STATE OF HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
Honolulu, Hawaiʻi

December 10, 2021

Board of Land and
Natural Resources
State of Hawaiʻi
Honolulu, Hawaiʻi

REGARDING: Petition for a Proposed Rule Amendment to Rezone Land from Limited to General Subzone in the State Land Use Conservation District Located at Lanikai Beach Tract, Kailua, Koolaupoko, Oahu

LANDOWNER: Randall N Longfield and Madolyn Ann Longfield

AGENT: HHF Planners
Scott Ezer, Principal

LOCATION: Kehaulani Drive, Lanikai Beach Tract, Oʻahu

TAX MAP KEY: (1) 4-3-005:077

SUBZONE: Limited

DESCRIPTION OF AREA:
The subject 2.24-acre parcel is located on the eastern slopes of Kaiwa Ridge in the Lanikai Beach Tract. The elongated parcel is undeveloped vacant land. There are single-family residences (SFRs) to the north and east, and the undeveloped hillside of Kaiwa Ridge to the west. Directly south of the property is undeveloped vacant land that extends southward to the edge of the SFR development on Kehaulani Drive. The parcel lies within the Limited Subzone of the State Land Use Conservation District (***Exhibits 1,2,3***).

According to the petition for the proposed Rule Amendement, the parcel contains slopes of 40% or greater. In addition, soils identified within the property appear to be Kokokahi very stony clay (0 to 35 percent slopes – KTKE) and Papaa clay (35 to 70 percent slopes – PYF). Both KTKE and PYF have a runoff class of "high" and fall under the soil order of Vertisols. According to *Soils of Hawaii* (Deenik and McClellan 2007), Vertisols, such as KTKE and PYF, are dark soils, rich in clays that shrink when dry and swell when wet. The high shrink-swell potential of Vertisols make them very unstable soils not suitable for construction of buildings or roadways (***Exhibit 4,5,6,7***)

PROPOSED ACTION OF THE LANDOWNER:
Pursuant to Hawaii Administrative Rules (HAR), §13-5-5 Amendments., the landowner(s) have filed a petition for a Rule Amendment to rezone land in the Conservation District from the Limited Subzone to the General Subzone. According to their petition, "A SFR is not allowed in the Limited Subzone, except in a flood zone or coastal high hazard area defined by the boundaries of the Flood Insurance Rate Maps (FIRM)". TMK: (1) 4-3-005:077 does not appear to lie in a flood zone or coastal high hazard area defined by the boundaries of the FIRM (***Exhibit 8***). The petition also notes: "Reclassification to the General Subzone would render the property eligible for an application to construct a SFR".

This petition for a Rule Amendment does not include a proposal for a SFR. No improvements are being proposed at this time. The petition states that: "Construction of a SFR would be subject to approval of a Conservation District Use Application (CDUA) and environmental review under Hawaii Revised Statutes (HRS), Chapter 343".

STAFF ANALYSIS:
Pursuant to HAR §13-1-26 Petitions for adoption, amendment, or repeal of rules., (c) *Petitions for proposed rulemaking shall become matters of public record upon filing. The board shall within thirty days following the filing of the petition either deny the petition in writing or initiate public rulemaking procedures. No public hearing, oral argument, or other form of proceedings need be held on the petition. If the board determines that the petition discloses sufficient reasons in support of the relief requested to justify the institution of public rulemaking proceedings, the procedures to be followed shall be as set forth in section 91-3, HRS, §13-1-21 and §13-1-22. When the board determines that the petition does not disclose sufficient reasons to justify the institution of public rulemaking procedures, or where the petition for rulemaking fails in any material respect to comply with the requirements of these rules, the petitioner shall be notified and given the grounds for the denial. The provisions of this section shall not operate to prevent the board, on its own motion, from acting on any matter disclosed in any petition*.

HAR §13-5-12 Limited (L) subzone. states:

(a) The objective of this subzone is to limit uses where natural conditions suggest constraints on human activities.

(b) **The (L) subzone shall encompass**:

1. Land susceptible to floods and soil erosion, lands undergoing major erosion damage and requiring corrective attention, as determined by the county, state, or federal government; and

2. Lands necessary for the protection of the health, safety, and welfare of the public by reason of the land's susceptibility to inundation by tsunami,

> flooding, volcanic activity, or landslides, **or which have a general slope of forty percent or more** [emphasis added].

TMK: (1) 4-3-005:077 lies in the Limited Subzone of the State Land Use Conservation District. The majority of the parcel and petitioned area with the exception of land that appears to be within 25-feet of the boundaries of the parcel (setback area) have slopes of forty percent or more. Thus, it appears that the Limited Subzone is an appropriate designation for TMK: (1) 4-3-005:077.

DISCUSSION:

It appears that it is the landowner(s) intent to rezone and apply for SFR on the property. As stated above, a majority of TMK: (1) 4-3-005:077 contains land that has a general slope of forty percent or more. Siting development on the property will likely require extensive grading and contouring. The topography of the parcel raises concerns regarding any type of ground disturbing activities on its slopes as well as potential challenges related to drainage, erosion, and rockfall that may impact downslope residences. Past applications processed by the Department for siting proposed development on the Lanikai Foothills and Kaiwa Ridge have stoked community concerns about potential impacts from unsteady terrain and alteration of existing drainage patterns to development below.

In Staff's opinion, the parcel's general slope of forty percent or more makes its Limited Subzone designation appropriate and compliant with HAR 13-5-12. It appears that the petition did not fully review the property's characteristics (namely its steepness or general slope) in relation to the objectives of the Limited Subzone designation. Given the parcels natural conditions and physical characteristics, TMK: (1) 4-3-005:077 should remain in the Limited Subzone of the State Land Use Conservation District.

Based on the above, the Board of Land and Natural Resources should deny this petition for a proposed Rule Amendment to rezone the parcel from the Limited to General Subzone. There are identified land uses in the Protective and Limited Subzone that the landowners can apply for. Additionally, the landowners do have the option to pursue a Boundary Amendment with the State of Hawaii Land Use Commission if the Board of Land and Natural Resources decides to adopt Staff's recommendation.

If the Board of Land and Natural Resources does not deny the landowners' petition for a proposed Rule Amendment, the Office of Conservation and Coastal Lands will initiate Rule Amendment proceedings.

AS SUCH, STAFF RECOMMENDS:

That pursuant to HAR §13-1-26 and HAR §13-5-12; the Board of Land and Natural Resources deny Randall N Longfield and Madolyn Ann Longfield's petition to initiate Rule Amendment proceedings to rezone TMK: (1) 4-3-005:077 from the Limited Subzone to the General Subzone of the Conservation District, due to the following:

1. HAR §13-5-12 Limited (L) subzone. states: The (L) subzone shall encompass: … Lands which have a general slope of forty percent or more;

2. The parcel, TMK: (1) 4-3-005:077, contains general slopes of forty percent or greater and therefore should remain in the Limited Subzone of the Conservation District; and,

3. The landowner's petition does not sufficiently review and evaluate the property's characteristics in relation to the Limited Subzone objectives and designation.

Respectfully submitted,

Trevor Fitzpatrick, Staff Planner
Office of Conservation and Coastal Lands

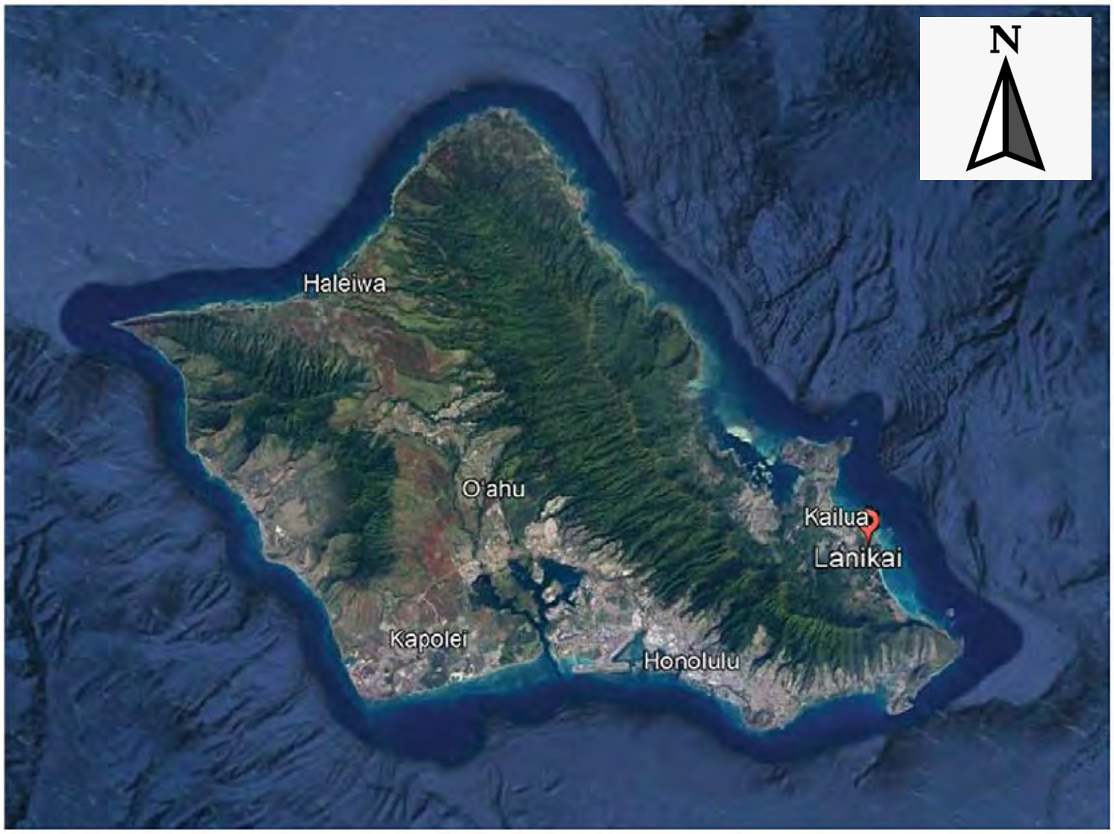
S Michael Cain

Approved for submittal:

