STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Forestry and Wildlife
Honolulu, Hawaii 96813

July 10, 2020

Chairperson and Members
Board of Land and Natural Resources
State of Hawaii
Honolulu, Hawaii

Land Board Members:

SUBJECT: REQUEST APPROVAL OF A REVISED WAIMEA VALLEY FOREST STEWARDSHIP MANAGEMENT PLAN AND FOREST STEWARDSHIP AGREEMENT WITH HIʻIPAKA LLC, TMK (l) 6-1-002:002, WAIALUA DISTRICT, ISLAND OF O'AHU.

BACKGROUND:

The State of Hawaiʻi Forest Stewardship Program (FSP) provides technical and financial assistance to private landowners and land managers committed to the stewardship, conservation, and restoration of important forest resources across the state. These private properties provide a variety of public benefits for the residents of Hawaiʻi, including but not limited to: fresh water capture and production, decreased soil erosion, wildlife habitat, forest products, recreational and educational opportunities, and local jobs. The assistance provided by FSP enables private landowners to develop and implement long-term multi-resource management plans to conserve, restore and maintain forested areas on their property.

The FSP was established through Chapter 195F-6, Hawaiʻi Revised Statutes (HRS) and provides the Department of Land and Natural Resources with the authority to provide financial assistance to approved Forest Stewardship projects for private landowners to manage, protect, and restore important natural resources on forested and formerly forested properties. The FSP is implemented pursuant to Chapter 195F, HRS, and Section 109, Hawaiʻi Administrative Rules (HAR). The program provides cost-share reimbursement for the development of long-term forest management plans and for the implementation of approved Forest Stewardship management plans.

To participate in FSP, interested landowners and managers follow a sequence of application steps in the process of developing a long-term Forest Stewardship management plan. All interested landowners submit their proposed project for review by the Forest Stewardship Advisory Committee (FSAC). The FSAC reviews the proposed project based on program eligibility requirements and assures the proposed project is in line with the program's goals of conservation, restoration, and/or forest production. Once a proposed project is accepted, the FSAC recommends the development of a Forest Stewardship management plan and reviews and approves the final management plan. The Forest Stewardship management plan is created by landowners in partnership with natural resource professional/experts and reviewed and approved by both the

Division and the FSAC. Final management plans are then recommended for approval by the Department.

At its meeting on September 11th, 2015, under agenda item C-1, the Board approved the Waimea Valley Forest Stewardship management plan and authorized total cost-share support in the amount of $422,639.00 over a 10-year period (Exhibit B) for Hiʻipaka LLC to implement the plan through a Forest Stewardship Agreement. The project proposed to restore and manage 101.5 acres of native and non-native forest systems on approximately 1,875 acres. All FSP projects are asked to review and evaluate their management actions at least once during the implementation of their management plan to assess their success and adjust their practices, as appropriate, to ensure that they meet their project goals and are practicing adaptative management. Additionally, FSP projects may request cost-share adjustments if costs associated with management activities have increased or decreased during the term of their agreement.

DISCUSSION:

The principal objective of the Waimea Valley Forest Stewardship plan is to promote the recovery of native Hawaiian plant and animal communities, with intensive management in five spatially distinct forest management units: Mauka Restoration Area, Kalahe'e Reforestation Area, Lama Forest, Eugenia Conservation Area, and Wetland/Streamside Management Zones. There is a range of diverse forest types present on these 101.5 acre management units, ranging from intact native forest to highly invaded, non-native forest. Hiʻipaka LLC has been successful in the first six years of their FSP project in completing management actions in the Mauka and Kalaheʻe reforestation areas that are primarily focused on maintaining and improving existing native forest cover and replacing current non-native forest cover with site-appropriate native species. As envisioned in their plan, they have been able to meet these objectives through the dedication of thousands of volunteers and support through their visitor engagement, averaging of 1,000 visitors a day. Waimea Valley has also focused on engaging volunteer hunters to support ungulate control, and community volunteers through their Hui Hanai Aina Program, which clears invasive plants and has planted tens of thousands of native Hawaiian plants in Waimea Valley.

As their project has advanced however, Hiʻipaka LLC has identified the need to revise their management plan to adjust the implementation schedule and corresponding annual budget to address new natural resource management concerns and to accurately account for the availability of resources, including volunteers, staff time, and funding. The revised Waimea Valley Forest Stewardship management plan (Exhibit A) includes changes to the implementation schedule and corresponding annual budgets for three of the five management areas (Kalaheʻe Reforestation Area, Lama Forest, and the Eugenia Conservation Area) for years six through ten. Hiʻipaka LLC has revised their management plan to better align the scheduling of priority activities such as fencing, reforestation and removal of invasive weeds with the availability of volunteers to focus on accessible management sites in the Kalahe'e Reforestation Area. As outlined in their revision, fencing for the other two units (Eugenia restoration and Lama forest) will be implemented, but postponed, as these areas are more inaccessible for staff and volunteers. The Eugenia management unit fencing will change to year 9 from year 6 and the Lama forest fencing to year 10 from year 6. Management goals for each of the individual management areas will still be met in the revised plan and the overall management goals, deliverables, and total budget for the proposed management plan are not altered in this revision.

The Division and FSAC reviewed and recommended the approval of the Waimea Valley Forest Stewardship plan revision at their meeting on February 28th, 2020 (Exhibit A). The Division is requesting Board approval of the revised Waimea Valley Forest Stewardship management plan for Fiscal Year 2021 through Fiscal Year 2025 through the authorized Forest Stewardship Program Agreement with Hi‘ipaka LLC. Per their Forest Stewardship Agreement, Board approval of the revised Waimea Valley Forest Stewardship plan is required, given that changes are being made to the implementation schedule and corresponding annual budget.

CHAPTER 343 – ENVIRONMENTAL ASSESSMENT

The Board approved a Declaration of Exemption for the Waimea Valley Forest Stewardship plan at its meeting on September 11th, 2015, under agenda item C-1 and this Exemption is still valid, as the overall project goals, deliverables and total budget remain the same.

RECOMMENDATIONS:

That the Board:

1. Approve the revised Waimea Valley Forest Stewardship management plan;

2. Authorize the Chairperson to amend, finalize, and execute an amendment to the Forest Stewardship Agreement with Hi‘ipaka LLC to participate in the State Forest Stewardship Program subject to the following:

    A. Availability of State Forest Stewardship funds; and
    B. Review and approval as to form of the Forest Stewardship Agreement amendment by the Department of the Attorney General.

Respectfully submitted,

DGS

DAVID G. SMITH, Administrator
Division of Forestry and Wildlife

APPROVED FOR SUBMITTAL:

Suzanne D. Case

SUZANNE D. CASE, Chairperson
Board of Land and Natural Resources

Attachments: Exhibit A and B

Exhibit A

WAIMEA VALLEY

HI'IPAKA LLC

FACILITATING NATIVE FOREST REGENERATION

Waimea Valley Forest Stewardship Plan

Proposed Revision Years Six through Ten

Conservation Manager: Chad Durkin

59864 Kamehameha Hwy

Haleiwa, Hi 96712

808 638-5877

cdurkin@waimeavalley.net

Table of Contents

1. APPLICANT AND PROPERTY INFORMATION 3

1.1. Applicant 3

2. FSP SIGNATURE PAGE 4

2.1. Applicant Certification: 4

2.2. State Forester's Approval: 4

2.3. Forest Stewardship Advisory Committee 4

3. Executive Summary 5

4. Introduction 7

4.1. Project background and objectives 7

5. Management Prescriptions 7

6. Budget and Schedule 7

6.1. Mauka forest restoration 7

6.2. Kalahe‘e reforestation area 7

6.2.1. Budget 8

6.2.2. Schedule 12

6.3. Wetland, lama forest, *Eugenia* conservation 14

6.3.1. Budget 15

6.3.2. Schedule 18

6.4. Property-wide management 19

Appendix A. Site Maps 20

1. APPLICANT AND PROPERTY INFORMATION

1.1. Applicant

Landowner Name:	Waimea Valley
Address:	Hi‘ipaka LLC
	59-864 Kamehameha Highway
	Hale‘iwa, HI 96712
Landowner Contact:	Chad Durkin
Address:	59-864 Kamehameha Highway

	Haleʻiwa, HI 96712
Email:	cdurkin@waimeavalley.net
Phone | Fax:	+1 (808) 277-4559 | +1 (808) 638-5877
TMK number:	(6)-1-002-002
State and County Zoning:	Conservation (General, Limited)
Total property acreage:	1,875 acres
Proposed stewardship area:	101.5 acres
Elevational range:	7 ft – 1080 ft ASL
Slope:	0% - 80%
Streams, gulches:	Kamananui Stream (South)
	Kaʻiwikoʻele Stream (South)
	ʻElehāhā Stream (North)

2. FSP SIGNATURE PAGE

2.1. Applicant Certification:

I have reviewed this Forest Stewardship Plan revision and hereby certify that I concur with the recommendations contained within. I agree that resource management activities implemented on the lands described shall be done so in a manner consistent with the practices recommended herein.

Prepared for: Waimea Valley

Applicant: Richard Pezzulo, Executive Director

Applicant's Signature/Date:_____

Applicant's Name: Waimea Valley

2.2. State Forester's Approval:

This plan revision meets the criteria established for Forest Stewardship Plans by Hawaii's Forest Stewardship Advisory Committee. The practices recommended in the plan are eligible for funding according to state of Hawai'i Forest Stewardship Program guidelines and administrative rules.

Approved by:_____

State Forester's Signature/ Date:_____

State Forester's Name:_____

2.3. Forest Stewardship Advisory Committee

Approved by:_____

Committee Signature/Date:_____

Printed Name:_____

3. Executive Summary

Waimea Valley proposes a revision to the forest management plan (FMP 2014) with the objective of scheduling priority activities to align with the resource availability. The Waimea Valley property encompasses 1,875 acres, more than 100 of which would be intensively managed during implementation of the present FMP. The project will pursue the main objective of promoting recovery of native Hawaiian plant and animal communities in five locations across the parcel.

i. Mauka restoration site: A 16.5-acre fenced exclosure containing a relatively intact native plant community and a manageable invasive weed problem.

   Proposed revision: none.

ii. Kalahe'e reforestation area: A 67-acre unfenced, ridge-top area where native plant species have been largely displaced by aggressive invasive trees and grasses.

   Proposed revision: 1. Combine fencing of unit K2 in year 6 and fence for K3 from year 10 to be constructed in year 6 to facilitate management and reforestation in these units.

   2. Move K5 fencing of Kalahe'e ridge to year 7 from year 10 to protect Ohia population.

   3. Postpone K4 fencing of Kalahe'e ridge to year 8 from year 6 due to resource availability.

iii. Lama forest: A 1-acre unfenced area with a predominantly *Diospyros sandwicensis* (lama) canopy.

   Proposed revision: Postpone fencing of the Lama forest to year 10 from year 6 due to resource availability.

iv. *Eugenia* conservation area: A 1.5-acre unfenced area in which the endangered plant species *Eugenia koolauensis* has been identified.

   Proposed revision: Postpone fencing of the Eugenia plot to year 9 from year 6 due to resource availability.

v. Wetland and Streamside Management Zones (SMZ): A nearly 50-acre block containing 10 acres of SMZ and 5 additional acres of heavily invaded forest; influences habitat quality for endangered waterfowl species.

   Proposed Revision: None

Forest management activities takes place concurrently at each of these five focal areas, with continuous work and monitoring throughout the ten year period defined in this plan. At the mauka restoration site, invasive tree extermination and native species planting was not completed in the first five years, maintenance and monitoring of the site is ongoing. At the Kalahe'e area, fencing and planting will occur throughout the project period, resulting in more than 67 acres of restored native mesic forest in which biodiversity can subsequently recover. The lama forest exclosure will be managed as a seed source for expanding *Diospyros*

populations throughout the valley. Intensive management of the *Eugenia* area is intended to preserve the endangered plant species *Eugenia koolauensis*; wetland SMZ management will improve habitat quality for the endangered Hawaiian moorhen (*Gallinula chloropus sandvicensis*) and other waterfowl. **In summary, the fundamental vision contained in this plan is a large-scale restoration of key plant and animal communities in a locally threatened and globally rare ecosystem.**

4. Introduction

4.1. Project background and objectives

The principal objective for this forest management plan is to conserve mesic native forest and riparian areas in Waimea Valley. The proposed revisions to the approved Forest Stewardship Program (FSP) management plan is for the budget and schedule of the conservation of Waimea Valley mesic forest areas. Management approaches are unchanged. Riparian areas an property wide management plans have no changes requested.

All prescribed forest management activities constitute native forest restoration, with no provisions for commercial forestry or land use. **Given no intention for tree harvesting or profit generation from restored areas, this plan features no financial analysis. The landowner, a non-profit company, intends to pursue cost-shared funding from FSP, reimbursement funding from relevant federal programs (e.g. EQIP), as well as grant funding from private and public sources yet to be identified**.

4.2 sections 1-5 No change

4.3 sections 1-3 No change

5. Management Prescriptions No change

6. Budget and Schedules

Specific budget revisons and schedules of operation are presented separately for the Kalahe'e reforestation area, lama forest, *Eugenia* conservation area. There are no changes to the Mauka restoration and wetland SMZ budget and schedule plan. Detailed budgets are presented for each of the five years remaining in the project, and a summary budgets for the entire project duration is included. Schedules are presented on an annual basis, and R_x are implemented in the years in which corresponding cells are shaded dark green.
Property-wide management activities are funded by FSP (Table 8), no changes are requested for the amounts required for ungulate control, access maintenance, incipient weed monitoring, and fuel break maintenance.

6.1 Mauka forest restoration No change

6.2 Kalahe'e reforestation area

Fencing, site preparation (brush management), and planting activities (seedlings, critical area planting, competition control) for K-2 and K-3 management units will be combined. Fencing of unit K2 originally scheduled in year 6 and fence for K3 scheduled in year 10 will be constructed in year 6 to facilitate management and reforestation in these units. Fencing in the K5 management unit of Kalahe'e ridge will be rescheduled to year 7 from year 10 to protect Ohia trees in the management unit. Fields K4 and K5 are positioned such that separate fences make sense for each field.

Fencing of the K4 management unit on Kalahe'e ridge will be postponed to year 8 from year 6 due to resource availability. The protection of trees communities currently established and the need to create protected areas to continue out planting of native species for reforestation are balanced in this revision request.

