D20 FIU Site Characterization Supporting Data

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See configuration management system for approval history.

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	4/18/2012	ECO-00259	INITIAL RELEASE
B	06/28/2016	ECO-03924	Updated document to reflect new core site; Delete relocatable site info

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LIST OF TABLES AND FIGURES

1 DESCRIPTION

1.1 Purpose

Data collected, analyzed and described here are used to inform the site design activities for NEON project Teams: EHS (permitting), FCC, ENG and FSU. This report was made based on actual site visit to the NEON core site in Domain 20. This document presents all the supporting data for FIU site characterization at D20.

1.2 Scope

FIU site characterization data and analysis results presented in this document are for the D20 core tower location: PuuMakaala Forest Reserve (Core). Issues and concerns for each site that need further review are also addressed in this document according to our best knowledge.

Disclaimer: all latitude and longitude points are subject to the tolerances of our measurement system, i.e., GPS, typically approximately ±3 m.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD [01]	NEON.DOC.011008 FIU Tower Design Science Requirements
AD [02]	NEON.DOC.011000 FIU Technical and Operation Requirements
AD [03]	
AD [04]	NEON.DOC.011072 FIU Precipitation Collector Site Design

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]		
RD [04]		

2.3 External References

External references contain information pertinent to this document, but are not NEON configuration-controlled. Examples include manuals, brochures, technical notes, and external websites.

ER [01]	
ER [02]	
ER [03]	

3 PU'U MAKA'ALA, CORE TOWER SITE

3.1 Site description

The core site is located in Pu'u Maka'ala Natural Area Reserve (NAR) boundary. The candidate tower location is at 19.553089°, -155.317310°, which is approximate 1 mile WNW of a Correction Facility.

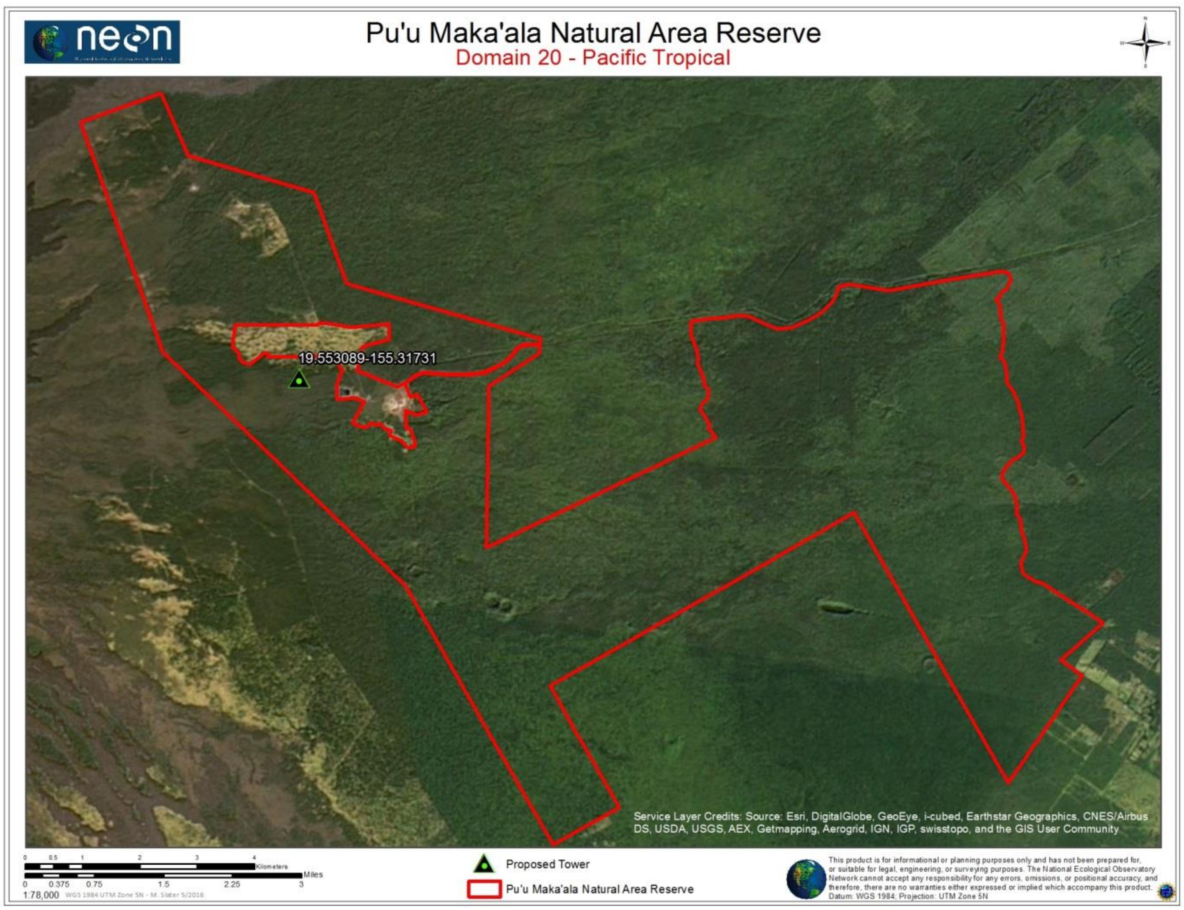


Figure 1. NEON core site at Pu'u Maka'ala. The marked location was the proposed tower location. Red box is the property boundary.

3.2 Ecosystem

Vegetation and land cover information at surrounding region of NEON site are presented below:

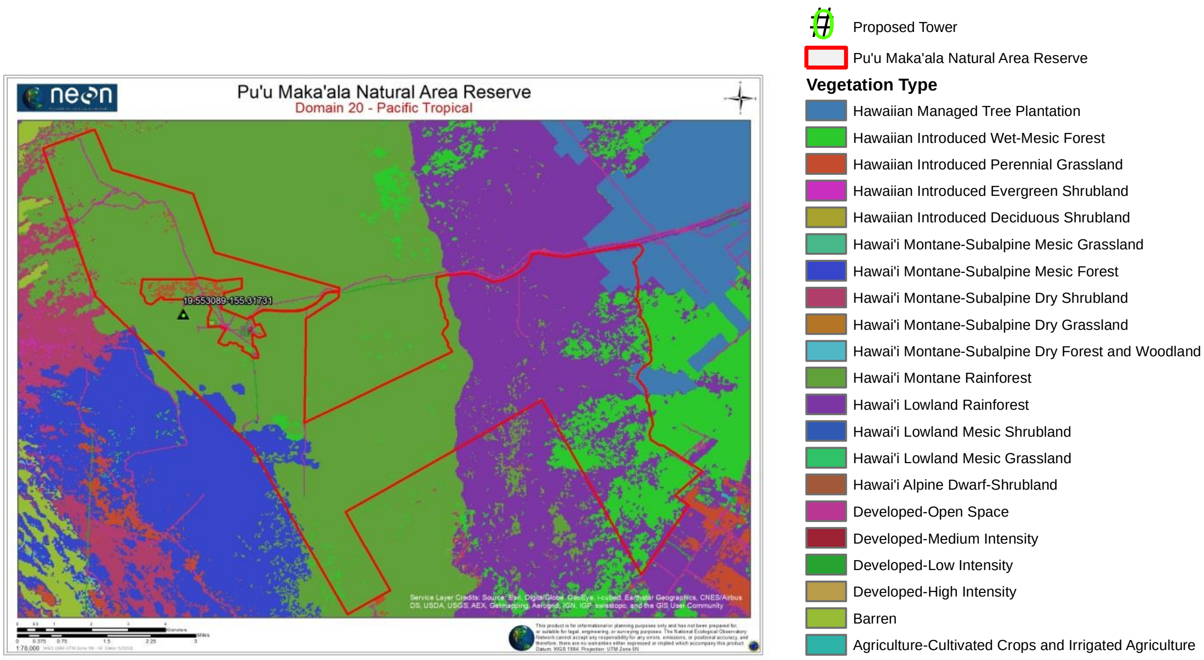


Figure 2. Vegetative cover map of Pu'u Maka'ala core site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm).

Table 1. Percent Land cover type at Pu'u Maka'ala core site and surrounding areas (information is from USGS, http://landfire.cr.usgs.gov/viewer/viewer.htm)

Vegetation Typ	*Vegetation Height*	*AreaKm2*	*Percentage*
Barren	Developed - Open Space	0.0005	0.00
Barren	Developed - Low Intensity	0.0017	0.00
Barren	Barren	0.0095	0.01
Developed-Low Intensity	Shrub Height 0.5 to 1.0 meter	0.0004	0.00
Developed-Low Intensity	Herb Height 0 to 0.5 meters	0.0008	0.00
Developed-Low Intensity	Barren	0.0022	0.00
Developed-Low Intensity	Developed - Medium Intensity	0.0026	0.00
Developed-Low Intensity	Forest Height 10 to 25 meters	0.0062	0.01
Developed-Low Intensity	Forest Height 5 to 10 meters	0.0147	0.02
Developed-Low Intensity	Developed - Open Space	0.0174	0.02
Developed-Low Intensity	Forest Height 25 to 50 meters	0.0424	0.05
Developed-Low Intensity	Developed - Low Intensity	0.2150	0.28
Developed-Medium Intensity	Shrub Height 0.5 to 1.0 meter	0.0005	0.00
Developed-Medium Intensity	Developed - Low Intensity	0.0010	0.00
Developed-Medium Intensity	Developed - Open Space	0.0028	0.00

Developed-Medium Intensity	Developed - Medium Intensity	0.0108	0.01
Developed-Open Space	Forest Height 0 to 5 meters	0.0002	0.00
Developed-Open Space	Shrub Height 0.5 to 1.0 meter	0.0010	0.00
Developed-Open Space	Herb Height 0.5 to 1.0 meters	0.0014	0.00
Developed-Open Space	Developed - Medium Intensity	0.0017	0.00
Developed-Open Space	Shrub Height 1.0 to 3.0 meters	0.0024	0.00
Developed-Open Space	Herb Height 0 to 0.5 meters	0.0058	0.01
Developed-Open Space	Shrub Height 0 to 0.5 meters	0.0086	0.01
Developed-Open Space	Developed - Low Intensity	0.0189	0.02
Developed-Open Space	Forest Height 10 to 25 meters	0.0271	0.03
Developed-Open Space	Forest Height 5 to 10 meters	0.0616	0.08
Developed-Open Space	Forest Height 25 to 50 meters	0.2274	0.29
Developed-Open Space	Developed - Open Space	0.9135	1.17
Hawai'i Lowland Mesic Grassland	Forest Height 10 to 25 meters	0.0028	0.00
Hawai'i Lowland Mesic Grassland	Forest Height 25 to 50 meters	0.0031	0.00
Hawai'i Lowland Mesic Grassland	Forest Height 5 to 10 meters	0.0055	0.01
Hawai'i Lowland Mesic Grassland	Herb Height 0 to 0.5 meters	0.0091	0.01
Hawai'i Lowland Rainforest	Developed - Low Intensity	0.0001	0.00
Hawai'i Lowland Rainforest	Shrub Height 1.0 to 3.0 meters	0.0020	0.00
Hawai'i Lowland Rainforest	Forest Height 0 to 5 meters	0.0042	0.01
Hawai'i Lowland Rainforest	Developed - Open Space	0.0344	0.04
Hawai'i Lowland Rainforest	Forest Height 5 to 10 meters	1.8737	2.40
Hawai'i Lowland Rainforest	Forest Height 10 to 25 meters	4.6538	5.97
Hawai'i Lowland Rainforest	Forest Height 25 to 50 meters	14.2413	18.26
Hawai'i Montane Rainforest	Forest Height 0 to 5 meters	0.0005	0.00
Hawai'i Montane Rainforest	Shrub Height > 3.0 meters	0.0008	0.00
Hawai'i Montane Rainforest	Shrub Height 1.0 to 3.0 meters	0.0066	0.01
Hawai'i Montane Rainforest	Herb Height 0.5 to 1.0 meters	0.0137	0.02
Hawai'i Montane Rainforest	Shrub Height 0.5 to 1.0 meter	0.0169	0.02
Hawai'i Montane Rainforest	Shrub Height 0 to 0.5 meters	0.0326	0.04
Hawai'i Montane Rainforest	Developed - Low Intensity	0.0585	0.08
Hawai'i Montane Rainforest	Herb Height 0 to 0.5 meters	0.1420	0.18
Hawai'i Montane Rainforest	Developed - Open Space	0.2557	0.33
Hawai'i Montane Rainforest	Forest Height 10 to 25 meters	3.7864	4.86
Hawai'i Montane Rainforest	Forest Height 5 to 10 meters	4.2170	5.41
Hawai'i Montane Rainforest	Forest Height 25 to 50 meters	35.1715	45.10
Hawai'i Montane-Subalpine Dry Shrubland	Shrub Height > 3.0 meters	0.0001	0.00
Hawai'i Montane-Subalpine Dry Shrubland	Herb Height 0 to 0.5 meters	0.0007	0.00
Hawai'i Montane-Subalpine Dry Shrubland	Developed - Low Intensity	0.0008	0.00