Suzanne D. Case, Chairperson
Board of Land and Natural Resources

Exhibit List of Item K-2:

Exhibit 1: Location Map (Page 6)
Exhibit 2: TMK: (1) 4-3-005:077 & Longfields (Page 7)
Exhibit 3: LUC Map & Limited Subzone Map (Page 8)
Exhibit 4: Parcel & Contour Map (Page 9)
Exhibit 5: Slope Analysis of TMK: (1) 4-3-005:077 & Photos of Kaiwa Ridge (Pages 10 to 12)
Exhibit 6: Soils Map of Parcel (Page 13)
Exhibit 7: Soils Classification & Description (Pages 14 to 20)
Exhibit 8: FHAT Report for TMK: (1) 4-3-005:077 (Page 21)



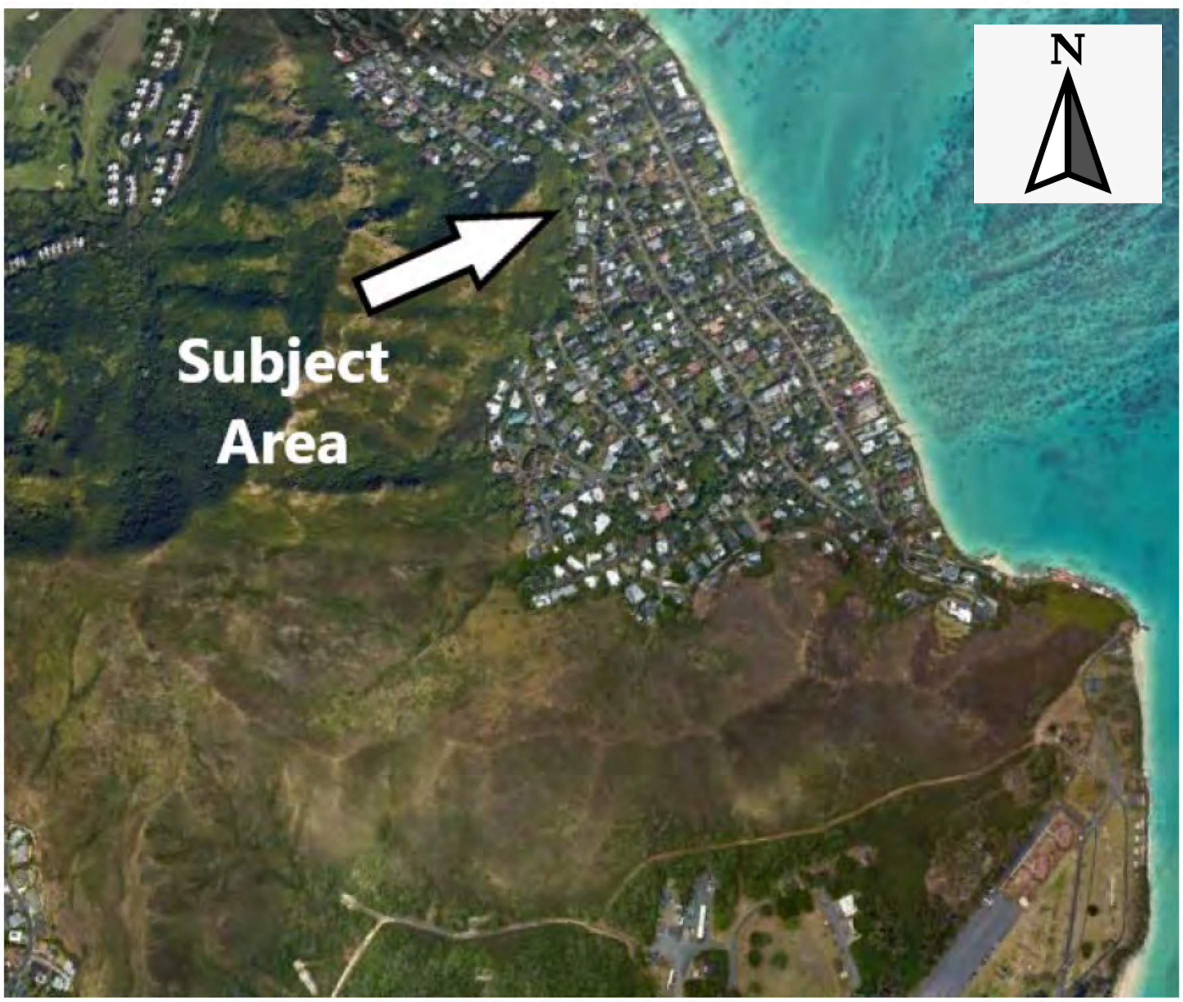


Exhibit 1
Location Map

City & County of Honolulu
Department of Planning & Permitting (DPP)
Property Information

Exhibit 2

undefined

Tuesday, November 23, 2021 | 12:08:21 PM

General Information

TMK:	43005077:0000
Building Value:	$0.00
Building Exemption:	$0.00
Land Value:	$50,400.00
Land Exempt:	$0.00
Acres:	0
Square Feet	97,656
Property Tax Class:	Preservation
City:	Kailua
Zip Code:	96734
Realtor Neighborhood:	Lanikai

Nearest Park: Kailua Beach Park show route

Tax Bill Owner Information

Name	Type	Address	Address 2	City State Zip
LONGFIELD,RANDALL N	Fee Owner	[redacted]		[redacted]
LONGFIELD,MADOLYN ANN	Fee Owner			

2010 Census Information

Tract Number:	011202
Block Number:	1009
Population (block):	455

Voting Information

City Council Member:	Ester Kia aina
Polling Place:	Lanikai Elem Sch
Address:	140 Alala Rd
Neighborhood Board:	Kailua

School and Transit Information

Elementary School:	Lanikai
High School:	KALAHEO
Near Transit Route:	Yes
Near Bus Routes:	70

Zoning and Flood Information

Zoning (LUO) Designation:	P-1
Ohana Zoning Designation:	Ineligible
FEMA Flood Designation:	X
Tsunami Evacuation Zone:	No