6.2.1 Proposed revision to management activities at Kalahe'e ridge.

Kalahe'e			Field	K1	K2	K3	K4	K5
Year 6 (2020)			**Month**	14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence construction	382	$7.00	2	$ -	$ 24,224	$ 16,016	$ -	$ -
Fence maintenance	382	$0.25	2	$ -	$ -	$ -	$ -	$ -
Access control	472	$100	2	$ 200	$ 200	$ 100	$ -	$ -
Brush suppression (chem)	314	$150	2	$ -	$ 300	$ 300	$ -	$ -
Brush management (chem)	314	$825	3	$ -	$ 1,650	$ 825	$ -	$ -
Competition control	315	$220	3	$ 440	$ -	$ 220	$ -	$ -
Rare habitat monitoring	643	$65	8	$ -	$ 130	$ 65	$ -	$ -
Brush management (manu)	314	$550	8	$ -	$ 1,100	$ 550	$ -	$ -
Woody residue treatment	384	$250	10	$ -	$ 500	$ 250	$ -	$ -
Competition control	315	$220	11	$ 440	$ 440	$ 220	$ -	$ -
Seedlings	342	$5.35	12	$ -	$ 2,140	$ 1,070	$ -	$ -
Critical area planting	342	$275	12	$ -	$ 550	$ 275	$ -	$ -
Year subtotal:	---	---	---	$ 1,080	$ 31,234	$ 19,891	$ -	$ -
NRCS%	---	---	---	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 540	$ 15,617	$ 9,946	$ -	$ -
FSP Share:	---	---	---	$ 540	$ 15,617	$ 9,946	$ -	$ -
Year 6 Applicant total:	**$ 26,102.50**			**Year 6 FSP Total:**			**$ 26,102.50**	

Kalahe'e			Field	K1	K2	K3	K4	K5
Year 7 (2021)			**Month**	14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence construction	382	$7.00	2	$ -	$ -	$ -	$ -	$ 26,879
Fence maintenance	382	$0.25	2	$ 572	$ 865	$ 594	$ -	$ 100
Access control	472	$100	2	$ 200	$ 200	$ 100	$ -	$ 300
Brush suppression (chem)	314	$150	2	$ -	$ -	$ -	$ -	$ 825
Brush management (chem)	314	$825	3	$ -	$ 1,650	$ 825	$ -	$ 220
Competition control	315	$220	3	$ 440	$ 440	$ 220	$ -	$ 65
Rare habitat monitoring	643	$65	8	$ -	$ 130	$ 65	$ -	$ 550
Brush management (manu)	314	$550	8	$ -	$ 1,100	$ 550	$ -	$ 250
Woody residue treatment	384	$250	10	$ -	$ 500	$ 250	$ -	$ 220
Competition control	315	$220	11	$ 440	$ 440	$ 220	$ -	$ 1,070
Seedlings	342	$5.35	12	$ -	$ 2,140	$ 1,070	$ -	$ 275
Critical area planting	342	$275	12	$ -	$ 550	$ 275	$ -	$ -
Year subtotal:	---	---	---	$ 1,652	$ 8,015	$ 4,169	$ -	$ 30,754
NRCS%	---	---	---	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 826	$ 4,008	$ 2,085	$ -	$ 15,377
FSP Share:	---	---	---	$ 826	$ 4,008	$ 2,085	$ -	$ 15,377
Year 7 Applicant total:	**$ 22,294.84**			**Year 7 FSP Total:**			**$ 22,294.84**	

Kalahe'e			Field	K1	K2	K3	K4	K5
Year 8 (2022)			**Month**	14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence construction	382	$7.00	2	$ -	$ -	$ -	$ 66,542	$ -
Fence maintenance	382	$0.25	2	$ -	$ -	$ -	$ -	$ -
Access control	472	$100	2	$ 200	$ -	$ -	$ -	$ -
Brush suppression (chem)	314	$150	2	$ -	$ -	$ -	$ -	$ -
Brush management (chem)	314	$825	3	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	3	$ 440	$ -	$ -	$ -	$ -
Rare habitat monitoring	643	$65	8	$ 130	$ -	$ -	$ -	$ -
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ -	$ -
Woody residue treatment	384	$250	10	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	11	$ 440	$ -	$ -	$ -	$ -
Seedlings	342	$5.35	12	$ -	$ -	$ -	$ -	$ -
Critical area planting	342	$275	12	$ -	$ -	$ -	$ -	$ -
Year subtotal:	---	---	---	$ 1,210	$ -	$ -	$ 66,542	$ -
NRCS%	---	---	---	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 605	$ -	$ -	$ 33,271	$ -
FSP Share:	---	---	---	$ 605	$ -	$ -	$ 33,271	$ -
Year 8 Applicant total:	**$ 33,876.00**			**Year 8 FSP Total:**			**$ 33,876.00**	

Kalahe'e			Field	K1	K2	K3	K4	K5
Year 9 (2023)			**Month**	14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence maintenance	382	$0.25	2	$ 572	$ 865	$ 865	$ 594	$ 594
Access control	472	$100	2	$ 200	$ 200	$ 200	$ 100	$ -
Brush suppression (chem)	314	$150	2	$ 300	$ -	$ 300	$ -	$ -
Brush management (chem)	314	$825	3	$ -	$ 1,650	$ 1,650	$ 825	$ -
Competition control	315	$220	3	$ -	$ 440	$ 440	$ 220	$ -
Rare habitat monitoring	643	$65	8	$ 130	$ 130	$ 130	$ 65	$ -
Brush management (manu)	314	$550	8	$ -	$ 1,100	$ 1,100	$ 550	$ -
Woody residue treatment	384	$250	10	$ -	$ 500	$ 500	$ 250	$ -
Competition control	315	$220	11	$ -	$ 440	$ 440	$ 220	$ -
Seedlings	342	$5.35	12	$ -	$ 2,140	$ 2,140	$ 1,070	$ -
Critical area planting	342	$275	12	$ -	$ 550	$ 550	$ 275	$ -
Year subtotal:	---	---	---	$ 1,202	$ 8,015	$ 8,315	$ 4,169	$ 594
NRCS%	---	---	---	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 601	$ 4,008	$ 4,158	$ 2,085	$ 297
FSP Share:	---	---	---	$ 601	$ 4,008	$ 4,158	$ 2,085	$ 297
Year 9 Applicant total:	**$ 11,147.41**			**Year 9 FSP Total:**			**$ 11,147.41**	

Kalahe'e			Field	K1	K2	K3	K4	K5
Year 10 (2024)			**Month**	14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence maintenance	382	$0.25	2	$ -	$ 865	$ -	$ 594	$ -
Access control	472	$100	2	$ 200	$ 200	$ 200	$ 100	$ 200
Brush suppression (chem)	314	$150	2	$ -	$ 300	$ -	$ 300	$ -
Brush management (chem)	314	$825	3	$ -	$ 1,650	$ 1,650	$ 825	$ 1,650
Competition control	315	$220	3	$ -	$ 440	$ -	$ 220	$ 440
Rare habitat monitoring	643	$65	8	$ 130	$ 130	$ 130	$ 65	$ 130
Brush management (manu)	314	$550	8	$ -	$ 1,100	$ 1,100	$ 550	$ 1,100
Woody residue treatment	384	$250	10	$ -	$ 500	$ 500	$ 250	$ 500
Competition control	315	$220	11	$ -	$ 440	$ 440	$ 220	$ 440
Seedlings	342	$5.35	12	$ -	$ 2,140	$ 2,140	$ 1,070	$ 2,140
Critical area planting	342	$275	12	$ -	$ 550	$ 550	$ 275	$ 550
Year subtotal:	---	---	---	$ 330	$ 8,315	$ 6,710	$ 4,469	$ 7,150
NRCS%	---	---	---	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 165	$ 4,158	$ 3,355	$ 2,235	$ 3,575
FSP Share:	---	---	---	$ 165	$ 4,158	$ 3,355	$ 2,235	$ 3,575
Year 10 Applicant total:	**$ 13,487.06**			**Year 10 FSP Total:**			**$ 13,487.06**	

6.2.2. Proposed schedule revision for Kalahe'e management activities

Kalahe'e Year 6 (2020)								
Activity	**NRCS code**	**Year**	**Start month**	**Field**				
				K1	**K2**	**K3**	**K4**	**K5**
				14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence construction	382	2020	2					
Fence maintenance	382	2020	2					
Access control	472	2020	2					
Brush suppression (chem)	314	2020	2					
Brush management (chem)	314	2020	3					
Competition control	315	2020	3					
Rare habitat monitoring	643	2020	8					
Brush management (manu)	314	2020	8					
Woody residue treatment	384	2020	10					
Competition control	315	2020	11					
Seedlings	342	2020	12					
Critical area planting	342	2020	12					

Kalahe'e Year 7 (2021)								
Activity	**NRCS code**	**Year**	**Start month**	**Field**				
				K1	**K2**	**K3**	**K4**	**K5**
				14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence construction	382	2021	2					
Fence maintenance	382	2021	2					
Access control	472	2021	2					
Brush suppression (chem)	314	2021	2					
Brush management (chem)	314	2021	3					
Competition control	315	2021	3					
Rare habitat monitoring	643	2021	8					
Brush management (manu)	314	2021	8					
Woody residue treatment	384	2021	10					
Competition control	315	2021	11					
Seedlings	342	2021	12					
Critical area planting	342	2021	12					

Kalahe'e Year 8 (2022)								
Activity	**NRCS code**	**Year**	**Start month**	**Field**				
				K1	**K2**	**K3**	**K4**	**K5**
				14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence construction	382	2022	2					
Fence maintenance	382	2022						
Access control	472	2022	2					
Brush suppression (chem)	314	2022	2					
Brush management (chem)	314	2022	3					
Competition control	315	2022	3					
Rare habitat monitoring	643	2022	8					
Brush management (manu)	314	2022	8					
Woody residue treatment	384	2022	10					
Competition control	315	2022	11					
Seedlings	342	2022	12					
Critical area planting	342	2022	12					

Kalahe'e Year 9 (2023)								
Activity	**NRCS code**	**Year**	**Start month**	**Field**				
				K1	**K2**	**K3**	**K4**	**K5**
				14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence maintenance	382	2023	2					
Access control	472	2023	2					
Brush suppression (chem)	314	2023	2					
Brush management (chem)	314	2023	3					
Competition control	315	2023	3					
Rare habitat monitoring	643	2023	8					
Brush management (manu)	314	2023	8					
Woody residue treatment	384	2023	10					
Competition control	315	2023	11					
Seedlings	342	2023	12					
Critical area planting	342	2023	12					

Kalahe'e Year 10 (2024)								
Activity	**NRCS code**	**Year**	**Start month**	**Field**				
				K1	**K2**	**K3**	**K4**	**K5**
				14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Fence maintenance	382	2024	2					
Access control	472	2024	2					
Brush suppression (chem)	314	2024	2					
Brush management (chem)	314	2024	3					
Competition control	315	2024	3					
Rare habitat monitoring	643	2024	8					
Brush management (manu)	314	2024	8					
Woody residue treatment	384	2024	10					
Competition control	315	2024	11					
Seedlings	342	2024	12					
Critical area planting	342	2024	12					

6.3. Wetland, lama forest, *Eugenia* conservation

Fencing to surround the *Eugenia* restoration and the lama forest will be postponed. Postpone fencing of the Eugenia plot to year 9 from year 6 due to resource availability. Postpone fencing of the Lama forest to year 10 from year 6 due to resource availability

6.3.1. Proposed revision to management activities Wetland, lama forest, Eugenia conservation budget.

Year 6 (2020)						
Activity	**NRCS code**	**Cost unit^{-1}**	**Field**	**E1**	**L1**	**W1**
			Area	1.4 ac	1 ac	43.2 ac
			Annual	1.4 ac	1 ac	1 ac
Fence maintenance	382	$0.13		$ -	$ -	$ -
Access control	472	$100		$ -	$ 100	$ 100
Integrated pest mgmt.	595	$250		$ -	$ 249	$ 250
Brush management (chem)	314	$650		$ -	$ -	$ 1,625
Competition control	315	$220		$ -	$ -	$ 220
Rare habitat monitoring	643	$65		$ 94	$ 65	$ -
Competition control 2	315	$110		$ -	$ -	$ 110
Seedlings	342	$5.35		$ -	$ -	$ 1,873
SMZ improvement	395	$1,400		$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 94	$ 414	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 47	$ 207	$ 2,789
FSP Share:	---	---	---	$ 47	$ 207	$ 2,789
Year 6 Applicant total:	**$**	**3,042.48**		**Year 6 FSP Total:**		**$ 3,042.48**

Year 7 (2021)						
Activity	**NRCS code**	**Cost unit^{-1}**	**Field**	**E1**	**L1**	**W1**
			Area	1.4 ac	1 ac	43.2 ac
			Annual	1.4 ac	1 ac	1 ac
Fence maintenance	382	$0.13		$ -	$ -	$ -
Access control	472	$100		$ -	$ 100	$ 100
Integrated pest mgmt.	595	$250		$ -	$ 249	$ 250
Brush management (chem)	314	$650		$ -	$ -	$ 1,625
Competition control	315	$220		$ -	$ -	$ 220
Rare habitat monitoring	643	$65		$ 94	$ -	$ -
Competition control 2	315	$110		$ -	$ -	$ 110
Seedlings	342	$5.35		$ -	$ -	$ 1,873
SMZ improvement	395	$1,400		$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 94	$ 349	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 47	$ 174	$ 2,789
FSP Share:	---	---	---	$ 47	$ 174	$ 2,789
Year 7 Applicant total:	**$**	**3,010.16**		**Year 7 FSP Total:**		**$ 3,010.16**

Year 8 (2022)						
Activity	NRCS code	Cost unit^{-1}	Field	E1	L1	W1
			Area	1.4 ac	1 ac	43.2 ac
			Annual	1.4 ac	1 ac	1 ac
Fence maintenance	382	$0.13		$ -	$ -	$ -
Access control	472	$100		$ -	$ 100	$ 100
Integrated pest mgmt.	595	$250		$ -	$ 249	$ 250
Brush management (chem)	314	$650		$ -	$ -	$ 1,625
Competition control	315	$220		$ -	$ -	$ 220
Rare habitat monitoring	643	$65		$ 94	$ 65	$ -
Competition control 2	315	$110		$ -	$ -	$ 110
Seedlings	342	$5.35		$ -	$ -	$ 1,873
SMZ improvement	395	$1,400		$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 94	$ 414	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 47	$ 207	$ 2,789
FSP Share:	---	---	---	$ 47	$ 207	$ 2,789
Year 8 Applicant total:	**$**	**3,042.66**			**Year 8 FSP Total:**	**$ 3,042.66**

Year 9 (2023)						
Activity	NRCS code	Cost unit^{-1}	Field	E1	L1	W1
			Area	1.4 ac	1 ac	43.2 ac
			Annual	1.4 ac	1 ac	1 ac
Fence construction	382	$7.00		$ -	$ 5,824	$ -
Fence maintenance	382	$0.13		$ -	$ -	$ -
Access control	472	$100		$ -	$ 100	$ 100
Integrated pest mgmt.	595	$250		$ -	$ 249	$ 250
Brush management (chem)	314	$650		$ -	$ 324	$ 1,625
Competition control	315	$220		$ -	$ -	$ 220
Rare habitat monitoring	643	$65		$ 94	$ -	$ -
Competition control 2	315	$110		$ -	$ -	$ 110
Seedlings	342	$5.35		$ -	$ -	$ 1,873
SMZ improvement	395	$1,400		$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 94	$ 6,497	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 47	$ 3,248	$ 2,789
FSP Share:	---	---	---	$ 47	$ 3,248	$ 2,789
Year 9 Applicant total:	**$**	**6,084.16**			**Year 9 FSP Total:**	**$ 6,084.16**

Year 10 (2024)						
Activity	**NRCS code**	**Cost unit^{-1}**	**Field**	**E1**	**L1**	**W1**
			Area	1.4 ac	1 ac	43.2 ac
			Annual	1.4 ac	1 ac	1 ac
Fence construction	382	$7.00		$ 8,364	$ -	$ -
Fence maintenance	382	$0.13		$ -	$ 108	$ -
Access control	472	$100		$ 144	$ 100	$ 100
Integrated pest mgmt.	595	$250		$ 360	$ 249	$ 250
Brush management (chem)	314	$650		$ 925	$ -	$ 1,625
Competition control	315	$220		$ 308	$ -	$ 220
Rare habitat monitoring	643	$65		$ 91	$ 65	$ -
Competition control 2	315	$110		$ 154	$ -	$ 110
Seedlings	342	$5.35		$ 1,498	$ -	$ 1,873
SMZ improvement	395	$1,400		$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 11,844	$ 522	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 5,922	$ 261	$ 2,789
FSP Share:	---	---	---	$ 5,922	$ 261	$ 2,789
Year 10 Applicant total:	**$**	**8,971.86**		**Year 10 FSP Total:**		**$ 8,971.86**