Hawai'i Montane-Subalpine Dry Shrubland	Forest Height 10 to 25 meters	0.0043	0.01
Hawai'i Montane-Subalpine Dry Shrubland	Developed - Open Space	0.0110	0.01
Hawai'i Montane-Subalpine Dry Shrubland	Shrub Height 1.0 to 3.0 meters	0.0237	0.03
Hawai'i Montane-Subalpine Dry Shrubland	Forest Height 25 to 50 meters	0.0245	0.03
Hawai'i Montane-Subalpine Dry Shrubland	Forest Height 5 to 10 meters	0.0401	0.05
Hawai'i Montane-Subalpine Dry Shrubland	Shrub Height 0.5 to 1.0 meter	0.0558	0.07
Hawai'i Montane-Subalpine Dry Shrubland	Shrub Height 0 to 0.5 meters	0.1069	0.14
Hawai'i Montane-Subalpine Mesic Forest	Forest Height 0 to 5 meters	0.0004	0.00
Hawai'i Montane-Subalpine Mesic Forest	Shrub Height 1.0 to 3.0 meters	0.0007	0.00
Hawai'i Montane-Subalpine Mesic Forest	Shrub Height 0 to 0.5 meters	0.0008	0.00
Hawai'i Montane-Subalpine Mesic Forest	Developed - Low Intensity	0.0027	0.00
Hawai'i Montane-Subalpine Mesic Forest	Developed - Open Space	0.0112	0.01
Hawai'i Montane-Subalpine Mesic Forest	Forest Height 5 to 10 meters	0.1227	0.16
Hawai'i Montane-Subalpine Mesic Forest	Forest Height 10 to 25 meters	0.1459	0.19
Hawai'i Montane-Subalpine Mesic Forest	Forest Height 25 to 50 meters	1.6748	2.15
Hawaiian Introduced Deciduous Shrubland	Forest Height 5 to 10 meters	0.0002	0.00
Hawaiian Introduced Deciduous Shrubland	Shrub Height 1.0 to 3.0 meters	0.0018	0.00
Hawaiian Introduced Deciduous Shrubland	Forest Height 25 to 50 meters	0.0025	0.00
Hawaiian Introduced Perennial Grassland	Shrub Height 0.5 to 1.0 meter	0.0006	0.00
Hawaiian Introduced Perennial Grassland	Forest Height 25 to 50 meters	0.0020	0.00
Hawaiian Introduced Perennial Grassland	Developed - Open Space	0.0097	0.01
Hawaiian Introduced Perennial Grassland	Herb Height 0.5 to 1.0 meters	0.0196	0.03
Hawaiian Introduced Perennial Grassland	Forest Height 5 to 10 meters	0.0519	0.07
Hawaiian Introduced Perennial Grassland	Forest Height 10 to 25 meters	0.0891	0.11
Hawaiian Introduced Perennial Grassland	Herb Height 0 to 0.5 meters	0.3167	0.41
Hawaiian Introduced Wet-Mesic Forest	Forest Height 0 to 5 meters	0.0001	0.00
Hawaiian Introduced Wet-Mesic Forest	Developed - Open Space	0.0284	0.04
Hawaiian Introduced Wet-Mesic Forest	Forest Height 10 to 25 meters	0.0591	0.08
Hawaiian Introduced Wet-Mesic Forest	Forest Height 25 to 50 meters	1.2217	1.57
Hawaiian Introduced Wet-Mesic Forest	Forest Height 5 to 10 meters	6.6656	8.55
Hawaiian Managed Tree Plantation	Forest Height 10 to 25 meters	0.0068	0.01
Hawaiian Managed Tree Plantation	Forest Height 25 to 50 meters	0.1513	0.19
Hawaiian Managed Tree Plantation	Forest Height 5 to 10 meters	1.0011	1.28
TOTAL		77.9856	100.00

The ecosystem at NEON Pu’u Maka’ala core site is Hawai'i Montane Rainforest, which is *ōhi‘a* (*Metrosideros polymorpha*) dominated middle structure young forest with dense understory (mainly tree ferns and false staghorn fern (also call Uluhe fern)). The mean canopy height varies from 6 m to 22 m for Ohia trees inside major and secondary airshed. Pockets of well-grew stands have much taller canopy (20-25 m). The tree height surrounding the tower location is ~ 20 m. The height for tree ferns are ~4-5 m and ~ 2-3 m for false staghorn fern. Tree ferns are present in the denser part of the forest, while false staghorn ferns fill the open area. Ohia tree density is ~200-300 stems/ha with DBH >5 cm in the denser part of the forest, and ~50-100 stems/ha with DBH >5 cm at open part of the forest. Ground cover (all vegetation) is ~80-90%. The landscape at site is rolling hills. Soil depth is very shallow (generally < 2") but with deeper soil pockets of >30 cm

Figure 3. Ecosystem at the Pu'u Maka'ala core site is Ohia dominated forest.

Table 2. Ecosystem and site attributes for Pu'u Maka'ala core tower site.

Ecosystem attributes	Measure and units
Mean canopy height	20 m
Surface roughness[a]	3 m

Zero place displacement height[a]	16.5 m
Structural elements	Open forest with denseunderstory
Time zone	Hawaii Standard Time
Magnetic declination	9° 51' E changing by 0° 03' W/year

Note, [a] From field observation.

3.3 Soils

3.3.1 Soil description

Soil data and soil maps below for the Pu'u Maka'ala site were collected from 5.5 km^2 NRCS soil maps (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) to determine the dominant soil types in the larger tower foot print. This was done to assure that the soil array is in the dominant (or in the co-dominant) soil type present in the tower footprint.

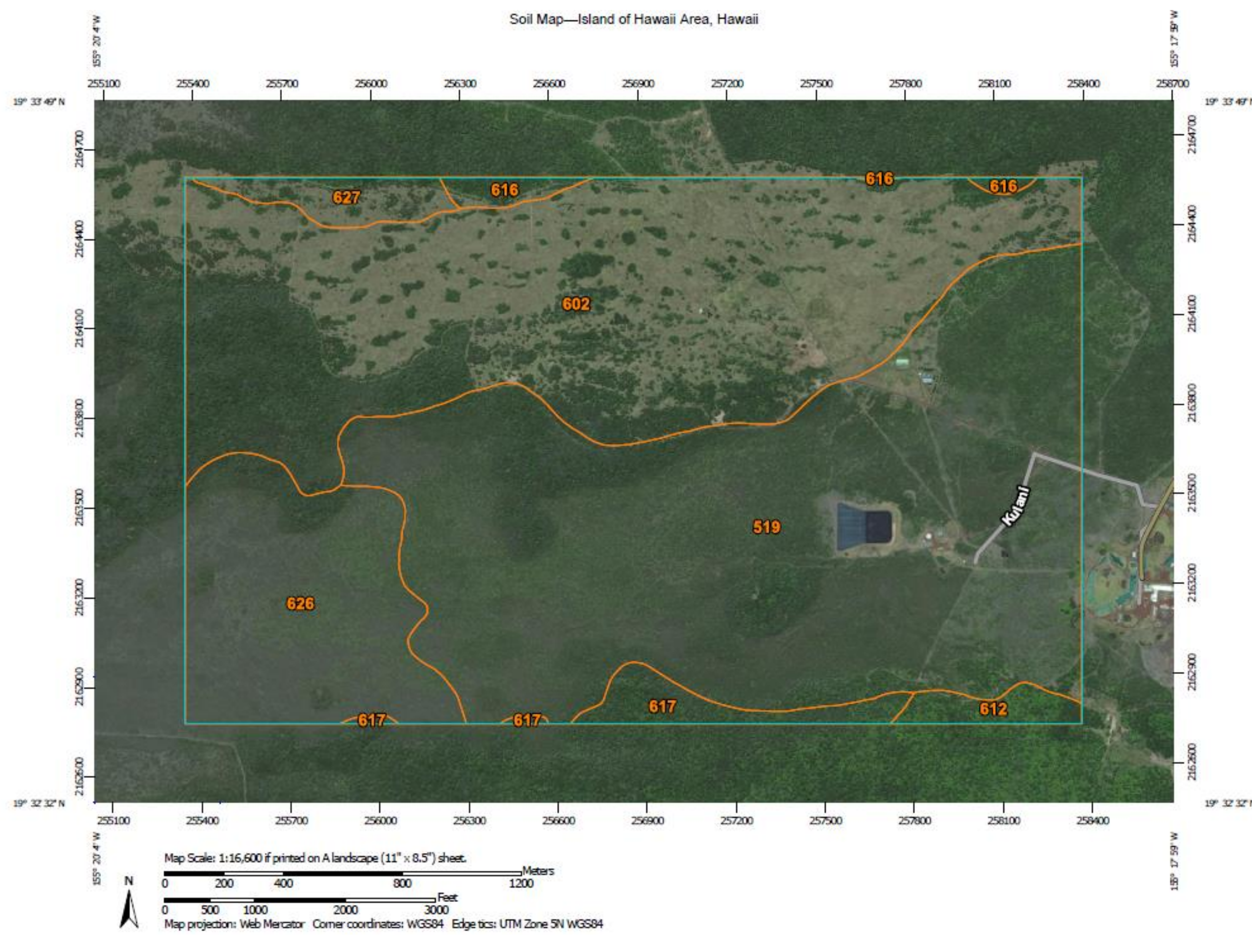


Figure 4. Soil map of the Pu'u Maka'ala site and surrounding areas.

Soil Map Units Description: The map units delineated on the detailed soil maps in a soil survey represents the soils or miscellaneous areas in the survey area. The map unit descriptions in this report, along with the maps, can be used to determine the composition and properties of a unit. A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils. Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called non-contrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas. An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series. Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example. An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example. An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, are an example. Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example. Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Table 3. Soil series and percentage of soil series within 5.5 km^2 at the Pu'u Maka'ala site

Island of Hawaii Area, Hawaii (HI801)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
519	Lalaau very cobbly highly decomposed plant material, 2 to 10 percent slopes	625.3	45.6%
602	Keamoku stony medial loam, 3 to 10 percent slopes	505.4	36.9%
612	Kulani hydrous highly organic loam, 3 to 10 percent slopes	15.5	1.1%
616	Kahaluu highly decomposed plant material, 3 to 10 percent slopes	11.7	0.9%
617	Kaholimo medial silt loam, 3 to 10 percent slopes	26.8	2.0%
626	Lalaau-Lava flows complex, 2 to 20 percent slopes	161.1	11.8%
627	Kahaluu-lava flows-Ainahou complex, 2 to 10 percent slopes	24.4	1.8%
Totals for Area of Interest		**1,370.1**	**100.0%**

Island of Hawaii Area, Hawaii 519—Lalaau very cobbly highly decomposed plant material, 2 to 10 percent slopes Map Unit Setting National map unit symbol: 2klhd Elevation: 1,000 to 7,000 feet Mean annual precipitation: 60 to 150 inches Mean annual air temperature: 52 to 59 degrees F Frost-free period: 365 days Farmland classification: Not prime farmland **Map Unit Composition** Lalaau and similar soils: 95 percent Minor components: 5 percent Estimates are based on observations, descriptions, and transects of the mapunit. **Description of Lalaau Setting** Landform: Aa lava flows Landform position (two-dimensional): Backslope Landform position (three-dimensional): Side slope Down-slope shape: Linear Across-slope shape: Linear, convex Parent material: Organic material over aa lava **Typical profile** Oa/2C1 - 0 to 3 inches: very cobbly highly decomposed plant material 2C2 - 3 to 53 inches: cobbles 2R - 53 to 63 inches: bedrock **Properties and qualities** Slope: 2 to 10 percent Depth to restrictive feature: 40 to 60 inches to lithic bedrock Natural drainage class: Well drained Runoff class: Low Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Salinity, maximum in profile: Nonsaline (0.0 to 2.0 mmhos/cm) Available water storage in profile: Very low (about 1.4 inches) **Interpretive groups** Land capability classification (irrigated): 7s Land capability classification (nonirrigated): 7s Hydrologic Soil Group: A Ecological site: Mauna loa savannah (R161AY010HI) **Minor Components Lava flows, \`a\`a** Percent of map unit: 5 percent Landform: Aa lava flows Down-slope shape: Linear Across-slope shape: Linear, convex