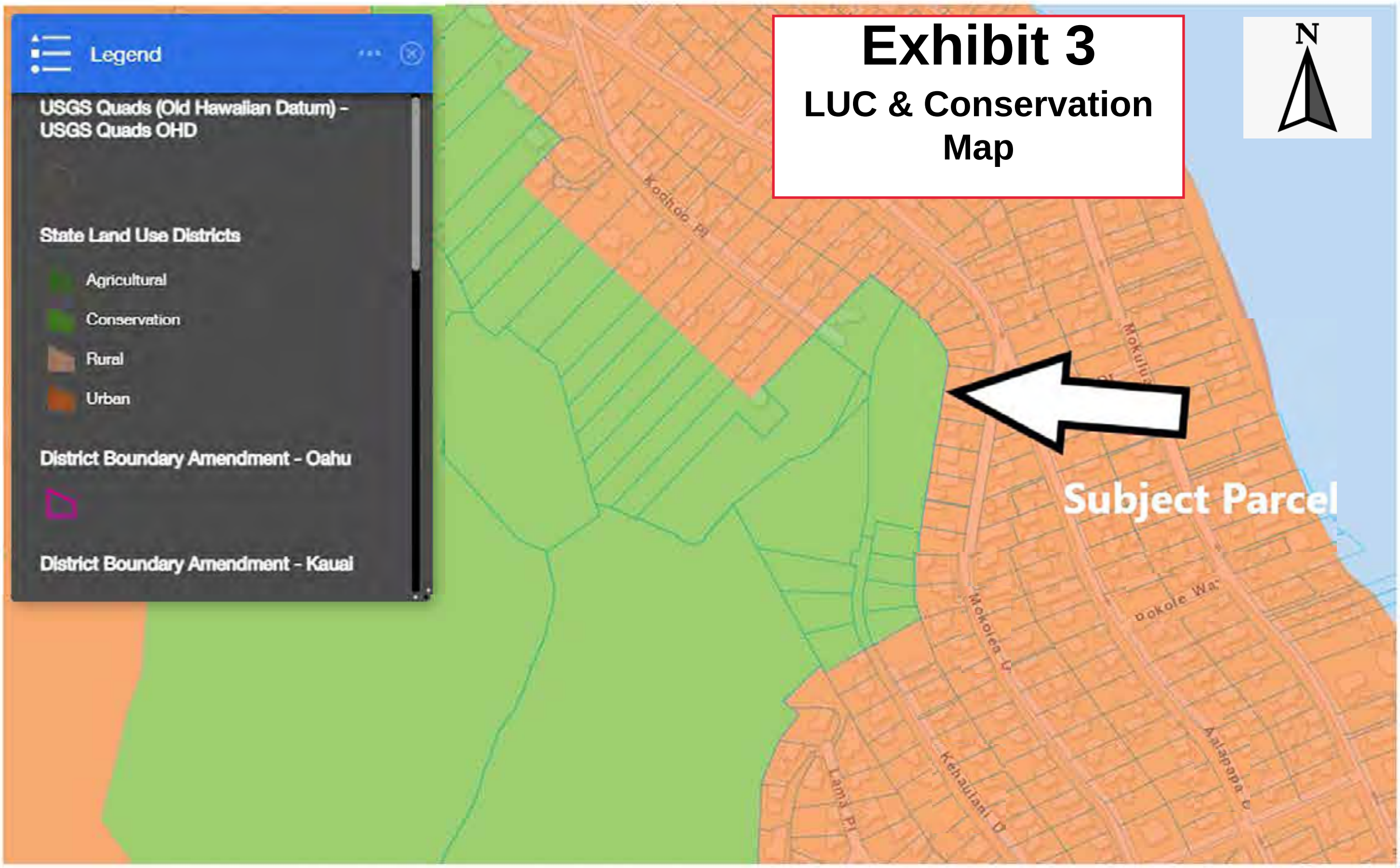
more public safety info >>

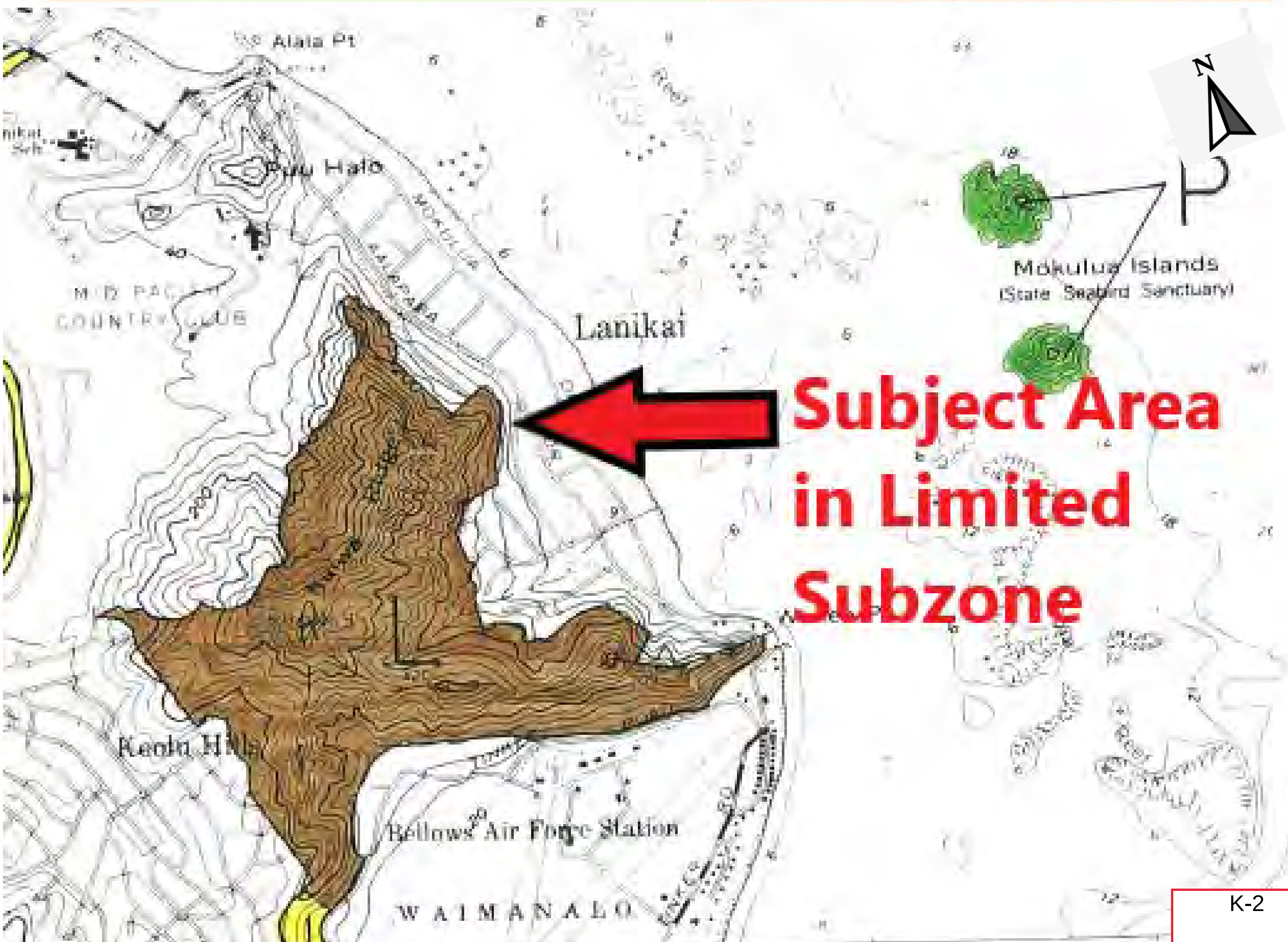
Page Tools: PRINT | BOOKMARK | EMAIL | STREET/BIRD'S EYE

More info: ZONE INFO | BUILDING PERMITS | PROPERTY TAX

Department of Planning & Permitting
650 S. King St, Ste 8, Honolulu, HI 96813
gis@honolulu.gov
Property Info Page FAQ

