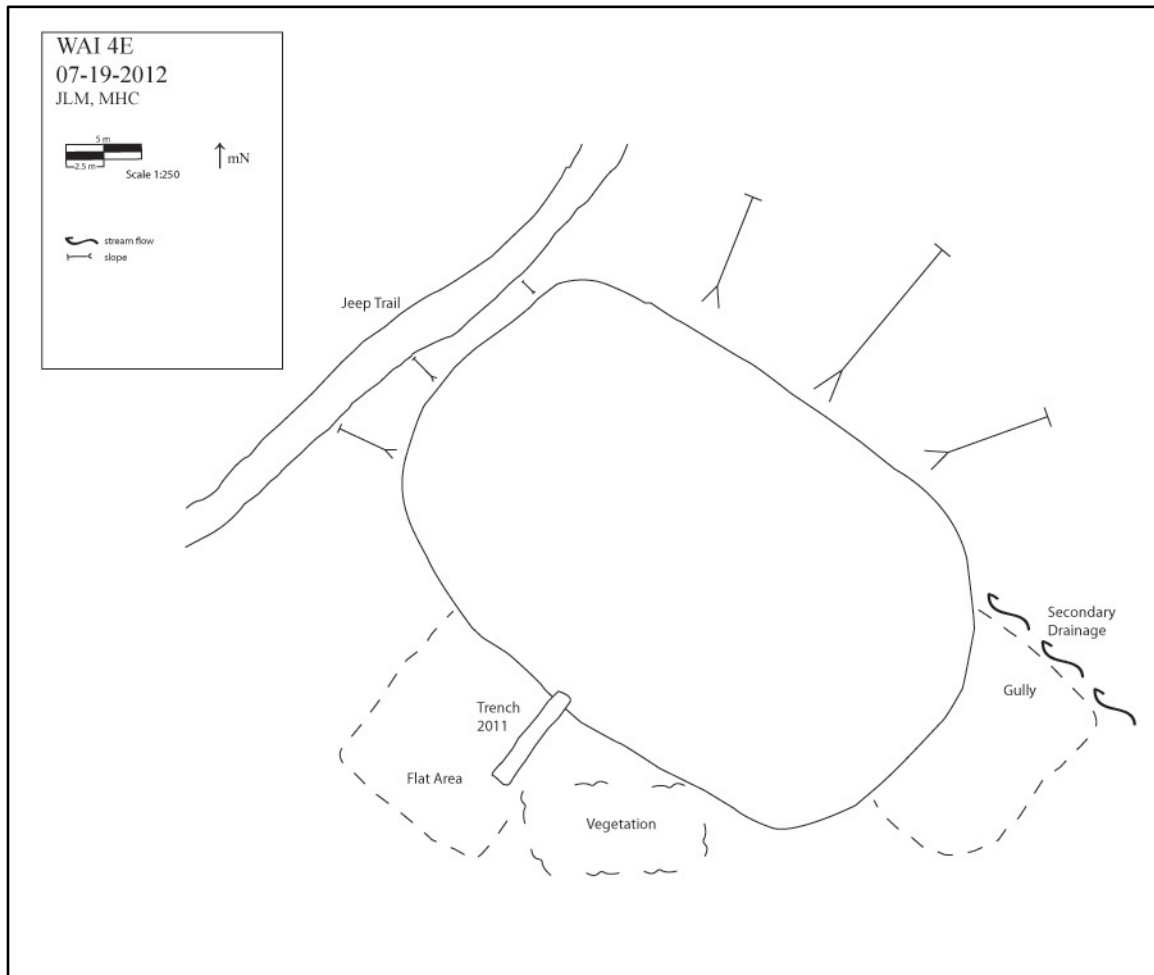
Currently, there are 37 archaeological sites recorded in Wai'āpuka, as shown in Appendix 1. This report includes new data developed as a result of revisiting four sites for additional documentation and mapping (WAI 4E, WAI 18, WAI 19, MAA 4B), and the location of six new sites, with two barrage terrace complexes (WAI 31, WAI-33) in secondary drainages, two agricultural terrace complexes (WAI-32, WAI-34), and one modified waterfall pond area (WAI-37), and a modified secondary drainage that was used for banana cultivation, along with a pond at its upper end and possible ritual water feature (WAI-35) on the cliff line and ridge top above the pond.





## Survey Archival Results, Revisited Areas

### Irrigated Barrage and Pond Field Agricultural Terrace Complex (WAI 4E)



WAI 4E originally referred to a series of barrage terraces in a dry secondary drainage that joins from the east with Waikama Stream. Based on aerial photographs, we identified an area near the lower end of this drainage that was likely used as an irrigated pond field terrace based on its topography and because it is a natural collection point for water (see Figure xx). WAI 4E was first mapped and documented by HARP in 2008, although this feature was assumed to be recent and the result of building a dirt road across the drainage. The barrage terraces associated with WAI 4E occur mostly on the lower section of the drainage but likely continued up the drainage, although they have been buried or destroyed by sugar cane cultivation. In 2011, the pond field area was completely dry, and a trench excavation was carried out, revealing levels of sediments above a buried oxidized soil that is indicative of pond field agriculture. This field season, the pond field terrace was wet, with standing water approximately 5-10 cm deep, as shown in Figure XX. There is at least one more terrace associated with this section of WAI 4E. The presence of the oxidized soil layer suggests that water flowed more regularly in this secondary drainage. LiDAR imagery shows the drainage continues up slope and may consist of multiple

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branches that would have collected water from the adjoining ridge top. No irrigation ditch has yet been identified at the top of the drainage that would have transported water into it from Waikama or Waiakala'e Streams, but this remains a possibility.



### [Agricultural Terrace Complex, Irrigation Ditch, and Ahupua'a Boundary \(WAI 18 and WAI 19, MAA 4B\)](#)

WAI 18 is a rock alignment and retaining wall, running parallel to the modern day ahupua'a boundary denoted on USGS topographic maps, and possibly serving as a prehistoric marker of this territorial division. At the top of WAI 18, the retaining wall extends into the top of a secondary drainage. In 2011, we mapped a barrage terrace and side retaining walls in this location. We also mapped a portion of MAA 4B, the irrigation ditch that crosses WAI 18 and extended down slope but did not confirm this portion of the ditch. In 2012, we confirmed and mapped the location of the MAA 4B ditch from the top of the ridge where it intersects the WAI 18 alignment and retaining wall and down slope to the point where it entered the secondary drainage. This is the same drainage that we mapped at its upper most portion. But note that the ditch does not water the top of the drainage where the upper most barrage terraces were located. It does, however, water the drainage at a point where we began WAI 31, a series of barrage terraces that was mapped in 2012.

WAI 19 was located in 2011 and portions of it inspected and two features were mapped. The first was a circular rock alignment to the north of the alignment and retaining wall (WAI 18) that we have associated with the ahupua'a boundary. The second feature mapped was a small house site that was located downslope from WAI 18 and circular feature of WAI 19 and in the middle of a flattened ridge that extends east of the secondary drainage of WAI 18/31. We flagged in 2011 but did not map a possible irrigation ditch that extended from the top of the slope near

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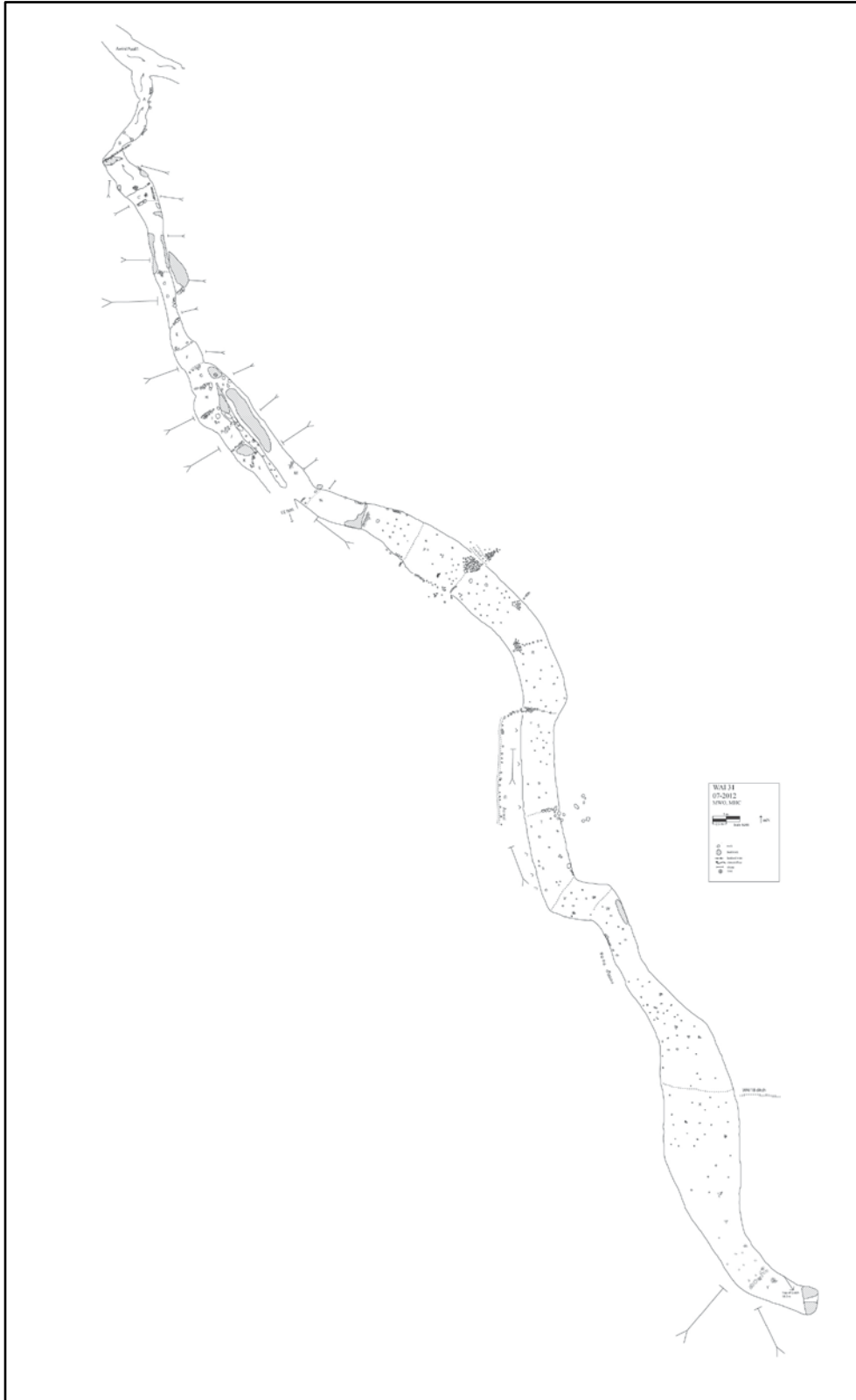
the circular feature to the bottom where the ridge flattens out. We were unclear if this was one or two ditches. Re-inspection of this area in 2012 revealed portions of two shorter ditches (WAI 19C and WAI 19D). These were drawn onto a field copy of the WAI 19 map of 2011. At the base of the slope, these ditches are no longer visible suggesting they were designed to channel water runoff onto this flat ridge. In 2012, this area was extremely muddy from summer rains and hence it would have been an ideal location to collect irrigation water from these short ditches.

map to be added- waiting on Joe 11/14

### Survey Archival Results, New Areas

[Irrigated Agricultural Barrage Terrace Complex \(WAI 31\)](#)

DRAFT



WAI 31 is a multiple barrage terrace complex located within the eastern secondary drainage connecting with 'Ōpaepilau in the ahupua'a of Wai'āpuka. WAI 13, an irrigated terrace complex