Island of Hawaii Area, Hawaii 602—Keamoku stony medial loam, 3 to 10 percent slopes Map Unit Setting *National map unit symbol:* 2klk3 *Elevation:* 4,530 to 5,000 feet *Mean annual precipitation:* 50 to 60 inches *Mean annual air temperature:* 50 to 59 degrees F *Frost-free period:* 360 to 365 days *Farmland classification:* Not prime farmland **Map Unit Composition** *Keamoku, stony, and similar soils:* 90 percent *Minor components:* 10 percent *Estimates are based on observations, descriptions, and transects of the mapunit.* **Description of Keamoku, Stony Setting** *Landform:* Ash fields on aa lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex *Parent material:* Basic volcanic ash over aa lava **Typical profile** *A1 - 0 to 3 inches:* stony medial loam *A2 - 3 to 10 inches:* stony medial loam *Bw1 - 10 to 14 inches:* stony medial loam *Bw2/3C1 - 14 to 21 inches:* very stony medial loam *3C2/2A - 21 to 35 inches:* extremely cobbly medial loam *3C3/2Bw1 - 35 to 50 inches:* extremely cobbly medial loam *2C - 50 to 60 inches:* extremely stony ashy coarse sand **Properties and qualities** *Slope:* 3 to 10 percent *Percent of area covered with surface fragments:* 25.0 percent *Depth to restrictive feature:* More than 80 inches *Natural drainage class:* Well drained *Runoff class:* Low *Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water storage in profile:* High (about 10.0 inches) **Interpretive groups** *Land capability classification (irrigated):* 6s *Land capability classification (nonirrigated):* 6s *Hydrologic Soil Group:* A *Ecological site:* Udic Forest (F159BY500HI) **Minor Components Lava flows, \`a\`a** *Percent of map unit:* 5 percent *Landform:* Aa lava flows *Down-slope shape:*

Linear *Across-slope shape:* Linear, convex **Oneula** *Percent of map unit:* 5 percent *Landform:* Ash fields on aa lava flows *Landform position (two-dimensional):* Shoulder, footslope, summit, backslope *Landform position (three-dimensional):* Mountainflank, side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex

Island of Hawaii Area, Hawaii 612—Kulani hydrous highly organic loam, 3 to 10 percent slopes Map Unit Setting *National map unit symbol:* 2klkf *Elevation:* 4,500 to 6,200 feet *Mean annual precipitation:* 80 to 120 inches *Mean annual air temperature:* 54 to 57 degrees F *Frost-free period:* 363 to 365 days *Farmland classification:* Not prime farmland **Map Unit Composition** *Kulani and similar soils:* 90 percent *Minor components:* 10 percent *Estimates are based on observations, descriptions, and transects of the mapunit.* **Description of Kulani Setting** *Landform:* Ash fields, cinder cones *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex *Parent material:* Basic volcanic ash over cinders **Typical profile** *Oa - 0 to 2 inches:* highly decomposed plant material *A - 2 to 7 inches:* hydrous highly organic loam *Bs - 7 to 7 inches:* hydrous highly organic loam *2C1/Bw - 7 to 14 inches:* extremely paragravelly hydrous loam *2C2 - 14 to 60 inches:* extremely paragravelly medial loamy coarse sand **Properties and qualities** *Slope:* 3 to 10 percent *Depth to restrictive feature:* 2 to 10 inches to placic *Natural drainage class:* Well drained *Runoff class:* High *Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm) *Available water storage in profile:* Very low (about 1.6 inches) **Interpretive groups** *Land capability classification (irrigated):* 3e *Land capability classification (nonirrigated):* 3e *Hydrologic Soil Group:* D *Ecological site:* Udic Forest (F159BY500HI) **Minor Components Typic hapludands** *Percent of map unit:* 10 percent *Landform:* Cinder cones, lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Convex, linear *Ecological site:* Udic Forest (F159BY500HI)

Island of Hawaii Area, Hawaii 616—Kahaluu highly decomposed plant material, 3 to 10 percent slopes Map Unit Setting National map unit symbol: 2klkk Elevation: 4,400 to 7,000 feet Mean annual precipitation: 90 to 150 inches Mean annual air temperature: 54 to 63 degrees F Frost-free period: 362 to 365 days Farmland classification: Not prime farmland **Map Unit Composition** Kahaluu and similar soils: 90 percent Minor components: 10 percent Estimates are based on observations, descriptions, and transects of the mapunit. **Description of Kahaluu Setting** Landform: Pahoehoe lava flows Landform position (two-dimensional): Backslope Landform position (three-dimensional): Side slope Down-slope shape: Linear Across-slope shape: Linear, convex Parent material: Organic material over pahoehoe lava **Typical profile** Oa - 0 to 10 inches: highly decomposed plant material R - 10 to 20 inches: bedrock **Properties and qualities** Slope: 3 to 10 percent Depth to restrictive feature: 8 to 12 inches to lithic bedrock Natural drainage class: Well drained Runoff class: High Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr) Depth to water table: More than 80 inches Frequency of flooding: None Frequency of ponding: None Available water storage in profile: Very low (about 2.2 inches) **Interpretive groups** Land capability classification (irrigated): 7s Land capability classification (nonirrigated): 7s Hydrologic Soil Group: D Ecological site: Metrosideros polymorpha-acacia koa/cibotium glaucum-broussaisia arguta/dryopteris wallichiana (F159BY500HI) **Minor Components Rock outcrop, basalt** Percent of map unit: 5 percent Landform: Pahoehoe lava flows Landform position (two-dimensional): Backslope Landform position (three-dimensional): Side slope Down-slope shape: Linear Across-slope shape: Linear, convex **Lithic haplosaprists** Percent of map unit: 5 percent Landform: Pahoehoe lava flows Landform position (two-dimensional): Backslope Landform position (three-dimensional): Side slope Down-slope shape: Linear Across-slope shape: Linear, convex

Island of Hawaii Area, Hawaii 617—Kaholimo medial silt loam, 3 to 10 percent slopes Map Unit Setting *National map unit symbol:* 2klkl *Elevation:* 4,260 to 6,200 feet *Mean annual precipitation:* 50 to 120 inches *Mean annual air temperature:* 54 to 57 degrees F *Frost-free period:* 300 to 365 days *Farmland classification:* Not prime farmland **Map Unit Composition** *Kaholimo and similar soils:* 90 percent *Minor components:* 10 percent *Estimates are based on observations, descriptions, and transects of the mapunit.* **Description of Kaholimo Setting** *Landform:* Ash fields on pahoehoe lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex *Parent material:* Basic volcanic ash over pahoehoe lava **Typical profile** *A1 - 0 to 2 inches:* medial silt loam *A2 - 2 to 4 inches:* medial silt loam *Bw1 - 4 to 7 inches:* medial loam *Bw2 - 7 to 10 inches:* medial loam *Bw3 - 10 to 12 inches:* medial loam *2A - 12 to 13 inches:* medial loam *3R - 13 to 23 inches:* bedrock **Properties and qualities** *Slope:* 3 to 10 percent *Depth to restrictive feature:* 2 to 20 inches to lithic bedrock *Natural drainage class:* Well drained *Runoff class:* High *Capacity of the most limiting layer to transmit water (Ksat):* Low to moderately low (0.00 to 0.06 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm) *Available water storage in profile:* Low (about 3.2 inches) **Interpretive groups** *Land capability classification (irrigated):* 7s *Land capability classification (nonirrigated):* 7s *Hydrologic Soil Group:* D *Ecological site:* Udic Forest (F159BY500HI) **Minor Components Typic hapludands** *Percent of map unit:* 5 percent *Landform:* Cinder cones, lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Convex, linear *Ecological site:* Udic Forest (F159BY500HI) **Lithic endoaquands** *Percent of map unit:* 5 percent *Landform:* Ash fields on pahoehoe lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex

Island of Hawaii Area, Hawaii 626—Lalaau-Lava flows complex, 2 to 20 percent slopes Map Unit Setting *National map unit symbol:* 2klkw *Elevation:* 4,500 to 7,000 feet *Mean annual precipitation:* 60 to 150 inches *Mean annual air temperature:* 52 to 59 degrees F *Frost-free period:* 363 to 365 days *Farmland classification:* Not prime farmland **Map Unit Composition** *Lava flows, `a`a:* 45 percent *Lalaau and similar soils:* 45 percent *Minor components:* 10 percent *Estimates are based on observations,* *descriptions, and transects of the mapunit.* **Description of Lalaau Setting** *Landform:* Aa lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex *Parent material:* Organic material over aa lava **Typical profile** *Oa/2C1 - 0 to 3 inches:* very cobbly highly decomposed plant material *2C2 - 3 to 53 inches:* cobbles *2R - 53 to 63 inches:* bedrock **Properties and qualities** *Slope:* 2 to 20 percent *Depth to restrictive feature:* 40 to 60 inches to lithic bedrock *Natural drainage class:* Well drained *Runoff class:* Low *Capacity of the most limiting layer to transmit water (Ksat):* Low to moderately low (0.00 to 0.06 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm) *Available water storage in profile:* Very low (about 1.4 inches) **Interpretive groups** *Land capability classification (irrigated):* 7s *Land capability classification (nonirrigated):* 7s *Hydrologic Soil Group:* A *Ecological site:* Mauna Loa Isomesic Savanna (R160XY006HI) **Description of Lava Flows, \`a\`a Setting** *Landform:* Aa lava flows *Down-slope shape:* Linear *Across-slope shape:* Linear, convex *Parent material:* Aa lava **Typical profile** *C - 0 to 39 inches:* extremely cobbly sand *R - 39 to 49 inches:* bedrock **Properties and qualities** *Slope:* 2 to 20 percent *Percent of area covered with surface fragments:* 10.0 percent *Depth to restrictive feature:* 20 to 60 inches to lithic bedrock *Natural drainage class:* Excessively drained *Runoff class:* Very low *Capacity of the most limiting layer to transmit water (Ksat):* Low to moderately low (0.00 to 0.06 in/hr) *Available water storage in profile:* Very low (about 0.4 inches) **Interpretive groups** *Land capability classification (irrigated):* 8s *Land capability classification (nonirrigated):* 8s **Minor Components Kahaluu** *Percent of map unit:* 5 percent *Landform:* Pahoehoe lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex **Lava flows, pahoehoe** *Percent of map unit:* 5 percent *Landform:* Pahoehoe lava flows *Down-slope shape:* Linear *Across-slope shape:* Linear, convex

Island of Hawaii Area, Hawaii 627—Kahaluu-lava flows-Ainahou complex, 2 to 10 percent slopes Map Unit Setting *National map unit symbol:* 2klkx *Elevation:* 5,400 to 6,690 feet *Mean annual precipitation:* 39 to 118 inches *Mean annual air temperature:* 50 to 63 degrees F *Frost-free period:* 360 to 365 days *Farmland classification:* Not prime farmland **Map Unit Composition** *Lava flows, pahoehoe:* 35 percent *Kahaluu and similar soils:* 35 percent *Ainahou and similar soils:* 30 percent *Estimates are based on observations, descriptions, and transects of the mapunit.* **Description of Kahaluu Setting** *Landform:* Pahoehoe lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex *Parent material:* Organic material over pahoehoe lava **Typical profile** *Oa - 0 to 10 inches:* highly decomposed plant material *2R - 10 to 20 inches:* bedrock **Properties and qualities** *Slope:* 2 to 10 percent *Depth to restrictive feature:* 8 to 12 inches to lithic bedrock *Natural drainage class:* Well drained *Runoff class:* High *Capacity of the most limiting layer to transmit water (Ksat):* Low to moderately low (0.00 to 0.06 in/hr) *Depth to water table:* More than 80 inches *Frequency of flooding:* None *Frequency of ponding:* None *Available water storage in profile:* Very low (about 2.2 inches) **Interpretive groups** *Land capability classification (irrigated):* 7s *Land capability classification (nonirrigated):* 7s *Hydrologic Soil Group:* D *Ecological site:* Udic Forest (F159BY500HI) **Description of Lava Flows, Pahoehoe Setting** *Landform:*

Pahoehoe lava flows *Down-slope shape:* Linear *Across-slope shape:* Linear, convex **Typical profile** *R - 0 to 10 inches:* bedrock **Interpretive groups** *Land capability classification (irrigated):* 8s *Land capability classification (nonirrigated):* 8s **Description of Ainahou Setting** *Landform:* Pahoehoe lava flows *Landform position (two-dimensional):* Backslope *Landform position (three-dimensional):* Side slope *Down-slope shape:* Linear *Across-slope shape:* Linear, convex *Parent material:* Organic material **Typical profile** *Oa - 0 to 9 inches:* muck *2R - 9 to 19 inches:* bedrock **Properties and qualities** *Slope:* 2 to 5 percent *Depth to restrictive feature:* 8 to 13 inches to lithic bedrock *Natural drainage class:* Poorly drained *Runoff class:* High *Capacity of the most limiting layer to transmit water (Ksat):* Low to moderately low (0.00 to 0.06 in/hr) *Depth to water table:* About 7 to 9 inches *Frequency of flooding:* None *Frequency of ponding:* Frequent *Available water storage in profile:* Very low (about 2.0 inches) **Interpretive groups** *Land capability classification (irrigated):* 7s *Land capability classification (nonirrigated):* 7s *Hydrologic Soil Group:* C/D *Ecological site:* Udic Forest (F159BY500HI)

3.3.2 Soil semi-variogram description

Due to the shallow depth of the soil it was not possible to collect soil temperature and moisture data to create the semivariograms.