6.3.2. Proposed revision to management schedules wetland, lama forest, *Eugenia* FMU.

Year 6 (2020)						
Activity	**NRCS code**	**Year**	**Start month**	**Field**		
				E1	**L1**	**W1**
				1.4 ac	1 ac	43.2 ac
Fence maintenance	382	2020	2			
Access control	472	2020	2			
Integrated pest mgmt.	595	2020	6			
Brush management (chem)	314	2020	3			
Competition control	315	2020	3			
Rare habitat monitoring	643	2020	8			
Competition control 2	315	2020	9			
Seedlings	342	2020	11			
SMZ improvement	395	2020	11			
Year 7 (2021)						
Activity	**NRCS code**	**Year**	**Start month**	**Field**		
				E1	**L1**	**W1**
				1.4 ac	1 ac	43.2 ac
Fence maintenance	382	2021	2			
Access control	472	2021	2			
Integrated pest mgmt.	595	2021	6			
Brush management (chem)	314	2021	3			
Competition control	315	2021	3			
Rare habitat monitoring	643	2021	8			
Competition control 2	315	2021	9			
Seedlings	342	2021	11			
SMZ improvement	395	2021	11			

Year 8 (2022)						
Activity	**NRCS code**	**Year**	**Start month**	**Field**		
				E1	**L1**	**W1**
				1.4 ac	1 ac	43.2 ac
Fence maintenance	382	2022	2			
Access control	472	2022	2			
Integrated pest mgmt.	595	2022	6			
Brush management (chem)	314	2022	3			
Competition control	315	2022	3			
Rare habitat monitoring	643	2022	8			
Competition control 2	315	2022	9			
Seedlings	342	2022	11			
SMZ improvement	395	2022	11			

Year 9 (2023)						
Activity	NRCS code	Year	Start month	Field		
				E1	L1	W1
				1.4 ac	1 ac	43.2 ac
Fence construction	382	2023	2			
Fence maintenance	382	2023	2			
Access control	472	2023	2			
Integrated pest mgmt.	595	2023	6			
Brush management (chem)	314	2023	3			
Competition control	315	2023	3			
Rare habitat monitoring	643	2023	8			
Competition control 2	315	2023	9			
Seedlings	342	2023	11			
SMZ improvement	395	2023	11			

Year 10 (2024)						
Activity	NRCS code	Year	Start month	Field		
				E1	L1	W1
				1.4 ac	1 ac	43.2 ac
Fence construction	382	2024	2			
Fence maintenance	382	2024	2			
Access control	472	2024	2			
Integrated pest mgmt.	595	2024	6			
Brush management (chem)	314	2024	3			
Competition control	315	2024	3			
Rare habitat monitoring	643	2024	8			
Competition control 2	315	2024	9			
Seedlings	342	2024	11			
SMZ improvement	395	2024	11			

6.4 Property-wide management **No change**

6.5. Management activities that will **No change**

Exhibit B

FACILITATING NATIVE FOREST REGENERATION

Waimea Valley Forest Stewardship Plan

***Acacia koa* at the Kalahe'e reforestation area, Waimea Valley, O'ahu**. *Image: T. Baribault.*

PO Box 2037
Kamuela, HI 96743
Tel +1 808 776 9900
Fax +1 808 776 9901

Responsible Forester:

Tom Baribault, Ph.D.
tom@hawaiiforest.com
+1 808 960 1041 (mobile)

Forest Solutions Inc.

Table of Contents

1. APPLICANT AND PROPERTY INFORMATION 4

1.1. Applicant 4

1.2. Consultant 4

2. FSP SIGNATURE PAGE 5

2.1. Professional Resource Consultant Certification: 5

2.2. Applicant Certification: 5

2.3. State Forester's Approval: 5

2.4. Forest Stewardship Advisory Committee 5

3. Executive Summary 6

4. Introduction 7

4.1. Project background and objectives 7

4.2. Site description 8

4.2.1. Parcel and location 8

4.2.2. Plant ecosystem types 8

4.2.3. Soils and rainfall 13

4.2.4. Threatened and endangered species 14

4.2.5. Threat assessments 15

4.3. Institutional capabilities 16

4.3.1. Staffing and volunteer labor 16

4.3.2. Equipment 16

4.3.3. Nursery, greenhouse, and botanical garden 16

5. Management Prescriptions 18

5.1. Forest management units 18

5.2. Access control 23

5.2.1. Fencing 23

5.2.2. Roads 23

5.3. Invasive tree removal 24

5.3.1. Brush management: chemical and manual 24

5.3.2. Brush maintenance: chemical 25

5.4. Restoration plantings 25

5.4.1. Species selection 25
5.4.2. Site preparation and planting 27
5.4.3. Out-planting maintenance 29
5.5. Streamside management zones 29
5.6. Objectives for the entire parcel 30
5.6.1. Incipient invasive weed monitoring 31
5.6.2. Integrated pest management 31
5.7. Ecological monitoring 32
5.7.1. Vegetation monitoring 32
5.7.2. Zoological monitoring 32
5.8. Property-wide management 33
5.8.1. Incipient weed control 33
5.8.2. Feral ungulate control 33
5.8.3. Fire management 34
5.8.4. Access maintenance 34
6. Budget and Schedule 35
6.1. Mauka forest restoration 36
6.1.1. Budget 36
6.1.2. Schedule 41
6.2. Kalahe‘e reforestation area 45
6.2.1. Budget 45
6.2.2. Schedule 51
6.3. Wetland, lama forest, *Eugenia* conservation 55
6.3.1. Budget 55
6.3.2. Schedule 60
6.4. Property-wide management 63
7. References 64
8. Maps 65

1. APPLICANT AND PROPERTY INFORMATION

1.1. Applicant

Landowner Name:	Waimea Valley
Address:	Hiʻipaka LLC
	59-864 Kamehameha Highway
	Haleʻiwa, HI 96712
Landowner Contact:	Laurent Pool
Address:	59-864 Kamehameha Highway
	Haleʻiwa, HI 96712
Email:	lpool@waimeavalley.net
Phone | Fax:	+1 (808) 277-4559 | +1 (808) 638-7776
TMK number:	(6)-1-002-002
State and County Zoning:	Conservation (General, Limited)
Total property acreage:	1,875 acres
Proposed stewardship area:	101.5 acres
Elevational range:	7 ft – 1080 ft ASL
Slope:	0% - 80%
Streams, gulches:	Kamananui Stream (South)
	Kaʻiwikoʻele Stream (South)
	ʻElehāhā Stream (North)

1.2. Consultant

Company:	Forest Solutions, Inc.
Name:	Thomas Baribault, Ph.D.
Title:	Research Forester
Address:	P.O. Box 2037
	Kamuela, HI 96743
Email:	tom@hawaiiforest.com
Phone | Fax:	+1 (808) 776-9900 x238 | +1 (808) 776-9901

2. FSP SIGNATURE PAGE

2.1. Professional Resource Consultant Certification:

I have prepared (or revised) this Forest Stewardship Plan. Resource professionals have been consulted and/or provided input as appropriate during the preparation of this plan.

Prepared by: Forest Solutions, Inc.

Professional Resource Consultant's Signature/Date: Tom W Baribault 4/18/2014

Professional Resource Consultant's Name: Thomas Baribault

2.2. Applicant Certification:

I have reviewed this Forest Stewardship Plan and hereby certify that I concur with the recommendations contained within. I agree that resource management activities implemented on the lands described shall be done so in a manner consistent with the practices recommended herein.

Prepared for: Waimea Valley

Applicant: Richard Pezzulo, Executive Director

Applicant's Signature/Date: 4/18/14

Applicant's Name: Waimea Valley

2.3. State Forester's Approval:

This plan meets the criteria established for Forest Stewardship Plans by Hawaii's Forest Stewardship Advisory Committee. The practices recommended in the plan are eligible for funding according to state of Hawai'i Forest Stewardship Program guidelines and administrative rules.

Approved by: Division of Forestry and Wildlife Administrator

State Forester's Signature/ Date: Randy Kennedy 2/20/15

State Forester's Name: Lisa J. Hadway

2.4. Forest Stewardship Advisory Committee

Approved by: Cooperative Resource Management Forester

Committee Signature/Date:

Printed Name: M. Irene Sprecher

Approved by Forest Stewardship Advisory Committee on 5/2/14.

3. Executive Summary

Waimea Valley proposes a forest management plan (FMP) with the objective of conserving and rehabilitating rare communities in the Koʻolau Watershed, Northwest Oʻahu. The Waimea Valley property encompasses 1,875 acres, more than 100 of which would be intensively managed during implementation of the present FMP. The project will pursue the main objective of promoting recovery of native Hawaiian plant and animal communities in five locations across the parcel.

i. Mauka restoration site: A 16.5-acre fenced exclosure containing a relatively intact native plant community and a manageable invasive weed problem.

   Intended outcome: exterminating non-native plant species and restoring the community with a suite of endemic plant species.

ii. Kalaheʻe reforestation area: A 67-acre unfenced, ridge-top area where native plant species have been largely displaced by aggressive invasive trees and grasses.

   Intended outcome: Reversing the infestation of non-native plants by fencing to exclude seed-dispersing feral pigs and completing large-scale out-plantings of robust native tree and shrub species.

iii. Lama forest: A 1-acre unfenced area with a predominantly *Diospyros sandwicensis* (lama) canopy.

   Intended outcome: Promote lama growth and regeneration by fencing the area to exclude seed-dispersing ungulates and exterminating invasive plant species.

iv. *Eugenia* conservation area: A 1.5-acre unfenced area in which the endangered plant species *Eugenia koolauensis* has been identified.

   Intended outcome: Eliminate invasive trees and recover a viable, protected *E. koolauensis* population.

v. Wetland and Streamside Management Zones (SMZ): A nearly 50-acre block containing 10 acres of SMZ and 5 additional acres of heavily invaded forest; influences habitat quality for endangered waterfowl species.

   Intended outcome: Stabilize stream banks with native tree and groundcover species to improve native biodiversity and prevent further sedimentation in critical waterfowl habitat downstream.

Forest management activities would take place concurrently at each of these five focal areas, with continuous work and monitoring throughout the ten year period defined in this plan. At the mauka restoration site, invasive tree extermination and native species planting would be completed in the first five years, followed by maintenance and monitoring of the restored system. At the Kalaheʻe area, fencing and planting would occur throughout the project period, resulting in more than 67 acres of restored native mesic forest in which biodiversity can subsequently recover. The lama forest exclosure will be managed as a seed source for expanding *Diospyros* populations throughout the valley. Intensive management of the *Eugenia* area is intended to preserve the endangered plant species *Eugenia koolauensis*; wetland SMZ management will improve habitat quality for the endangered Hawaiian moorhen (*Gallinula chloropus sandvicensis*) and other waterfowl. **In summary, the fundamental vision contained in this plan is a large-scale restoration of key plant and animal communities in a locally threatened and globally rare ecosystem.**

4. Introduction

4.1. Project background and objectives

The principal objective for this forest management plan is to conserve mesic native forest and riparian areas in Waimea Valley. The present Forest Stewardship Program (FSP) management plan was developed along guidelines set forth in a Conservation Action Plan[1] (CAP) adopted by Waimea Valley in 2011. The CAP identified five conservation objectives for the whole property, (i) mesic forest conservation, (ii) endangered waterfowl habitat management, (iii) botanical gardens maintenance, (iv) protection of the Kamananui Stream ecosystem, and (v) maintenance of sacred cultural sites (Wahi Pana). Components of the current FSP plan will directly address CAP objectives (i) and (iv), with indirect effects on (ii) and (iii); objective (v), although consistent with the proposed work, is technically beyond the scope of this plan.

Conservation of Waimea Valley mesic forest areas must take into account the diversity of forest types present on the property. Forests range from intact native species composition within fenced areas through unfenced forests completely devoid of native plant species. Management approaches will focus on promoting growth and regeneration of target tree and understory species in areas protected by extant or new fences. Riparian areas are located along streams with strong variation in seasonal depth and a tendency to flash flood; riparian forest management recommendations will concentrate on accomplishing stream bank erosion control by planting native species.

Secondary effects of forest management will include conservation of waterfowl habitat and improvement of the Kamananui Stream aquatic ecosystem. Mauka reforestation and forest restoration will reduce downstream siltation, which simultaneously improves stream water quality and maintains open water of adequate depth for waterfowl habitat. In the broader context of the Koʻolau Mountains watershed, reduced erosion will positively influence marine ecosystems as well.

The remainder of this management plan will present detailed methods, schedules, and budgets for accomplishing forest conservation in five distinct areas within Waimea Valley. One section of the valley has already been fenced; ongoing activities in this Mauka Restoration Area will include invasive plant species eradication, native species planting, and integrated pest management. Other sections of the valley, including ridge-top areas (Kalaheʻe), steep slopes (lama forest), and endangered species habitat (*Eugenia* conservation area) will need to be fenced prior to beginning conservation work. Management in the riparian areas will consist of invasive plant control, erosion control, and planting appropriate native species to stabilize stream banks.

Implementing the prescriptions (aka R_x) in this management plan will require substantial funding. All prescribed forest management activities constitute native forest restoration, with no provisions for commercial forestry or land use. **Given no intention for tree harvesting or profit generation from restored areas, this plan features no financial analysis. The landowner, a non-profit company, intends to pursue cost-shared funding from FSP, reimbursement funding from relevant federal programs (e.g. EQIP), as well as grant funding from private and public sources yet to be identified**.

[1] Gon, S., Pool, L., Sumiye, J. 2011. Waimea Valley Conservation Action Plan. Hiʻipaka LLC.

4.2. Site description

4.2.1. Parcel and location

Waimea Valley is located immediately to the South of Pūpūkea, or 4.6 miles (7.4 km) North of Haleiwa, on O‘ahu’s Northwestern shore. The parcel is bounded to the South and North by ridge-tops, and encompasses a central ridge (Kalahe‘e) defined by two streams. The Kamananui and Ka‘iwiko‘ele Streams to the south include the Waimea Valley Waterfall, to which there is road access. To the North, the ‘Elehāhā Stream parallels the main 4x4 access into the mauka areas of Waimea Valley.

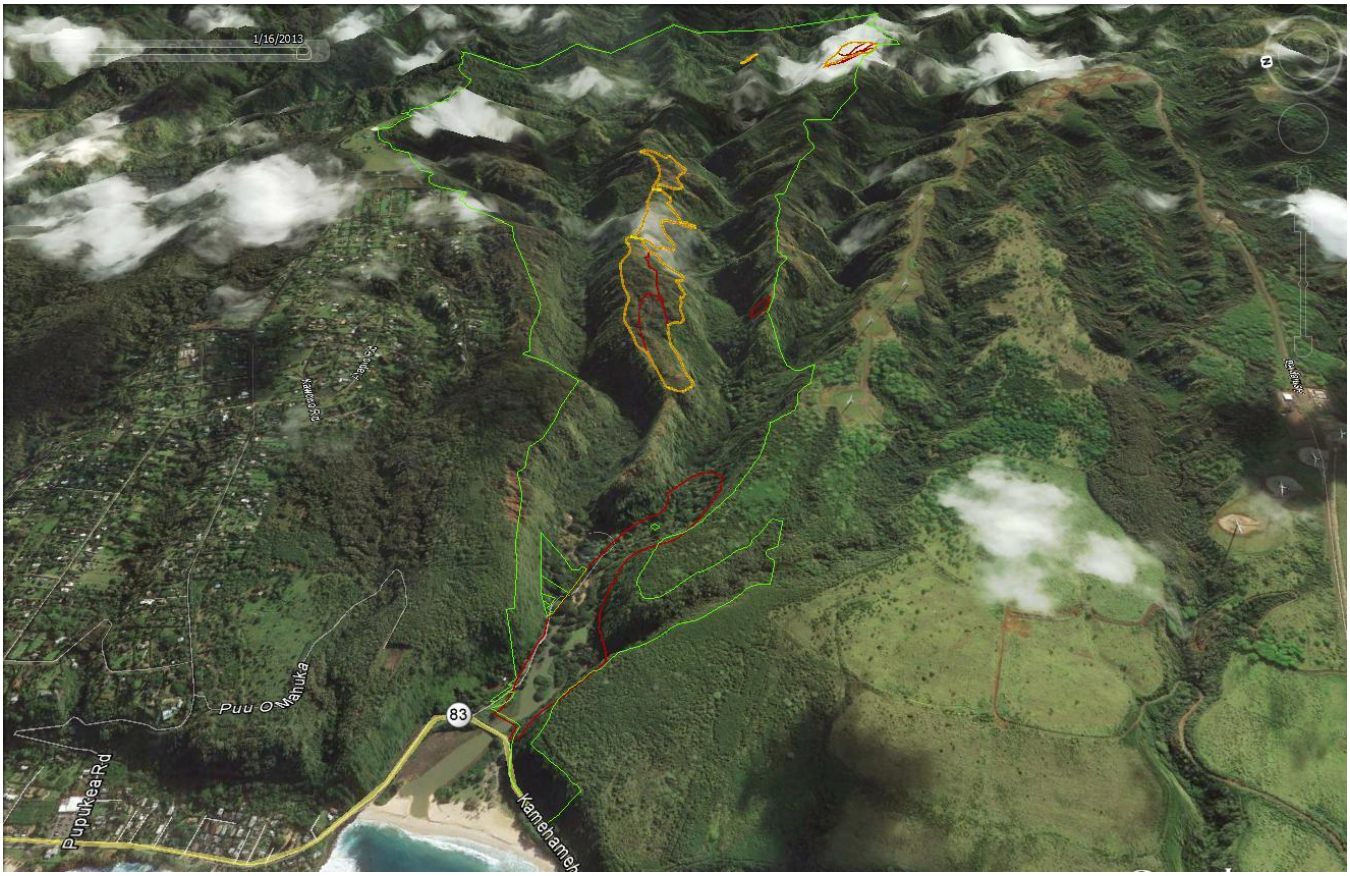


Figure 1. Perspective map of Waimea Valley, showing Pūpūkea to the North (left). The Kalahe‘e ridge is at the center of this image (orange fence outline), with Kamananui Stream to the right and ‘Elehāhā Stream to the left.