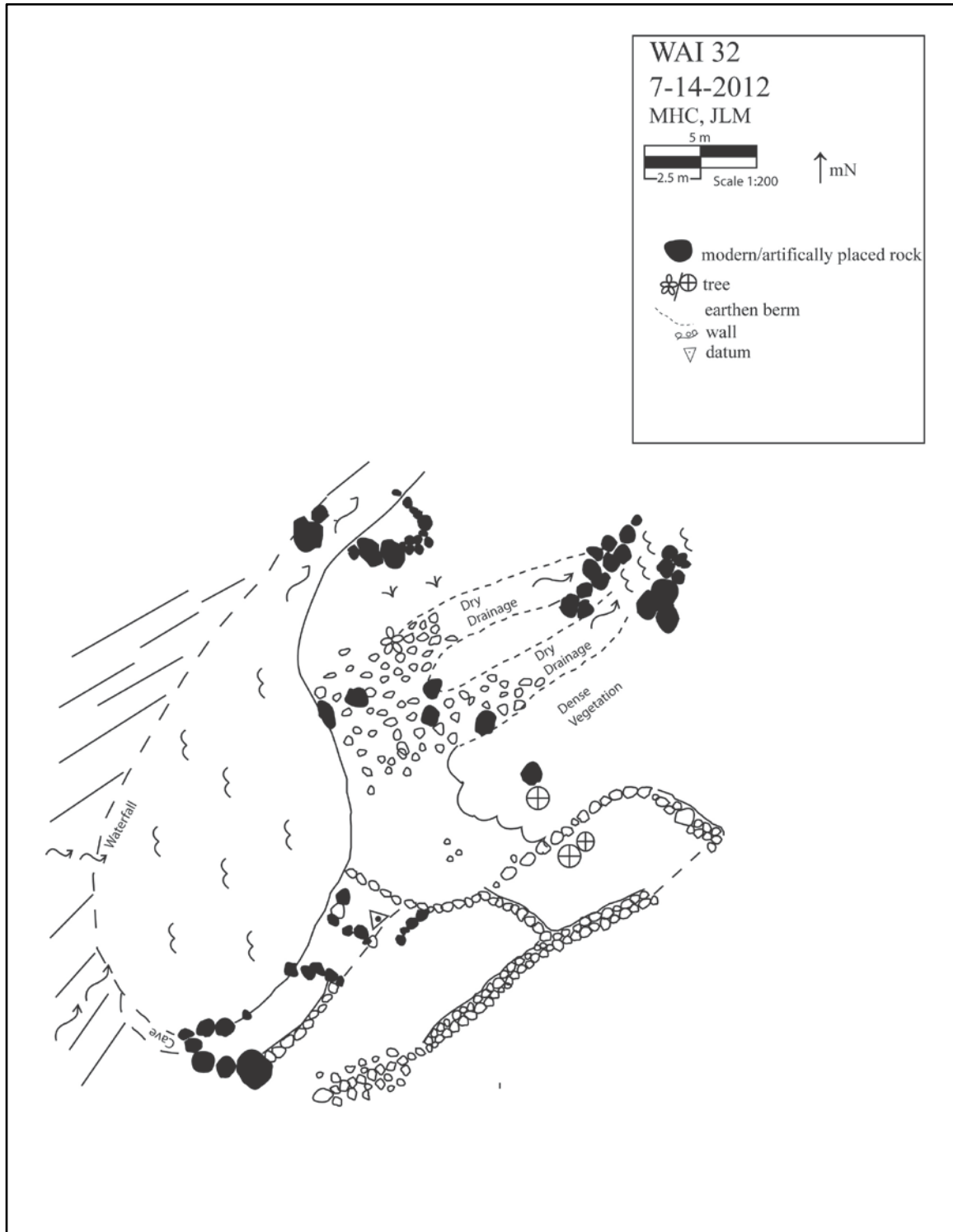
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is located south of WAI 31 just above the point where the drainage of WAI 31 joins the Stream. WAI 19 is located up the same drainage at the point where the irrigation ditch (MAA 4B) is located. WAI 18 is located to the east and north of WAI 31 and includes two shorter ditches that end on the upslope edge of the flattened ridge just above the secondary drainage of WAI 19-31. For the most part, this secondary drainage is dry, and in 2011, there was no water in it, but in 2012 a spring had developed in the bottom of the gully approximately 110 meters from the northeast end of the drainage. This spring provided sufficient water to keep most of the gully bottom wet throughout the month of July. The total length of WAI 31 is approximately 350 m; it varies in width from less than 5 m to as much as 15-20 m in some sections. The majority of this site is in poor condition with most of the walls badly deflated. Terrace retaining wall remnants are largely found at the sides of the features, on the edge of the gully bottom itself. The centers of the walls have been blown out over time due to lack of maintenance and flash flooding. The overall poor condition of these walls, in comparison to nearby complexes such as WAI 4W with similar features, suggests that this site has probably not been in use for a long period of time. Because the walls have been badly eroded it is difficult to determine the exact number of terraces that would have originally been in place. Nonetheless, at least 25 terraces of varying widths and lengths are visible. Walls that are still intact average 2-4 courses in height (approximately 10-30 cm). Cobbles to moderate-sized basalt boulders are the primary construction material. Additionally, this site has a generous amount of exposed bedrock which has also been utilized in the terrace construction. It is important to note that the little evidence for soil buildup with the exposed bedrock suggests that either the soil has washed out (possible considering all of the heavy wall erosion) or that the primary function of these terraces were to slow or control water flow, not necessarily for growing purposes.

A ditch that originated from MAA-4A and bisects WAI 18 supplies the south end of the terraces with water. It is possible that water to feed this complex was also brought in at the upper end of the gulch through a shallow gully that connects to the top of the system. Evidence for additional shorter ditches can also be found along portions of the west side of the terraces and while segments of the ditch walls are visible, it is difficult to determine where they originate and what they are feeding.

[Agricultural Terrace and Waterfall Pool Complex \(WAI 32\)](#)



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WAI 32 is a small agricultural terrace and modified drainage complex that is adjacent to Waikama Stream on the east and directly inland of NIU 32, which is a restored lo'i terrace complex. This places the complex within Wai'āpuka ahupua'a. The eastern portion of the site is forested with hibiscus (hau or *Hibiscus tiliaceus*), Christmas berry, and guava. The best preserved portion of this complex includes the retaining wall extending along the far eastern side of the complex for approximately 20 to 25 m, and which is oriented between the SW/NE boundaries, as shown in [Figure XX](#). The retaining wall is part of a terrace section that appears to have been used for agricultural purposes ([Fig xy](#)). Boulders included in this wall range from 0.5 m to 1.0 m in diameter. No clear evidence of an irrigation ditch to these terraces was found, although the pool of water in the stream is fed by a small waterfall from which irrigation water could have been diverted.

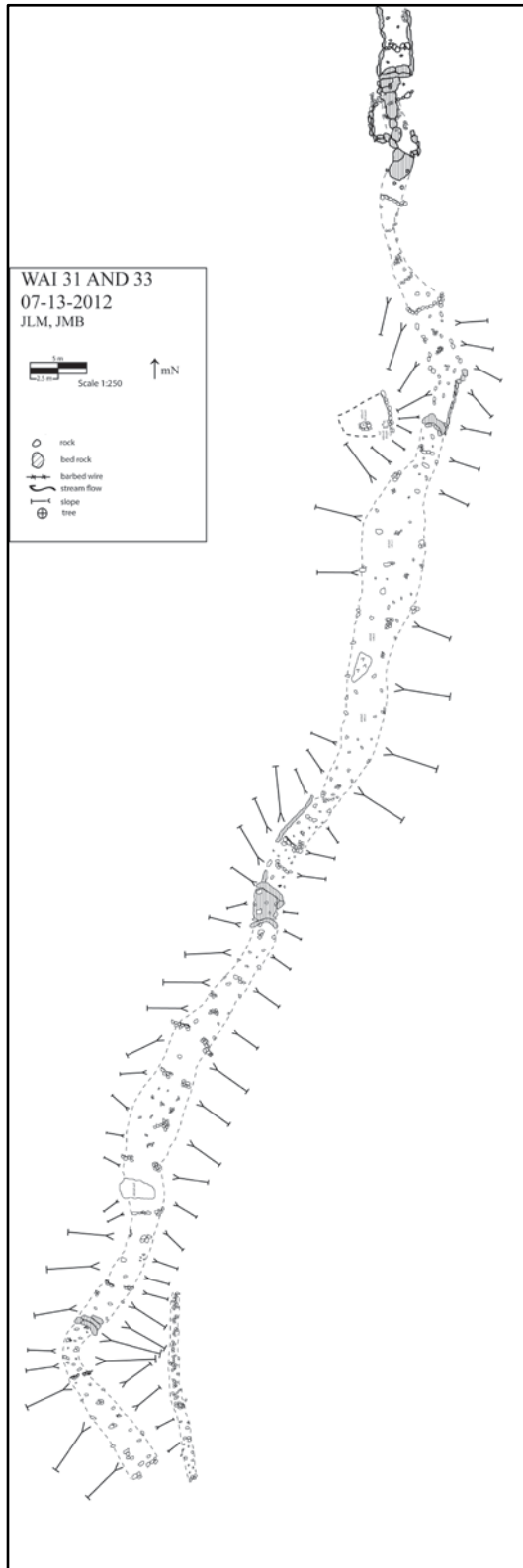






The western portion of the terraces abut a large collection pool located at the base of the waterfall, and extend northeast along the parallel drainages, as shown in [Figure XX](#). These two artificial drainages connect approximately 5 m downstream from the edge of the pool, and empty into Waikama Stream downstream from NIU 32. A small amount of land disturbance has occurred as a result of eco-tours led by Hawaii Forest and Trail, and between the 2011 and 2012 HARP seasons, a trail was constructed along the far eastern edge of the site. In general, WAI-32 remains well preserved, and there is a possibility for additional features to be located within areas of dense vegetation adjacent to Waikama Stream. The heavily vegetated areas were not examined during the 2012 field season due to poor visibility and difficult access. No artifacts or soil samples were collected from this site.

Irrigated Agricultural Barrage Terrace Complex (WAI 33)





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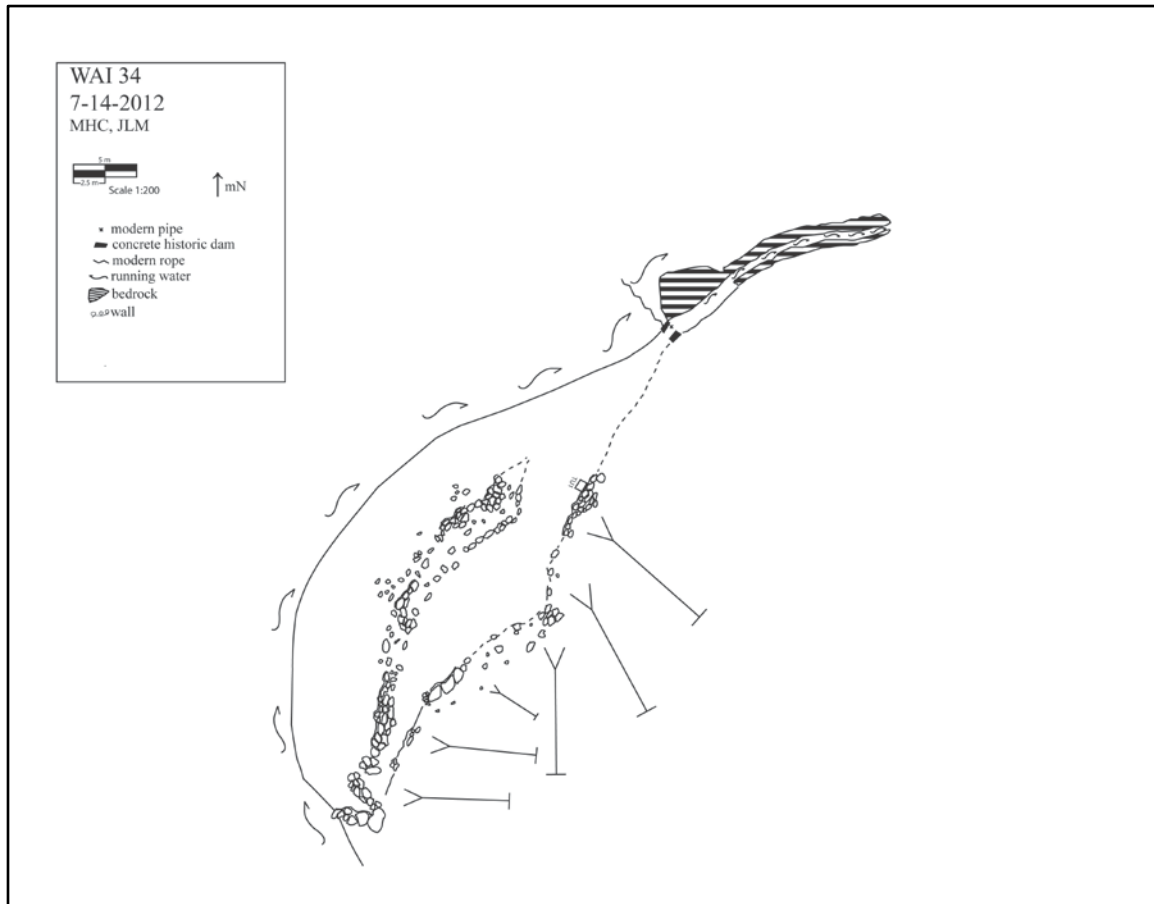
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WAI 33 is a multiple barrage terrace complex located within one of the secondary drainages that flow into 'Ōpaepilau from the east. The complex and drainage in which it is located terminates at a point where it joins with WAI 31, another barrage terrace complex within a secondary drainage (and previously described). The gulch of WAI 33 is dry, and extends approximately 350 m in length. The upper origination point of the terraces is unknown due to heavy vegetation, cattle perturbation, and general poor preservation of the area. As was the case with WAI 18/31 the upper portion of the drainage widens and terracing may have been unnecessary. There are approximately 26 terraces present with retaining walls of varying widths and heights. Cobbles to moderate sized boulders are the primary construction material, with many areas using the exposed bedrock of the drainage as a portion of a wall or retaining wall. Most of the barrage walls that were still visible are located towards the lower end of WAI 33 where it joins with WAI 31. As with WAI 31, it is likely that one of the functions of these terraces was to slow or control water flow. There is not much sediment deposited within this drainage even behind the barrage terraces but this may be due to the poor condition of the terraces.

Above the gulch along the slope line, near barrage terrace Features I and J, a flat area with a small single course free standing wall is present, indicating a likely house site, which was given the designation of Feature . At the southeast end of the feature, a small hearth (approximately 50 cm in diameter) is present. A test excavation in this feature yielded charcoal for dating purposes. At the southern end of site, along the western ridge line, a free standing wall approximately 30 meters long runs almost directly north to south. Given the location of this wall and the wall and alignment found on the east side of Wai'āpuka, it is possible this wall is also an ahupua'a or other boundary marker, indicating the change from Wai'āpuka to Niuli'i. The ridge top separating the drainages of WAI 19/31 and WAI 33 contain a number of regularly spaced, old growth mountain apple (*Syzygium malaccense*) trees, with much younger guava (*Psidium guajava*), and **Christmas berry** interspersed. The abundance of mountain apple suggests that it may have been previously cultivated or managed. The fruits are edible and its wood shows up ubiquitously in charcoal assemblages we have collected during excavations at higher elevations in Wai'āpuka.