3.3.3 Soil array layout and soil pit location

The minimum distance allowable between soil plots is 25 m to ensure a degree of spatial independence in non-measured soil parameters (i.e., other than temperature and water content) and the maximum distance allowable between soil plots is 40 m due to cost constraints. Since we were unable to create semivariograms based on soil temperature and moisture to inform soil plot spacing and the very shallow depth of soil at the site, coordinates were selected for each soil plot that were approximately 40 m apart and located in areas with relatively deep soil to allow for soil sensor installation. The soil array shall follow a non-standard design with the soil plots being 5 m x 5 m. The location of the soil plots is shown below in the table. The FIU soil pit for characterizing soil horizon depths, collecting soil for site-specific sensor calibration, and collecting soil for the FIU soil archive will be located at 19.553320°, -155.317470° (primary location); or 19.55354, -155.31532 (alternate location 1 if primary location is unsuitable); or 19.55331, -155.31654 (alternate location 2 if primary location is unsuitable). However, due to some endangered plant species in this area, FIU and FCC personnel should work with site host to identify them, and relocate the soil pit location as needed prior to construction.

A summary of the soil information is shown in Table 4 and site layout can be seen in Figure 5.

Dominant soil series at the site: Lalaau very cobbly highly decomposed plant material, 2 to 10 percent slopes. The taxonomy of this soil is shown below:

Order: Histosols

Suborder: Folists

Great group: Udifolists

Subgroup: Typic Udifolists

Family: Euic, isomesic Typic Udifolists

Series: Lalaau very cobbly highly decomposed plant material, 2 to 10 percent slopes

Table 4. Summary of soil array and soil pit information at Pu'u Maka'ala. 0° represents true north and accounts for declination.

Soil plot dimensions	5 m x 5 m
Soil array pattern	Non-standard
Distance between soil plots: x	Varies (~ 40 m)
Distance from tower to closest soil plot: y	25 m
Latitude and longitude of 1st soil plot OR direction from tower	19.55301, -155.31708
Latitude and longitude of 2nd soil plot OR direction from tower	19.55284, -155.31668
Latitude and longitude of 3rd soil plot OR direction from tower	19.55264, -155.31638
Latitude and longitude of 4th soil plot OR direction from tower	19.55247, -155.31592
Latitude and longitude of 5th soil plot OR direction from tower	19.55231, -155.31558
Direction of soil array	~115 degrees
Latitude and longitude of FIU soil pit 1	19.553320°, -155.317470° (primary location)
Latitude and longitude of FIU soil pit 2	19.55354, -155.31532 (alternate 1)
Latitude and longitude of FIU soil pit 3	19.55331, -155.31654 (alternate 2)
Dominant soil type	Lalaau very cobbly highly decomposed plant material, 2 to 10 percent slopes
Expected soil depth	1.02-1.52 m
Depth to water table	>2 m

Expected depth of soil horizons	**Expected measurement depths***
0-0.08 m (Oa/2C1 - 0 to 3 inches: very cobbly highly decomposed plant material)	0.04 m
0.08-1.35 m (2C2 - 3 to 53 inches: cobbles)	0.72 m
1.35-1.60 (2R - 53 to 63 inches: bedrock)	

*Actual soil measurement depths will be determined based on measured soil horizon depths at the NEON FIU soil pit and may differ substantially from those shown here.

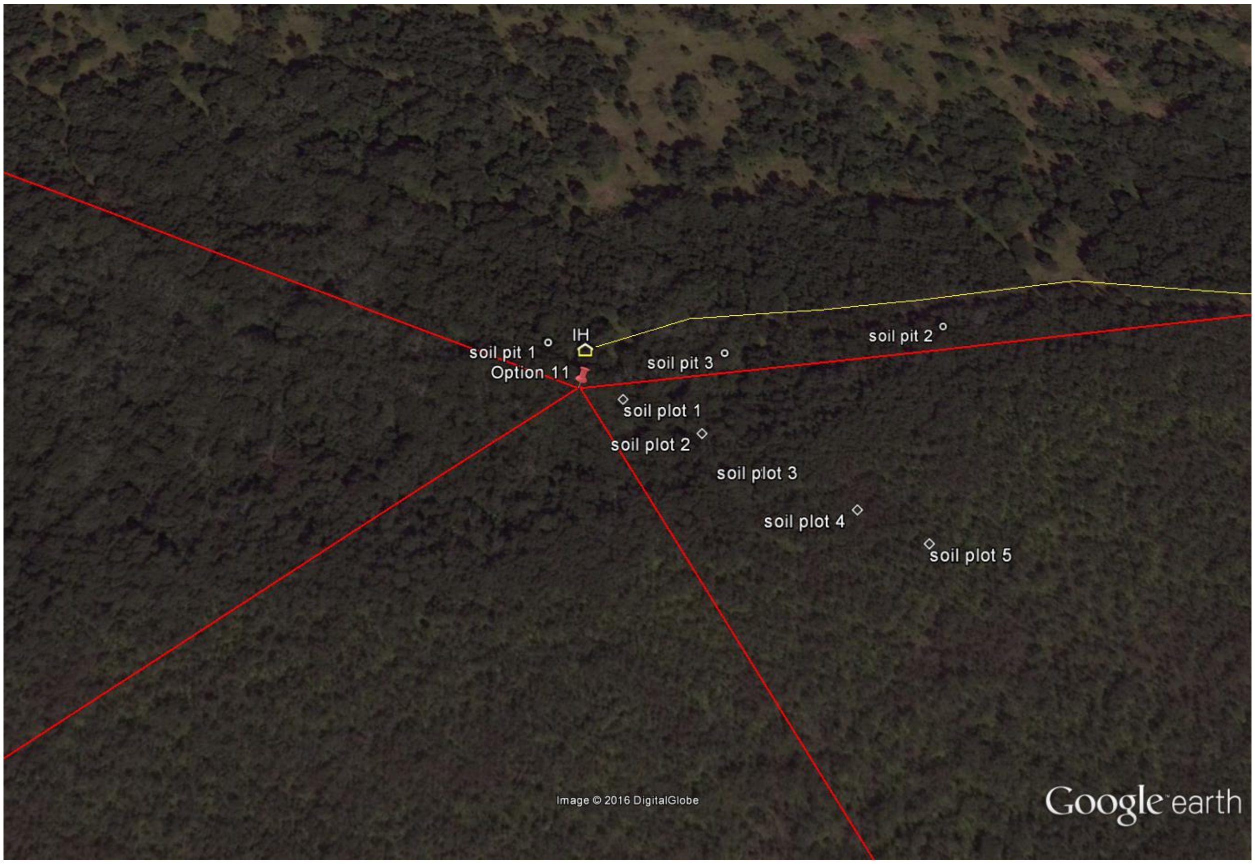


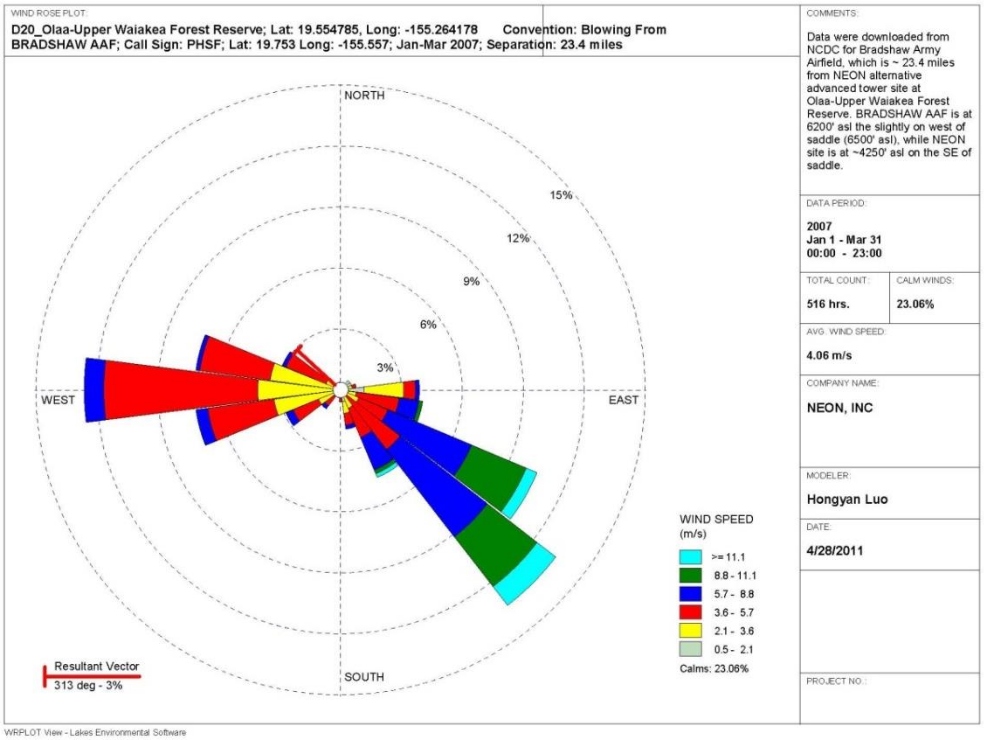
Figure 5. Site layout at Pu'u Maka'ala showing soil array and location of the FIU soil pit.