Exhibit 3
LUC & Conservation Map





TMK: (1) 4-3-005:077 Longfield Parcel

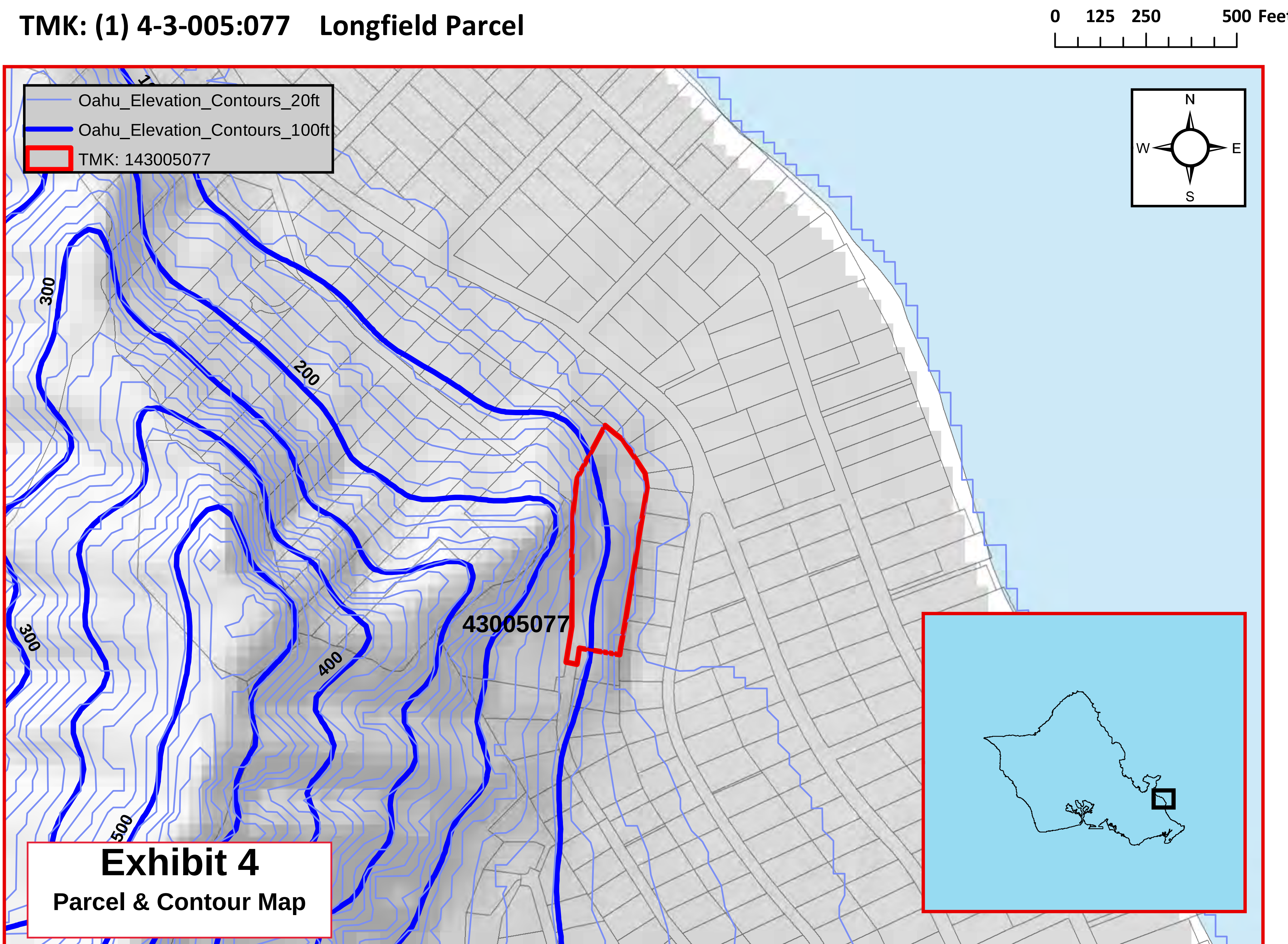


Exhibit 4

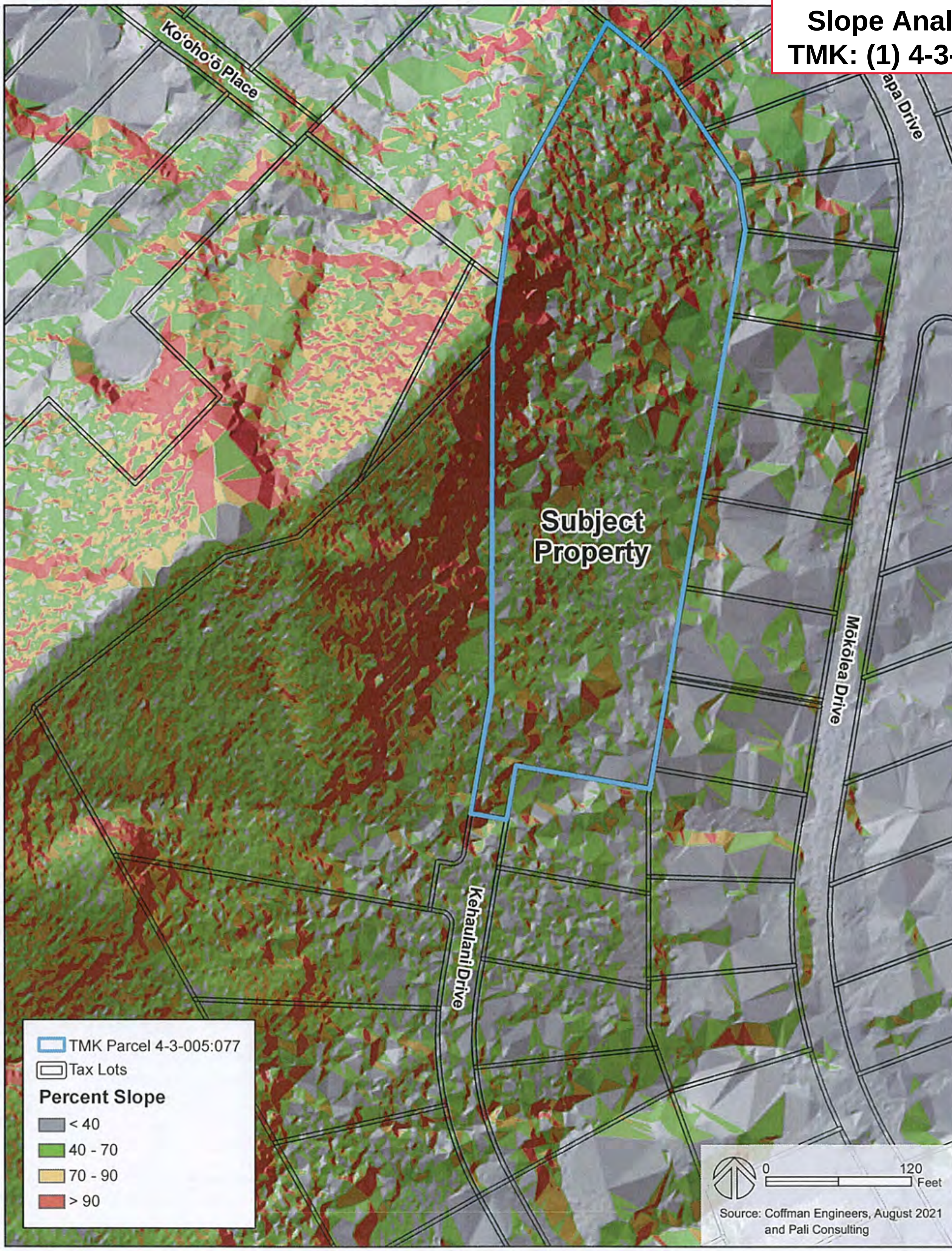
Parcel & Contour Map

Produced by Trevor Fitzpatrick @ OCCL All boundaries are approximate

Date: 11/26/2021

Exhibit 5

Slope Analysis of TMK: (1) 4-3-005:077



Slope Analysis Map

Figure 4

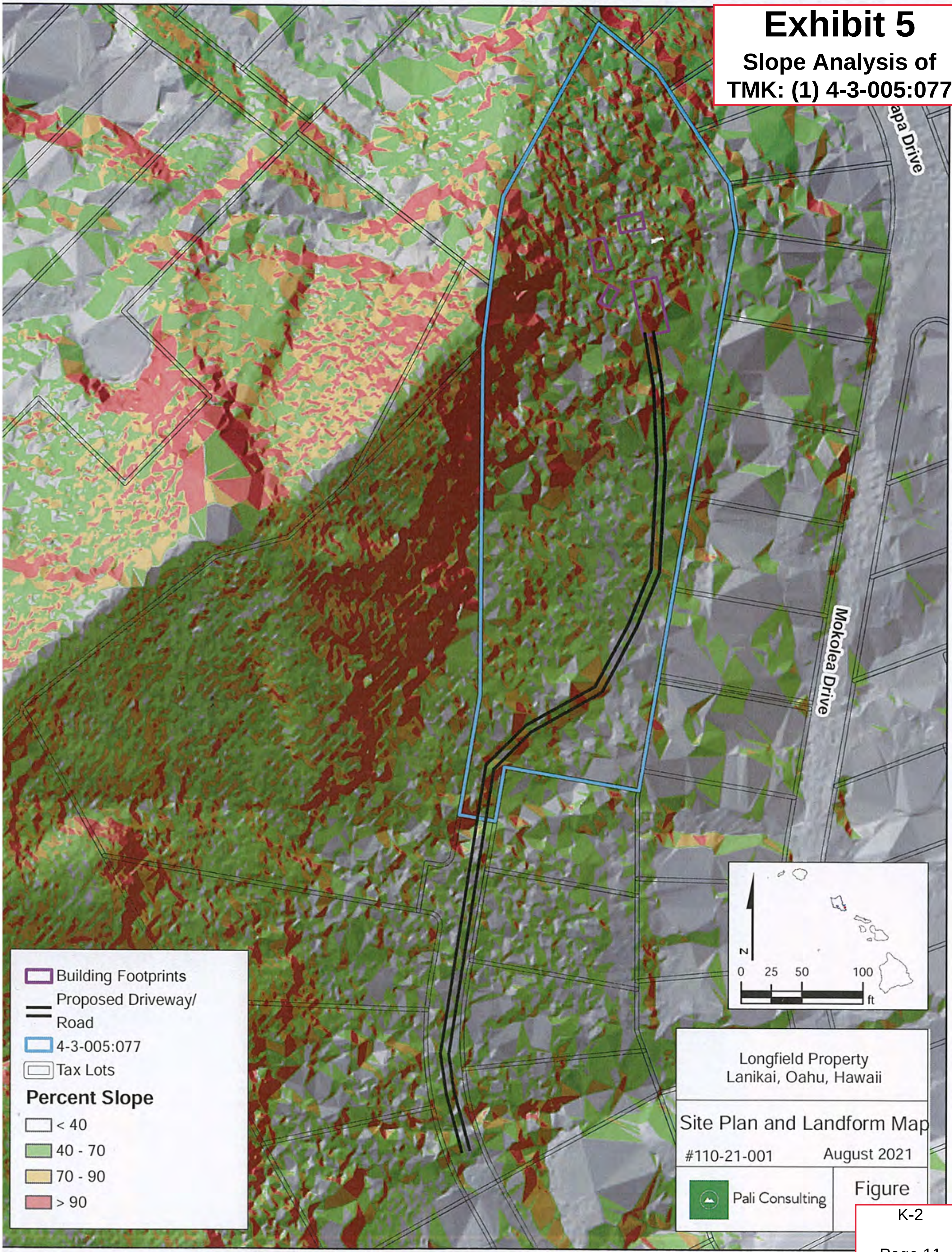
Longfield Subzone Request