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## Agricultural Terrace, Irrigation Ditch and Sluice-Gate (WAI 34)



WAI 34 is comprised of a single agricultural terrace running east along Waikama Stream, two associated retaining walls, and an irrigation ditch hand-excavated into bedrock. The terrace retaining walls are located in the southernmost portion of the site near the edge of the stream. The lower, westernmost wall measures approximately 25 m in length, and is generally characterized by collapsed rubble with the exception of four segments still standing. The upper wall, which follows the base of the eastern slope of the stream drainage, is extremely deteriorated, and is only standing in two segments, one of which is located near the northern end boundary. This retaining wall also measures approximately 25 m in length, and it consists of three to four courses in remaining section. No irrigation ditch was visibly associated with this terrace on the upstream end. An excavation unit (TU1) was placed near the base of the upper retaining wall on the north end, and yielded a charcoal sample and flotation sample of sediment from beneath the wall

The irrigation ditch located at the northern edge of the complex has been carved from into the bedrock and is associated with a historic concrete sluice-gate. The ditch is near a point in the stream where the water drops about 20 cm creating a very low fall and where a crossing is located (with rope from one side to the other). A plastic pipe is located in the ditch with rock

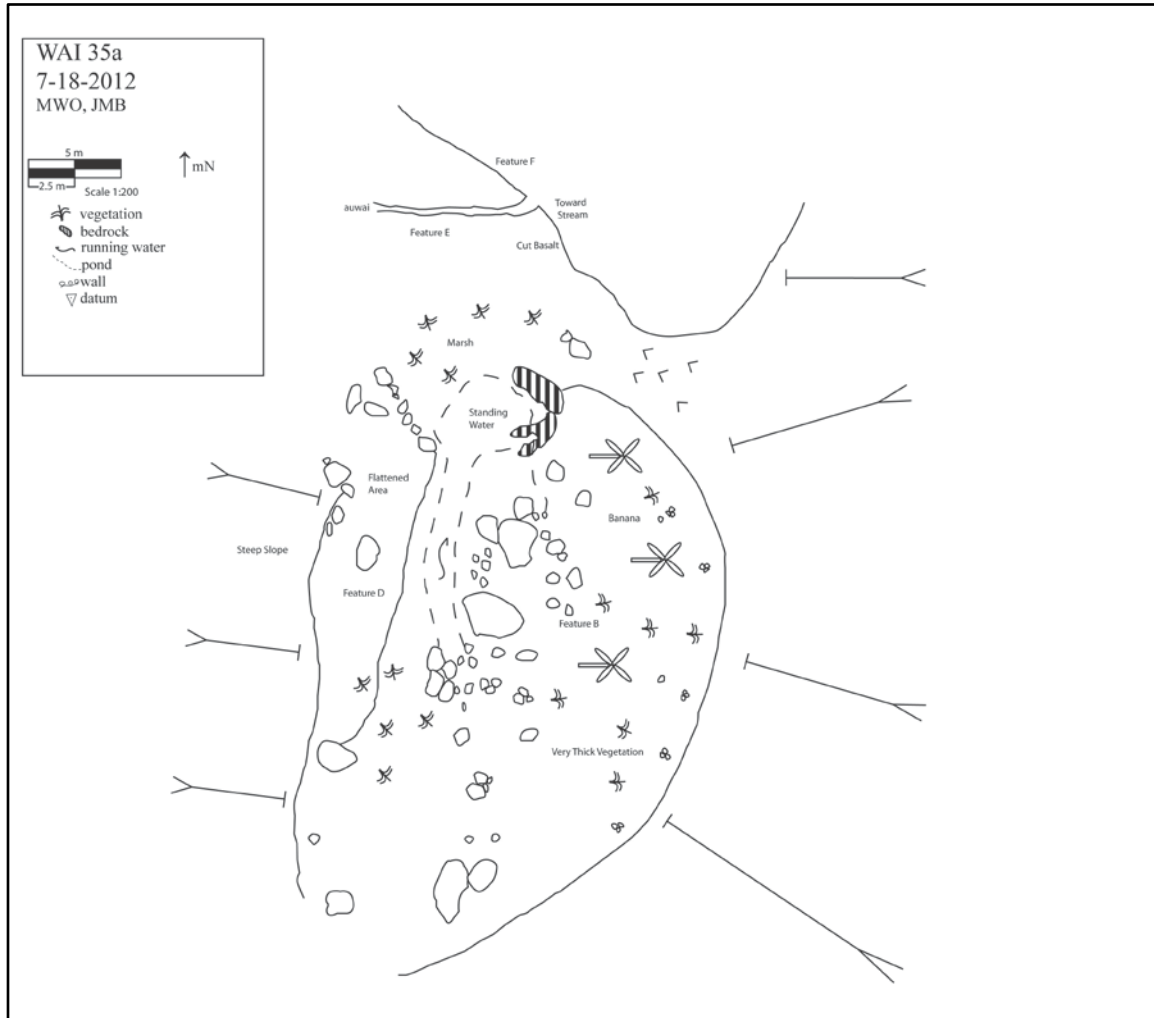
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rubble on top of it. The ditch extends about 3 m and then is dug out as a tunnel into the lower portion of a ridge line. This tunnel, which is only 3-5 m in length, then emerges on the east side of the ridge where a bedrock excavated ditch is located (and which is further described in WAI 35). The plastic pipe extends out of the tunnel as well and then down stream and slope for more than 50 m. An apparent ditch-digging tool was located on the exterior berm of the irrigation ditch on the WAI 35 side of the ditch-tunnel, and measured approximately 10 cm in length, as shown in **Figure XX**.



[Agricultural Terrace Complex and Ritual Feature \(WAI 35\)](#)



WAI 35 is a complex comprised of an agricultural complex, bedrock cut water transport ditch, and associated ritual feature located just to the east of WAI 34 where a short secondary drainage extends upslope of Waikama Stream. The bedrock cut ditch (shown as Feature E in Figure XX) connects to the tunnel described for WAI 34. This ditch extends to the top a bedrock portion of the secondary drainage, which then drops 10 m to Waikama Stream below. The bedrock has a notch in it where the water once flowed. The puzzling aspect of this configuration is the water diverted from Waikama Stream at WAI 34 and into a bedrock cut ditch, through a bedrock cut tunnel, and then back again into a bedrock cut ditch would not have fed any obvious agricultural terraces of features at the north end of WAI 35. Rather it would have created a small waterfall at this section of the secondary drainage.

The agricultural portion of WAI 35 is believed to be the upper portion of the secondary drainage. Currently, this area, especially on the east side of the drainage supports a dense growth of banana. There do not appear to be terraces in which the bananas are growing; rather there is talus rock from the adjoining slope. This talus sits just above the drainage bottom and around a portion of the pool that exists at the south end of the drainage and which must be fed by a



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series of springs. On the west side of the drainage, there is a small terrace measuring 17 x 14 m (Feature D). Feature D has a single course retaining wall at its northeastern corner. The feature identified at the southern end (Feature C) of the complex, is a pond fed by a spring or by the water-ritual feature located above the site, as shown in [Figure XX](#). The pond measures approximately 15 to 20 m in diameter. Along the southeastern portion of the pond is a cave or rockshelter (Feature G), which is inaccessible by foot and was not investigated during 2012. Water from the pond drains into the channel of this secondary gully and extends down slope to the cliff line above Waikama Stream. The area around the cliff line has also been modified, had standing water in 2012, and was likely used for cultivation in the past.

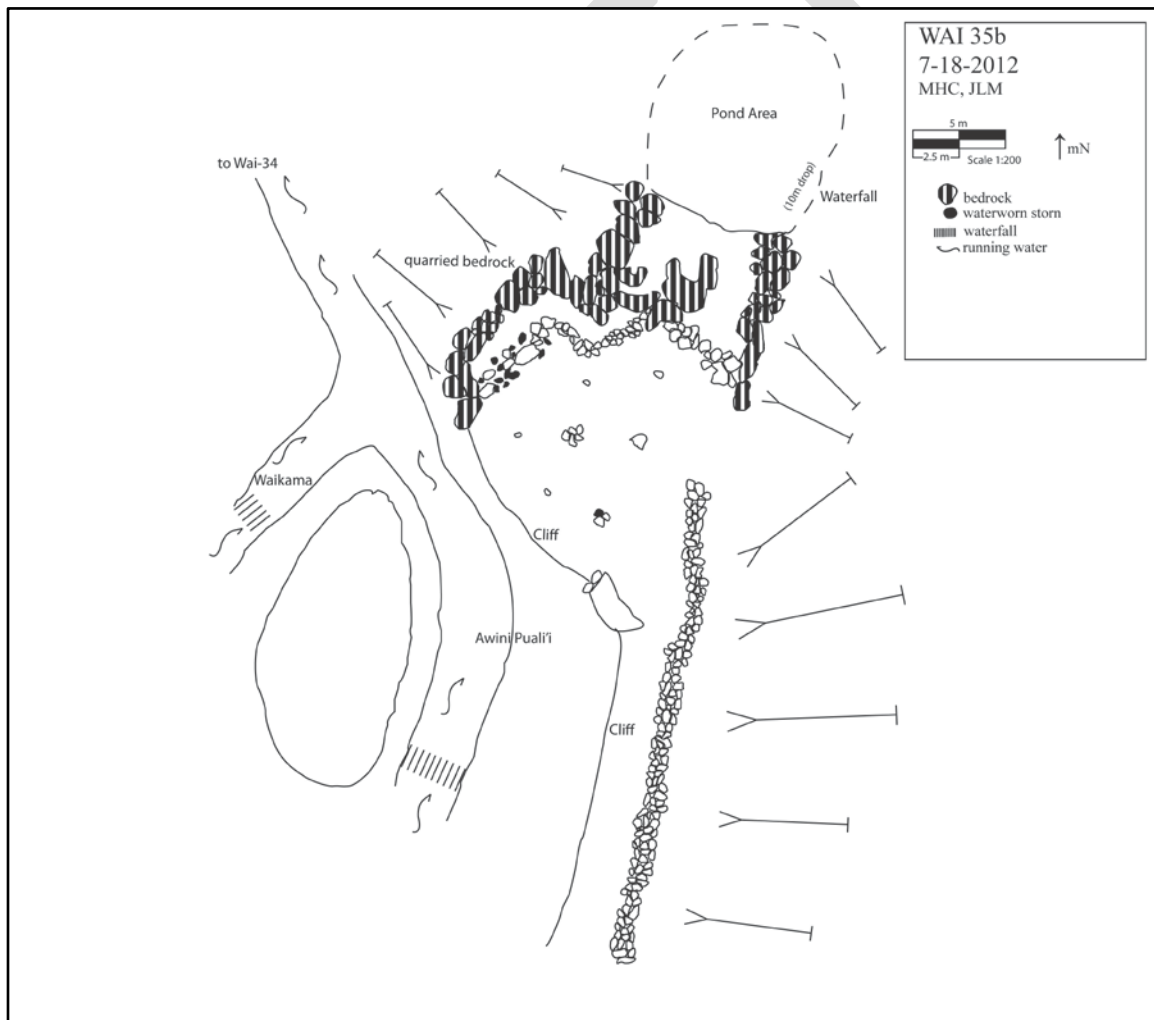


At the top of the drainage comprising WAI 35, 30 to 35 meters above the pond area, there is a shrine or ritual feature. This feature can be reached by walking a trail along the ridge line separating WAI 35 drainage from Waikama Stream to the west. The feature lies at the back of the ridge line; above it to the east is a steep slope that extends up to the upper ridge top lands (where WAI 4W and 4E are located). The ritual feature appears to have used the natural topography for the back end of the ridge line but also appears to have been cut into the ridge line at this point. Evidence for this is the depressed or lowered elevation at the back of the ridge and the relatively steep but low slope from the ridge line top to the feature itself. Bedrock has been quarried out in this area to a depth of 1 to 2 m.



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The overall scale of the feature is about 25 m (from one cliff line to another) by 20 m (from one side of the slope to the ridge line slope). Internal components of WAI 35B include a retaining wall that extends along the eastern slope back towards the stream. The southeastern point of this feature provides a direct view to the convergence of 'Ōpaepilau and Waikama Streams. A low terrace formed at back of this feature oriented roughly east to west, with a surface of water worn pebbles and cobbles. The terrace steps down to a boulder whose center has been carved and chiseled out to give the appearance of being water worn. There is no evidence for a ditch or other water transport features that would have brought water into WAI 35B; it lies 10 m above the Streams. Water may have drained into this feature from the side slopes and based on the plan view of the site could have been collected and transported by the long retaining wall on the south end of the feature, north and into the water feature and the “water worn boulder” and down to the cliff edge above the pond (WAI 35C).



WAI 35 is clearly a complicated complex of archaeological features focused around a secondary drainage and there is nothing like this to our knowledge. In some respects it is comparable to

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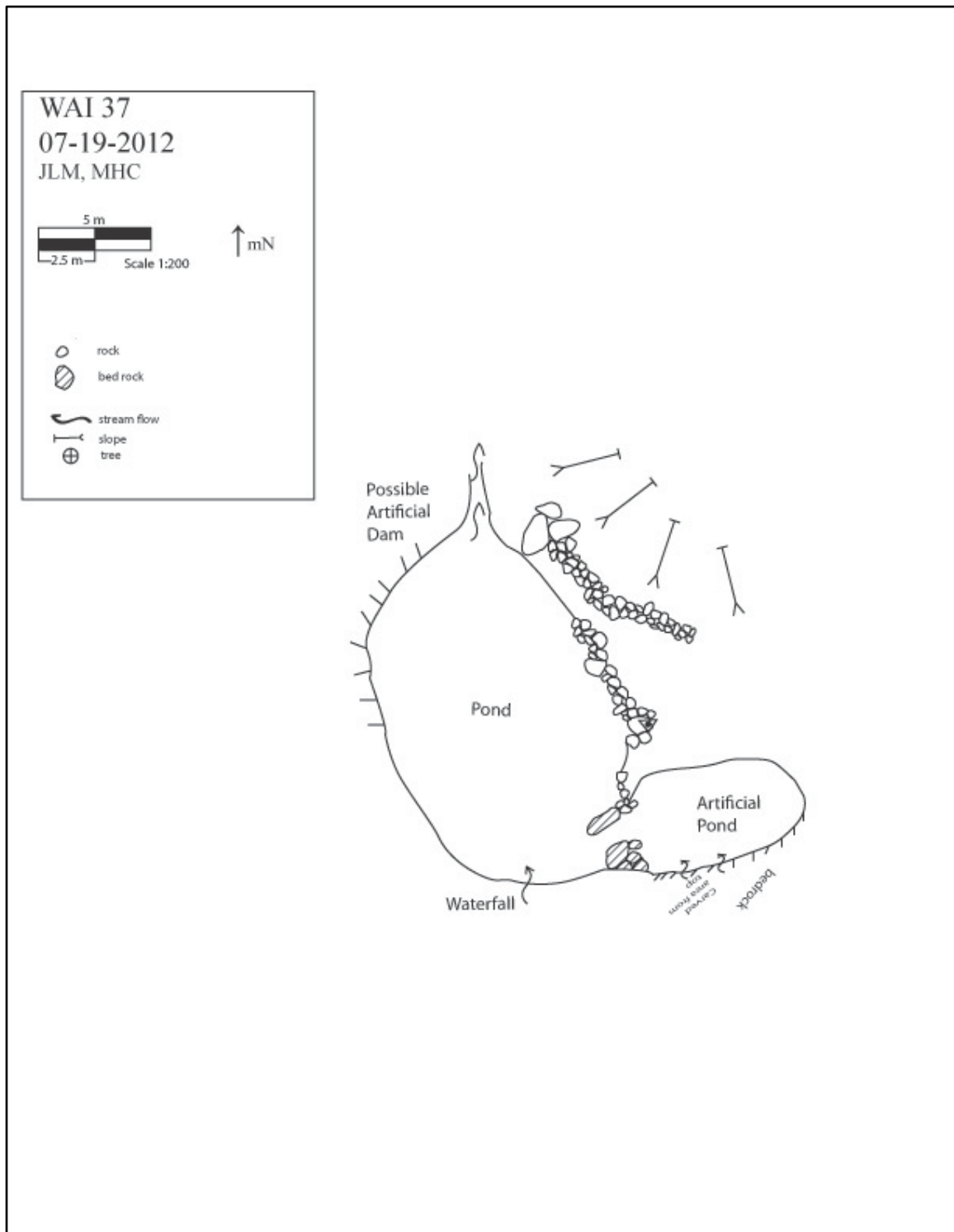
WAI 14/17, the heiau and water control complex in Lower Waikama that was recorded in 2011. WAI 35 is distributed over a much later area;