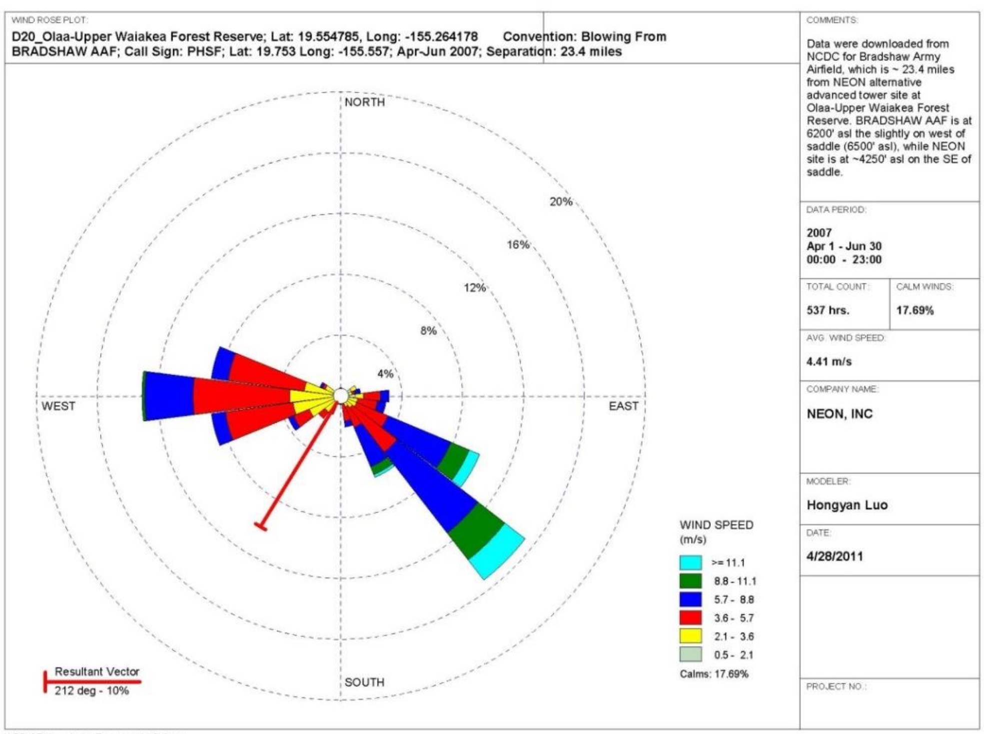
3.4 Airshed

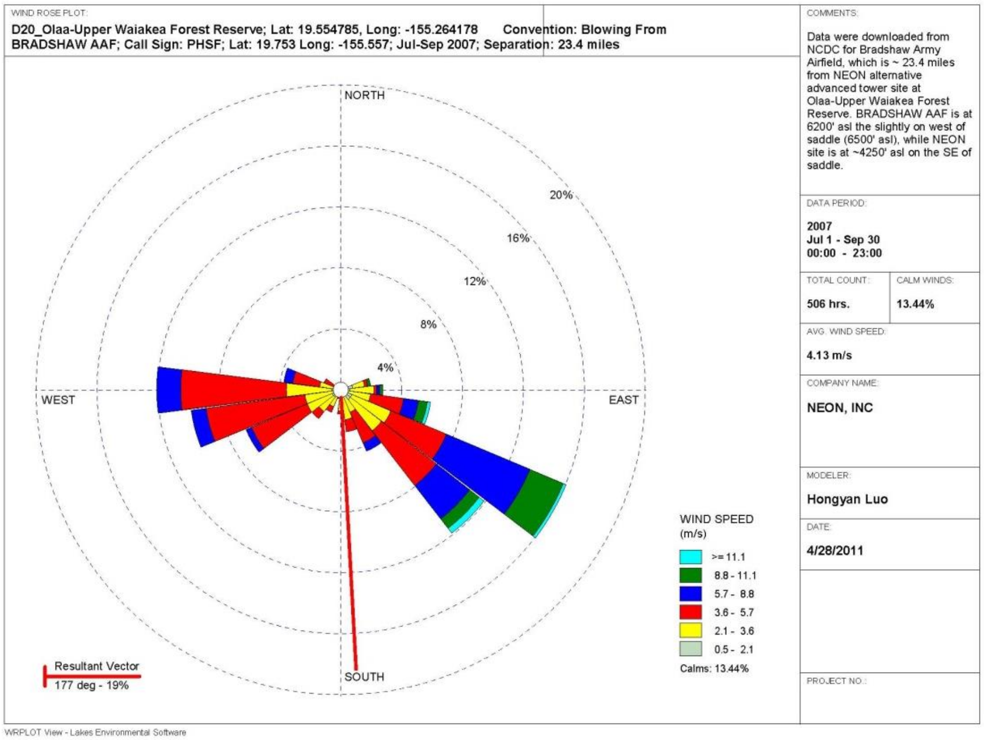
3.4.1 Seasonal windroses

Wind roses analytically determine and graphically represent the frequencies of wind direction and wind speed over a given timeseries. The data used to make the wind roses below are 2007 data from Bradshaw Army Airfield (PHSF) at Lat: 19.753 Long: -155.557, which is ~ 21 miles away on the northwest of the NEON tower site. Local contacts confirmed that the wind patterns shown on the windroses below are also representative and applicable at NEON site. The orientation of the windrose follows that of a compass (assume declination applied). When we describe the wind directions it should be noted that they are the cardinal direction that wind blows from. The directions of the rose with the longest spoke show wind directions with the largest frequency. These wind roses are subdivided into as 24 cardinal directions in this case.

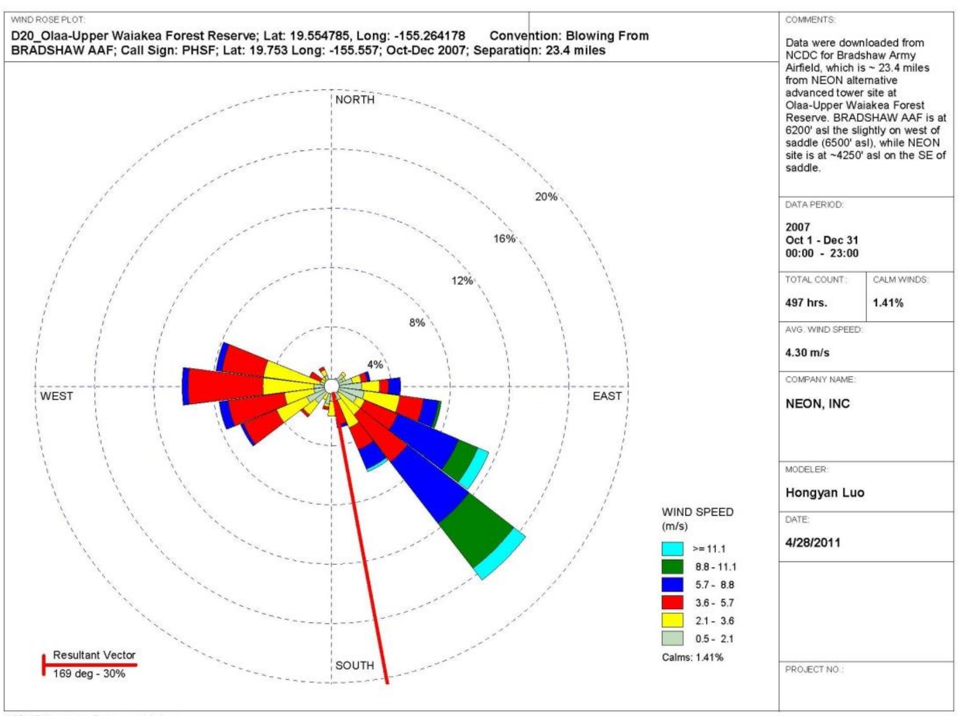
3.4.2 Results (graphs for wind roses)







WIND ROSE PLOT:
D20_Olaa-Upper Waiakea Forest Reserve; Lat: 19.554785, Long: -155.264178 Convention: Blowing From
BRADSHAW AAF; Call Sign: PHSF; Lat: 19.753 Long: -155.557; Jul-Sep 2007; Separation: 23.4 miles
NORTH
SOUTH
WEST
EAST
4%
8%
12%
16%
20%
Resultant Vector
177 deg - 19%
WIND SPEED (m/s)
>= 11.1
8.8 - 11.1
5.7 - 8.8
3.6 - 5.7
2.1 - 3.6
0.5 - 2.1
Calms: 13.44%
COMMENTS:
Data were downloaded from NCDC for Bradshaw Army Airfield, which is ~ 23.4 miles from NEON alternative advanced tower site at Olaa-Upper Waiakea Forest Reserve. BRADSHAW AAF is at 6200' asl the slightly on west of saddle (6500' asl), while NEON site is at ~4250' asl on the SE of saddle.
DATA PERIOD:
2007
Jul 1 - Sep 30
00:00 - 23:00
TOTAL COUNT:
506 hrs.
CALM WINDS:
13.44%
AVG. WIND SPEED:
4.13 m/s
COMPANY NAME:
NEON, INC
MODELER:
Hongyan Luo
DATE:
4/28/2011
PROJECT NO.:
WRPLOT View - Lakes Environmental Software



WIND ROSE PLOT:
D20_Olaa-Upper Waiakea Forest Reserve; Lat: 19.554785, Long: -155.264178 Convention: Blowing From
BRADSHAW AAF; Call Sign: PHSF; Lat: 19.753 Long: -155.557; Oct-Dec 2007; Separation: 23.4 miles
NORTH
SOUTH
WEST
EAST
4%
8%
12%
16%
20%
Resultant Vector
169 deg - 30%
WIND SPEED (m/s)
>= 11.1
8.8 - 11.1
5.7 - 8.8
3.6 - 5.7
2.1 - 3.6
0.5 - 2.1
Calms: 1.41%
COMMENTS:
Data were downloaded from NCDC for Bradshaw Army Airfield, which is ~ 23.4 miles from NEON alternative advanced tower site at Olaa-Upper Waiakea Forest Reserve. BRADSHAW AAF is at 6200' asl the slightly on west of saddle (6500' asl), while NEON site is at ~4250' asl on the SE of saddle.
DATA PERIOD:
2007
Oct 1 - Dec 31
00:00 - 23:00
TOTAL COUNT:
497 hrs.
CALM WINDS:
1.41%
AVG. WIND SPEED:
4.30 m/s
COMPANY NAME:
NEON, INC
MODELER:
Hongyan Luo
DATE:
4/28/2011
PROJECT NO.:
WRPLOT View - Lakes Environmental Software

Figure 6. Windroses for Pu'u Maka'ala core tower site
The data used to make these wind roses are 2007 data downloaded from NCDC for Bradshaw Army Airfield, which is ~ 21 miles from NEON core tower site at Pu'u Maka'ala. BRADSHAW AAF is at 6200' ASL the slightly on west of the saddle (6500' ASL), while NEON site is at ~5540' ASL on the SE side of the saddle. Local people confirmed that the wind patterns on the windroses are also representative and applicable at NEON site. It is assumed that the wind data was corrected for declination. Panels are (from top to bottom) January to March, April to June, July to September, and October to December.

3.4.3 Expected environmental controls on source area

Two types of models were commonly used to determine the shape and extent of the source area under different and contrasting atmospheric stability classes. An inverted plume dispersion model with modeled cross wind solutions were used for convective conditions (Horst and Weil 1994). For strongly stable conditions, and Lagrangian solution was used (Kormann and Meixner 2001). The source area models where bounded by the expected conditions depict the extreme conditions. Convective conditions typically have strong vertical mixing between the ecosystem and atmosphere (surface layer). Stable conditions typically have long source area and associated waveforms. Convective turbulence is often characterized by short mixing scales (scalar) and moderate daytime wind speeds, *e.g.,* 1-4 m s^{-2}. Higher wind speeds, like those experienced over the Rockies, are often the product of mechanical turbulence with long waveforms. Because thermal stratification is very efficient in suppressing vertical mixing, stable conditions also have typically very long waveforms.

As a general rule, shorter and less structurally complex ecosystems have good vertical mixing during all atmospheric stabilities. Taller and more structurally complex ecosystems have well mixed upper canopies during the daytime, and can be decoupled below the canopy under neutral and stable conditions. The type of turbulence (mechanical verse convective) and the physical attributes of the ecosystem control the degree of mixing, and the length and size of the source area.

Here, we used a web-based footprint model to determine the footprint area under various conditions (model info: http://www.geos.ed.ac.uk/abs/research/micromet/EdiTools/). Winds used to run the model and generate following model results are extracted from the wind roses. Vegetation information, temperature and energy information were either from the RFI document, previous site visit report, available data files or best estimated from experienced expert. Measurement height was determined from the Tower Height Info document provided by ENG group, then verify according to the real ecosystem structure after FIU site characterization at site. Runs 1-3 and 4-6 represents the expected conditions for summer and winter conditions, respectively, with maximum and mean windspeeds (daytime convective) and nighttime (stable atmospheres) conditions. The wind vector for each run was estimated from wind roses and is placed as a centerline in the site map included in the graphics. The width of the footprint was also estimated using the length between the isopleth of 80% cumulative flux and center line to calculate the angle from centerline. This information, along with distance of the cumulative flux isopleths and wind direction, will define the source area for the flux measurements on the top of the tower.

Table 5. Expected environmental controls to parameterize the source area model, and associated results for Pu'u Maka'ala core site.