TMK Parcel (1) 4-3-005:077

Lanikai, Oʻahu, Hawaiʻi

Exhibit 5

Slope Analysis of TMK: (1) 4-3-005:077



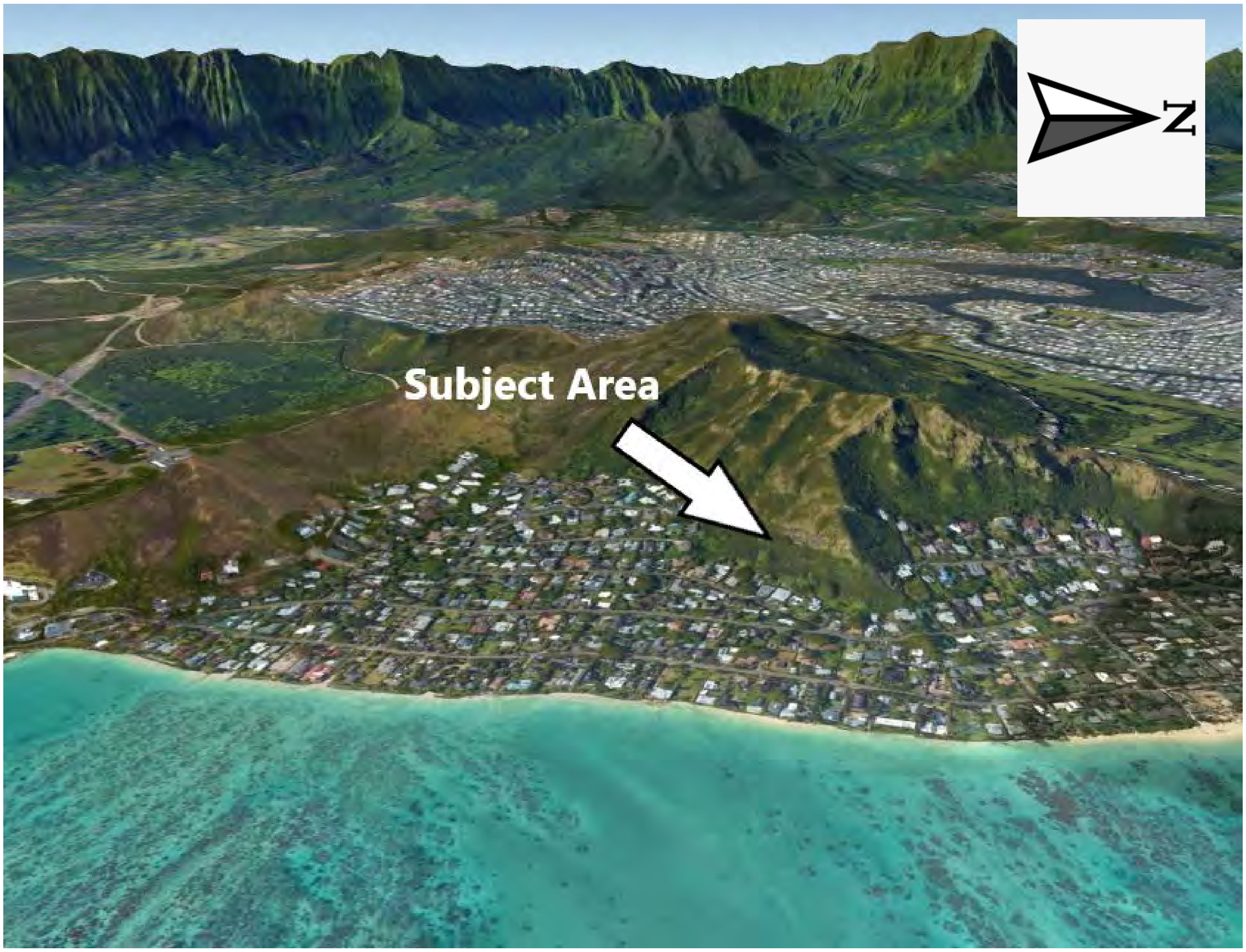


Exhibit 5

Photos of Kaiwa Ridge

Top Photo - Google Earth & Bottom Photo - https://www.redfin.com/HI/Kailua/1160-Koohoo-PI-96734/home/63903516

Exhibit 6
Soils Map of TMK: (1) 4-3-005:077

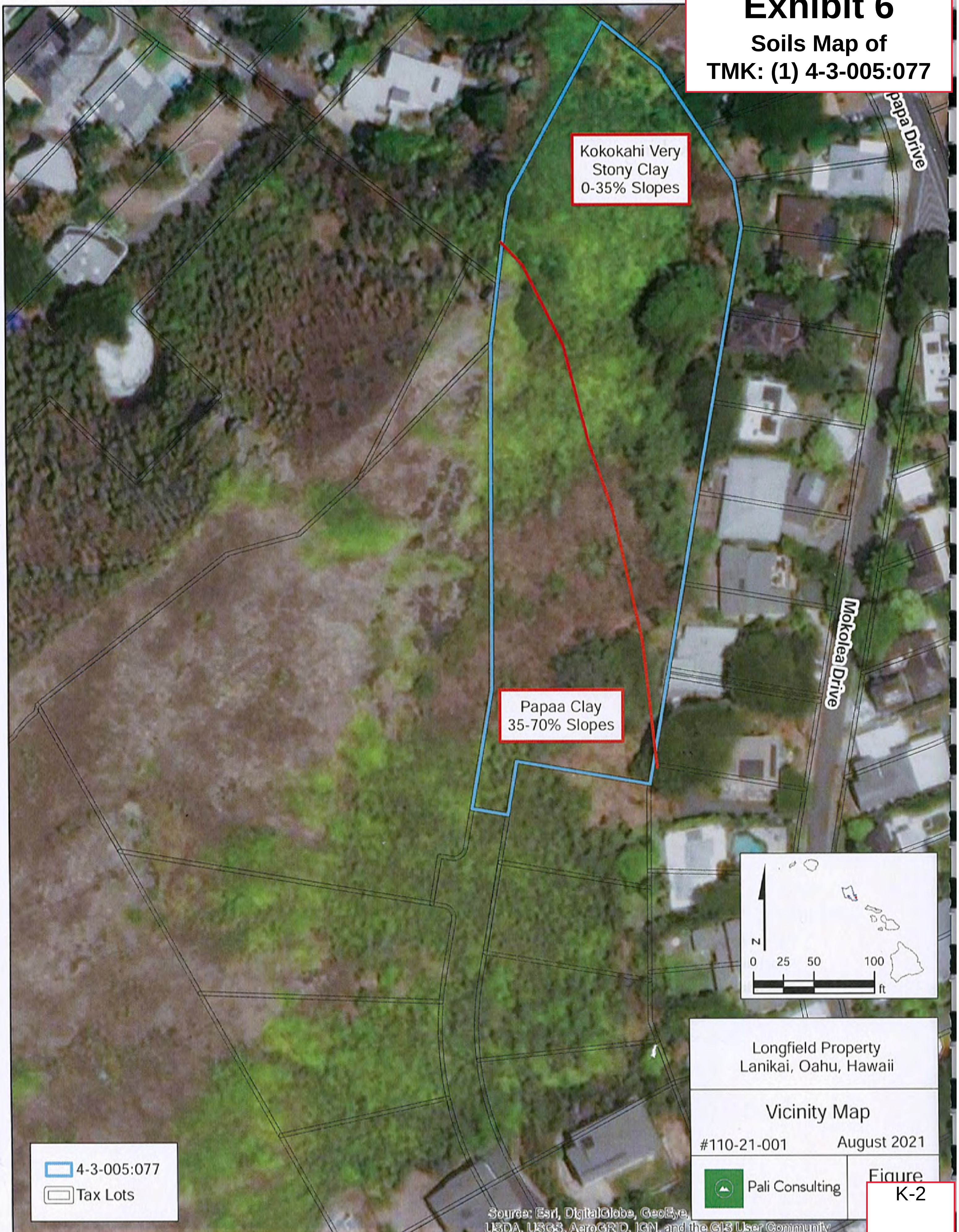
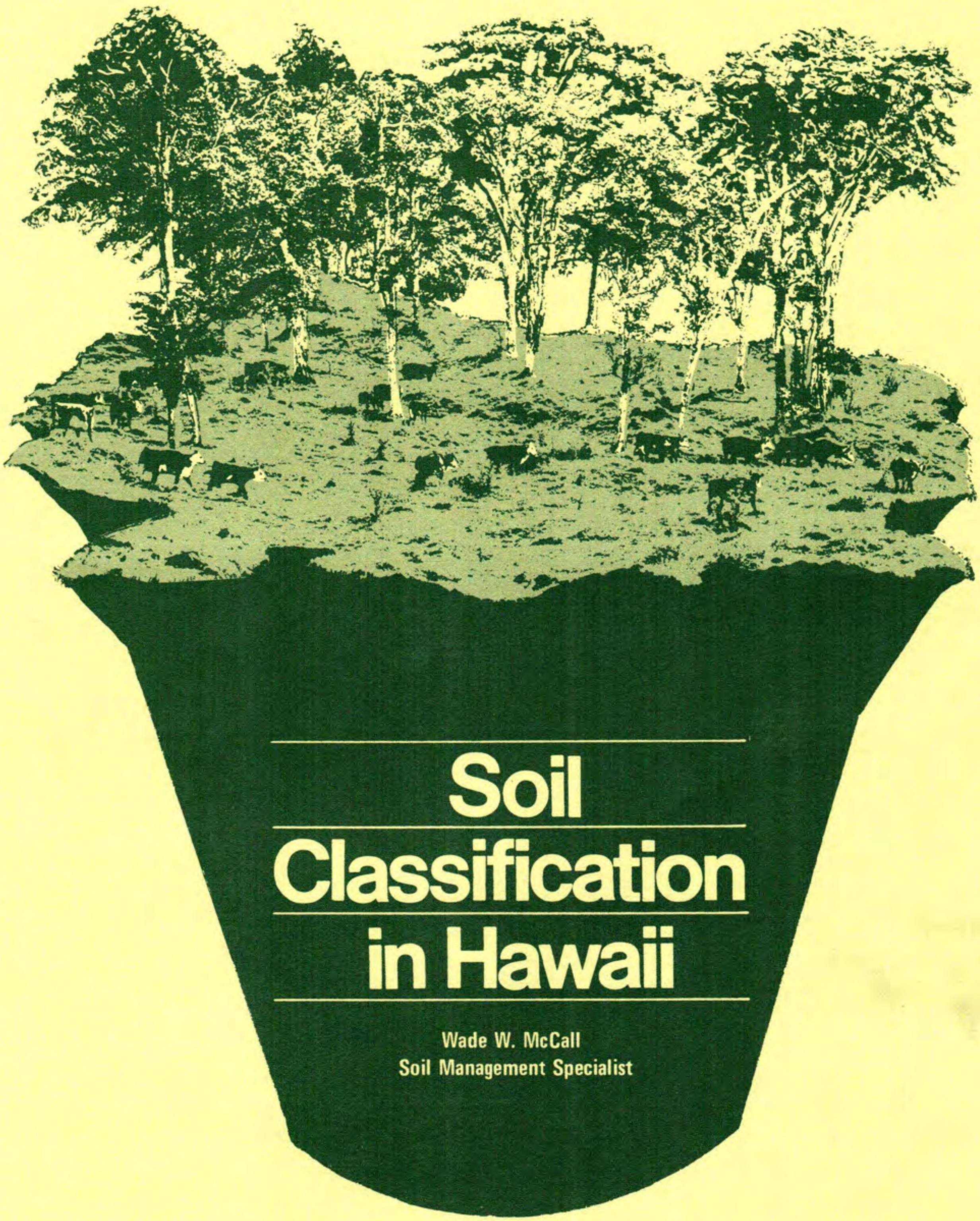