Prior to the middle of the 20th century, forests were removed by a combination of land uses, including grazing, logging, and agriculture. Although Waimea Valley has been a botanical preserve for decades, the consequences of deforestation have remained. Most of the vegetation cover consists of non-native trees and shrubs, and these weed species have radiated outward from their points of introduction to infest areas that were originally unaffected by agricultural land uses.

4.2.2. Plant ecosystem types

Within the Waimea Valley (WV) TMK are several forest types distinguished by elevation, slope, and species composition. Formulations of management R_x are determined in large part by the preexisting vegetation, so it will be useful to review the major forest type categories. Lowland areas toward the makai portions of the valley tend to be heavily invaded by alien tree and shrub species, some with extremely high weed risk

assessment values (Table 2, Table 3). Mauka and ridge-top areas are also infested with invasive plant species, but usually to a lesser degree. In some mauka areas, native species (Table 1) predominate, and these areas have been selected for restoration or reforestation. The streamside management zones (SMZ) in the wetland are almost entirely populated by non-native plants with the exception of some out-planted *Cyperus* (Table 3). Vegetation growth habits represented include tall and short trees, shrubs, vines, herbaceous types, ferns, and grasses and sedges (Table 1, Table 2, Table 3).

Table 1. Endemic and indigenous tree species are most abundant in mauka areas of Waimea Valley. This species list was derived from surveys completed by Waimea Valley as well as during site reconnaissance for this management plan.

Species name	Species	Abundance†	Origin	Flower	Fruit	Seed
koa	*Acacia koa*	5	Endemic			X
ahakea	*Bobea spp.*	2	Endemic			
lama	*Diospyros hillebrandii*	2	Endemic			
lama	*Diospyros sanwicensis*	3	Endemic			
kalia	*Elaeocarpus bifidus*	1	Endemic			
ni‘oi	*Eugenia koolauensis*	2	Endemic			
‘ōhi‘a	*Metrosideros polymorpha*	3	Endemic			
kolea	*Myrsine lessertiana*	1	Endemic			
olopua	*Nestegis sandwicensis*	3	Endemic			
holei	*Ochrosia compta*	2	Endemic	X	X	
ho‘awa	*Pittosporum confertiflorum*	4	Endemic		X	
halapepe	*Pleomele halapepe*	3	Endemic			
ala‘a	*Pouteria sandwicensis*	1	Endemic			
ala‘a	*Pouteria spathulata*	3	Endemic			
kopiko	*Psychotria mariniana*	3	Endemic			
hao	*Rauvolfia sandwicensis*	2	Endemic	X		
‘iliahi	*Santalum freycinetianum*	3	Endemic			
maua	*Xylosma spp.*	2	Endemic	X		
hala	*Pandanus tectorius*	3	Indigenous		X	
alahe‘e	*Psydrax odorata*	4	Indigenous			
kukui	*Aleurittes moluccana*	2	Polynesian		X	X
hau	*Hibiscus tilliacius*	3	Polynesian	X		

Source: Plant Survey for Waimea Valley Native Forest Restoration Project (7-20-12)[1]

† Abundance metrics: (5) abundant, (4) common, (3) occasional, (2) scarce, (1) 1x, 2x

[1] Surveyors: Lau, J., Tsuneyoshi, A., Rorher, J., Hoh, J., Orr, D., Pool, L., Belcher, R.

4.2.2.1. Mesic mid-elevation native forest

Relatively few areas of WV remain forested with a primarily native species assemblage; these areas are limited to mauka sections (§5.1) best characterized as mid-elevation mesic native forest. The USDA NRCS has not yet developed ecological site descriptions (ESD) for O‘ahu, but elements of several Hawai‘i Island

ESD[2] accurately describe Waimea Valley. Dominant native tree species at the highest elevations and on exposed ridge-tops include *Acacia koa* (koa), *Metrosideros polymorpha* (ʻōhiʻa), *Santalum freycinetianum* (ʻiliahi), and *Psydrax odorata* (alaheʻe). All of the preceding species are also present in forests growing on slopes below the ridge crests. These more protected areas also support many other native trees, including *Diospyros sandwicensis* and *hillebrandii* (lama), *Pleomele halapepe* (halapepe), *Myrsine lessertiana* (kolea), and *Pittosporum confertiflorum* (hoʻawa), among many others (Table 1).

Table 2. Many alien tree species have invaded Waimea Valley, including several with extremely high weed risk scores[3]. Highest density and diversity of non-native / invasive trees occurs in the valley floors; mauka and ridge-top

Species name	Species	Abundance†	Origin	HWRA‡	Flower	Fruit	Seed
Formosan koa	*Acacia confusa*	3	Alien	10	X		X
ironwood	*Casuarina equisetifolia*	3	Alien	21			
satinleaf	*Chrysophyllum oliviforme*	5	Alien	7	X		
Spanish elm	*Cordia alliodora*	4	Alien	8		X	X
Eucalyptus	*Eucalyptus spp.*	3	Alien	(>5)			
Albizia	*Falcataria moluccana*	5	Alien	8			
ficus	*Ficus spp.*	2	Alien	(>10)		X	
silk oak	*Grivellea robusta*	4	Alien	(>10)			
haole koa	*Leucaena leucocephala*	2.5	Alien	15			
bingabinga	*Macaranga mappa*	5	Alien	11	X		
punktree	*Melalucca quinquinervia*	3	Alien	(>10)			
strawberry guava	*Psidium cattleianum*	5	Alien	18		X	
common guava	*Psidium guajava*	4	Alien	21		X	
African tulip tree	*Spathodea campanulata*	3	Alien	14	X	X	
Java plum	*Syzygium cumini*	2	Alien	9			
gunpowder	*Trema orientalis*	3	Alien	(>10)			

Source: Plant Survey for Waimea Valley Native Forest Restoration Project (7-20-12)[1]

† Abundance metrics: (5) abundant, (4) common, (3) occasional, (2) scarce, (1) 1x, 2x

[1] Surveyors: Lau, J., Tsuneyoshi, A., Rorher, J., Hoh, J., Orr, D., Pool, L., Belcher, R.

4.2.2.2. Mesic invaded forest

Mauka forests at WV typically support at least some non-native or invasive tree species, with the most common including *Chrysophyllum oliviforme* (satinleaf), *Casuarina equisetifolia* (ironwood), *Acacia confusa* (Formosan koa), *Grivellea robusta* (silk oak), and several species of *Eucalyptus* (Table 2). Forests in the valley floors around the watercourses of Kamananui and ʻElehāhā Streams consist almost entirely of non-native species. Canopy trees in these areas include *Falcataria moluccana* (albizia), *Syzygium cumini* (Java plum), *Spathodea campanulata* (African tulip tree), and *Trema orientalis* (gunpowder), with essentially no native canopy species (Table 2). Subcanopy species are overwhelmingly invasive taxa as well (Table 2), dominated by *Macaranga mappa*, *Psidium cattleianum*, and woody shrubs (Table 3) such as *Ardesia*

[2] http://efotg.nrcs.usda.gov/references/public/HI/F162XY501HI_Lama-Alahee-Pandanus_Coastal_Forest.doc
http://efotg.nrcs.usda.gov/references/public/HI/F162XY500HI_Ohia_Lama_Pandanus_Coastal_Forest.doc
http://efotg.nrcs.usda.gov/references/public/HI/F161BY503HI_Koa_Sandalwood_Mamane_Forest.doc

[3] https://sites.google.com/site/weedriskassessment/home

humilis (inkberry) and *Clidemia hirta* (Koster's curse).

4.2.2.3. Riparian forest and wetlands

The species composition of riparian forests changes dramatically along the length of the two major streams on the WV parcel. In mauka areas, streamside species are typical of the mesic invaded forest, while at the coastal extremes the major invasive tree species are *F. moluccana* and *Cordia alliodora* (Spanish elm). Although these tree species serve a useful purpose in stabilizing steep banks and preventing erosion, they are incompatible with a native species assemblage because of their extremely aggressive reproduction and growth habits. Streamside management must include replacement of these species with native trees, shrubs, and water-adapted species (e.g. sedges).

Table 3. An assortment of native (endemic, indigenous) and introduced (Polynesian, post-Polynesian) non-tree plants are common in Waimea Valley. In general, native shrubs are restricted to mauka forest areas and native grasses, sedges,

etc., to the wetlands and SMZ. Non-native plants occupy a majority of WV in terms of space and total population.

Species name	Species	Abundance†	Origin	HWRA‡	Flower	Fruit	Seed
Bushes/Shrubs							
inkberry	*Ardesia humilis*	3	Alien	(>10)			
koʻoloa ʻula	*Abutilon mensiesii*		Endemic	---			
Koster's Curse	*Clidemia hirta*	5	Alien	(>20)	X		
ki	*Cordyline fruticosa*	3	Polynesian	---			
aʻa liʻi	*Dodonea viscosa*	4	Endemic	---			X
ginger	*Hedychium gardnerianum*	3	Alien	16	X		
lantana	*Lantana camara*	2.5	Alien	32	X		X
ulei	*Osteomeles anthyllidifolia*	3	Endemic	---	X		
pluchea	*Pluchea carolinensis*	2	Alien	15			
rubus	*Robus rosifolius*	2.5	Alien	(>15)			
naupaka kuahiwi	*Scaevola gaudichaudiana*	3	Endemic	---			
pukiʻawe	*Styphelia tameiameiae*	3	Endemic	---		X	
akia	*Wikstroemia oahuensis*	2	Endemic	---		X	
Grass and Sedges							
sedge	*Carex meyenii*	4	Endemic	---			
sedge	*Carex wahuensis*	3	Endemic	---			
sedge	*Cyperus javanicus*	3	Endemic	---	X		
pili	*Heteropogon contortus*	3	Endemic	---			X
guinea grass	*Panicum maximum*	2.5	Alien	17	X		
Ferns							
paiʻiʻiha	*Christella dentata*	4	Alien	NA			
hāpuʻu	*Cibotium glaucum*	2	Endemic	---			
uluhe	*Dicranopteris linearis*	5	Indigenous	---			
lace fern	*Sphenomeris spp.*	2.5	Native	---			
Vines and herbaceous plants							
maile	*Alixia oliviformis*	4	Endemic	---	X		X
cape (German) ivy	*Delairea odorata*	3	Alien	14	X		
ʻie ʻie	*Freycinetia arborea*	3	Indigenous	---			
cork passionflower	*Passiflora suberosa*	4	Alien	12			
ʻilieʻe	*Plumbago zeylanica*	2	Endemic	---	X		
ala ala wainui	*Piperomia spp.*	2	Endemic	---			

Source: Plant Survey for Waimea Valley Native Forest Restoration Project (7-20-12)[1]

† Abundance metrics: (5) abundant, (4) common, (3) occasional, (2) scarce, (1) 1x, 2x

[1] Surveyors: Lau, J., Tsuneyoshi, A., Rorher, J., Hoh, J., Orr, D., Pool, L., Belcher, R.

‡ https://sites.google.com/site/weedriskassessment/

4.2.3. Soils and rainfall

4.2.3.1. Soil classification

An extensive diversity of soil types exist on the WV parcel, from highly erodible clays on ridges to deep organic muck soils in the wetland areas. Soil descriptions for the major constituents are included below, at-length quotation from the USDA NRCS Soil Data Viewer[4].

HLMG - Helemano silty clay, 30 to 90 percent slopes:

The Helemano component makes up 100 percent of the map unit. Slopes are 30 to 90 percent. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 4 percent. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

HnA - Hanalei silty clay, 0 to 2 percent slopes:

The Hanalei component makes up 85 percent of the map unit. Slopes are 0 to 2 percent. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is poorly drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is moderate. This soil is frequently flooded. It is occasionally ponded. A seasonal zone of water saturation is at 42 inches during January, February, March, April, May, June, July, August, September, October, November, December. Organic matter content in the surface horizon is about 4 percent. Nonirrigated land capability classification is 2w. Irrigated land capability classification is 2w. This soil does not meet hydric criteria. The soil has a slightly sodic horizon within 30 inches of the soil surface.

KIG - Kapaa silty clay, 40 to 100 percent slopes:

The Kapaa component makes up 100 percent of the map unit. Slopes are 40 to 99 percent. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 9 percent. Nonirrigated land capability classification is 7e. This soil does not meet hydric criteria.

KlaB - Kawaihapai stony clay loam, 2 to 6 percent slopes:

The Kawaihapai component makes up 100 percent of the map unit. Slopes are 2 to 6 percent. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is occasionally flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 2 percent. Nonirrigated land capability classification is 2e. Irrigated land capability classification is 2e. This soil does not meet hydric criteria.

rRT - Rough mountainous land:

The Rough mountainous land component makes up 100 percent of the map unit. Slopes are 50 to 99 percent. Depth to a root restrictive layer, bedrock, paralithic, is 20 to 40 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is high. Available water to a depth of 60 inches is low. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 25 percent. Nonirrigated land capability classification is 8e. This soil does not meet hydric criteria.

[4] http://soildatamart.nrcs.usda.gov/templates.aspx

4.2.3.2. Rainfall patterns

Mean annual rainfall at Waimea Valley is relatively low, ranging from just over 50 mm per month in the dry summer months to more than 150 mm per month (Figure 2) in November or December[5]. Mean annual rainfall between 1,200 mm and 1,325 mm is typically sufficient to support restoration plantings without the use of supplemental irrigation. Soils are typically well-drained and non-hydric (4.2.3.1), but the lack of a strong seasonal drought should mean that restoration plantings will be relatively immune to drought-related mortality. Nonetheless, the project is equipped with water catchment at both the mauka restoration and the Kalahe'e reforestation area (see §4.3) to water seedlings or for emergency irrigation.