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## Irrigated Agricultural and Modified Waterfall Pool Complex (WAI 37)



WAI 37 is an artificial pool associated with a small waterfall in 'Ōpaepilau Stream, along with a small bedrock ditch, two associated rock walls, and a ponded area. The waterfall and modified pool located in the main stream channel provides the water for the artificial pond through a



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ditch carved into the bedrock surface, which measures approximately 40 to 50 cm in width, 2 m in length, and 75 cm in depth, as shown in [Figure XX](#) and [Figure XX](#). The steep cliff on the south edge of the pond has also been altered along the top in order to direct water runoff to cascade down the cliff face to the pond. Two associated rock walls are located to the north of the carved ditch and pond, one of which originates from the north edge of the carved ditch bedrock. Both walls measure approximately 8 m in length, and are composed of two and three courses or rock. Located north of the naturally occurring collection pool is a possible artificial dam or embankment, which creates the pool within the stream. While it is possible this embankment formed naturally, there are no boulders in this area. Water from the pool flows back into the stream on the east side of the embankment. No artifacts or soil samples were collected from this site. As is visible in [Figure xx](#), this area is heavily vegetated.









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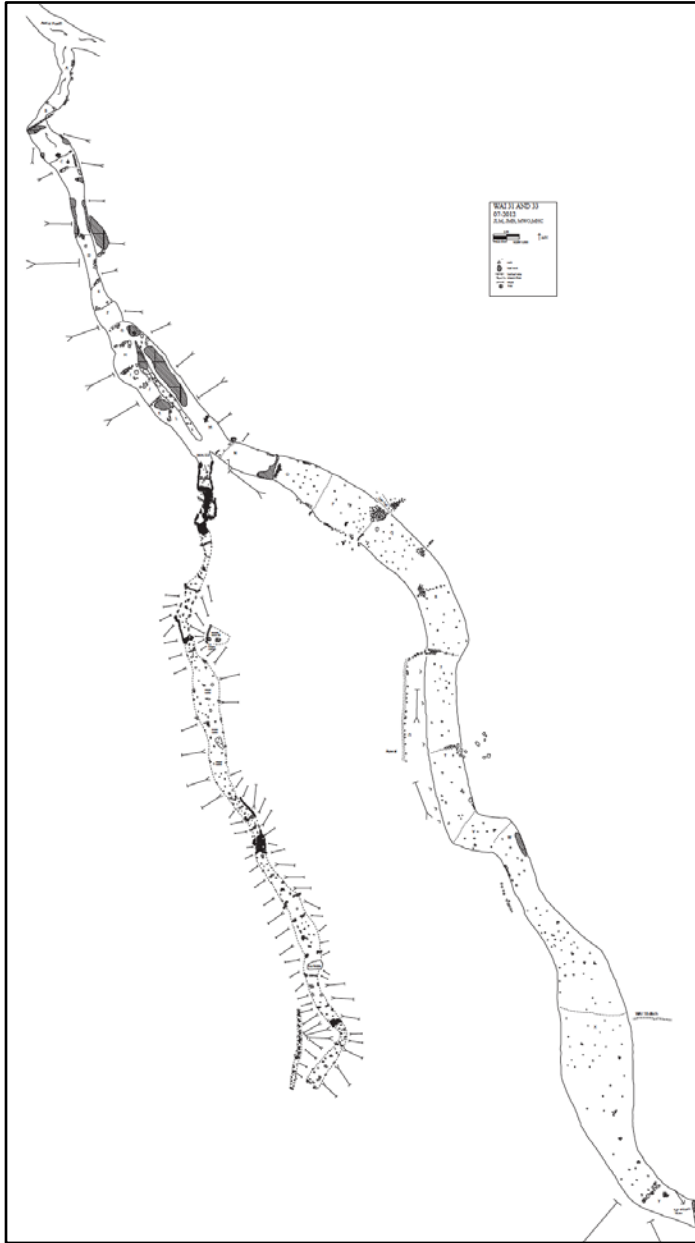
These six sites add significantly to the inventory of archaeological and traditional complexes in Wai'āpuka ahupua'a. From WAI 4E, we have documented the creation of irrigated (lo'i) terraces within a larger or other barrage terrace complex in a secondary drainage. During the re-inspection of WAI 18 and 19 (along with the associated irrigation ditch, MAA 4B), we confirmed the extension of the ditch (MAA 4B) across the WAI 18 alignment and retaining wall and down the slope in the secondary drainage in which the barrage terrace system associated with the new complex, WAI 31. The map of WAI 18 was modified to show how the barrage terrace complex at the top of the gully connected back to the location where the ditch enters the drainage and WAI 31 begins. Essentially, this is all one "site". Additionally, the ditch crosses an ahupua'a boundary (Fig xy) to transport water into a completely different drainage (Ōpaepilau) from where it originates (Waiakala'e Stream). For WAI 19, the two shorter ditches that had been noted in 2011 but not mapped were fully documented; similar kinds of ditches have now been noted for MAA 8 and WAI 31 and confirm that water was led into these dry secondary drainages, not out as was once thought.

Map of WAI 18, 19, MAA 4B, top of WAI 31

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The two barrage terrace complexes of WAI 31 and WAI 33 illustrate a very different kind of system from what had previously been noted in WAI 4W. In these two barrage complexes, there is much less soil build up, except at the upper end of the secondary drainage. There is evidence of flooding and scouring of the channel. As a result barrages terraces are generally in poor shape and do not extend across the bottom portion. Rather, sidewalls of the barrage terrace retaining walls may be visible, or there may be accumulations of rock within the channel that suggests the former presence of a barrage terrace. More bedrock occurs within these two drainages as channel bottom and sides compared to WAI 4W. Whether WAI 31 and 33 were designed primarily to slow water movement downstream is unclear. It may be that the preservation of barrage terrace segments is poorer and flooding more frequent, making it more difficult to reconstruct any agricultural practices within them. Additionally, mulch from the surrounding forest may have been used within these drainages to plant dry land taro or other cultigens rather than relying upon pond fields.



Finally, we have documented additional bedrock cut ditches that appear to be pre-European in age, though some were still in use historically and up through the present. A short tunnel was associated with two of these bedrock cut ditches and this transported water from a stream to a dry (or mostly dry) secondary drainage (WAI 34 and WAI 35). The secondary drainage of WAI 35 currently supported a patch of large banana plants and there was a pond at its upper end. A cliff line extended up to the ridge line separating the secondary drainage from Waikama Stream on the west. A complex at the top of the cliff appears to have been used ritually to create the appearance of a small stream channel within which water was diverted from nearby slopes. Elsewhere we have detailed modified waterfall locations (WAI 32 and WAI 37) and in one

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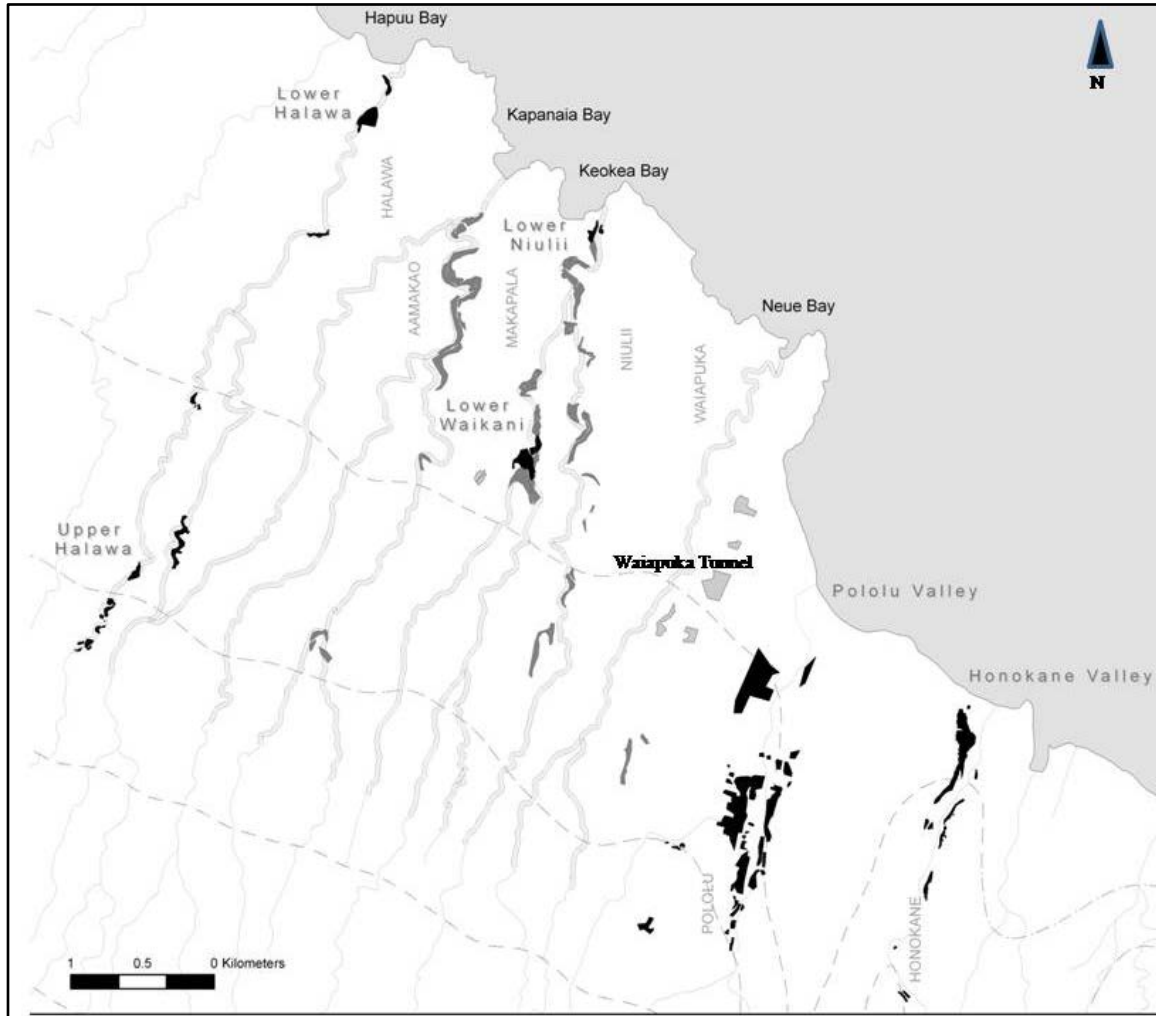
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instance the creation of a pond on one side of a stream channel that was likely used for agriculture.

## Niuli'i (NIU) Study Area

The ahupua'a of Niuli'i is located on the windward side of the District of Kohala, adjacent to the ahupua'a of Makapala (to the north) and Wai'āpuka (to the west). The distance from the coastline to the mountain border is approximately seven km. This area receives ample rainfall each year, with Niuli'i Stream serving as the major drainage for the ahupua'a in its lower course. The stream however is fed by several branches with different names, Puakane and Waikane. This fieldwork was conducted at the coastal end of Niuli'i, in the area directly mauka of Kēōkea Beach Park, on land owned by Don and Nani Svendsen, and Anthony Sun, respectively.