Parameters	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	units
Approximate season	summer			winter			
	Day (max WS)	Day (mean WS)	Night	Day (max WS)	Day (mean WS)	night	qualitative
Atmospheric stability	convective	convective	Stable	convective	convective	Stable	qualitative
Measurement height	30	30	30	30	30	30	m
Canopy Height	20	20	20	20	20	20	m
Canopy area density	2.5	2.5	2.5	2.5	2.5	2.5	m
Boundary layer depth	1800	1800	1000	1800	1800	1000	m
Expected sensible heat flux	400	400	0	250	250	-10	W m^{-2}
Air Temperature	30	30	24	24	24	20	Celsius
Max. windspeed	11.0	6.0	4.0	11.0	7.5	4.5	m s^{-1}
Resultant wind vector	120	120	270	135	135	270	degrees
Results							
(z-d)/L	-0.01	-0.07	0.00	-0.01	-0.03	0.01	m
d	15.00	15.00	15.00	15.00	15.00	15.00	m
Sigma v	3.70	2.50	1.20	3.60	2.70	1.80	m^2 s^{-2}
Z0	0.99	0.99	0.99	0.99	0.99	0.99	m
u*	1.70	0.97	0.59	1.70	1.20	0.65	m s^{-1}
Distance source area begins	0	0	0	0	0	0	m
Distance of 90% cumulative flux	800	650	900	850	750	950	m
Distance of 80% cumulative flux	500	400	500	480	450	500	m
Distance of 70% cumulative flux	300	250	350	350	300	300	m
Peak Contribution	65	55	65	65	65	65	m

3.4.4 Results (source area graphs)

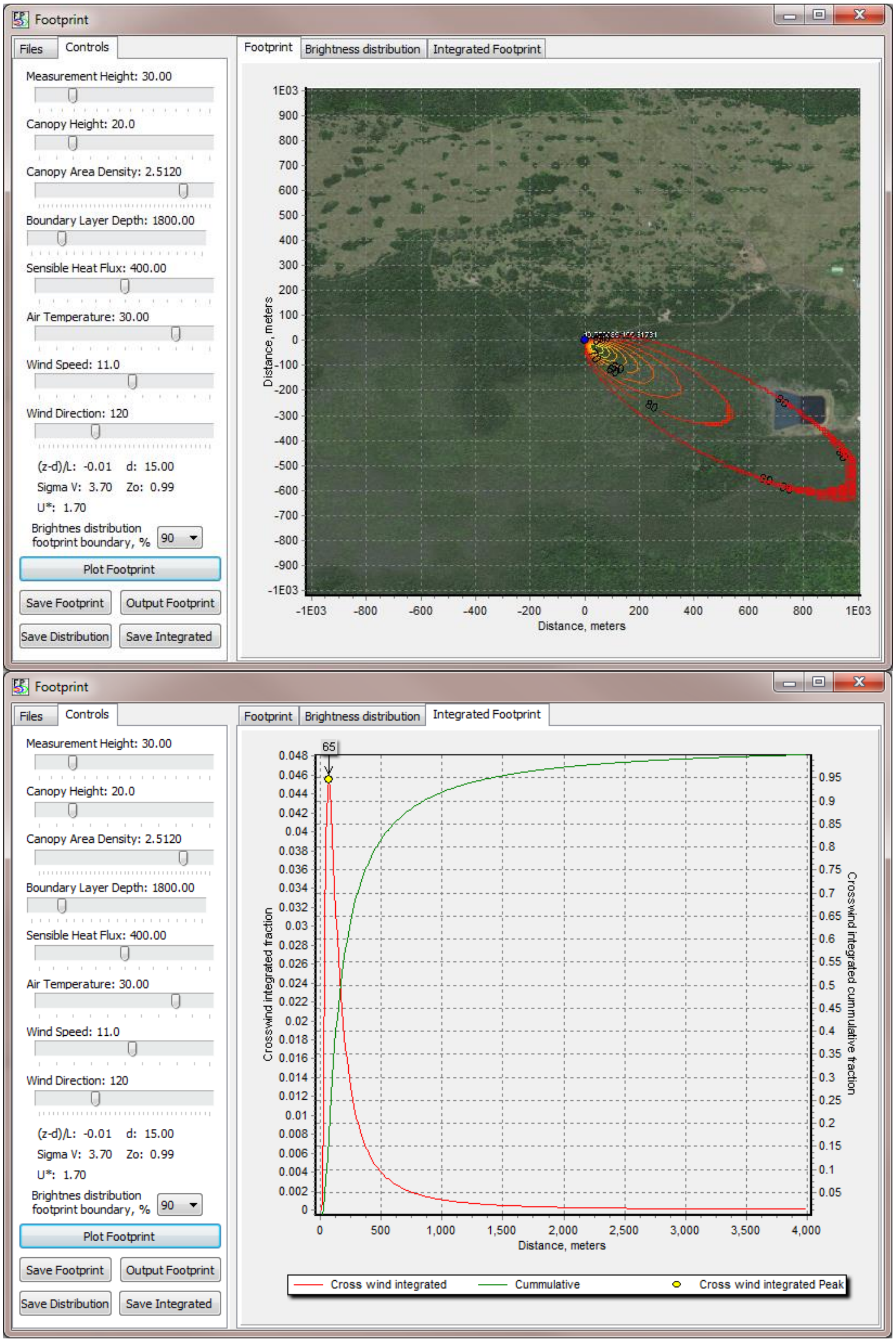
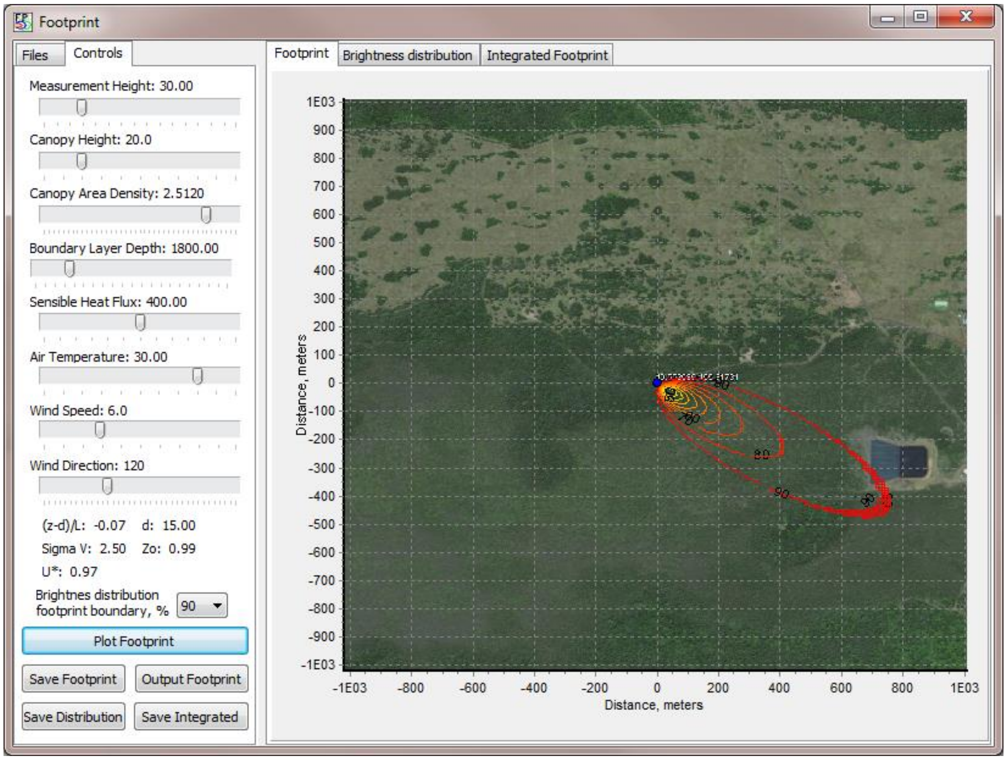


Figure 7. summer, daytime, max wind speed



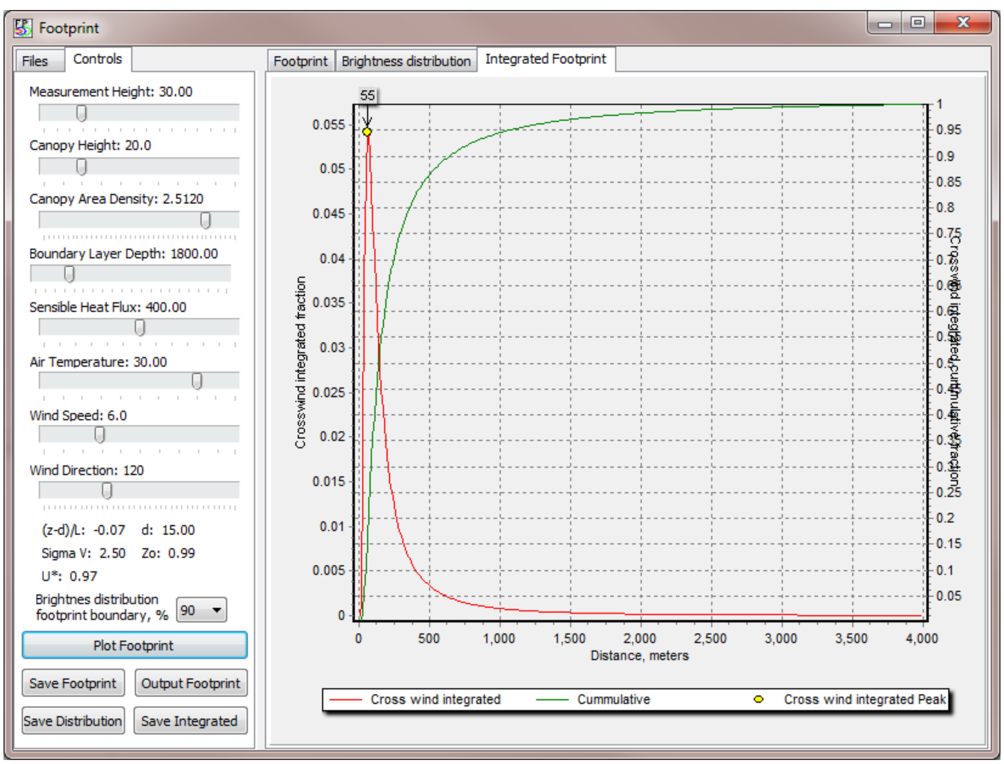
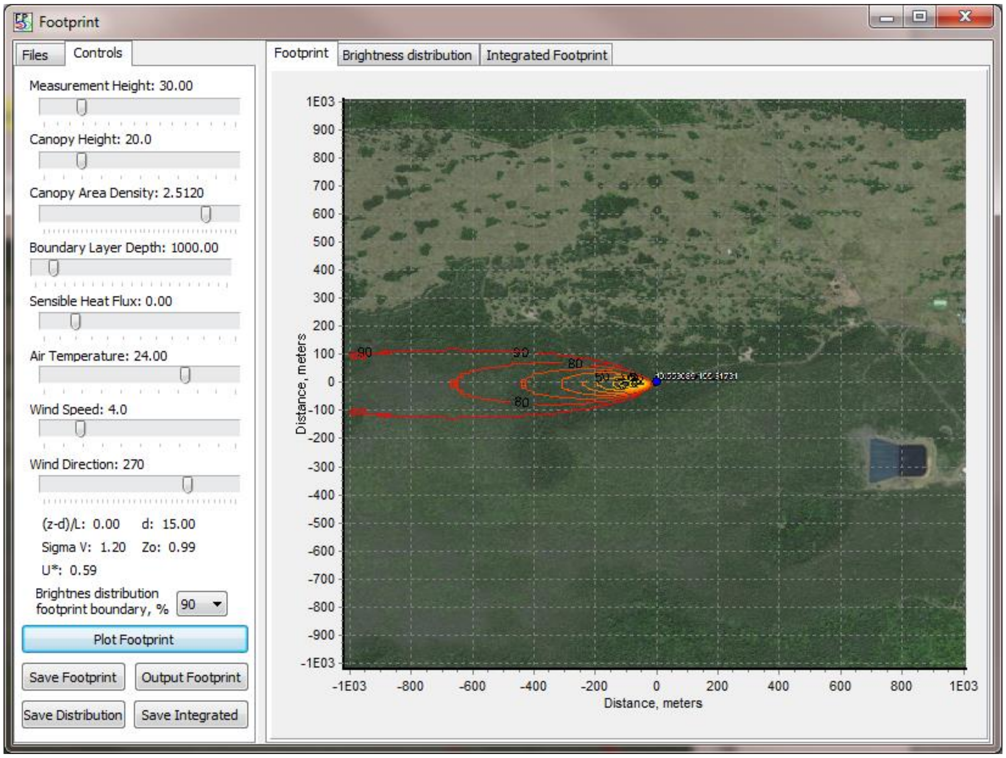