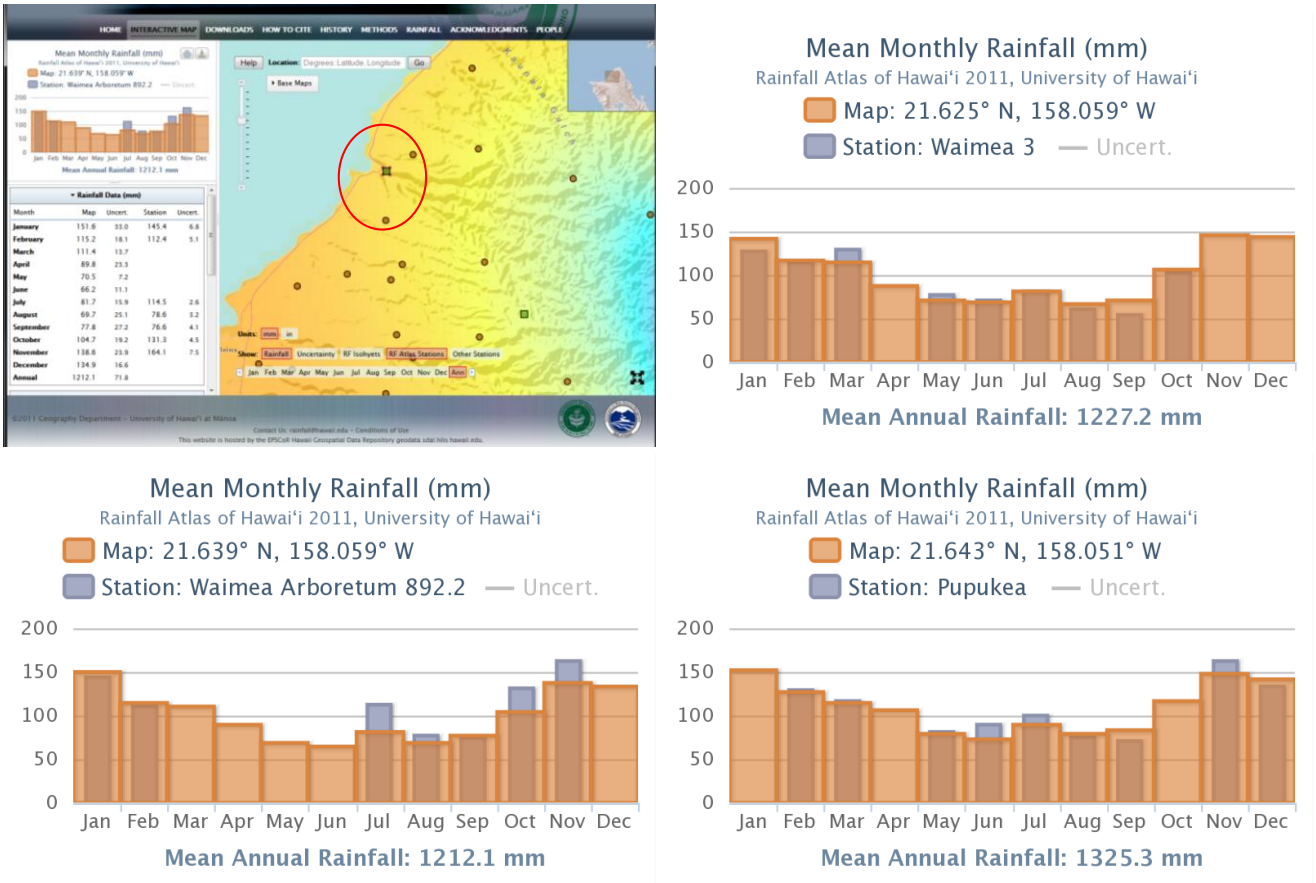


Figure 2. Rainfall at Waimea Valley is somewhat seasonal, with approximately twice as much rain falling from November to February as during the rest of the year. Overall, the site is mesic to dry-mesic, with up to 150 mm of rain falling per month in the winter. Three proximate weather stations (red circle) show a similar range of likely precipitation.

4.2.4. Threatened and endangered species

4.2.4.1. Flora

The main plant species of concern in Waimea Valley is ni'oi, or *Eugenia koolauensis*. This shrub or small tree is constrained to an area just North of the Mauka Restoration Area (Figure 4), and will be a target for conservation under this FMP (see §5.1). Other threatened or endangered species may be encountered during the course of rare habitat monitoring (see §5.7.1). In the event of such an encounter, WV will

[5] Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte, 2013: Online Rainfall Atlas of Hawai'i. *Bull. Amer. Meteor. Soc.* 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1.

update this management plan to include (1) a description of the endangered species, (2) the location of individuals or of the focal population, (3) a management strategy to safeguard existing populations and work toward restoration of the species to broader areas.

4.2.4.2. Fauna

Two endangered animal species will be of concern in the management of Waimea Valley. These species are the Hawaiian moorhen (‘alae ‘ula, *Gallinula chloropus sandvicensis*) and the Hawaiian hoary bat (‘ope‘ape‘a, *Lasiurus cinereus semotus*). Presence of the Hawaiian moorhen, Hawaiian coot (*Fulica alai*), and other waterfowl has been documented in the WV CAP (Gon et al. 2011), and the Hawaiian hoary bat is also known to occur based on encountering one dead animal[6]. Since practices such as canopy tree felling are not proposed in this management plan, detrimental effects on bat habitat will not occur and further documentation of bat presence will be passive. The management plan as written is fully consistent with supporting existing bat habitat and developing new habitat areas. Monitoring the status of endangered fauna will be a component of rare habitat monitoring (see §5.7).

4.2.5. Threat assessments

The Waimea Valley CAP (Gon and Sumiye, 2011) proposes a threat matrix (Table 4) for each of its conservation objectives, including the FMU proposed in this management plan (§5.1) as well as the indirect conservation targets (alae ‘ula, botanical garden, Wahi Pana).

Table 4. Aggregate threat assessments for conservation targets in Waimea Valley.

Threat	Alae ‘ula	Kamananui Stream	Botanical Garden	Lowland Mesic Forest	Wahi Pana	Summary Rating
Ungulates	NA	High	High	High	Low	**High**
Invasive weeds	Medium	Medium	High	High	Low	**High**
Fire	NA	Medium	Medium	Medium	Low	**Medium**
Human misuse	Medium	Low	Low	Medium	Low	**Medium**
Pests, pathogens	Medium	Medium	Medium	High	NA	**Medium**
Flooding	Low	NA	Medium	NA	Low	**Low**
Summary Rating	**Medium**	**Medium**	**High**	**High**	**Low**	**High**

4.2.5.1. Invasive species

By a large margin, invasive species present the most serious persistent threat to integrity of native Hawaiian forest ecosystems in Waimea Valley. Indeed, most of the forest areas are already substantially invaded by non-native trees and shrubs, often to the total exclusion of native flora. The few remaining areas of significant native plant populations are constrained to mauka areas and are by no means free of invasive taxa. Invasive animal species also threaten native ecosystems. The most destructive of these species are feral hogs (*Sus scrofa*) and rats (*Rattus rattus*, *R. norvegicus*). Feral hogs destroy native plant species and disperse the seeds of invasive plants. Rats consume the seeds of rare and common native plants alike, thereby preventing natural regeneration even in areas protected by topography from e.g. feral hog damage. Strategies to combat feral hogs focus on fencing (§5.2) and to some extent trapping,

[6] L. Pool, R. Belcher, pers. comm. 2014.

while rat control strategies fall into the rubric of Integrated Pest Management (IPM, §5.6.2).

4.2.5.2. Fire risk

Fire risk in Waimea Valley is medium for most areas except streams and wetlands (Figure 22).

4.2.5.3. Flood risk

Both main streams (Kamananui, ʻElehāhā) may flash flood during any time of the year. Flash flooding is unlikely to affect the mauka, Kalaheʻe, *Eugenia*, or lama forest restoration areas (Figure 5, Figure 6), but the wetland SMZ restoration will be subject to flooding (Figure 9). Waimea Valley infrastructure (buildings, roads) was designed with the assumption that flooding will occur in riparian and wetland areas. Erosion control measures must be taken in SMZ restoration (bank stabilization, geotextiles, timing planting to ensure establishment prior to most frequent flood seasons (October to March).

4.2.5.4. Human access control

Although identified as only a low or potentially medium threat by the CAP (Table 4), damage by humans to forest management projects is nonetheless a concern. The greatest deterrent to vandalism or other problems will be a sustained presence on the property, including staff and volunteers working in the various FMU. Likely human-related problems could be trespassing (e.g. to access the Waimea Valley Waterfall), unauthorized hunting, fence destruction, or introducing feral pigs to fenced areas.

4.3. Institutional capabilities

4.3.1. Staffing and volunteer labor

Waimea Valley employs two full-time staff with expertise in botanical identification, nursery operations, ungulate control, fence maintenance, invasive plant control, integrated pest management, GIS, reporting, and grant writing. The current plan could support hiring one additional person dedicated to field labor, or up to four interns annually. As a non-profit company, WV has and will continue to accomplish native forest restoration with the assistance of volunteers. The staff at WV is experienced in the organization and effective deployment of volunteer forest restoration crews, and this labor source will be instrumental to completing the forest management activities proposed in this plan.

4.3.2. Equipment

All essential forest management equipment for native species restoration is available at Waimea Valley. Equipment includes 4x4 vehicles for site access, an agricultural tractor for hauling, mix tanks for herbicide spraying, catchment surfaces and tanks for supplemental water, and a full-service greenhouse (Figure 3).

4.3.3. Nursery, greenhouse, and botanical garden

The Waimea Valley botanical garden is fully equipped as a plant species preservation facility (Figure 3). Although many of the specimens in the living collection are non-native, the native Hawaiian component is significant and will serve as a seed source for mauka restoration efforts. Native species appropriate for out-planting in the Koʻolau Range will be used exclusively, with accessions collected either in Waimea Valley itself or in adjacent valleys or ridge-tops. Maintenance of the botanical garden itself is not a feature of this management plan; the State of Hawaiʻi Kaulunani Urban and Community Forest Program[7] is

[7] http://dlnr.hawaii.gov/forestry/lap/kaulunani/

recommended as a potential additional source of funding for botanical garden maintenance.

Figure 3. Equipment already available at Waimea Valley includes (top left) water catchments and tanks, (top right) 4x4 vehicles for site access and volunteer transportation, (middle left) herbicide spray / mix tanks, (middle right, bottom left) a fully equipped greenhouse and nursery, and (bottom right) a botanical garden with numerous accessions of plant species native to the Koʻolau Mountains.

5. Management Prescriptions

5.1. Forest management units

A set of forest management R_x will be presented for each of five spatially distinct forest management units (FMU). In particular, management activities are defined for (1) the Mauka Restoration Area, (2) the Kalahe'e ridge-top reforestation area, (3) a fenced exclosure for rehabilitating *Eugenia koolauensis*, (4) a fenced exclosure containing lama (*Diospyros sandwicensis*) forest, and (5) streamside management zones (SMZ) within the wetland portion of the property (Table 5). At the Mauka Restoration Area and lama forest, the management objectives are to maintain and improve existing native forest cover. In contrast, vegetation cover at Kalahe'e is primarily non-native, so the objective will be to replace the current cover with a site-appropriate native species composition. In the *Eugenia* restoration area, the primary focus will be to establish a viable population of *Eugenia koolauensis*, but other native species will be planted as well. Finally, the objective for the wetland area will be to establish riparian-adapted native species in order to prevent stream bank erosion and improve downstream water quality.

Forest management unit		Area		Perimeter	
		acre	hectare	m	ft
Mauka Restoration	M1	1.21	0.49	280	918
	M2	2.16	0.88	397	1,303
	M3	2.59	1.05	448	1,469
	M4	2.14	0.87	424	1,392
	M5	1.86	0.75	400	1,314
	M6	1.17	0.47	300	984
	M7	1.81	0.73	360	1,182
	M8	1.14	0.46	303	993
	M9	2.40	0.97	371	1,217
Subtotal:		16.48	6.67	3,283	10,771
Kalahe'e	K1	14.61	5.91	1,319	4,328
	K2	16.56	6.70	1,996	6,549
	K3	11.19	4.53	1,320	4,330
	K4	14.73	5.96	1,449	4,753
	K5	10.25	4.15	1,170	3,840
Subtotal:		67.34	27.25	7,254	23,799
Lama forest	L1	1.00	0.40	254	833
Wetland	W1	15.25	6.17	1,145	3,756
Eugenia area	E1	1.44	0.58	364	1,195
Total:		**101.50**	**41.08**	**12,300**	**40,355**

Forest management unit	Area		Perimeter	
	acre	hectare	m	ft
Mauka restoration	16.48	6.67	1,042	3,419
Kalahe'e Fence 1	42.36	17.14	2,447	8,028
Kalahe'e Fence 2	14.73	5.96	1,449	4,753
Kalahe'e Fence 3	10.25	4.15	1,170	3,840
Lama forest	0.99	0.40	254	832
Eugenia area	1.44	0.58	364	1,195
Total:	**86.24**	**34.90**	**6,726**	**22,067**

Table 5. Forest Management Units in the WV project will include the mauka restoration site, the Kalahe'e reforestation area, exclosures around lama forest and the *Eugenia* conservation area, and a SMZ in the wetland. In terms of acreage, the Kalahe'e reforestation area represents the largest sub-project at more than 67 acres. The wetland area is the second largest net acreage, but forest management activities will be focused on a 15-acre portion of the overall wetland. Together, FMU in the mauka restoration site sum to nearly 16.5 acres, and this area will be managed to control invasive trees and restore native plant taxa. Fencing has already been constructed around the mauka restoration, but will need to be constructed at Kalahe'e, the lama forest, and the *Eugenia* conservation area.

The mauka restoration site is a roughly square unit divided into nine (9) fields (Figure 4) and encompassing nearly 16.5 acres (Table 5). Certain management activities (fencing maintenance, IPM) will occur across the entire FMU every year, while other activities are concentrated in single (e.g. site preparation, planting) or alternate years (e.g. rare habitat monitoring). The five units constituting the Kalahe'e reforestation area (Figure 7) sum to a total of more than 67 acres (Table 5). In a given year, only a small portion of each FMU will be slated for restoration activities, but the complete acreage would be reforested by the end of the

decade-long project period. Forest management in the wetland area (Figure 9) would focus on two SMZ of just over five (5) acres each (Figure 8), with additional invasive tree control in adjacent areas (principally herbicide control of *Cordia alliodora*). Activities in the *Eugenia* area (Figure 4) and lama forest (Figure 7) would focus on endangered species preservation and invasive species removal.