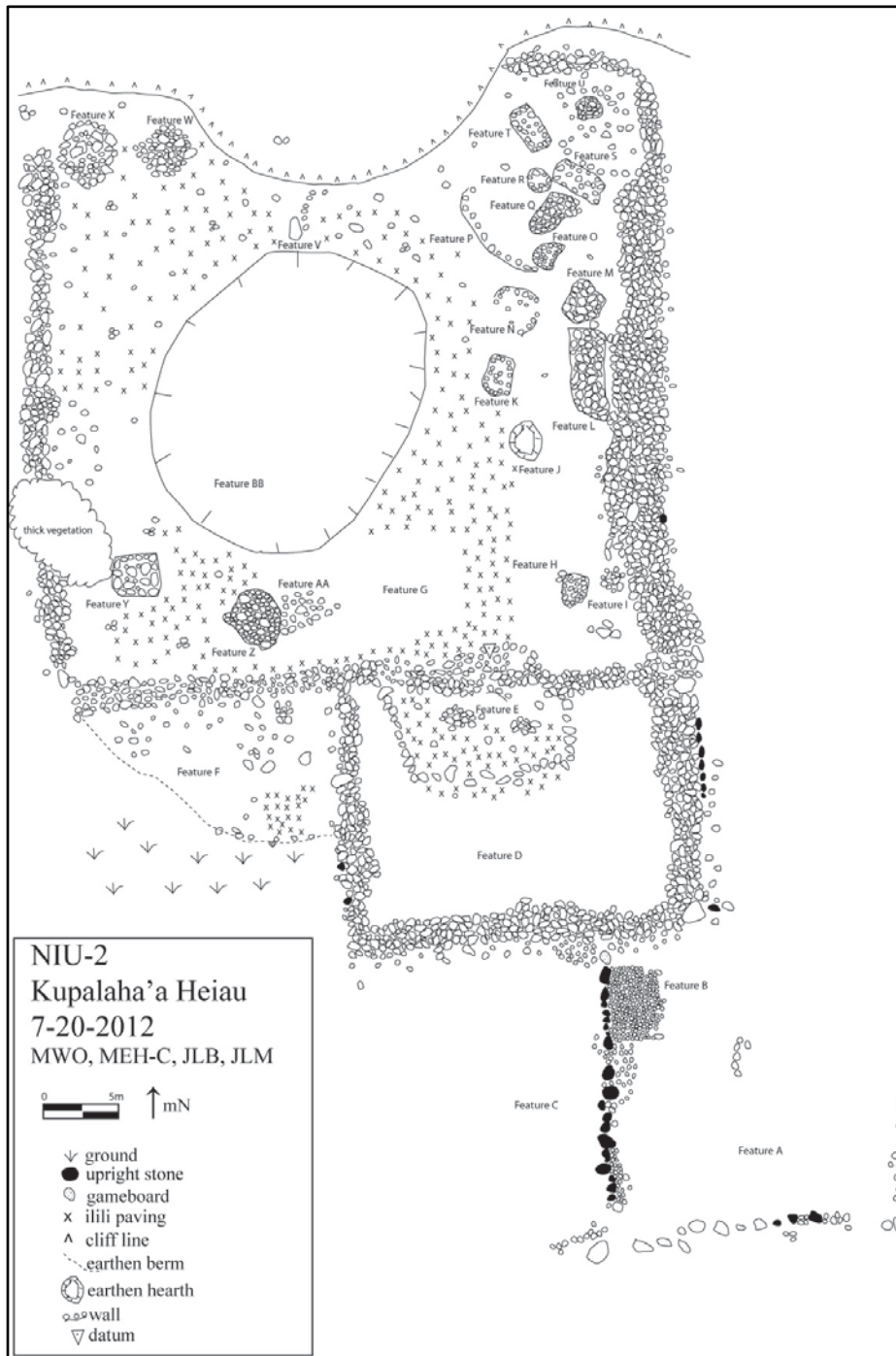
Currently, there are 36 archaeological features recorded in Niuli'i, as shown in Appendix 2. This report includes data from revisiting two sites for additional mapping, and six new sites, with one agricultural terrace complex and associated 'auwai (NIU 30) that is a restored lo'i complex currently in use, a second irrigated agricultural complex (NIU 31) on the east side of Niuli'i Stream across from NIU 30, two 'auwai one with possible historic use and the other potentially prehistoric in age (NIU-33, NIU-34), a boulder garden and associated possible house site (NIU-35), and a tentative ahupua'a boundary marker with petroglyph (NIU-36). The revisited sites include NIU 2, a heiau known as Kupalaha'a located on the cliff line above Kēōkea Bay. We also mapped the extension of the irrigation ditch that feeds NIU 30 down stream to the top of NIU 1, an irrigated agricultural complex first documented in 2006 (Field and Graves 2008a). NIU 31, the agricultural complex in lower Niuli'i across from NIU 30 was partly mapped in 2006. We completed mapping and documentation of this complex in 2012.





## Survey Archival Results, Revisited Areas

### Heaiu Complex (NIU 2)



NIU 2, known as Kupalaha'a Heiau, is a large ritual complex originally with more than 30 features (of which 28 remain) located atop a bluff within Niuli'i ahupua'a (and near the boundary with Makapala) that is to the west of lower Niuli'i Stream and immediately south of Kēōkea Bay. The site, located on private property, is accessible from the Kēōkea Beach Park,

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private property to the south of the site and via Nani Svendsen's lo'i complex (NIU 30) from the southeast. NIU 1, an agricultural complex, is located just to the east of the heiau and shares at least a single retaining wall at the eastern most end of the heiau. While the heiau has not been directly dated, the adjacent NIU 1 has been dated to AD 1450 or thereafter. In 2006 when NIU 1 was mapped, an effort was made to show the location (and association) of NIU 2 to the agricultural terraces.

Prior to 2012, limited archaeological work had been conducted at Kupalaha'a Heiau. J. F. Stokes of the Bishop Museum located this site in the early 20<sup>th</sup> century during his survey of Hawai'i Island ritual sites (in Dye 1991). The site was also noted by Thrum (1908) about the same time. Additionally, M. J. Tominari-Tuggle recorded the site (designated as WK-17 (4149) in the 1980s during her cultural survey of North Kohala. This site, well-known by the local community, is notable for a large hole in the center of the uppermost terrace that has been created naturally by an eroding sea cave that is located directly beneath the heiau. The hole, measuring approximately 17.5 m in diameter, drops dramatically (6 to 9 m) to a rocky bottom that leads to an opening to the sea. In 1970, Loo and Bonk, during the island survey in the early 1970s measured the hole as approximately 6 m in diameter (Tominari-Tuggle 1988: 41). Additionally, based on Tominari-Tuggle's map (citation and page), it is evident that in addition to the hole, the cliff line at the north end of the site has/is eroding significantly. Tominari-Tuggle's map shows a paved platform along the north cliff line; this feature has since eroded to the sea below. Based on previous visits to the site, the erosion at the site has increased significantly just within the last six years. During a previous visit to this site in 2006, heavy vegetation (primarily hau) made it difficult to assess the site's full features. However, recent clearing and burning of vegetation has afforded ideal conditions to survey and record this site. Even though the overall condition of the site is good, the eroding cliff line and sinkhole poses a significant threat to the continued integrity of the site. The majority of the site's features are within 1 to 10 meters of the eroding sinkhole and/or cliff line. The recent clearing and burning of vegetation over the site may also pose additional erosional threats to the site. Additionally, the close proximity to Kēōkea Beach Park poses a problem of increased foot traffic to the site.

Overall, the site measures 80 m N/S by 60 m E/W, measuring about 2500 m<sup>2</sup>. The temple is divided into a minimum of four terraced areas. The main walls of the heiau are constructed with large water worn basalt cobbles and boulders. These stones were likely procured from both the Niuli'i stream to the east as well as the nearby coastline. Depending on the location, wall construction varies from seven to ten courses with a maximum height of 80-100 cm. The lowermost terrace (Fea A), measuring 20 by 20 m, is located just above and to the west of the NIU 1 agricultural complex. On the lowermost terrace, there are two unique components within feature A that have been designated as separate features. Feature B is a rock mound that measures 4 by 5 m. The mound is constructed with small to medium water worn cobbles and is about 30-40 cm in height. Compared to the other features of the site, the stones of feature B appear to be more recent and may have been added to the site within the last 30 years. Feature

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B is absent from Tominari-Tuggle's map; however, because of very dense vegetation, it is possible that Tominari-Tuggle missed many of the site's smaller features. Abutting feature B is feature C, an 18 m long wall that trends north-south and is constructed from large, flattened upright boulders. Feature D is a terrace to the NW of the lowermost terrace (Fea. A). Feature D measures 20 m N/S by 25 m E/W. Centered at the north end of feature D is a stone platform that has been designated as feature E. Feature E measures 7.5 m N/S by 12 m E/W. To the west of features D and E is another terrace (Fea. F). Feature F is a terraced area that lacks any clear retaining walls (compared to the three other main terraces). Feature F measures 10 m N/S by 15 m E/W. At the southeast end of feature F is a small (3 x 3 m) area paved with 'ili 'ili. Feature G is the uppermost and largest terrace of the site. Feature G measures approximately 40 m N/S by 40 m E/W and has a minimum of 21 features (H through BB) within it. Because of the recent clearing and burning of vegetation, this is likely the first time that many of the site's smaller features have been recorded. The majority of the terrace (especially the east end) has 'ili 'ili paving which appears to have once been continuous throughout this portion of the complex. The east and west walls of this terrace are large mounds of basalt cobbles and boulders. At the east end of the terrace, 14 features were noted: two depressions (Fea. I and J), five areas paved with large cobbles (Fea. H, K, L, S, and T), four semi-circular (single course) alignments (Fea. N, O, P, and R), three mounds (Fea. M, Q, and U). While the function of many of these features can only be surmised, features M, Q and U have the potential to be human burial mounds based on their overall size and the potential presence of human bone fragments near the features (Tominari-Tuggle 1988: 41). At the north end of the site, adjacent to the sink hole, is a large modified boulder. Based on Tominari-Tuggle's map (Fig xx), this location once had a large platform. Due to the erosion of the cliff, this platform is no longer present. At the NW end of the site is a mound (Fea. W) and a mound with a depression in the center (Fea. X). Both features W and X may have been utilized as ki'i holders. At the SW corner of the site is feature Y, an area paved with neatly dressed large cobbles. Feature Z, a collapsed Portuguese brick oven, is abutted against a cobble paved area (Fea. AA). The oven has since collapsed within itself and bricks from the oven can be found scattered across the site. At the center of the terrace is a large sinkhole, feature BB, created by the natural erosion of a sea cave. Based on what can be observed of feature BB, it does not appear to have been directly modified for the heiau. Additionally, it is possible that the hole did not exist prior to the construction of the site and may have developed post-abandonment. While Hawaiian oral tradition does not mention the existence of the hole within the heiau, Silverman (DLNR 1972: 37) did interview A. Pule who "related how Kamehameha's warriors eluded pursuing enemy warriors from the Hamakua area by leaving their canoes as decoys and swimming underwater to the cave where they concealed themselves" (Tominari-Tuggle 1988: 41).

This complex has a variety of surface artifacts including coral, branch coral, volcanic glass flakes, basalt flakes, ground stone cobbles, basalt choppers, historic metal (portion of steel lock), glass, ceramics, brick, faunal remains, and possibly human remains. The presence of human remains was first noted by Tominari-Tuggle (1988: 41): "human bones were observed (during present survey) beneath the paving exposed by the collapse". Bones, including cut and charred bones,

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were observed throughout the site; with the greatest density found at the NE corner of feature G. Most of the larger bones observed appear to be non-human (likely bovid); this was confirmed by a visit to the site by Dr. Heather Edgar, a biological anthropologist. Nonetheless, there are many small bone fragments that, although not easily identifiable, may be human. Several opihi shells were observed on the surface; given their overall good condition, they may be a more recent introduction. The majority of the lithic artifacts from this site appear to be local as well as several basalt flakes that are consistent with materials that originate from Pololū Valley. The larger lithic tools (e.g. choppers) likely originate from dense basalt cobbles obtained from Niuli'i stream or the nearby coast. The site also has a high density of coral; some quite large in size. Branch coral is less common although present. A single piece of branch coral was collected from the south end of the site for potential dating. Historic artifacts are common at this site with ceramic sherds being the most common artifact encountered. The lower portion of a hollowed steel pad lock was also identified (with no markings). The Portuguese oven located with feature G is associated with the historic occupation at the site. The oven, constructed from brick and mortar, clearly indicates that food was cooked at the site. This may explain the high density of processed animal bones, ceramic sherds and glass shards at this site. Bricks from the oven can be found scattered across much of the site. The ceramics observed varied considerably but included brown stoneware, glazed earthenware, white porcelain, porcelain with floral print, and even a "corn cobb" patterned yellow glazed ceramic. Historic glass included clear and brown bottles. Several intact upper portions suggest many of the bottles were machine made.

Overall, Kupalaha'a Heiau is one of the area's most significant and well-preserved prehistoric (and historic) sites. It is directly associated NIU 1, an irrigated agricultural complex along the west bank of Niuli'i Stream, irrigated by a ditch that emanated from NIU 30, a large, restored agricultural complex to the south. The plan and scale of NIU 1 has been interpreted as a chiefly agricultural complex. Its precise temporal and functional relationship with NIU 30 is as yet unknown. The heiau is also associated with a complex to the west (NIU 35) and is not far from a boulder (NIU 36) that is located on the Makapala- Niuli'i ahupua'a boundary. The association of oral history linking Kupalaha'a with Kamehameha means that it was still in use in the late 18<sup>th</sup> and possibly early 19<sup>th</sup> centuries. As with other heiau sites in Hawaii, its conversion to habitation during the historic period, extends its occupation into the late 19<sup>th</sup> century when Portuguese workers were brought to Hawaii to work on the sugar plantations (citation for this date).

### [Irrigated Agricultural Terrace Complex \(NIU 31\)](#)

map to be inserted- waiting on Joe 11/14

NIU 31 is an irrigated agricultural terrace complex located to the east of Niuli'i Stream and south of Kēōkea Beach Park. It is across the stream from NIU 30 and the southern portion of NIU 1. The site was first documented by HARP in 2006; it was designated as NIU 3 and 10 terraces were mapped on the north end of the complex. Some of these terraces were assumed to be habitation, but our rendering of the complex would attribute an agricultural use to most, if not, all of them. The site is in mostly heavy vegetation of hau trees, although two terraces at the southern end have been completely cleared of vegetation recently. Two new terraces were

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identified on the south end of the complex this year, bringing the total to 12 features present. The two new terraces are the largest in the complex. The terrace retaining walls at NIU 31 are in fair to poor preservation within the vegetated area, consisting of both cobbles and boulders, and ranging from one to six courses (10 to 100 cm in height). In some walls, large bedrock boulders create the majority of the wall. The two new documented terraces have been completely cleared and portions if not all of their retaining walls are rebuilt. A concrete stairway and path have been built onto the upper most of these terraces.