Exhibit 7
Soils Classification & Description



Soil Classification in Hawaii

Wade W. McCall
Soil Management Specialist

COOPERATIVE EXTENSION SERVICE / UNIVERSITY OF HAWAII / CIRCULAR 476

Exhibit 7
Soils Classification & Description

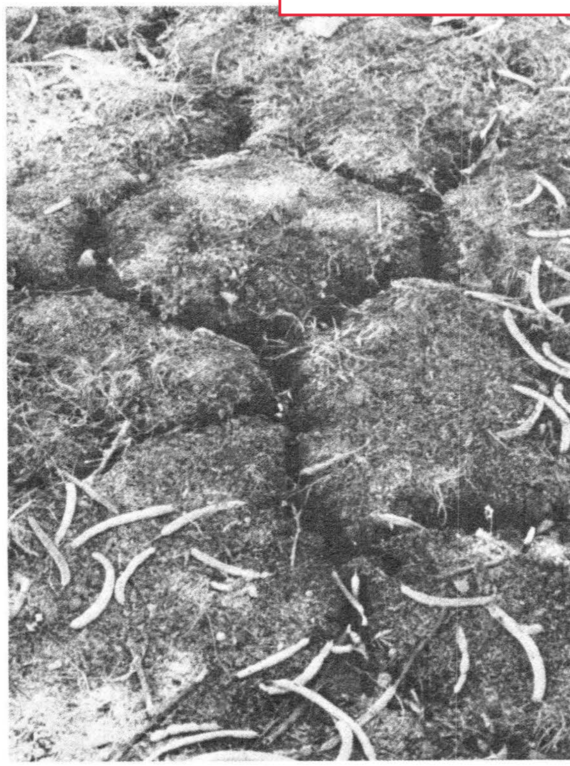
Gibbsihumox have relatively high organic matter in the surface and are found in higher cooler elevations. Acrorthox has low cation exchange capacity, is highly weathered, has low base saturation and appears to have no structure in the oxic horizon. However, when observed under a hand lens, a highly developed microstructure can be seen. Eutrorthox has greater than 35 percent base saturation and more than 1.5 meq/100 g clay of cation retention capacity. Gibbsiorthox has gravel-sized aggregates cemented by gibbsite within 25 cm of the surface. Umbriorthox has more organic matter than the other great groups in the Orthox suborder. Orthox great groups are all lower in organic matter and formed under drier climate conditions than Humox great groups. Eutrustox has 50 percent base saturation and more than 1.5 meq/100 g clay cation retention capacity. Haplustox has lower cation exchange and lower base saturation than Eutrustox. These two great groups of the Ustox suborder are developed under extended periods of dryness, although there is a rainy period of at least 90 consecutive days each year. Torrox is found where extended dry periods occur and requires irrigation for use. They are apparently remnants from former periods of rain indicating a major change in climate since these soils were formed.

These groups are used for sugarcane, pineapple, pasture and urban development. They are excellent soils for agricultural use when properly managed, producing some of the highest yields of sugar of any soils in the world. These soils are well suited for any type of agricultural enterprise.

Oxisols were classified as Low Humic Latosols, Humic Latosols, and Humic Ferruginous Latosols in the 1938 system.

Vertisols

Vertisols contain sufficient amounts of expanding type clays to cause deep wide cracks to form in the soil during dry periods. While these cracks are open, some loose material from the surface may fall into them. When rains first fall, water will run into these open cracks, causing the clays at the bottom of the cracks to swell and force their way upward through the open crack; this gives the inversion effect of these soils. Mounds of various sizes occur where this swelling has



Cracks in Vertisols are open for 90 days or more each year. Some cracks extend to a depth of 40 inches (1 meter).

taken place, causing what is known as "gilgai". As this mass of soil slides upward through the crack, it places pressure upon the other soil causing "slickenslides." This pressure also causes the soil aggregates (structural units) to be tipped from the horizontal. These characteristics are used to identify this order of soils.

Vertisols develop from parent materials high in bases. In Hawaii, the major parent material is the basic igneous rocks that provide the bases found in the soil. The dispersion of organic matter gives a dark color to the soil even though the actual amount of organic matter is low (generally less than 2 percent). The presence of magnesium in the environment of these soils in Hawaii has led to the formation of expanding clays with a greater degree of expansion than in most Vertisols. This causes deeper and wider cracking and greater dispersion of organic matter.

There are four great groups of Vertisols in Hawaii: Chromusterts, Pellusterts, Pelluderts, and Torrerts. Some Vertisols are found on all islands of the State. The cracking occurs during dry periods unless the soils are irrigated. Cracks remain open less than 90 days each year in Pelluderts, to more than 150 days in Chromusterts, to closed less than 60 days in Torrerts. Generally, Torrerts do not develop the gilgai characteristics as they are too dry for most of the year. Cultivation and/or irrigation destroys this characteristic in the other great groups. These soils are used for vegetables, sugarcane, pasture and wildlife. On Oahu where urban pressure is great, many areas are used for urban development. This is poor usage as the shrinking and swelling characteristic causes foundations and pavement to crack and pipelines to rupture. Under certain conditions of moisture and slope, these soils begin to creep, causing severe structural damage to homes, roads, etc.

These soils were classified as Dark Magnesium Clays, Gray Hydromorphic and Low Humic Latosol in the 1938 system.

Aridisols

Aridisols are soils of the deserts. Inadequate moisture is received for plant growth, and accumulations of calcium carbonate or of other soluble materials occur. These mineral soils show little influence of moisture in the soil profile, although some movement of clay into the subsurface may have occurred. Aridisols generally have low organic matter content, especially in the surface horizon, although those in Hawaii are higher in organic matter than most Aridisols.

Vertisols are poor soils for engineering use, especially on steep areas. Slides in this area of Vertisols have damaged buildings and sidewalks.

Exhibit 7

Soils Classification & Description

Table 5. Nomenclature of the Soils of Hawaii

Order	Suborder	Great group	Subgroup	Family	Series
Histosols	Saprists	Troposaprists,	Terric Troposaprists	Clayey, kaolinitic, dysic, isomesic	Alakai
	Folists	Tropofolists	Typic tropofolists	Euic, isohyperthermic	Kaimu, Papai
				Euic, isothermic	Puna
				Euic, isomesic	Mawae
				Dysic, isohyperthermic	Malama
				Dysic, isothermic	Kiloa
				Dysic, Isomesic	Lalaau
			Lithic tropofolists	Euic, isohyperthermic	Punaluu
				Euic, isothermic	Kona
				Dysic, isohyperthermic	Keaukaha, Opihikao
				Dysic, isothermic	Keei
				Dysic, isomesic	Kahaluu, Kekake
Spodosols	Aquods	Tropaquods	Histic lithic tropaquods	Fine, oxidic, isomesic	Waialeale
Oxisol	Humox	Acrohumox	Typic acrohumox	Clayey, oxic, isothermic	Mahana
			Petroferric acrohumox	Clayey, ferritic, isothermic	Kahanui
		Gibbsihumox	Typic gibbsihumox	Clayey, ferritic, isothermic	Halii
	Orthox	Acrorthox	Plinthic acrorthox	Clayey, ferritic, isothermic	Kunuweia
		Eutrorthox	Tropeptic eutrorthox	Clayey, oxidic, isohypothermic,	Puhi
		Gibbsiorthox	Typic gibbsiorthox	Clayey, oxidic, isohyperthermic	Pooku, Kapaa
		Umbriorthox	Tropeptic umbriorthox	Clayey, oxidic, isohyperthermic	Hanamalu, Lawai, Makapili
	Torrox	Torrox	Typic torrox	Clayey, kaolinitic, isohyperthermic	Molokai
	Ustox	Haplustox	Tropeptic haplustox	Clayey, kaolinitic, isohyperthermic	Halemano, Kahana, Lahaina, Niu, Wailuku
		Eutrustox	Tropeptic eutrustox	Clayey, kaolinitic, isohyperthermic	Lihue, Wahiawa
				Clayey, kaolinitic, isohyperthermic, shallow	Koloa
Vertisols	Torrerts	Torrerts	Mollic torrerts	Very fine, montmorillonitic, isohyperthermic	Kapuhikani
	Uderts	Pelluderts	Typic pelluderts	Very fine, montmorillonitic, isohyperthermic	Kaena
	Usterts	Chromusterts	Typic chromusterts	Very fine, kaolinitic, isothermic	Waihuna
				Fine, mixed, isohyperthermic	Honouliuli
				Very fine, montmorillonitic, isohyperthermic	Lualualei, Makalapa
			Entic chromusterts	Very fine, kaolinitic, isohyperthermic	Nonopahu
			Udic chromusterts	Very fine, montmorillonitic, isohyperthermic	Papaa
		Pellusterts	Udorthentic pellusterts	Very fine, montmorillonitic, isohyperthermic	Kokokahi
Aridisols	Orthids	Salorthids	Typic salorthids	Coarse-loamy, mixed, isohyperthermic	Kealia
		Camborthids	Ustollic camborthids	Medial, isohyperthermic	Kawaihae
				Fine-loamy, kaolinitic, isohyperthermic	Holomua
Ultisols	Humults	Tropohumults	Humoxic tropohumults	Clayey, ferritic, isohyperthermic	Haiku
				Clayey, oxidic, isohyperthermic	Kalapa, Paumalu, Pauwela
				Clayey, oxidic, isothermic	Kokee
				Clayey, oxidic, isothermic	Honolua, Leilehua, Makawao, Olelo, Paaloa
				Clayey, kaolinitic, isohyperthermic	Kaneohe, Lolekaa, Waikane
			Orthoxic tropohumults	Clayey, oxidic, isothermic	Halawa
				Clayey, oxidic, isohyperthermic	Alaeloa, Hamakuapoko, Ioleau, Manana
			Ustoxic tropohumults	Clayey, oxidic, isothermic	Kalae, Puu Opae
Mollisols	Aquolls	Calciaquolls	Typic calciaquolls	Fine, isohyperthermic	Kaloko
		Haplaquolls	Cumulic haplaquolls	Very fine, montmorillonitic (calcareous), isohyperthermic	Nohili