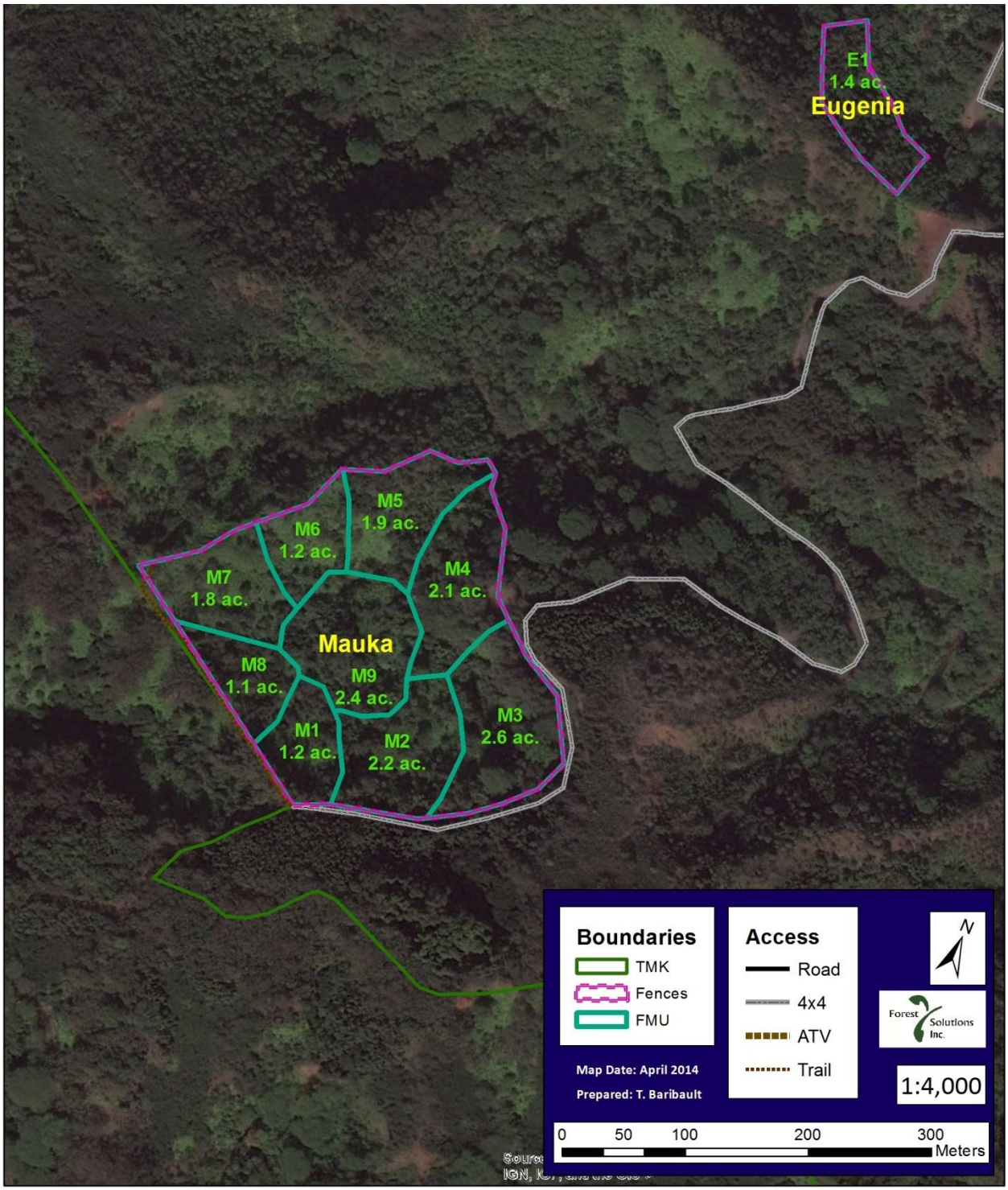


Figure 4. Mauka restoration area and sub-units M1 – M9 (blue). Fencing has already been constructed around this FMU (pink), and areas are ready for invasive tree control (brush management) and native species out-planting.

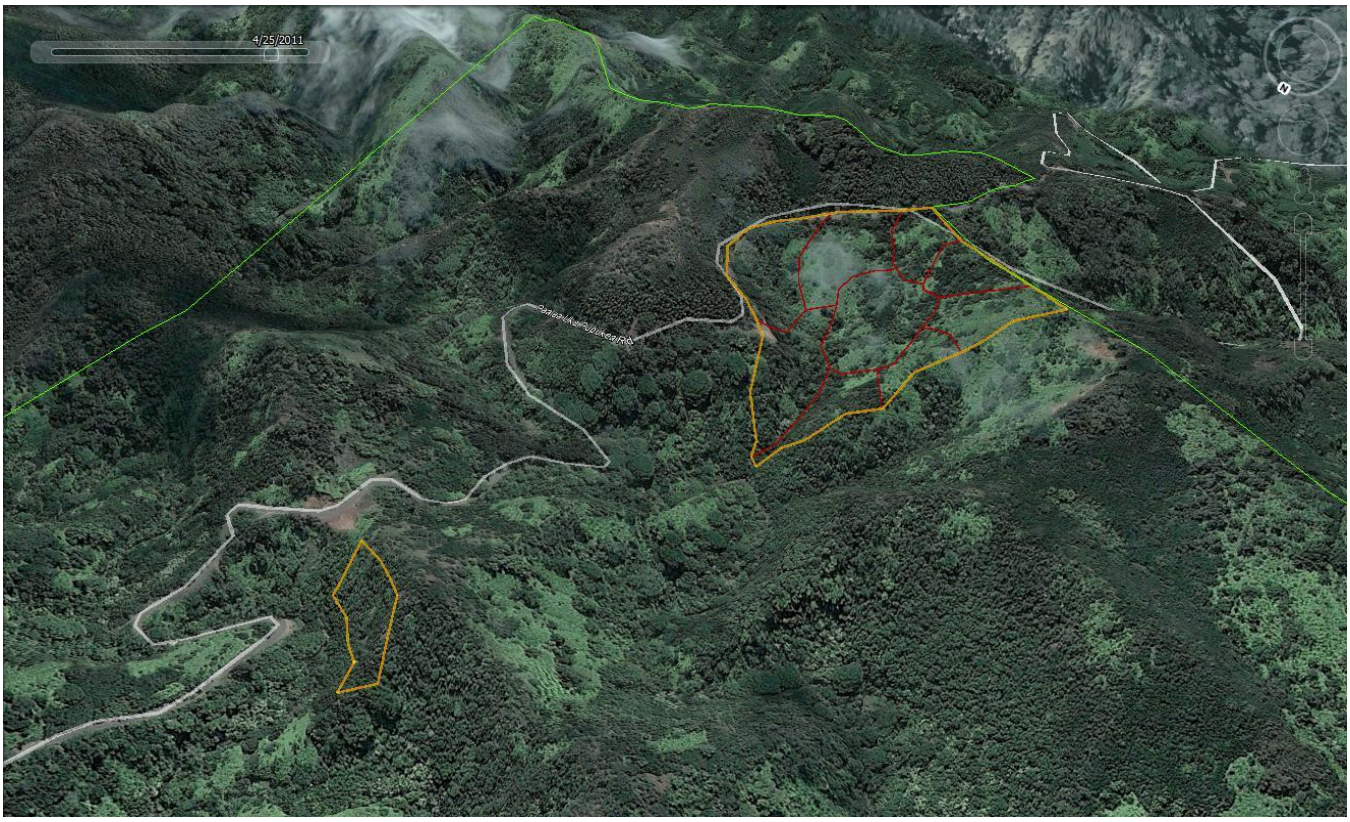


Figure 5. Perspective map of the mauka restoration site shows steep banks and uluhe fern punctuated by trees.

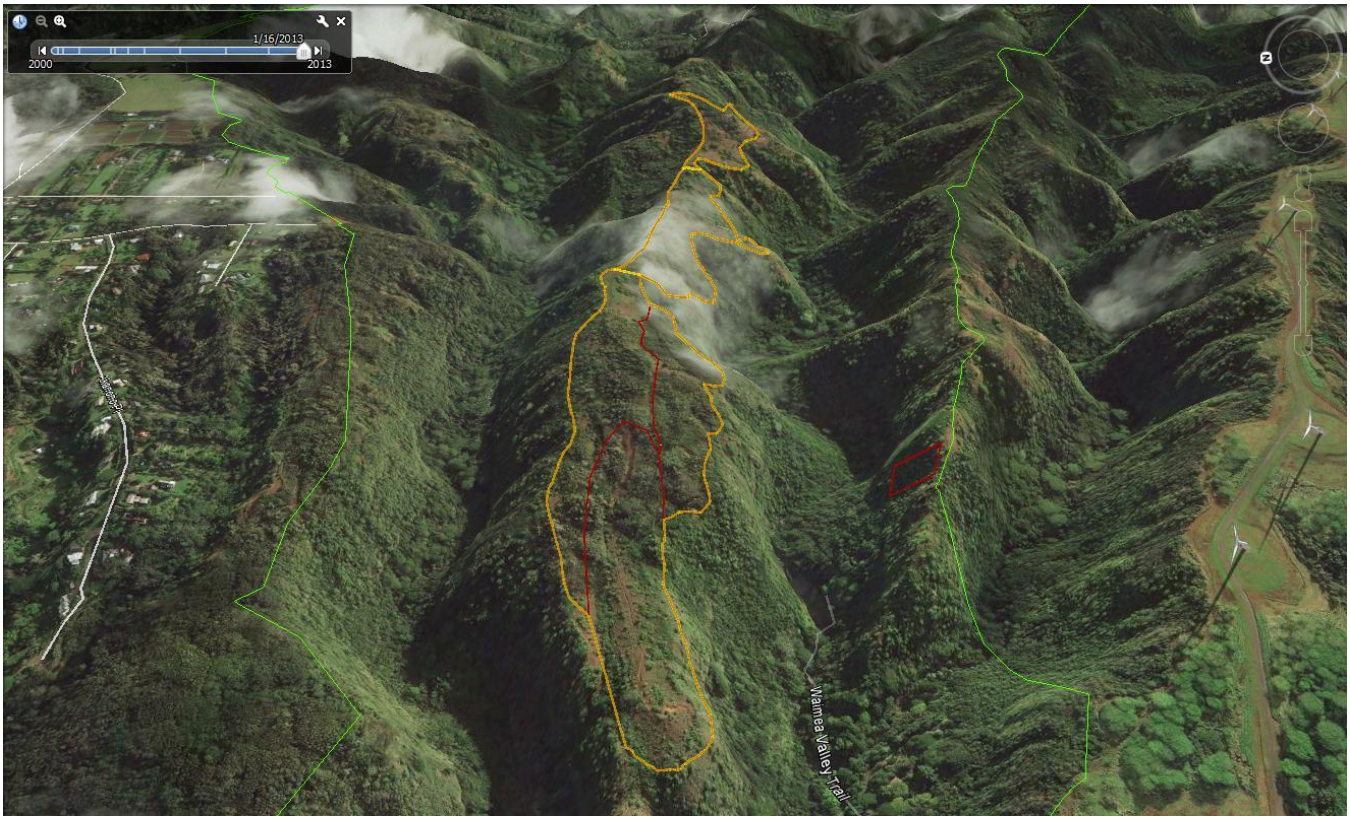


Figure 6. Perspective map of the proposed Kalahe'e reforestation exclosures. The lama forest area is located on the

right-hand (Southern) valley wall.

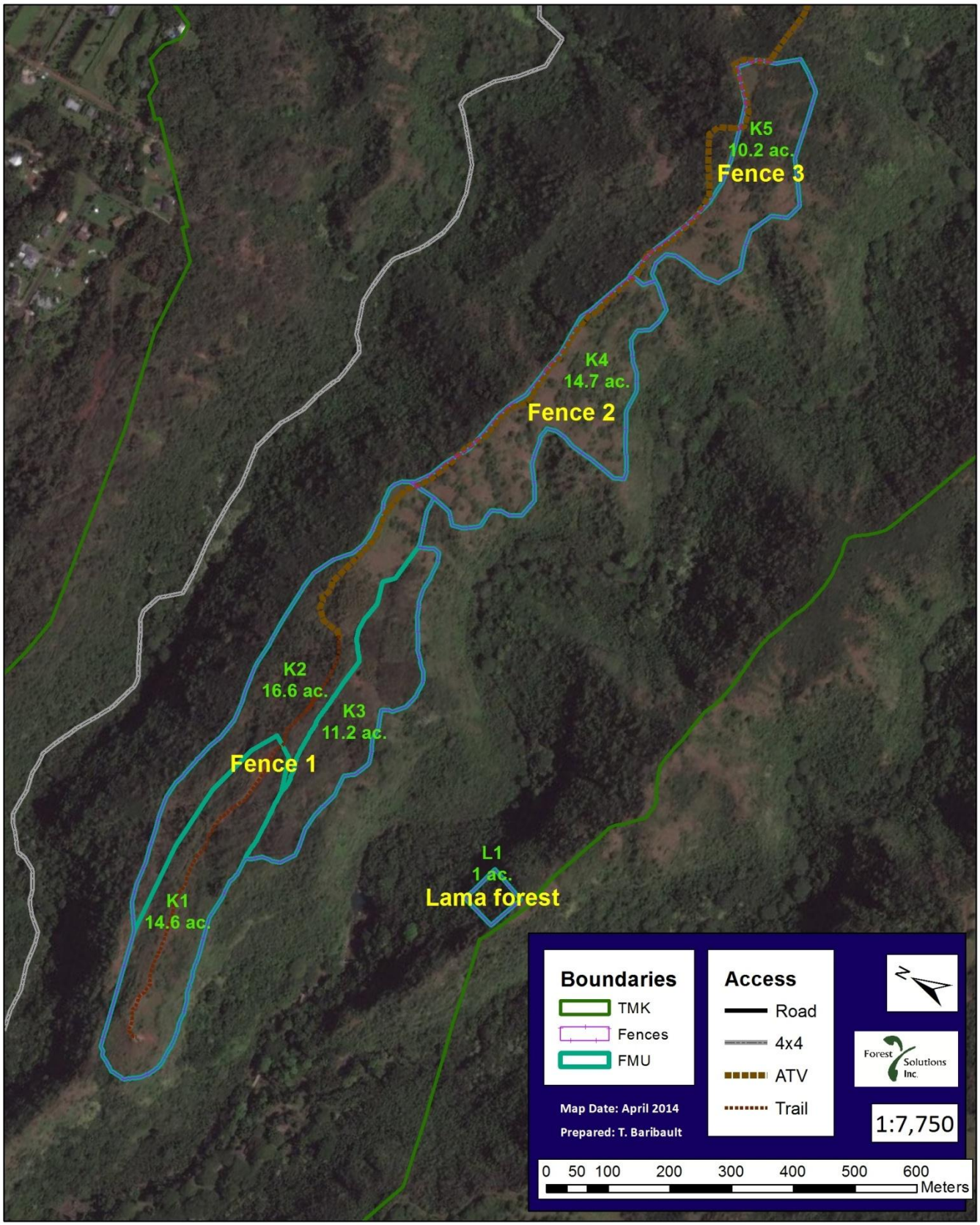


Figure 7. The Kalahe'e reforestation area will be divided into three fenced sections and managed as five (5) sub-units

called F1 – F5. The lama forest (center bottom) will be fenced and managed to exclude invasive plant species.

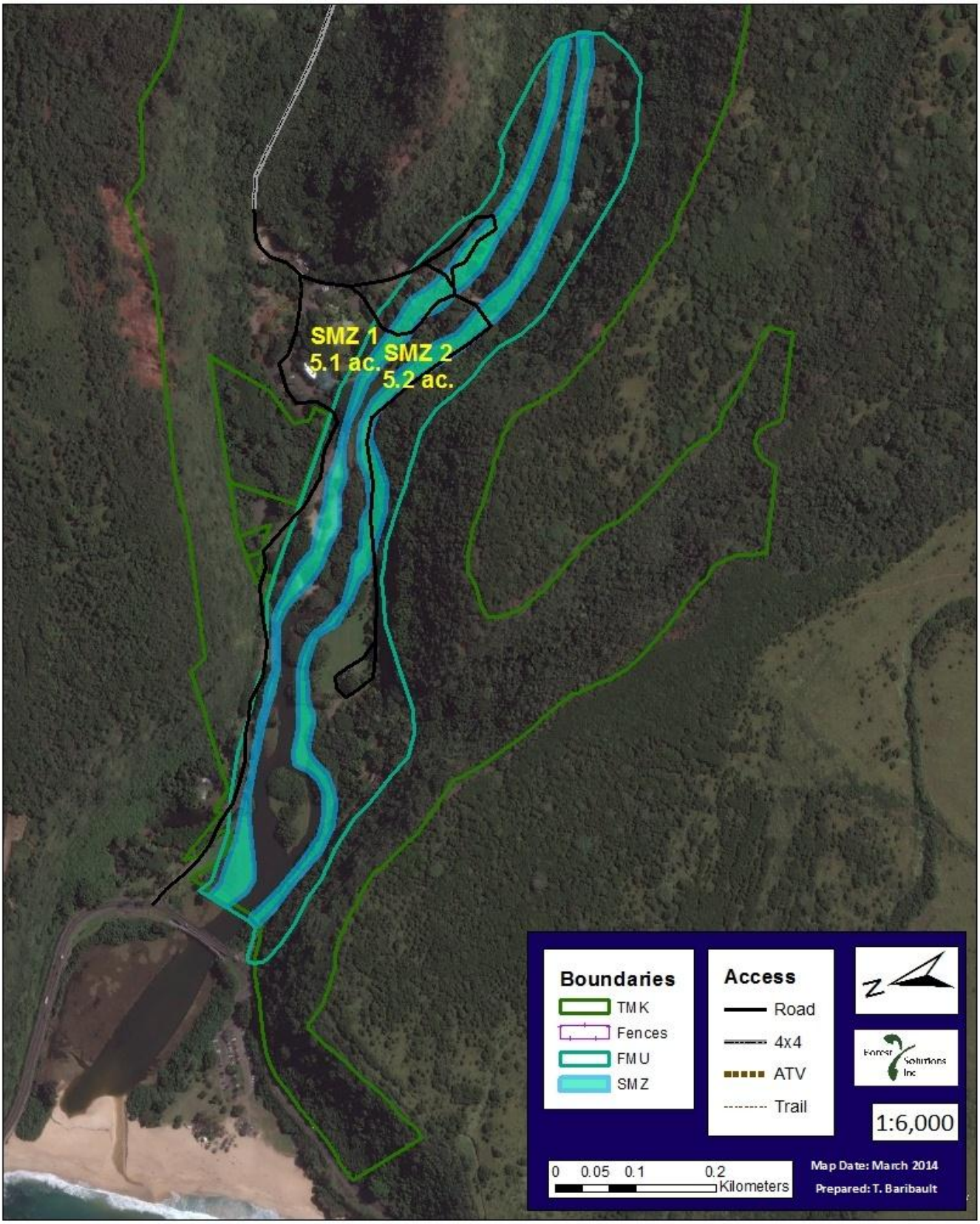


Figure 8. Streamside management zones in the wetland area that surrounds the Waimea Valley botanical garden.