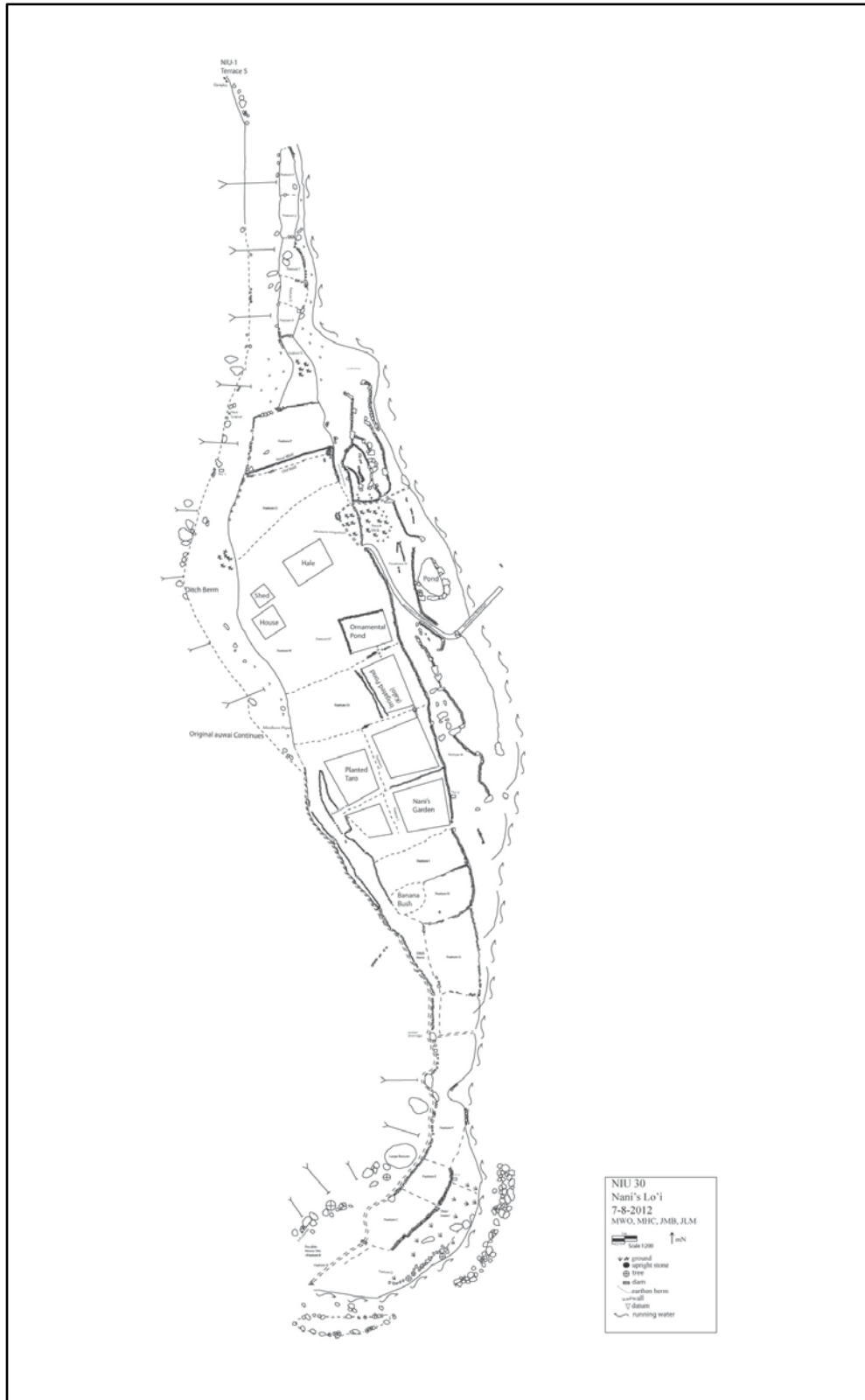
Currently, there is no physical evidence remaining for an irrigation ditch on the south end of the complex. However, there is an irrigation ditch documented on the east side of Nuili'i Stream at the same point where the irrigation ditch for NIU 30 originated. As was the case of NIU 30, there is an artificial islet in the stream near the possible NIU 31 irrigation ditch origination point. This ditch can be seen from the upper end of NUI 30 and as there is no other possible agricultural feature nearby, we have inferred that it was likely the source of water for NIU 31.

The entire complex of NIU 31 is approximately 40 m in length and 10 m in width, and also includes a section of a historic road leading to Kēōkea Park. Historic and modern garbage can is found near the road area. A test excavation unit was placed along a retaining wall in Feature 7, that yielded charcoal and volcanic glass.



## Survey Results, New Areas

### Irrigated Agricultural Terrace Complex (NIU 30)



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NIU 30 is large irrigated agricultural complex located on the west bank and lower slope of Niuli'i Stream near Kēōkea Bay in the ahupua'a of Niuli'i. The landowners of this property are Don and Nani Svendson, local residents, and portions of the complex have been put back into cultivation, both of irrigated kalo or taro (*Colocasia esculenta*) and along with other traditional crops (e.g., sugarcane, bananas [*Musa* sp]), vegetables, flowers, and a variety of tree crops (Figure xx—see below). More than 20 features (A-Y) were identified as part of this complex, including an irrigation ditch, at least 20 terraces, an modified islet in Niuli'i Stream, one possible habitation feature, and a series of modifications that mostly involved low terraces and walkways that appear to be recent (see Figure xx—plan view map of NIU 30). The complex is no more than 200-300 m from Kēōkea Bay. It is linked to NIU 1, another large irrigated agricultural complex directly adjacent to Kēōkea Bay by an irrigation ditch that extends from the south end of NIU 30, along the western edge of the complex (adjacent to the slope) to the north end of NIU 30 over a distance of approximately 200 m and then continues north another 50 m to the upstream end of Feature 5 of NIU 1 (see Figure xx). There are a total of five agricultural terraces associated with NIU 1, with boulders in several retaining walls, and retaining walls along the stream side of the complex that are more than 3 m high. The NIU 30 complex, as well as NIU 1, are thus oriented roughly north to south, paralleling the course of the stream.



In addition to NIU 1 (mapped in 2006), the complex of NIU 30 is associated with NIU 31 across the stream on the east bank of Niuli'i. NIU 31 is another irrigated agricultural terrace complex described previously. Portions of NIU 31 were also mapped in 2006 and they overlap with what was identified as NIU 3. NIU 3 included the lower agricultural terraces of NIU 31 in addition to

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several small irregular terraces that may have been for habitation. The two irrigation ditches for NIU 30 and NIU 31 are associated with two islets in Niuli'i Stream that appear to be human modified or built. These islets create secondary channels within the stream, making it easier to raise the water level for diversion by their respective ditches. Finally, NIU 30 and NIU 1 are associated with a large heiau (NIU 2), known as Kupalaha'a.







Kupalaha'a heiau is located on the ridge and cliff line above NIU 1. The heiau has several structural features, including a large central partly walled terrace abutting the cliff line with a large hole in the center that extends to the ocean below. To the immediate west of NIU 1 is an enigmatic site, consisting of a "boulder garden", and what appears to be a curbed walk-way that is oriented to the east in the direction of the heiau. Altogether these five complexes include agricultural, engineered water transport, habitation, ritual, and possibly other functions as yet to be identified.

Because much of NIU 30 has been restored to agricultural production it is important to attempt to distinguish between recent construction (i.e., rebuilding of walls) and what its built configuration would have been in the 19<sup>th</sup> or early 20<sup>th</sup> century. A number of retaining walls, particularly those on the edges of the complex (e.g., adjacent to the ditch or near the stream) appear to be newly built based on the appearance of the rock used in construction. Typically, these rocks lacked lichen growth on their facings and were red brown in color (Figure xx). Similarly, the restoration of farming within the terraces that comprise NIU 30 has led to rebuilding of walls that had collapsed. As a consequence, the map for NIU 30 combines both recent and ancient constructions and one goal of archaeological and historical investigations should be delineate the where walls (or other features) can be confirmed to be "ancient" or part of the original complex as opposed to more recent. The bridge across the Niuli'i Stream that leads to the complex from the east bank and ridge top has been rebuilt at least once since it was first re-established and there is a pathway that is partly edged with retaining walls on either side and it cuts through the original large retaining wall that defines the eastern edge of the complex. The restoration of NIU 30 also affects the integrity of some archaeological deposits in

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subsurface contexts as well. One indication of such effects would be unburned kukui nut shells in deposits, as well as recent historic materials in such deposits as well. Obviously areas that are currently being cultivated for taro or other crops within the original terraces would be unlikely to preserve ancient materials, unless they underlie the current cultivated zone of these terraces. Preserved soils are likely to be found within the immediate margins of terraces as these were not always cultivated (or not cultivated continuously).



There is also an area of NIU 30 that has likely been eroded by stream activity; this is found on the upper portion of the complex, concentrated on Fea F where part of the stream side retaining wall is missing, and a center portion of the terrace has been cut away by as much as 2 to 3 m.

Despite these caveats, NIU 30 is an excellent and well-preserved example of a lower stream lo'i complex. It has a large number of terraces, exhibiting considerable variety in size, and the 'auwai is easily identified and can be traced across the entire length of the complex.

The construction of NIU 30 can be separated into three main terrace sections. The first, at the top (south end) of the complex, and was at first thought to consist of a set of terraces in a single line. This section is defined by a stream side retaining wall on the east and the irrigation ditch



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along the west side. The location of the head of the ditch is still visible and this is associated with an islet 30 m in length, 1-2 m wide set within the stream. The exterior of the islet is built out of boulders with smaller rocks and fill within its interior portion. The islet creates a secondary channel within the stream, slowing the flow of water towards the east bank and creating pools of water that could be used for water diversion into the irrigation ditch. The retaining wall in the southern section of NIU 31 ranges from less than 1 m to more than 1.5 m in height, averaging about 6-7 courses of rock. It is likely there were a lower set of terraces next to the stream and that would have abutted the longer main retaining wall of the terraces adjacent to the irrigation ditch and bottom of the slope. There is a remnant of a retaining wall that was placed directly on the west bank of the stream in this upper section. It was not possible to determine how many terraces would have been located directly next to the stream. However, there are 5 to 7 agricultural terraces in the upper section of NIU 30 adjacent to the slope. An area on the upper west end of this section, west of the irrigation ditch, and adjacent to the slope has been cleared and there are remnants of boulder and stacked cobble enclosing walls that may have formed a defined a habitation area within the complex.



The main retaining wall and ditch in the upper section of the complex parallel each other on the plan view map for about 40 to 45 m, where upon the natural stream embankment widens from about 15 m to more than 25 m, doubling the area that could be converted to pond field terraces. This marks the second section of the complex and is defined by a high stream side retaining wall that is more than 2 m in height in some areas and extends for nearly 100 m. This is the section that has been put back into cultivation by the property owners and it may have originally had two parallel sets of terraces extending along much of its length. This was suggested by slight (20-30 cm) differences in the elevation of surfaces within terraces in this section of the complex. There are remnant rock and earthen berms that likely defined terrace retaining walls within. None of these berms were as prominent as the main retaining walls on the east side and stepping down slope on the north side of this section. Mapping of these components was difficult given the on-going cultivation within this section, although estimated 10 to 15 terraces were likely located here. These would have been the primary areas for cultivation, given their location well above the stream but immediately adjacent to the irrigation

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ditch. The high retaining wall along the eastern side of this section is well built, partially restored in some locations, with large basal basalt boulders. There are more than 10 courses of rock visible above grade where the retaining wall reaches its greatest height, and at either end of this section the retaining wall drops to about 1 m height with no more than 5 or 6 courses of rock.

Beginning at the top of this second section of the complex, the irrigation ditch was increasingly defined by a retaining wall or bund on its east side that elevated it above the agricultural terraces; above this the irrigation ditch was dug into the ground surface and was not elevated. The ditch is closely aligned to the bottom of the slope that defines the western edge of the valley bottom land. It is likely there were short secondary ditches that diverted water from the primary ditch but these were difficult to confirm. One place where such a ditch was identified was at the juncture of the upper and middle section of the complex. The ridge line along the upper and middle section of the complex is fairly low, only about 3-5 m above the bottom of the slope. On the east side of the second section of NIU 30 and below the large retaining wall is an area of low retaining walls, several of which appear to be of recent construction. One of the retaining walls, closest to the stream, is parallel of the large retaining wall and hence may be an original construction. This would match what was found in the upper section of the complex. This low retaining wall would have demarcated an area nearer to the stream for cultivation. This area now has a number of secondary crops and trees planted across it, including pandanus, sugarcane, bananas, and various fruit trees.

The third section of the complex, at its lowest end is defined by a series of small terraces in a single alignment that lie just above the stream and beneath the slope up to the ridge line. These terraces are no more than about 5 m wide, extend about 50 m, and the main stream side retaining walls are built on boulders and cobbles often right to the edge of the stream. This area has not been cleared and is overgrown with hau. Seven terraces are estimated for this section. The irrigation ditch parallels this lower section of the complex but is situated along the middle of the slope, 3-5 m above the terraces that comprise this section. The ditch is dug partly into the slope and into the bedrock that is covered by soil and occasionally exposed along the slope. This ditch connects with the top terrace of NIU 1, the irrigated agricultural complex that adjoins the coast line of Kēōkea Beach.

The overall length of NIU 30 is at least 200 m but its width varies from a little as 3-5 m (at the lower end) to as much as 20-25 m (in the middle portion). The main portion of terraces (defined by the main retaining walls) has a total area of xxx sq m; with another xxx sq m along the stream in the upper and middle sections of the complex. The drop in elevation across the complex total about 10 m from the upper to lower ends, with a good portion of the drop in the lower section of the complex.