Cooperative Extension Service
College of Tropical Agriculture and Human Resources
University of Hawai‘i at Mānoa

Soil and Crop Management
Sept. 2007
SCM-20

Soils of Hawai‘i

J. Deenik and A.T. McClellan
Department of Tropical Plant and Soil Sciences

Soil, like water and air, is crucial to life on earth. Soil has five key functions in supporting life:

- Soils provide physical support to anchor plant roots.
- Soils store water, air, and plant nutrients and mediate their supply to plants.
- Soils recycle plant organic matter to form humus, thus playing a key role in the earth’s geochemical cycle.
- Soils are habitat for a myriad of organisms, from microscopic bacteria to the ubiquitous earthworm.
- Soils are an engineering medium and vary dramatically in physical properties and stability.

Given these crucial functions, an understanding of soil contributes to actions that help maintain a healthy planet.

Soils are not uniform across the earth’s surface. They vary depending upon the factors that contribute to their formation: time, parent material, climate, living organisms, and topography. For example, the deep, dark, fertile soils developed from prairie grasses are different from the acid, infertile soils that develop under coniferous forests, which are in turn different from the highly weathered, clayey, oxide-rich, infertile soils formed in the hot, humid climates of the tropics.

The eight main Hawaiian Islands show a tremendous diversity in soil types, despite their small total land area (approximately 6420 square miles). Soils vary dramatically over small distances in Hawai‘i because the factors that contribute to their formation also vary dramatically. The soils of Kaua‘i are very different from those found on the island of Hawai‘i because the former have been exposed to weathering for a much longer time. Likewise, the effect of rainfall on soil differentiation is clearly exhibited as you move from the dry coastal lowlands to the moist ridges of most islands. This is well illustrated in Figure 1 with a view of the northeast shore of O‘ahu. On the coastal plains of Kahuku, where annual rainfall is around 40 inches, the soils are mostly fertile Mollisols. Further up the mountain, as rainfall increases to above 59 inches, the soils have weathered to become acidic, infertile Ultisols, which eventually change into highly weathered, infertile Oxisols under conditions where rainfall is above 120 inches.

To make sense of this diversity, soil scientists have developed a hierarchical classification system that places soils with similar measurable properties into the same broad groups. Soils formed by similar factors are grouped into the same category, and they respond and behave similarly. In other words, a soil formed at low elevation on the dry leeward side of Kaua‘i will be similar to a soil that formed in the same environment on O‘ahu.

At the highest and most general classification level are twelve soil orders, all ending with the suffix “sol”; these orders comprise all of the soils found on earth. Five lower categories within each order each carry increasing amounts of detail and information. In this publication we will discuss only the soil orders found in Hawai‘i, highlighting the main features of each soil order with an emphasis on its fertility and potential for agriculture, and including maps for each island depicting the spatial distribution of the orders.

Ten of the twelve soil orders are represented in the Hawaiian Islands, exemplifying Hawai‘i’s tremendous biodiversity (Table 1). The effect of time on soil diversity is evident when we compare the soils on Kaua‘i with the soils on the island of Hawai‘i. Kaua‘i is the oldest island (about 5 million years) and it shows the

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with the U.S. Department of Agriculture. Andrew G. Hashimoto, Director/Dean, Cooperative Extension Service/CTAHR, University of Hawai‘i at Mānoa, Honolulu
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Liming increases soil pH and detoxifies the soil by removing free Al and Mn ions from the soil solution.

Ultisols

Ultisols are weathered soils, usually rich in kaolinite (a silicate clay), that generally form in warm, humid climates with distinct wet and dry seasons. In Hawai‘i, Ultisols are found in mountainous areas in close proximity to Oxisols on the windward side of the islands where rainfall is moderate to high (50–90 inches). They are typically forest soils with good physical properties (i.e., good tilth and drainage,) and a humus-rich surface horizon. They are less weathered than Oxisols but are often acidic to strongly acidic, deficient in essential plant nutrients including Ca, K, and P, and have a high concentration of exchangeable aluminum that is toxic to many crops. Like Oxisols, they have a high capacity to fix P.

Although Ultisols are relatively infertile in their natural state, they are highly productive agricultural soils given appropriate management. Liming to increase soil pH, detoxify Al, increase Ca levels, and reduce P adsorption capacity are critical first steps in ameliorating these soils. With good fertilizer application programs, these soils can support a wide variety of agriculture, including sugarcane, pineapple, vegetables, orchard crops, and pasture.

Aridisols

Aridisols are desert soils, where lack of moisture limits growth of most plants. These soils typically are found in coastal areas of the leeward sides of the islands, where rainfall is low and dry periods are prolonged. The lack of moisture limits weathering reactions, and these soils tend to be shallow and show minimal profile development (i.e., no distinct soil horizon sequences). In addition to being dry, these soils tend to accumulate salts because there is insufficient water to leach them through the profile.

With adequate irrigation, Aridisols in Hawai‘i can be very productive agricultural soils, because they are usually rich in plant nutrients. The Keahua series on the lower slopes of Hāleakala in central Maui is a good example of a highly productive Aridisol. These soils were planted extensively to sugarcane and pineapple in the past and are now planted to a wide range of vegetable crops.

Entisols

Entisols are poorly developed mineral soils with no distinct subsurface soil horizons. They are either recent soils in the early stages of soil formation, or possibly old soils where the parent materials have not been transformed by soil-forming influences. In Hawai‘i, Entisols are commonly either sandy soils developed from coral limestone, found in low-lying coastal areas, with a surface horizon rich in organic matter, or soils developed from alluvium in dry areas. The Jaucas series is a common Entisol found near the shoreline of most of the islands. It is a sandy soil with an organic-rich surface horizon, usually alkaline in pH, and excessively drained.

Entisols show great diversity in physical and chemical properties, depending on where they were formed. The Jaucus series, formed close to the shoreline, is sandy, alkaline, and typically deficient in nutrients such as P and K. The Kamakoa series, an Entisol found near intermittent streams in the South Kohala area of Hawai‘i, is an organic, rich, sandy soil developed from alluvial volcanic ash. Entisols are neutral to slightly alkaline and well supplied with Ca, K, and Mg. Careful management of fertilizers to reduce leaching is essential to maintain good crop growth on these sandy soils.