Figure 8. summer, daytime, mean wind speed



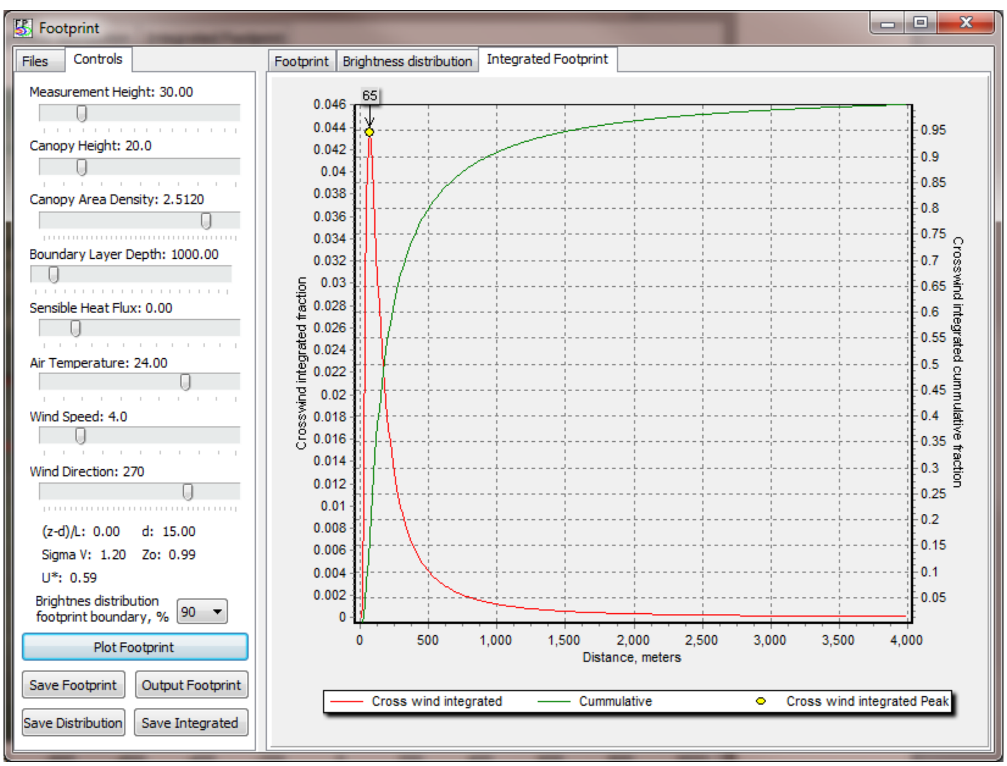
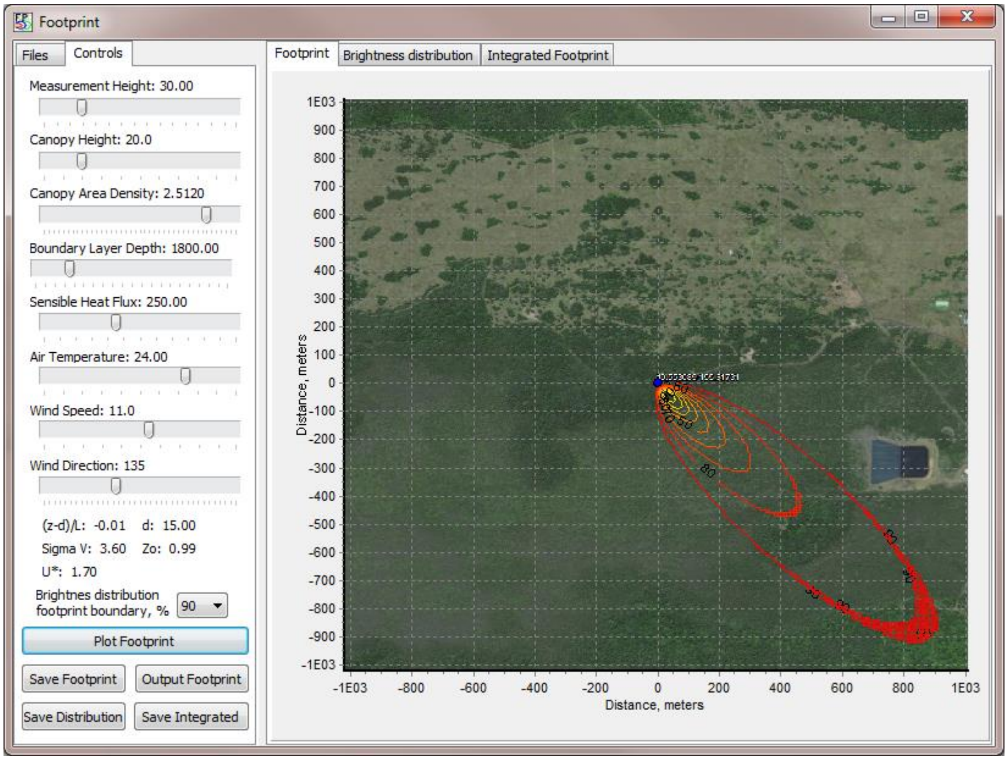


Figure 9. summer, nighttime, mean wind speed



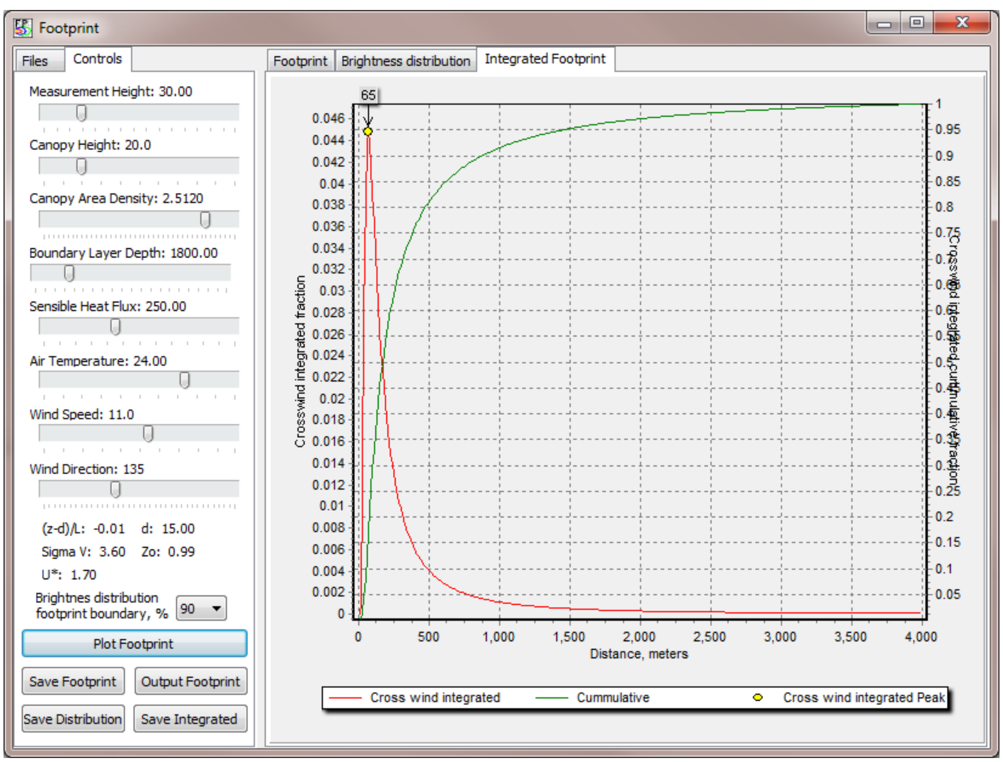
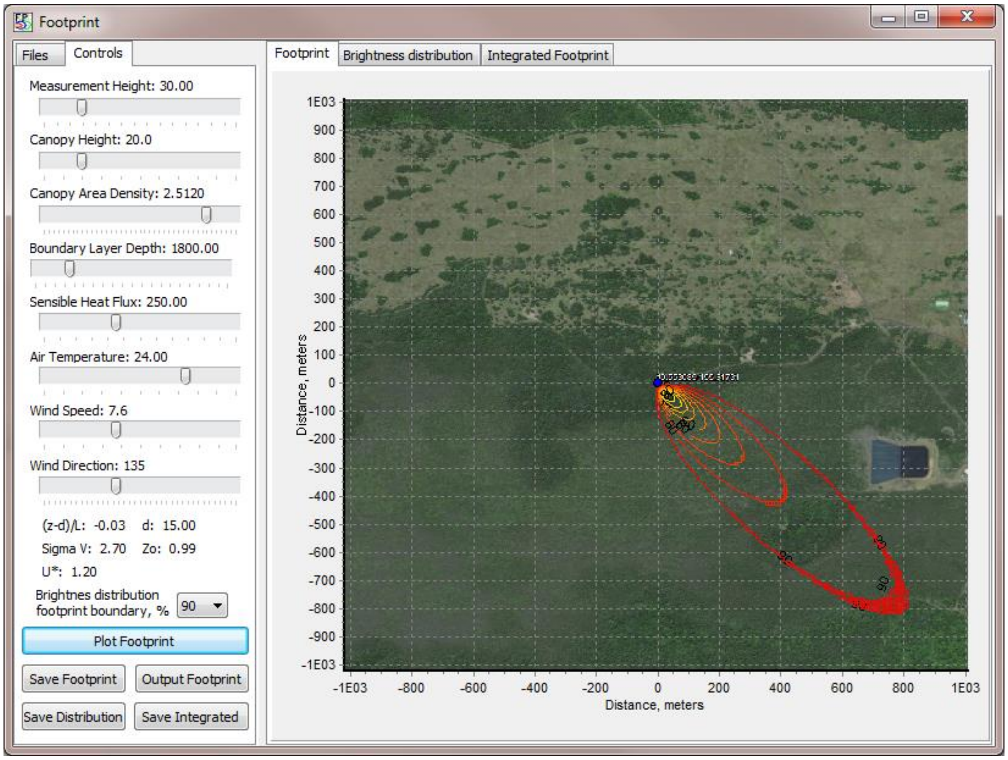


Figure 10. winter, daytime, max wind speed



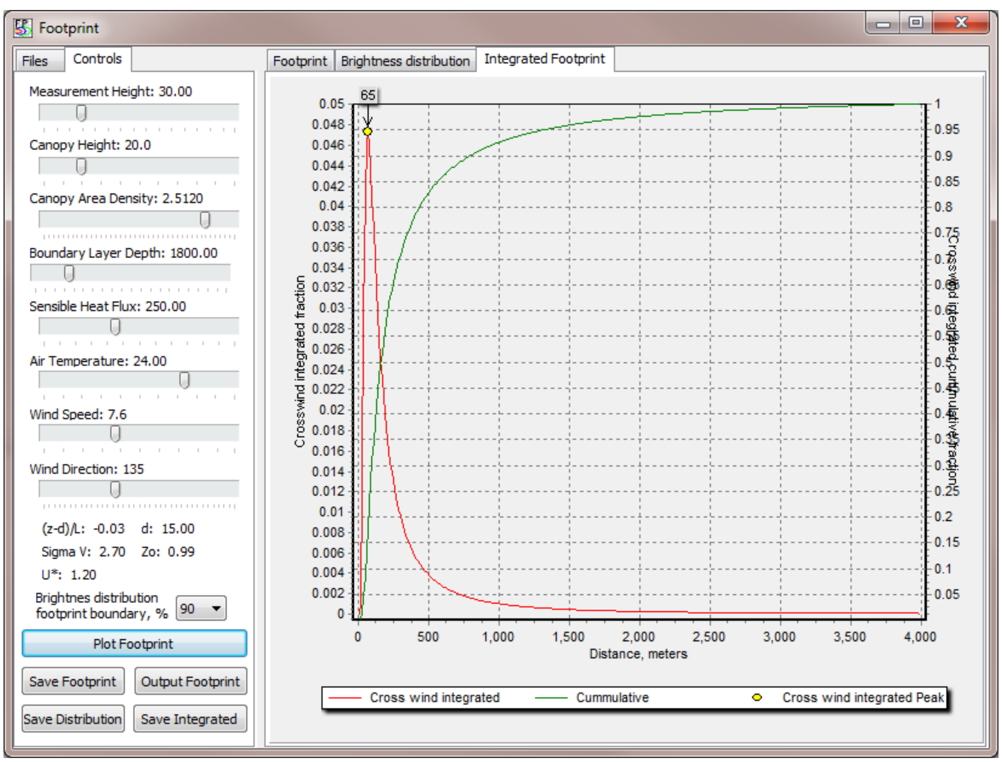
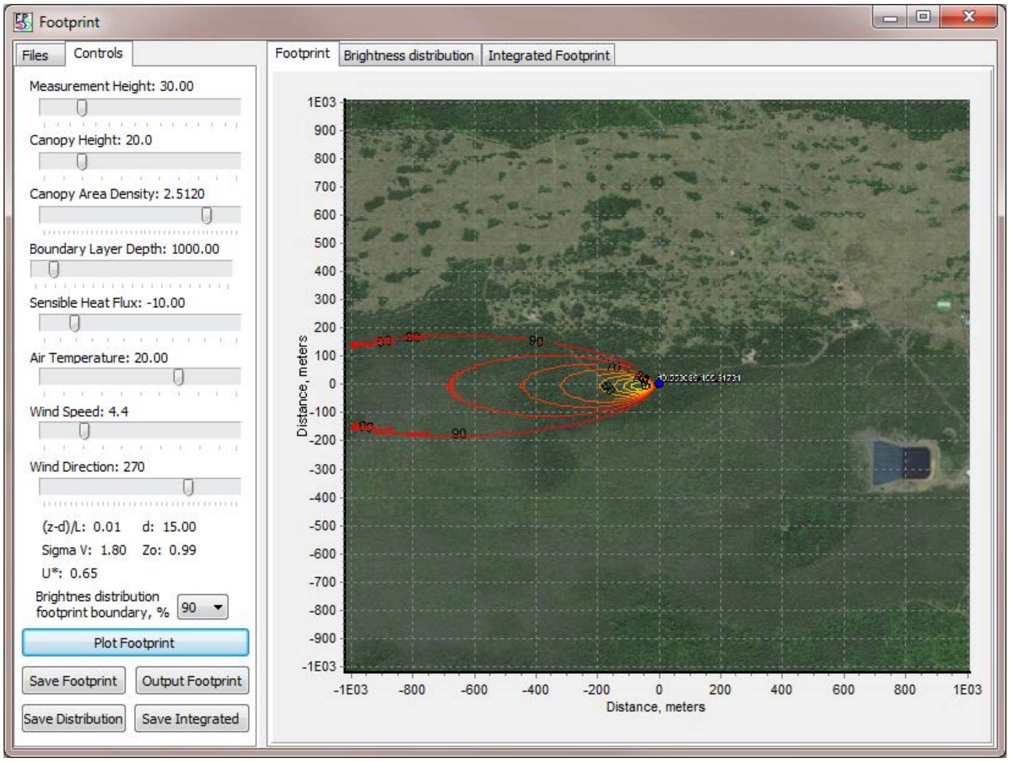