A number of modern artifacts and other features have been placed across the NIU 30 complex. These include statuary, modified rocks, and carved wooden images and posts among others. No

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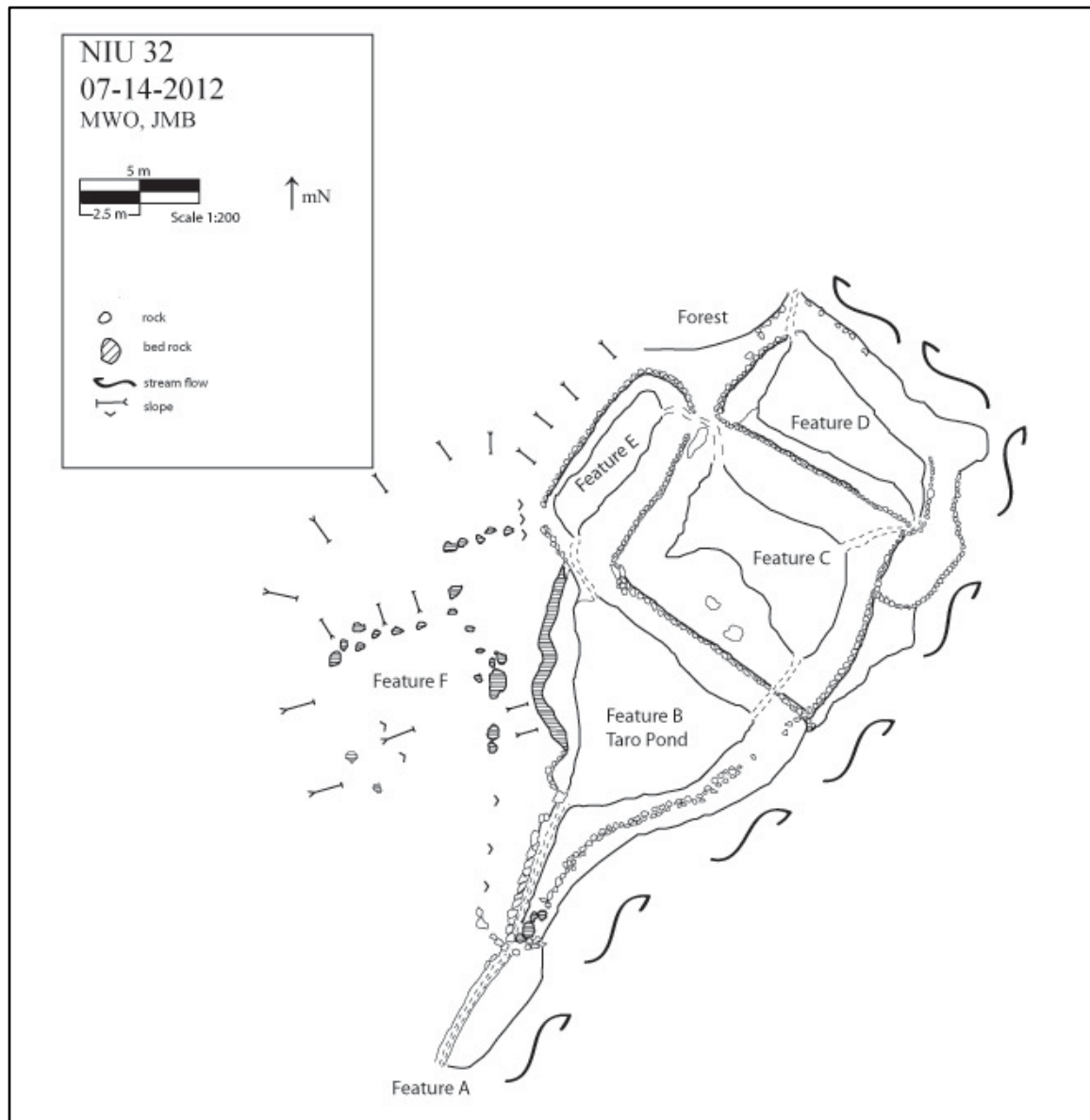
other traditional or possibly ancient features were noted beyond the agricultural terraces, irrigation ditches, and the habitation feature noted above.

NIU 30 is currently being used for cultivation. It appears on the map produced by Lydgate in the 1870s and on the Loebenstein map of 1904. It appears to have been part of two land awards in the mid 19<sup>th</sup> century, one to an individual named Kaina, and the other whose name is not legible on the Lydgate map. Thus, this complex was still in use during the historic period and into the early part of the 20<sup>th</sup> century. Its original construction date is very likely prehistoric given that there is a radiocarbon date from NIU 1, the coastal agricultural complex below NIU 30 but which is fed from the irrigation ditch that originated with NIU 30. The <sup>14</sup>C date was calibrated to AD **xxxx-xxxx**.

**profile map of terraces?**

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## Irrigated Agricultural Terrace Complex (NIU 32)



NIU 32 is a multiple terrace complex located approximately 100 m north of the Kohala Ditch. The complex is on the west side of the 'Ōpaepilau Stream on a natural terrace at about 1015' asl. The site has been restored and put into use by Hawaii Forest and Trail, a local tour company. Directly across and slightly upstream of NIU 32 is WAI 32, a modified waterfall and agricultural complex. There is little evidence of modification at NIU 32 from the original retaining wall locations, other than restacking of rock. Historic glass bottles are present, and have been arranged near the entrance to the complex. All four bottles are machine made, three featuring pop-tops and one a twist-off top. NIU 32 contains four separate irrigated terraces (Features B-E), all currently in use, and the walls which serve to delineate each terrace and provide support for the irrigation ditch are in excellent condition, as shown in [Figure XX](#). Feature B ([Figure XX](#)) was under cultivation in 2012, growing taro. While the terraces' excellent condition may be a



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product of its maintenance by Hawaii Forest and Trail, the site's overall integrity may also be attributable to its location. Well above the Ōpaepilau Stream, the four terraces are fed by an 'auwai (Feature A) which joins the stream approximately 10 m south of the first terrace (Feature B), as shown in [Figure XX](#). Given such a spatial orientation even the most severe flash flooding would be unlikely to affect the site's integrity. Three of the terraces, in particular Features B, C, and D provide the majority of the planting surface for the site. Feature E, also an irrigated terrace located along the northwest corner of the complex, displays a comparatively smaller growing area. On site vegetation includes banana sugarcane, taro and ti. The 'auwai exits at the northwest end of the site, from Terrace D, nearest to the forest. Slightly upslope towards the west end of the site is a flattened area with exposed bedrock, which may have served for habitation or other short term occupation of the complex (Feature F).



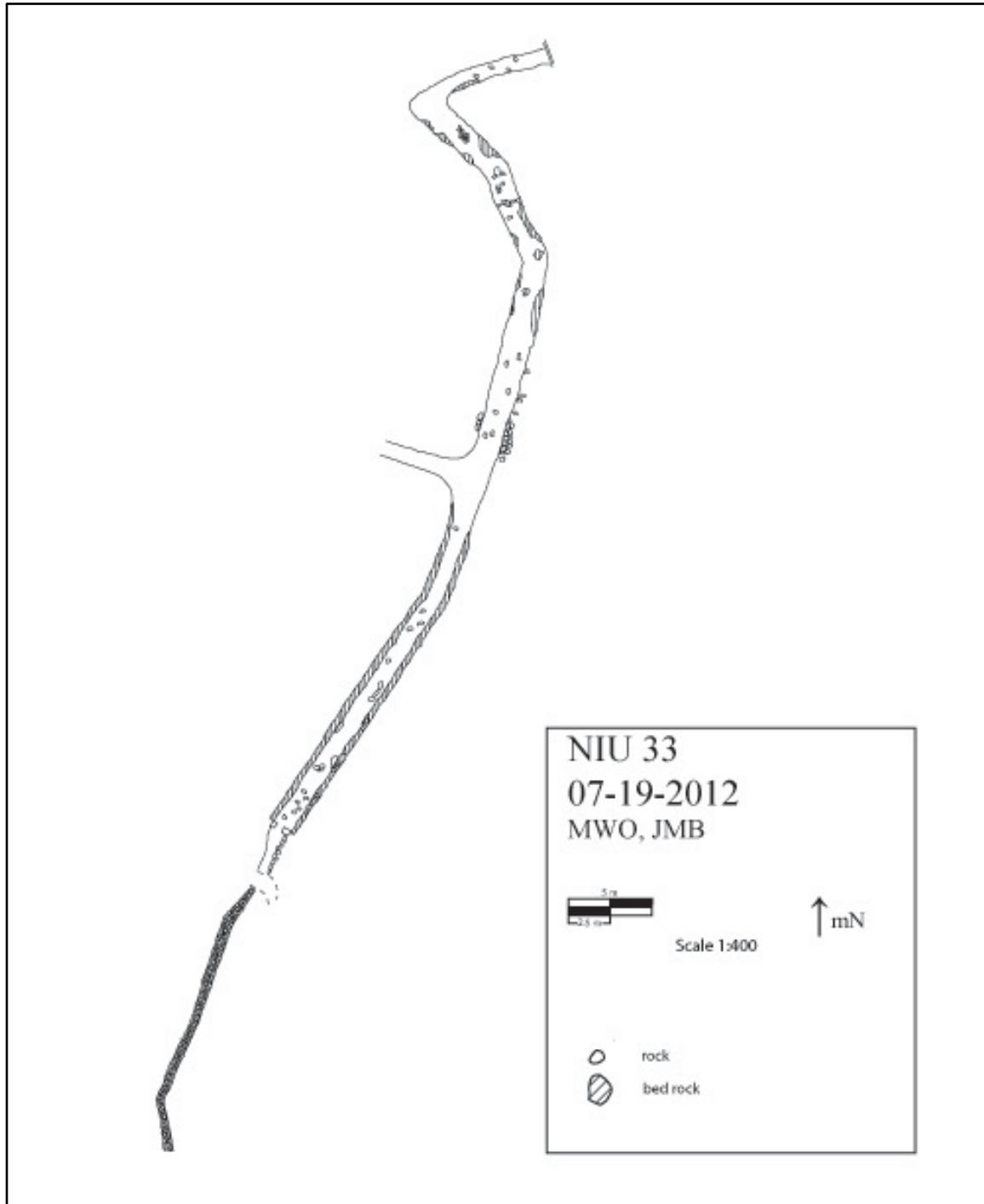


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[Historic Dam and Irrigation Ditch Complex \(NIU 33\)](#)



NIU 33 is a complex consisting of two major features, a dam (most of which currently mortared and cemented: Feature A, Figure XX) across the stream as well as an irrigation ditch (Feature B) cutting into bedrock approximately 50 m long, as shown in Figure XX. The complex is on 'Ōpaepilau Stream and extends westward towards Niuli'i at approximately 1200 ft asl. The dam consists of two parts, a section extending from the east bank that appears to use bedrock in the

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stream along with other boulders to raise the level of the stream. The second section, linking the west bank to the first section is oriented perpendicularly to the stream and it appears to have been built entirely out of transported rock. The dam in this second section is currently cemented and thus this part of the feature may be historic in its entirety. A low retaining wall that extends out the stream on the west bank, has not been cemented but is rather an example of dry laid masonry, which suggests traditional Hawaiian construction. The combination of this dry laid masonry along with the boulder enhanced east section of the dam suggests traditional Hawaiian construction techniques and thus, it is possible parts of this complex were originally built prior to European contact.

The irrigation ditch located in NIU 33 (Feature B) and cut into bedrock extends for approximately 50 m, reaching depths of 1.5 to 2.5 m. The width of the ditch is over 1 m in most sections, a notable difference when comparing the feature to similar bedrock cut ditches recorded elsewhere in this area. Unlike the dam the ditch shows no evidence of cementing nor did we observe metal tool excavation marks on the ditch walls. The sluice gate for the ditch is still in place and is constructed out of cement. A small pump generator sits adjacent to the sluice gate, and pushes water through a plastic pipe to a plastic pool on the ridge top nearby for livestock. The ditch extends along the base of the slope leading up to the ridge for approximately 50 m. Given that the top of the ridge in this area is less than 5-10 m above the slope and ditch, it would seem likely that the ditch extended into an area that was under sugar cane cultivation in the 20<sup>th</sup> century. However, an entry point could not be found for this link, though there is a 'berm' of soil on the upslope/ridge side of the ditch just before the ditch makes a sharp right turning back towards the stream. This extension of the ditch is approximately 10 m and appears to end abruptly. The land where the ditch may have entered the ridge top includes NIU 34 (a large irrigation ditch complex draining the ridge between 'Ōpaepilau and Waikama Streams. No soil samples or artifacts were collected at this site.





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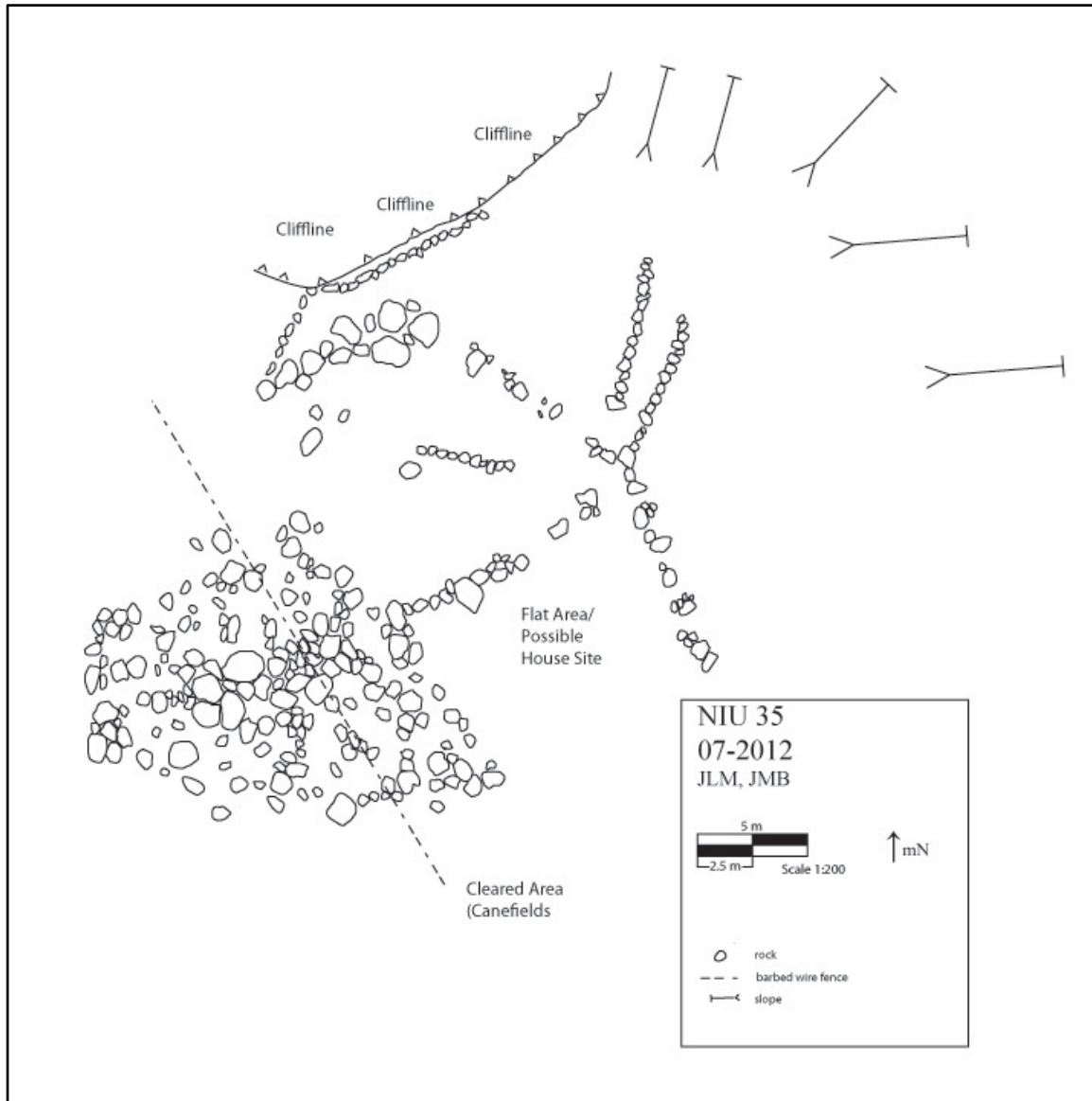
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## [Irrigation Ditch and Agricultural Terrace Complex \(NIU 34\)](#)

NIU 34 is a long segment of a main irrigation ditch, along with secondary channels that appears to have been included in the 1904 Loebenstein map. The ditch is located on previously cultivated sugar cane land, upslope from the confluence of Waikama and 'Ōpaepilau Streams. The ditch extends (to the south) and can be traced nearly to the edge of the Kohala Forest Preserve lands. This ditch can also be seen on Google Earth images. Some sections have eroded as shown on **Figure XX** but elsewhere the original ditch can still be observed. The main ditch intersects both a fence line and jeep trail. North of the fence line, it heads NE to a forested gully area. South of the fence line, the ditch follows the slope up, and there is at least one and probably two secondary channels that feed into the main ditch from the SE.. There are a few areas adjacent to the ditch or within the surrounding drainage that are flattened, and could be former terraces. The origin and termination points of the ditch could not be identified. Approximately 600 m of this feature were mapped in 2011 using a Trimble GPS.