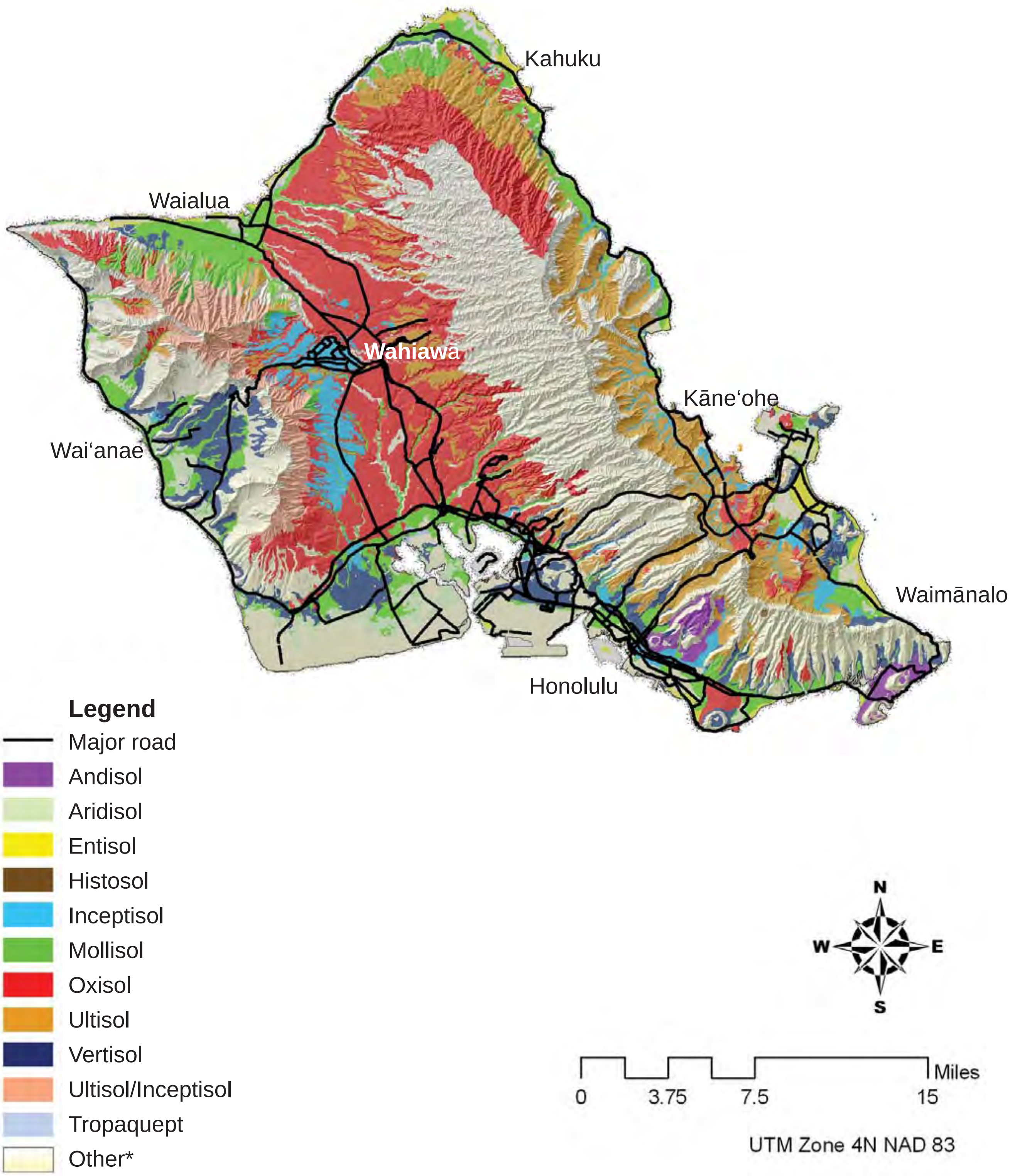
Vertisols

Vertisols are dark soils, rich in clays that shrink when dry and swell when wet. They generally occur in relatively dry environments in lowland regions. During dry periods the clay shrinks, creating deep, wide cracks, but when the rains return the clay rehydrates and swells, closing the cracks. The high shrink-swell potential of Vertisols make them very unstable soils not suitable for construction of buildings or roadways. These soils are also difficult to cultivate because when they are dry they form large, hard clods that are difficult to break apart, and when they are wet they are excessively sticky. The Lualualei series, found on flat valley floors of leeward Kaua‘i and O‘ahu, is a good example of a Vertisol.

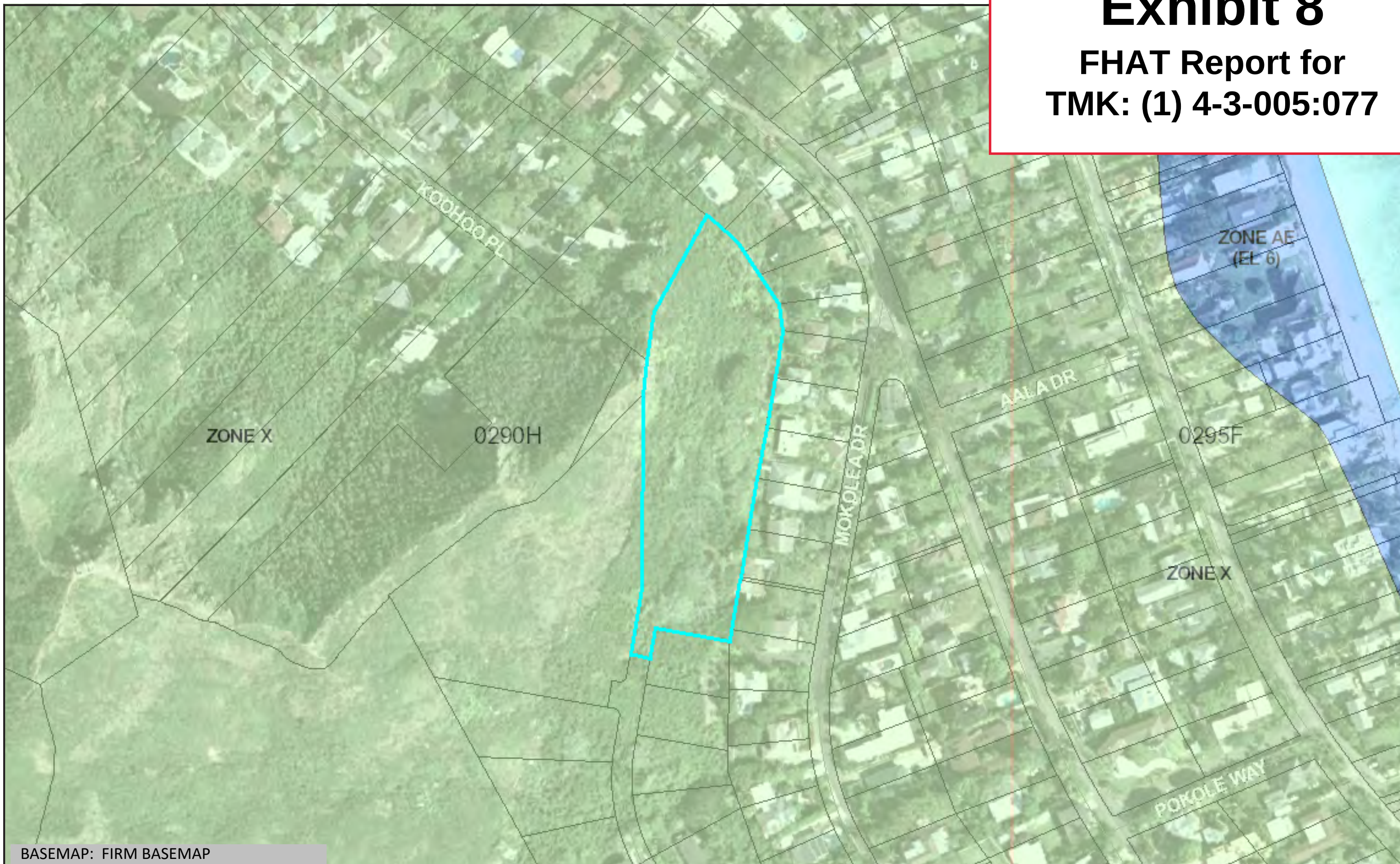
Despite their poor physical properties, Vertisols are very fertile, neutral to alkaline soils capable of supporting good crop growth. Cultivation is possible in conjunction with proper water management to control soil moisture. Their physical properties can be improved by adding organic matter.

(continued on p. 12)

Soil Orders of O‘ahu



*Beaches, coral, fill land, marsh land, and rocky land



Flood Hazard Assessment Report

www.hawaiinfip.org

Property Information

COUNTY:	HONOLULU
TMK NO:	(1) 4-3-005:077
WATERSHED:	KAELEPULU
PARCEL ADDRESS:	ADDRESS NOT DETERMINED KAILUA, HI 96734

Notes:

Flood Hazard Information

FIRM INDEX DATE:	NOVEMBER 05, 2014
LETTER OF MAP CHANGE(S):	NONE
FEMA FIRM PANEL:	15003C0290H
PANEL EFFECTIVE DATE:	NOVEMBER 05, 2014

THIS PROPERTY IS WITHIN A TSUNAMI EVACUTION ZONE: NO
FOR MORE INFO, VISIT: http://www.scd.hawaii.gov/

THIS PROPERTY IS WITHIN A DAM EVACUATION ZONE: NO
FOR MORE INFO, VISIT: http://dlnreng.hawaii.gov/dam/

0 200 400 ft

Disclaimer: The Hawaii Department of Land and Natural Resources (DLNR) assumes no responsibility arising from the use, accuracy, completeness, and timeliness of any information contained in this report. Viewers/Users are responsible for verifying the accuracy of the information and agree to indemnify the DLNR, its officers, and employees from any liability which may arise from its use of its data or information.

If this map has been identified as 'PRELIMINARY', please note that it is being provided for informational purposes and is not to be used for flood insurance rating. Contact your county floodplain manager for flood zone determinations to be used for compliance with local floodplain management regulations.

FLOOD HAZARD ASSESSMENT TOOL LAYER LEGEND
(*Note: legend does not correspond with NFHL)*

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD - The 1% annual chance flood (100-year), also know as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. SFHAs include Zone A, AE, AH, AO, V, and VE. The Base Flood Elevation (BFE) is the water surface elevation of the 1% annual chance flood. Mandatory flood insurance purchase applies in these zones:

- **Zone A**: No BFE determined.
- **Zone AE**: BFE determined.
- **Zone AH**: Flood depths of 1 to 3 feet (usually areas of ponding); BFE determined.
- **Zone AO**: Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined.
- **Zone V**: Coastal flood zone with velocity hazard (wave action); no BFE determined.
- **Zone VE**: Coastal flood zone with velocity hazard (wave action); BFE determined.
- **Zone AEF**: Floodway areas in Zone AE. The floodway is the channel of stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without increasing the BFE.

NON-SPECIAL FLOOD HAZARD AREA - An area in a low-to-moderate risk flood zone. No mandatory flood insurance purchase requirements apply, but coverage is available in participating communities.

- **Zone XS (X shaded)**: Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- **Zone X**: Areas determined to be outside the 0.2% annual chance floodplain.

OTHER FLOOD AREAS

- **Zone D**: Unstudied areas where flood mined, but flooding is possible. No man purchase apply, but coverage is available nities.