Figure 9. Perspective map of the wetland area at the makai end of Waimea Valley.

5.2. Access control

5.2.1. Fencing

For the mauka restoration, Kalahe‘e reforestation, lama forest, and *Eugenia* conservation areas, fencing will be the first management activity to occur. Fencing has already been constructed around the mauka restoration, but will need to be constructed around the other three forest management areas to ensure that ungulates (principally feral hogs) are excluded (Appendix **Error! Reference source not found.**). Extant nd future fences will require annual maintenance, which has been factored as an annual per-foot cost varying by topography (steeper slopes corresponding to greater maintenance expense (§5.8)). Fencing also serves as a reminder to staff and volunteers to practice good hygiene against vectoring weed seeds. At the mauka restoration site, a boot brush has been installed at the main access style; comparable foot cleaning installations are recommended at other access points in the mauka section as well as at Kalahe‘e, lama, and *Eugenia*.

5.2.2. Roads

The road and trail network in Waimea Valley is adequate for all forest management activities prescribed in this plan; specific road related activities are not included in the budget or prescriptions. Should road repairs become necessary, e.g. after a landslide, earthquake, or flood, all construction or repair activities

should conform to the State of Hawai'i Best Management Practices (BMP) for forestry roads[8].

5.3. Invasive tree removal

5.3.1. Brush management: chemical and manual

Invasive tree removal, interchangeably called brush management in accordance with the relevant NRCS practice code, will be a universal practice across all of the FMU at WV. Target species vary by site: principal targets at the mauka restoration are *C. oliviforme*, *M. quinquinervia*, and *Eucalyptus spp*. At Kalahe'e, the majority of non-native stems are *C. equisetifolia*, followed by varying components of *P. cattleianum*, *P. guajava*, *A. confusa*, and *S. cumini*. The *Eugenia* conservation area is infested with *P. cattleianum*, while the wetland SMZ has infestations of *S. cumini*, *C. alliodora*, and minor amounts of *F. moluccana*.

Regardless of the target species, chemical brush management will be accomplished using a frill or drill application (Figure 10) of concentrated herbicide agents effective against the target. Certain weed species resist common herbicides such as glyphosate or tryclopyr. For example, *P. cattleianum* and *P. guajava* with diameters of 2" or less may be killed using a frill / drill application of at least 6 ml glyphosate (Roundup PowerMax) or 3 ml triclopyr (Garlon 4, Element 4), but the same trees are easily killed using only 1 or 2 ml of aminopyralid (Milestone) or aminocyclopyrachlor (Perspective). In contrast, *F. mollucana* trees may be killed in the most cost effective way using glyphosate, which is substantially cheaper than other herbicide options. An intermediate cost solution is imazapyr (Polaris AC), which has been documented to terminate such challenging species as *Morella faya* (not present at WV).

Figure 10. Frill (left), drill (center), or single incision (right) methods for administering optimized doses of herbicides to invasive tree species. Effective herbicide agents for this application type include Milestone, Polaris AC, Roundup PowerMax, and Garlon 4 / Element 4; effects vary strongly by target species. (*Right image: Leary et al. 2012*)

Following chemical control of invasive tree cover, manual removal of dead brush may be necessary. For example, *C. equisetifolia* stems at Kalahe'e are so densely distributed that no planting would be possible without first chain-sawing the debris and organizing it into piles or wind-rows. Debris may also be used to

[8] http://www.hawaiiforest.org/files/Bestmana.pdf

prevent erosion (i.e. wattles or check dams). In contrast, *C. oliviforme* in the mauka site may be allowed to stand in place with native species planted in the understory.

5.3.2. Brush maintenance: chemical

Some regeneration is inevitable following the initial treatment of invasive tree species. The invasive trees may regenerate from root sprouts, incompletely killed stems, or from seed. In most cases, this regeneration is best controlled using a timely foliar application of appropriate herbicides. The herbicide Streamline (aminocyclopyrachlor and metsulfuron methyl) is highly effective particularly against *P. cattleianum*, a species that stubbornly resists damage by reasonable doses of many other herbicides. Streamline is an effective broadleaf herbicide appropriate for mauka areas (i.e. no applications with rain forecasted, no applications near surface water or in areas with low water table). Any herbicide agent should not be applied in a manner that may result in ground- or stream-water contamination.

5.4. Restoration plantings

5.4.1. Species selection

Plantings will feature endemic or indigenous species documented to occur naturally on their respective restoration sites or in the Northern Koʻolau Mountains. Plant propagation, including seed collection, accession tracking, germination (or air layering or cutting), and nursery production, will all be accomplished on site using existing facilities and with pre-trained staff. All propagation will conform to the Waimea Valley Plant Collections Policy (Ho 2010) also in use at the botanical garden.

Table 6. Species selected for planting in the mauka restoration site (left), and at either Kalaheʻe or both mauka and Kalaheʻe (right). The species designated Kalaheʻe only are so identified because they are (1) robust to poor soils, strong winds, and dry conditions, and (2) because they already exist in the Kalaheʻe area. Species appropriate for the mauka area

are less capable of tolerating harsher conditions of Kalahe'e. *E. koolauensis* and other species will occupy the *Eugenia* site.

Species name	Species	Form
ko'oloa 'ula	*Abutilon mensiesii*	Shrub
ahakea	*Bobea spp.*	Tree
hāpu'u	*Cibotium glaucum*	Fern
'aku 'aku	*Cyanea tritomantha*	Herb
uluhe	*Dicranopteris linearis*	Fern
lama	*Diospyros hillebrandii*	Tree
kalia	*Elaeocarpus bifidus*	Tree
'Ie 'ie	*Freycinetia arborea*	Vine
kolea	*Myrsine lessertiana*	Tree
olopua	*Nestegis sandwicensis*	Tree
holei	*Ochrosia compta*	Tree
ala ala wainui	*Piperomia spp.*	Herb
mamaki	*Pipturus albida*	Tree
ho'awa	*Pittosporum confertiflorum*	Tree
halapepe	*Pleomele halapepe*	Tree
ala'a	*Pouteria sandwicensis*	Tree
kopiko	*Psychotria mariniana*	Tree
hao	*Rauvolfia sandwicensis*	Tree
naupaka kuahiwi	*Scaevola gaudichaudiana*	Shrub
Schidea	*Schiedea obovata*	Shrub

Species name	Species	Form	FMU
pili	*Heteropogon contortus*	Grass	K
ulei	*Osteomeles anthyllidifolia*	Shrub	K
'ilie'e	*Plumbago zeylanica*	Herb	K
akia	*Wikstroemia oahuensis*	Shrub	K
koa	*Acacia koa*	Tree	M,K
maile	*Alixia oliviformis*	Vine	M,K
awe'owe'o	*Chenopodium oahuense*	Shrub	M,K
a'a li'i	*Dodonea viscosa*	Shrub	M,K
wili wili	*Erythrina sanwicensis*	Tree	M,K
'ōhi'a	*Metrosideros polymorpha*	Tree	M,K
alahe'e	*Psydrax odorata*	Tree	M,K
'iliahi	*Santalum freycinetianum*	Tree	M,K
puki'awe	*Styphelia tameiameiae*	Shrub	M,K
maua	*Xylosma spp.*	Tree	M,K

All species proposed for out-planting in either mauka, Kalahe'e, or SMZ sites can be produced by WV on site. Precise per-seedling costs vary somewhat depending on germination rate, benching time, etc., but a realistic aggregate cost of $5.35 per seedling will be used for budgeting purposes. Tree species with poor germination rates (e.g. 'iliahi) and extremely slow growth rates have a real seedling cost closer to $12.00. In contrast, the sedges, with good germination rates, short bench times, and limited horticultural requirements, likely cost closer to $1.00 to produce. On average, WV has found the $5.35 cost to reflect an integrated price per plant across all of the species on these lists (Table 6, Table 7).

Table 7. Species designated for planting in the wetland SMZ.

Species name	Species	Form	FMU
ʻaeʻae	*Bacopa monnieri*	Herb	SMZ
bayonet grass	*Bolboschoenus martitimus*	Sedge	SMZ
sedge	*Carex meyenii*	Sedge	SMZ
sedge	*Carex wahuensis*	Sedge	SMZ
kou	*Cordia subcordata*	Tree	SMZ
sedge	*Cyperus javanicus*	Sedge	SMZ
ʻehuʻawa	*Cyperus laevigatus*	Sedge	SMZ
sedge	*Cyperus polystacos*	Sedge	SMZ
hala	*Pandanus tectorius*	Tree	SMZ
loulu	*Pritchartia kahukuensis*	Tree	SMZ
hāwane	*Pritchartia martii*	Tree	SMZ
ohe makai	*Reynoldsia sandwicensis*	Tree	SMZ
milo	*Thespesia populnea*	Tree	SMZ

5.4.2. Site preparation and planting

Planting site preparation and planting may occur several months after removal of invasive trees (brush management). In areas with dense invasive tree overstory, brush debris must be removed prior to site preparation; debris can be used in check dams or wattles, or composted for amendments to future plantings. Brush killed with imazapyr or aminopyalid should not be used as compost for at least two years. Areas (e.g. mauka site) with relatively sparse, larger invasive overstory (*Chrysophyllum*) may be planted without removal of the dead overstory. Certain portions of Kalaheʻe where the dominant cover consists of non-native grasses should be sprayed with an imazapyr-glyphosate mixture at least three months before site preparation. Circular areas should be sprayed with a 1 m radius around each planting location.

At Kalaheʻe, harder, compacted soils must be loosened with a motorized auger. In other areas, soils may be prepared either with the auger or with hand tools (pick, shovel, bar). Planting holes should be dug at least one inch (2.54 cm) deeper than the depth of the seedling pot; any shallower cavity will result in part of the root system being exposed to air. Soil should be packed firmly around each seedling, with the exception of air layered seedlings whose roots tend to be easily dislodged from the stem. In the mauka and Kalaheʻe areas, trees and shrubs are prescribed to be planted at a density of 200 seedlings per acre (unless otherwise prescribed), or at a square lattice spacing of 14.5 ft apart. This relatively sparse geometry allows for remaining overstory trees in the mauka site, and will reduce intraspecific competition in the drier Kalaheʻe reforestation area. In the SMZ, woody species should be planted at 300 plants per acre (12 ft square lattice).

Figure 11. The most challenging planting area in the whole project is located in a small, highly eroded portion of the Kalahe'e reforestation area, sub-unit F0. Species including a'a li'I and 'ilie'e were planted in this area by blasting through clay hardpan using a motorized auger. Supplemental water from the on-site catchment (top left) was provided at planting. At six months after planting, both species, as well as several koa, were thriving despite only moderate rainfall and a lack of proper soil. Other planting zones in WV are far more favorable, promising positive outcomes for the project in general.

5.4.3. Out-planting maintenance

Extant out-plantings, e.g. at Kalahe'e (Figure 11) have shown good survival and growth despite being planted in harsh conditions on heavily eroded soils. In contrast, other seedlings planted into grassy areas (also at Kalahe'e (Figure 12)) have suffered from apparently slow growth rates. It appears that the most influential factor in seedling performance throughout the restoration areas has been competition. For example, koa and a'a li'i growth rates were good at the mauka site immediately after planting when weed control was recent, but have since slowed in the presence of rampant *Clidemia hirta* growth (Figure 12). In general, this FMP will recommend herbicide or manual control of any competing weeds through at least 18 months after planting. This corresponds to three competition control entries spaced six (6) months apart.

Figure 12. Koa seedling suffering from competition with surrounding grass at Kalahe'e (left). Koa and a'a li'I seedlings grew at phenomenal rates in the mauka site until they were overtaken by nearby *Clidemia hirta* (right).

5.5. Streamside management zones

Special procedures will be required for out-planting in the SMZ. The species list for the SMZ (Table 7) contains plants adapted to riparian conditions, periodic flooding, warmer temperatures, less well-drained soils, and even some saline tolerance. Site preparation in the SMZ should not rely on herbicide applications because of the immediate proximity of standing and moving water (Figure 13). Many of the herbicides recommended for mauka and Kalahe'e could potentially contaminate the stream and wetland when applied as a foliar spray in the SMZ. Glyphosate (e.g. Roundup PowerMax, Accord XRT II, Aquamaster) is a potential exception, and should not contaminate groundwater when carefully applied so as to avoid any contact with open water. Brush management using IPA is, however, a safe technique for the SMZ. To prepare planting site in areas with existing non-native vegetation, plants should be removed manually. Planting holes should then be dug by motorized auger or pick as appropriate, per instructions above. Planting densities in the SMZ should vary by growth habit, with trees planted at a relatively sparse density (300 per acre, 12' x 12' spacing) and sedges or other ground cover stabilizers planted more closely together (for example, 3' x 3' spacing). Both trees and groundcovers should be planted in areas where they may successfully establish before serious erosion from flash flooding is expected. Unlike other areas where planting should take place in November to capitalize on winter rainfall, SMZ planting should occur at the end of the rainy season (approximately April) to minimize risk of flooding to new plantings.

Additional techniques may be used in the SMZ to facilitate plant establishment and reduce erosion damage. Seedlings can be planted downstream from physical barriers, including naturally occurring large rocks (Figure 13) or installed structures such as wire cages filled with smaller rocks and affixed to the banks. Seedling size is another factor to consider more carefully in the SMZ. Elsewhere, relatively small seedlings are suitable and even preferable to minimize transplant shock. Here, however, small seedlings may be washed away by floods (Figure 13). Larger trees and well-established sedges or grasses have a better chance of withstanding floods. Trees with larger stems may be staked to reinforcing rods or bigger trees (Figure 13) resist breakage during moderate floods. Sedge clumps (Figure 13) with large root systems will more rapidly establish and tolerate inundation as well as moving water.

Figure 13. Planting areas in the SMZ include stream banks susceptible to erosion (top), as well as areas where floodwaters are slow-moving and plants can more easily establish (bottom right). Rocks and other obstructions that slow the rate of flow during floods can facilitate establishment (bottom left).

Stream banks that already exhibit serious erosion problems (Figure 13) may be stabilized first with geotextiles or rock cages; after silt accumulates behind these physical barriers, planting may become possible in these locations where it is currently infeasible.