Figure 11. Winter daytime, mean wind speed



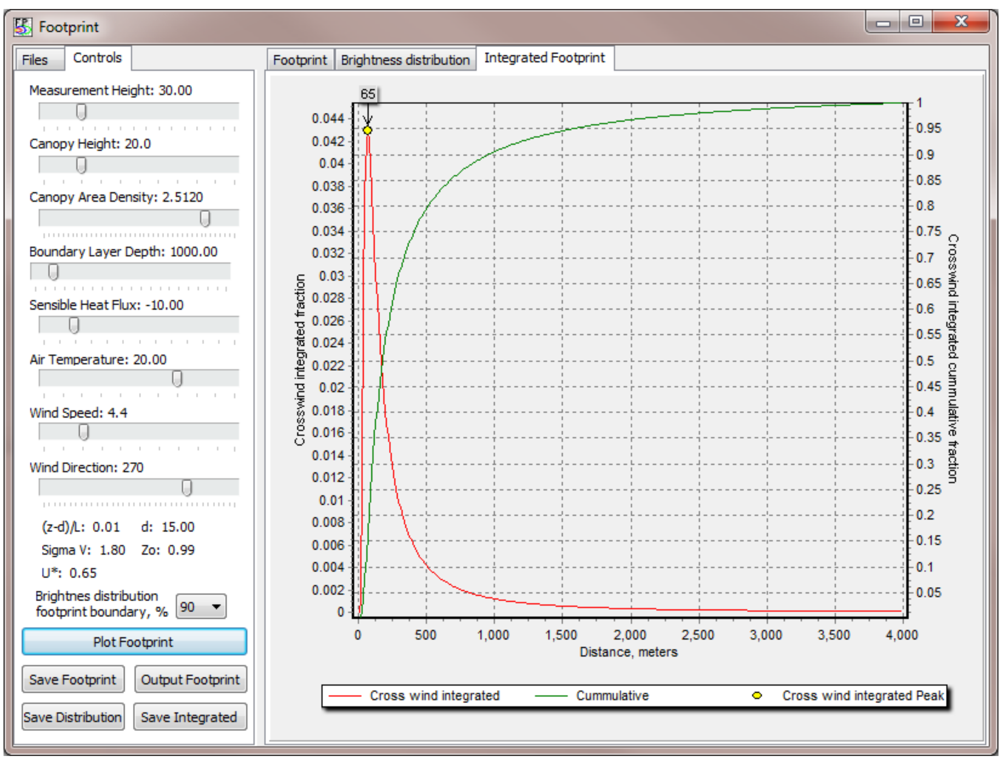


Figure 12. winter, nighttime, mean wind speed

3.5 Site design and tower attributes

According to the wind roses, wind can blow up hill to the tower location from ocean on the southeast (80° to 150°, clockwise from 80°), and nighttime drainage flow blows from higher mountain area on the west toward the tower location (230° to 290°, clockwise from 230°). **Tower** should be placed to a location to best catch the signals from the airshed of the ecosystem in interest, which is Ohia forest at this site. After FIU site characterization visit, we determined that the tower location should be at 19.55309°, -155.31731°.

Eddy covariance, sonic wind and air temperature **boom arms** orientation toward the southwset will be best to capture signals from all wind directions. **Radiation boom arms** should always be facing south to avoid any shadowing effects from the tower structure.

An **instrument hut** should be outside the prevailing wind airshed to avoid disturbance in the measurements of wind and should be positioned to have the longer side parallel to frequent wind direction to minimize the wind effects on instrument huts and to minimize the disturbances of wind regime by instrument hut. At this site, we determined the instrument hut location at 19.553265°, -155.317279°. The instrument hut should be positioned to have the longer side parallel to E-W direction.

The ecosystem at Pu'u Maka'ala core site is *ōhi'a* (*Metrosideros polymorpha*) dominated middle structure young forest with dense understory (mainly tree ferns and false staghorn fern). The mean canopy height is ~6-22 m for Ohia trees, ~5-6 m for tree ferns and ~ 2 m for false stagfern. We require 6 **measurement layers** on the tower with top measurement height at 30.5 m, and remaining levels are 24 m, 19 m, 12 m, 4 m and 0.3 m, respectively, to best characterize the fluxes on the tower top and environmental conditions in profile.

DFIR location is at 19.556761°, -155.310330°, which is ~800 m northeast of tower location into an open pasture area. A secondary precipitation gauge on tower top may be needed based on the 600 m distance requirement. Wet deposition collector will collocate at the top of the tower. See AD 04 for further information and requirements for bulk precipitation collection and wet deposition collection.

The site layout is summarized in the table below. **Anemometer/temperature boom arm direction** is ***from*** the tower ***toward*** the prevailing wind direction or designated orientation. **Instrument hut orientation vector** is parallel to the long side of the instrument hut. **Instrument hut distance z** is the distance from the center of tower projection to the center of the instrument hut projection on the ground. The numbering of the **measurement levels** is that the lowest is level one, and each subsequent increase in height is numbered sequentially.

Table 6. Site design and tower attributes for Pu'u Maka'ala core site.

0° is true north with declination accounted for. Color of Instrument hut exterior shall be tan or best match the surrounding environment.

Airshed area			80° to 150° and 230° to 290°		Clockwise from first angle
Tower location	19.553089°	-155.317310°	--	--	
Instrument hut	19.553265°	-155.317279°			
Instrument hut orientation vector	--	--	90°-270°		Longwise
Instrument hut distance z	--	--	--	20	meter
Anemometer/Temperature boom orientation	--	--	205°	--	
DFIR	19.556761°	-155.310330°			
Height of the measurement levels					
Level 1				0.3	m.a.g.l.
Level 2				4	m.a.g.l.
Level 3				12	m.a.g.l.
Level 4				19	m.a.g.l.
Level 5				24	m.a.g.l.
Level 6				30.5	m.a.g.l.
Tower Height				30.5	m.a.g.l.

See AD 03 for technical requirement to determine the boom height for the bottom most measurement level.

Figure below shows the proposed tower location, instrument hut location, DFIR, airshed area and access road.

Figure 13. Site layout for Pu'u Maka'ala core tower site.

i) Tower location is presented (red pin), ii) red lines indicate the airshed boundaries. Vectors 80º to 150º (clockwise from 160º) and 230º to 290º (clockwise from 230º) would have quality wind data without causing flow distortions, respectively, iii) Yellow line is the suggested access road to instrument hut, and iv) Purple pin is DFIR location

Boardwalks. Ultimately, the decision to use a boardwalk will be, in part, based on owner's preferences. There are strong science requirements that minimize site disturbance to the surrounding area, which will be difficult to manage over a 30-y period. Traffic control is key to minimizing the site disturbance. Confining foot traffic to boardwalks minimizes site impact; this is particularly true in places where wear caused by foot traffic becomes noticeable and grows. For example, in places with snow part of the year, worn footpaths tend to have low places that collect water, or places where the snow pack or heavy rains causes paths to become uneven and further causing personnel to walk farther and farther around the sides of the original path, causing the path to grow in width. This is a very common phenomenon. FIU assumes that all conduits will be either buried, or placed inside the boardwalk such that it does not extend beyond the 36" (0.914 m). The boardwalk to access the tower is not on any side that has a boom.

Specific Boardwalks at this site:

- No boardwalk/path is needed to instrument hut since the instrument hut is on the roadside.
- No boardwalk is needed between tower and instrument hut since the dirt road run between them. Even this road is rarely used, we should not block it.
- On-grade boardwalk to the soil array.
- On-grade boardwalk from the soil array boardwalk to the individual soil plots.
- No boardwalk or path needed to DFIR site.

The relative locations between tower, instrument hut and boardwalk can be found in the Figure below:

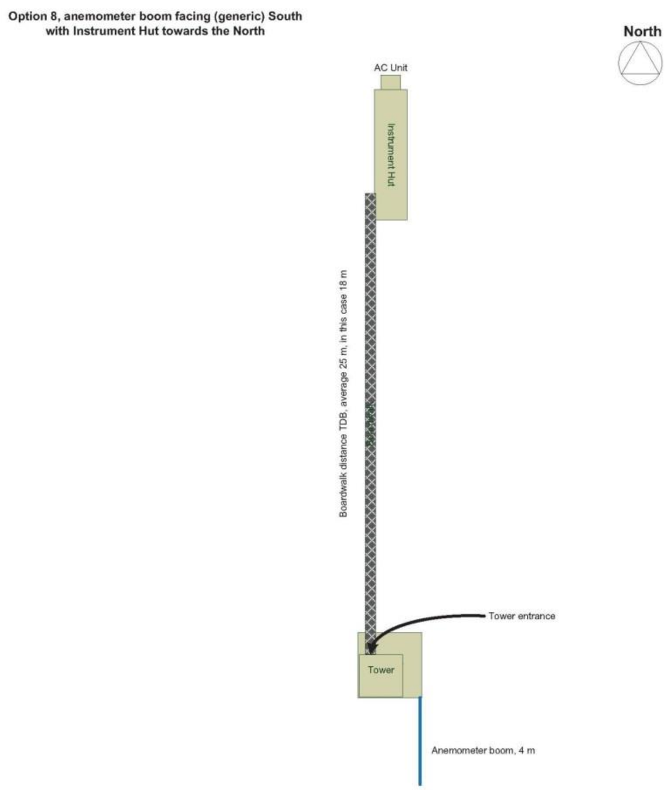


Figure 14. Generic diagram to demonstration the relationship between tower and instrument hut when boom facing south and instrument hut on the north towards the tower.

This is just a generic diagram. The actual layout of boardwalk (or path if no boardwalk required) and instrument hut position will be the joint responsibility of FCC and FIU. At this site, the boom angle will be 205 degrees, instrument hut location is on the northwest toward tower, the distance between instrument hut and tower is 20 m. The instrument hut vector will be E-W (90^o-270^o, longwise).

3.6 Information for ecosystem productivity plots

The tower at this site has been positioned to optimize the collection of the air/wind signals both temporally and spatially over the desired ecosystem (Ohia Forest). Wind blows from the airshed of 80^o to 150^o (clockwise from 80^o), and 230^o to 290^o (clockwise from 230^o). 90% signals for flux measurements are within 1000 m from tower, and 80% within 500 m. We suggest FSU Ecosystem Productivity plots are placed within the boundaries of 80^o to 150^o (clockwise from 80°) and 230^o to 290^o (clockwise from 230^o) from tower.

3.7 Issues and attentions

DFIR location is >800 m away from tower location. A secondary precipitation gauge is needed at tower top based on the 600 m distance requirement.

Soil is rocky, new and shallow. Typical design of soil array doesn't work here. Special design is needed for this site. The location of soil plots was handpicked at field. Each picked location is indicated by two orange ribbons tied on nearby trees.

Field design above for this site was made by following the standard FIU site design procedures and assuming that we will have ability to deploy the full set of the standard FIU measurements above and below ground. However, due to the ususual shallow soil depth, the deployment of the standard soil array is not possible at this site. Variance in FIU design is needed.

Understory is super dense and fast-growing. It may be a challenge for NEON construction, deployment and maintanence.

There are endanged plant species at site. NEON personnel should work with site host to identify the plants, and microsite soil pit, soil plot locations accordingly as needed prior to construcction.

This site location is next to Correction Facility. No public activities. Security is high.

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