## Terrace and Boulder Garden Complex (NIU 35)



NIU 35 is a complex with multiple features, with several free-standing or retaining walls and an apparent boulder garden. The site is adjacent to the cliff line west of Kupalaha'a heiau (NIU 2). There are various sections of retaining wall with very large boulders present along most walls, with one wall oriented parallel to the cliff face. The site is approximately 60 m long by 50 m wide. The boulder garden is a rock formation of extremely large basalt rocks as well as various cobbles that appear to be placed alongside one another, as shown in [Figure XX](#). Most of the boulders present are more than 1 m x 1 m in size. A possible house site is present at the SW corner of the compound, with a flattened area surrounded on three sides by low walls. The site is in fair preservation. No artifacts were located, and no excavations were carried out, although modern trash (specifically, a sleeping bag) was located in one area.





### [Boundary Marker and Petroglyph \(NIU 36\)](#)

NIU 36 is a large basalt boulder that is located approximately 10 m from the coastal cliff line, along what appears to be the Makapala and Niuli'i ahupua'a border, on the slope above and to the west of NIU-35. It is approximately 2 by 2 m in length and width, and includes petroglyphs in human form. It is unknown if the petroglyphs are prehistoric, historic, or modern. There is a prepared basalt foundation next to the boulder, which indicates that it likely stood upright at some point. No artifacts were recovered at the site.

## Conclusions

The summer of 2012 proved to be successful in several respects. Altogether, 12 new sites were mapped, several others were re-visited and their maps updated, and excavations took place at four sites. Excavation results will be presented in a future report.

In the remainder of this section we describe three aspects of windward Kohala archaeology that make a number of complexes and sites significant. These are: 1. the physical association of

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agricultural and ritual complexes, 2. the extensive use of ditches not only to water fields but to transport water across considerable distances, linking water sources with agricultural terraces, but also occasionally putting water into secondary drainages, all of which had barrage terraces, and 3. the modification of water falls and the creation of water-related features.

### Lower Niuli'i Agricultural and Ritual Complex

We completed the mapping of several sites in lower Niuli'i that now make it possible to link different complexes containing agricultural, ritual, and possibly habitation features. One form in which two of these sites (NIU 1 and 30) are linked is through a shared irrigation ditch that begins upstream, runs through the west side of NIU 30, and diverts water more than 250 m to the top of NIU 1 (whose agricultural terrace then extend another 80 m the coast). Across the stream from NIU 30, another irrigated agricultural complex (NIU 31) was mapped; the likely irrigation ditch associated with NIU 31 begins at about the same location in the stream and at both NIU 30 and 31 there are artificial islets in the stream that create secondary channels from which their respective irrigation ditches were fed.

The mapping of Kupalaha'a heiau now confirms its association with the agricultural complex of NIU 1 by virtue of proximity and at least one shared retaining wall. Oral traditions and oral histories show that the heiau was in use in the late 18<sup>th</sup> century and was converted for habitation in the middle to late 19<sup>th</sup> century. Likely the heiau is partly contemporaneous and functionally related to NIU 1. The five terraces of NIU 1 employ large boulders in the construction of retaining walls both exterior, fronting the stream and rising as much as 3 m above grade, and between terraces. The plan view of the four lower terraces shows features of rectilinear shape and of virtually identical dimensions. This agricultural complex likely served ali'i or the religious leaders associated with Kupalaha'a heiau. Immediately to the west of the heiau is a complex that may contain habitation features, as well as an enigmatic "boulder field", similar to what we have documented at other sites in windward Kohala (e.g., WAI 9 and WAI 17). Immediately west of the heiau and the habitation complex is a large boulder that may have served as the ahupua'a boundary between Makapala and Niuli'i.

### Construction of Ditches for Water Transport and Agricultural Use

In 2011 and again in 2012, HARP documented a number of new irrigation ditches and re-mapped some that had previously been identified. We have long known that irrigation ditches would be associated with individual terrace complexes as a means to bring water (and its nutrients) to taro (and presumably other crops) for cultivation. However, it appears that there is more complexity than first imagined. First, we have identified and mapped ditches that link agricultural complexes with one another. The irrigation ditch in lower Niuli'i is one such example, as it drew water from the stream and distributed it both to NIU 30 and NIU 1. The construction of the pathway of this ditch between the two terraces complexes involved excavation into the slope and bedrock to create a stable channel in which water could flow. This bedrock cut channel was effective but was not dug particularly deep into the slope. Sidewalls of

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the channel are usually sloping to some extent and in plan view this kind of ditch appears approximately V-shaped in profile. And the distance (ca. 50 m) that the ditch was extended to reach from NIU 30 to NIU 1 is not terribly large. Similar kinds of channels have been documented in Wai'āpuka (WAI 4W). These all appear to be traditional in form and construction, and associated <sup>14</sup>C dates place them in the late prehistoric period.

Second, we have now documented several ditches (or portions of their segments) that are dug in a formal fashion that required excavation of bedrock to deeper levels and wider channels (see Fig xx). Their channels are generally flat or nearly flat on the bottom surface with vertical sidewalls. When dug into slopes, there is often a “berm” of rock from the bedrock portion of the excavation on the slope edge; on occasion there are small retaining walls on the upslope side of the ditch. This type of ditch occurs in upper Niuli'i, upper Wai'āpuka and and Makanikahio and extend as far to the east as the top of the slopes of upper Pololū. Most, but not all, are located in the Kohala Forest Preserve, where they have been protected because they lie outside of the sugar cane cultivation zone. These ditches are much longer (250-1,000 m) in length and often connect to more than one agricultural terrace complex and on occasion appear to utilize natural, secondary drainages as a means to transport water over even longer distances.







The ditch complex represented by MAA 4A and 4B, combine both traditional and the more formal forms of irrigation ditches in the same segment. MAA 4A, which begins in Waiakala'e Stream is excavated into the slope above the stream and then extends around the front of the ridgeline that defines western boundary of the stream for more than 250 m. It seemingly terminated at MAA 6, agricultural complex, but it joins a secondary drainage that flows northward for more than 500 m into the lower part of Pololū Valley. The large agricultural terrace complex (POL 4800) in the marsh behind the coastal dunes of Pololū would have been fed, in part, by water from this drainage. Remnants of barrage terraces and other features are located in the secondary drainage.

MAA 4B, the secondary ditch that diverges to the west from MAA 4A near the top of the ridgeline is a traditional form, although some care needs to be exercised here as these forms may be collapsed and simply obscure the bedrock sidewalls. For much of MAA 4B there is no indication of sidewall collapse. As with other such ditches they were dug across less steep slopes where soil may be deeper, and across and down shorter slopes where the channel was excavated nearly perpendicular to the slope (e.g., from a ridge top to a lower ridge). This was the case for MAA 4B; it extends across the upper south slope of the ridge and crosses over an



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ahupua'a boundary wall and then drops down, perpendicular to the slope, into a secondary drainage that flows to the west and north. Within this drainage is WAI 31, a series of barrage terraces, many of which would have been fed by MAA 4B. The drainage extends more than 300 m to join with 'Ōpaepilau Stream to the west, which in turns flows into Waikama Stream. Altogether this system extends more than 500 m in length from the top of MAA 4A, to MAA 4B, to WAI 18 (the boundary wall), and to WAI 31.

Only the ditch associated with NIU 33 and the ditch and tunnel segment of WAI 34 and WAI 35 are entirely of the more formal, bedrock-excavated variety. In the case of WAI 34 and 35 there is again the transport of water from the Waikama Stream drainage under the ridgeline (via the tunnel) to a secondary drainage that flows back into Waikama. The short (3 to 4 m in length) ditch excavated through stream bedrock in WAI 37 below the waterfall would also fall into this category. The first two examples are both associated with contemporary use—they have plastic hoses or piping running within the channel (and in the case of WAI 34-35 through the tunnel). In both cases, the sluice gate has been built with cement on top of rock and a rock-cemented dam is located in the stream to divert water into the ditch. The top of MAA 4A is also associated with a rock wall dam that has been mortared, although there is no sluice gate with cement on rock. Elsewhere in the upper part of MAA 4A there appears to be mortar or cement on the rock "berm" or in the small retaining walls on the upslope portion of the ditch. These ditches all have use-lives that extend into the historic period. In this sense, these ditches are similar to the Kohala Ditch, which is excavated in places through bedrock (including tunnels), has sections where the rock is mortared or cemented, although the Kohala Ditch is much larger, and generally is as wide as it is deep (contrary to most of the formal ditches we have documented archaeologically). Confirmation of the construction or use of the ditches reported here into the prehistoric period will need to await <sup>14</sup>C dating of charcoal found beneath retaining walls or berms associated with these channels.

There are several indications that many of these ditches, even those cut formally through bedrock, were initially built in prehistory. First, although we have not yet examined them thoroughly, we have not seen any indications of metal tool marks on the excavated sidewalls. This is in contrast to the Kohala Ditch where entries to tunnels have been partly excavated with metal tools. Second, most of the ditches that have formal channel excavations lead to or have water diverted to traditional agricultural terraces. This is the case for MAA 4A, which has at least two terrace complexes associated with it before it terminates above MAA 6, a terrace complex in former sugar cane land near the edge of the forest. On the 1904 Loebenstein map MAA 6 is depicted as an agricultural terrace complex and at that time was part of an LCA award. Similarly, the irrigation ditch that comprises MAA 9 does not lead to sugar cane lands but rather flows into a traditional habitation and agricultural complex (POL 4870) at the top of the slope above Pololū, and then continued over the cliff line and was collected at its base by another ditch that led to POL 4838. Both POL 4870 and 4838 have associated <sup>14</sup>C dates that fall largely into the period before European contact. Third, all of the ditches thus far documented follow land contours and are rarely, if ever, constructed in linear fashion (except when they traverse short

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slopes). NIU 34 is an excellent example of this contouring, with much of ditch cut into the existing drainage across the ridge top land between Waikama and 'Ōpaepilau Streams. The ditch and its secondary channels meander within this drainage following the small drainages that cut across the ridge. And although this ditch is located within an area of former sugar cane cultivation, there is no evidence that the ditch water was diverted onto the sugar cane fields. Most historic irrigation ditches, because they could also use metal or wooden flumes, cut across slopes and drainages; they do not as a rule generally conform to drainages. Finally, in the case of MAA 4B, the water transported by this ditch led into a secondary gully with traditional barrage terraces, which in turn led into 'Ōpaepilau Stream. There is no record that such practices were part of sugar cane cultivation in Kohala. The system of tunnels built by the Kohala sugar companies is a version of this, drawing water from one watershed and transporting it into another watershed to the west where stream flow was less abundant or predictable. This, however, may have been an adaptation of an earlier Hawaiian practice of moving water across (not under) the landscape.

### Modified and Artificially Created Waterfalls

At the end of the 2012 field season, we identified a new kind of archaeological site in Wai'āpuka: modified waterfalls. Such modifications were evident above NIU 33 and WAI 32, on opposite banks of 'Ōpaepilau Stream. A small waterfall occurs here and WAI 32 consisted in part of an embankment across the stream with two artificial, but dry, channels that would have fed water into an area on the east side of the stream. WAI 37, the waterfall farther upstream in 'Ōpaepilau, also showed indications of an embankment across the stream and there was a small pond field on the east side of the stream that was fed both by a secondary channel from the top of the waterfall and by a cut bedrock ditch from the pool formed at the base of the waterfall.

The linked complexes of WAI 34 and WAI 35 also preserved evidence of artificial waterfalls. At the lower end of WAI 35, water from the bedrock cut ditch and tunnel associated with WAI 34 fed into the secondary drainage just above a cliff of approximately 10 m and would have created an artificial waterfall. Ordinarily water does not flow within this secondary drainage except after rainfall. Additionally, at the top of WAI 35, there is a ritual feature (WAI 35B) that imitates a waterfall setting: the collection of water from the surrounding slope onto the top of the ridge line (which has been partly quarried), the re-creation of a water channel (complete with water worn pebbles), bedrock that has been carved out to appear water worn and with a small channel that leads to the cliff line and over which water captured from the slopes would have flowed into a small pond at the base of the cliff.

Linked agricultural and ritual complexes, agricultural systems linked by ditches and secondary drainages across considerable distances and span of elevations, and the shaping of the landscape by enhancing waterfalls and dry secondary drainages, and creating features that resembled waterfalls—these are qualities of some of the archaeological sites HARP has documented in windward Kohala. Additional documentation and study of these features and complexes is needed to better understand their antiquity, how they were engineered, and their

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purposes within traditional Hawaiian society. Nonetheless, these expand the range of archaeological sites in windward Kohala illustrating complexity of organization, scale of water transport, and the labor devoted to constructing ditches, in some cases through bedrock.

## References

Appendix 1. Listing of Archaeological Sites and Historic Properties for Wai'āpuka

Appendix 2. Listing of Archaeological Sites and Historic Properties for Niuli'i

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