5.6. Objectives for the entire parcel

Although specific prescriptions (e.g. herbicides, seedling spacing, species selection) are not relevant for the majority of the remaining areas on the rest of the 1,800 acres of Waimea Valley, several vital forest

management practices should be implemented across the property. Monitoring for incipient invasive weed species (§5.6.1) and implementing an integrated pest management (IPM) framework for the entire parcel (§5.6.2) may be modeled on those presented here, but would require alternate funding.

5.6.1. Incipient invasive weed monitoring

With lax import regulations and an ideal climate for rapid plant growth, Hawai‘i suffers from aggressive invasive plant species infestations. Reversing the tide of long-established infestations across large areas is widely recognized to be impossible with realistic levels of funding, but preventing the incursion of new species can be done in a cost effective way. A property-wide monitoring scheme should be implemented to detect any incipient invasions. Such a program can focus on primary vector paths, especially roadsides, but should also periodically scan back-country locations in a systematic way to check for bird- or pig-dispersed species. This monitoring should be considered a part of IPM (see next section).

5.6.2. Integrated pest management

The IPM approach, which can be applied to both weed and insect pests, focuses on (1) monitoring potential pest agents, (2) identifying threshold densities or populations at which pests cause unacceptable economic damage, and (3) identifying and applying the most effective control agent. To control insect pests in IPM, the first step is to identify potential pest species. This requires a monitoring program that can take on varying degrees of sophistication. When damaging levels of the pest are discovered, the first option for control methods is typically a pheromone-based trapping system or adhesive traps. Chemical insecticides are used if control is impossible with more benign methods.

Generalist insect pests likely on the site include the Chinese rose beetle (*Adoretus sinicus*) and the black twig borer (*Xylosandrus compactus*). These pests are not typically problematic for native species, but damage levels should be monitored. Of substantial concern is the fungus *Fusarium oxysporum*, which could cause koa wilt disease at elevations below 2000 feet above sea level (asl). To date, WV personnel have not observed any symptoms of koa wilt, but the fungus is transported in soil and could easily be vectored by e.g. contaminated boots or tires. Development of a *Fusarium* hygiene program is strongly recommended, the basics of which would include chlorine bleach sterilization of all staff and volunteer footwear prior to entering the site. Because koa wilt has not yet been observed, *A. koa* planting should proceed; monitoring for wilt may be able to identify and curtail future infestations.

Other pests and pathogens can also be addressed in an IPM framework[9]. Feral hogs (*S. scrofa*) and rats (*R. rattus*, *R. norvegicus*) are known to be present on the site and have caused extensive damage to previous restoration efforts. In particular, Maintaining vigor and overall plant health is the first line of defense against insect and fungal pathogens. Pests and pathogens are ubiquitous, but vigorous trees resist attacks more effectively. Selecting species adapted (i.e. endemic) to the locale will mitigate pest and pathogen problems to a large extent. Some plants may be vulnerable to certain diseases, however, but they are nonetheless worth planting. For example, ‘ōhi‘a may be susceptible to the fungal pathogen *Puccinia psidii*, but ‘ōhi‘a is the one of the best options for restoration at Kalahe‘e, so this risk should be taken.

[9] Flint et al. 2003.

The final phase of IPM involves intervention with appropriate control methods. For animal pests, control options should focus on exclusion (e.g. hogs), but extermination may be necessary in exclosures (e.g. using traps for hogs, traps or poison for rats). For weed pests, the most effective control may not always be herbicide application, although herbicides are certainly an indispensable tool. Manual removal of weeds may be preferable especially for extremely high-threat species (e.g. *Miconia calvescens*, *Cyathea cooperi*) if any individuals are detected before populations become established.

5.7. Ecological monitoring

Effectiveness of the R_x, detecting incipient invasive species, and tracking progress of endangered species conservation can all be accomplished with an ecological monitoring program concentrating on rare habitat monitoring (designated NRCS practice).

5.7.1. Vegetation monitoring

Standard vegetation monitoring protocols should be implemented at WV, including point-based sampling in active restoration areas and line-intersect, transect, or non-systematic methods in areas not under intensive management. At the mauka restoration site, circular permanent sampling plots (PSP) with a radius of 5 m are recommended for each FMU. That is, a total of nine (9) PSP should be installed directly following the first out-planting. Trees and shrubs should be measured across the entire plot, while groundcovers and small seedlings should be measured on a smaller sub-plot of radius 2 m. At Kalahe‘e, at least two PSP should be installed in each sub-unit, for a total of ten (10) PSP in the FMU after five years. In these areas, PSP should be measured on an annual schedule, preferably at the same date each year.

Vegetation monitoring in the lama forest should occur on the level of the whole exclosure. There are relatively few extant trees, and all new plantings can be tracked by individual. Similarly, out-planting survival of *Eugenia koolauensis* must, according to federal law, be measured for at least two years after establishment, and measures taken to ensure survival. On the rest of the property, vegetation monitoring may be limited to incipient weed detection programs (see §5.6.1).

5.7.2. Zoological monitoring

Although zoological monitoring is outside the purview of FSP, and therefore beyond the scope of this management plan, a low-level or passive zoological monitoring program may be implemented as part of the vegetation monitoring activities. For example, whilst walking invasive weed transects through the parcel outside of the FMU, staff or volunteers should watch out for native bird species or native tree snails. Similarly, if native bird sightings occur at any of the FMU PSP, especially as the project advances, these should be noted in the same dataset. Sightings of endangered waterfowl or the hoary bat may also be reported with vegetation datasets for this plan.

5.8. Property-wide management

5.8.1. Incipient weed control

Although much of the Waimea Valley parcel is already occupied with a known set of invasive weeds, there is a considerable risk from incipient weed species. The area experience heavy animal traffic both human (staff, volunteers, trespassers) and not (feral pigs, birds, rodents), which poses a significant threat of factoring weed seeds from elsewhere on the island(s). Two additional measures are recommended to combat the incipient weed threat, boot scrubbers and a property-wide monitoring program. It is already standard practice at the mauka site to scrub boots prior to entering the exclosure. This plan recommends expanding the boot cleaning protocol to the forest as a whole; requiring staff and volunteers to thoroughly clean footwear will improve the chances of avoiding importation of high-threat, especially small-seeded species such as the spore-dispersed Australian tree fern. Furthermore, asking volunteers to pre-clean footwear and inspect clothing for weed seeds should be emphasized during recruitment.

Controlling non-human animal vectors is a more challenging proposition. To some extent, feral pig control (§5.8.2) will reduce local seed movements and limit disturbances that facilitate germination of weed seeds. Importation of seeds by birds and rodents, however, will be virtually impossible to prevent, so the effects must be addressed by monitoring. Human-vectored weeds will grow primarily in the vicinity of trails, roads, fences, and work areas, which improves chances of detection. Pig, bird, or rodent-dispersed weeds, in contrast, may appear anywhere on the property. A monitoring program should cover areas inaccessible by road using a transect scheme that can be intensified over time in reaction to detection of new weed species or, inversely, scaled back if the apparent rate of introductions is low.

One strategy for such a monitoring program is to survey the property on an annual basis via a lattice of sampling points. Given the size of the parcel, a lattice 100 m by 400 m would adequately cover the area. Transects would be spaced 400 m apart, with sample points 100 m apart along the lines. Detailed species composition data would be recorded at sample points[10], while presence or absence of species could be recorded whilst walking between points. Annually for a 1,900-acre parcel, approximately 160 person-hours of staff time would be required for field surveys, 40 hours for data processing and visualization, and supplemental time for eradication should any incipient weeds be detected.

5.8.2. Feral ungulate control

One of the most significant threats to native forest integrity is Waimea Valley is the large feral pig population. In the first third of 2014, staff and contract hunters removed 158 animals from the property; estimated staff time required on a weekly basis for activities related to pig control is 15 hours[11]. At this point, staff are actively participating in trapping, snaring, and hunting (Figure 14). In the future, Waimea Valley will work to outsource pig control to contract hunters and potentially form a hunting club or cooperative. In either case, comparable staff time will be required for administration of these groups. Overall, feral ungulate removal can both achieve conservation objectives of weed control and disturbance reduction, as well as provide opportunities for responsible members of the hunting community.

[10] Sample point configuration may vary with forest density, from a 5 m radius circle to smaller plots in dense forest
[11] L. Pool, Pers. Comm.

Figure 14. Waimea Valley staff control feral pigs using a combination of rifle hunting (left), snaring (center), and trapping (right). Feral pig control will continue to be a focus in this management plan, with outsourcing of the hunting activities as much as possible to afford full-time staff more opportunities to work directly with forest restoration.

5.8.3. Fire management

The Waimea Valley parcel is considered a medium fire risk area overall, but on a smaller scale certain areas are much drier than others. The wetland and lama forest are sufficiently damp to be low fire risks, but Kalahe'e and the *Eugenia* are can become quite dry on a seasonal basis. Fire breaks should be maintained around these two exclosures, with a clear width of at least twice the height of surrounding tree vegetation and six times the height of grasses. At Kahale'e, the firebreak will travel through grass and also ironwood (*Casuarina equisetifolia*) stands, potentially requiring firebreaks from 3 m to 10 m. Construction of the exclosure fences will typically clear a path wide enough to quality as a fire break; the areas should be kept vegetation-free likely using herbicides as the most cost-effective method. A broad-spectrum formulation with post- and pre-emergent activity (e.g. glyphosate and sulfometuron methyl) would be preferred.

5.8.4. Access maintenance

Road infrastructure across Waimea Valley totals approximately 10 miles, and consists principally of dirt surfaced 4x4 paths with several concrete stream fords. The roads are generally stable despite frequent and unpredictable flash flood conditions. Nevertheless, these access routes are critical to completing the forest management activities proposed in this plan, and their maintenance must be considered as part of the project cost. At the same time, the roads serve as potential corridors for invasive weed introduction or further movement of extant weeds within the property. Two types of road maintenance are recommended for this plan, (1) surface repair and maintenance as necessary, and (2) roadside weed control to prevent incipient weed establishment and contain existing species. The relevant access maintenance NRCS practice code is 518, particularly Non-Recreational routes of trail classes 3 – 5 (Accessible Routes, e.g. for volunteer and contract hunter access).

6. Budget and Schedule

The preceding management R_x are planned around a specific budget and implementation schedule for each FMU. Each R_x is assigned to a corresponding USDA NRCS code, and is given a per-unit cost. Costs of fencing (construction, maintenance) are assessed on per-foot basis. Seedling costs are assessed per plant, and integrated across species to an aggregate value of $5.35. Remaining practices are assessed on a per-area basis, either of the FMU, the sub-unit (M1, etc., K1, etc.), or the annual managed acreage within a subunit. Specific budgets and schedules of operation are presented separately for the mauka restoration site, Kalahe'e reforestation area, lama forest, *Eugenia* conservation area, and wetland SMZ. Budget and schedule formatting are preserved across FMU. Detailed budgets are presented for each of the ten (10) years of the project, and summary budgets for the entire project duration. Schedules are presented on an annual basis, and R_x are implemented in the years in which corresponding cells are shaded dark green.

If property-wide management activities are funded by FSP (Table 8), costs would increase by the amounts required for ungulate control, access maintenance, incipient weed monitoring, and fuel break maintenance.

Table 8. Annual expenditures by FMU for the Waimea Valley forest management plan.

Period	Applicant	FSP	Mauka	Period	Applicant	FSP	Kalahe'e	Period	Applicant	FSP	Lama, *Eug*, Wetland	Annual Total
Year 1	$ 3,145	$ 3,145	$ 6,290	Year 1	$ 20,055.00	$ 17,295.00	$ 37,350	Year 1	$ 2,789.00	$ 2,789.00	$ 5,578	**$ 49,218**
Year 2	$ 819	$ 819	$ 1,638	Year 2	$ 3,586.00	$ 826.00	$ 4,412	Year 2	$ 2,789.00	$ 2,789.00	$ 5,578	**$ 11,628**
Year 3	$ 4,306	$ 4,306	$ 8,612	Year 3	$ 3,586.00	$ 826.00	$ 4,412	Year 3	$ 2,789.00	$ 2,789.00	$ 5,578	**$ 18,602**
Year 4	$ 3,244	$ 3,244	$ 6,488	Year 4	$ 3,586.00	$ 826.00	$ 4,412	Year 4	$ 2,789.00	$ 2,789.00	$ 5,578	**$ 16,478**
Year 5	$ 1,770	$ 1,770	$ 3,540	Year 5	$ 3,586.00	$ 826.00	$ 4,412	Year 5	$ 2,789.00	$ 2,789.00	$ 5,578	**$ 13,530**
Year 6	$ 3,013	$ 3,013	$ 6,026	Year 6	$ 51,366.00	$ 51,366.00	$102,732	Year 6	$ 10,857.00	$ 10,857.00	$ 21,714	**$ 130,472**
Year 7	$ 4,566	$ 4,566	$ 9,132	Year 7	$ 6,918.00	$ 6,918.00	$ 13,836	Year 7	$ 3,393.00	$ 3,393.00	$ 6,786	**$ 29,754**
Year 8	$11,019	$11,019	$ 22,038	Year 8	$ 6,997.00	$ 6,997.00	$ 13,994	Year 8	$ 3,379.00	$ 3,379.00	$ 6,758	**$ 42,790**
Year 9	$10,528	$10,528	$ 21,056	Year 9	$ 6,693.00	$ 6,693.00	$ 13,386	Year 9	$ 3,393.00	$ 3,393.00	$ 6,786	**$ 41,228**
Year 10	$ 3,618	$ 3,618	$ 7,236	Year 10	$ 13,487.00	$ 13,487.00	$ 26,974	Year 10	$ 3,379.00	$ 3,379.00	$ 6,758	**$ 40,968**
FMU Total:	**$46,028**	**$46,028**	**$ 92,056**	**Total:**	**$ 119,860.00**	**$ 106,060.00**	**$225,920**	**Total:**	**$ 38,346.00**	**$ 38,346.00**	**$ 76,692**	**$ 394,668**

Property-wide mgmt	Annual total w/ property-wide
$ 38,001	**$ 87,219**
$ 43,401	**$ 55,029**
$ 43,401	**$ 62,003**
$ 43,401	**$ 59,879**
$ 43,401	**$ 56,931**
$ 43,401	**$ 173,873**
$ 43,401	**$ 73,155**
$ 43,401	**$ 86,191**
$ 43,401	**$ 84,629**
$ 43,401	**$ 84,369**
$ 428,610	**$ 823,278**

6.1. Mauka forest restoration

6.1.1. Budget

Activity	NRCS code	Cost unit^{-1}	Start month	M1	M2	M3	M4	M5	M6	M7	M8	M9
Year 1 (2015)												
Fence maintenance	382	$0.25	6	$ 82	$ 117	$ 131	$ 125	$ 118	$ 88	$ 106	$ 89	$ -
Integrated pest mgmt.	595	$250	6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 285	$ -
Brush management (chem)	314	$550	6	$ 664	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Access control	472	$100	6	$ 121	$ -	$ -	$ -	$ -	$ -	$ -	$ 114	$ -
Rare habitat monitoring	643	$65	8	$ 78	$ -	$ -	$ -	$ -	$ -	$ -	$ 74	$ -
Brush management (manu)	314	$550	8	$ 664	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Woody residue treatment	384	$250	9	$ 302	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Seedlings	342	$5.35	11	$ 1,291	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Critical area planting	342	$275	11	$ 332	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	12	$ 266	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Year subtotal:	---	---	---	$ 3,916	$ 248	$ 256	$ 242	$ 206	$ 194	$ 668	$ 562	$ -
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 1,958	$ 124	$ 128	$ 121	$ 103	$ 97	$ 334	$ 281	$ -
FSP Share:	---	---	---	$ 1,958	$ 124	$ 128	$ 121	$ 103	$ 97	$ 334	$ 281	$ -
Year 1 Applicant total:	**$**	**3,145.36**		**Year 1 FSP Total:**		**$**		**3,145.36**				
Year 2 (2016)												
Fence maintenance	382	$0.25	1	$ -	$ 117	$ -	$ 125	$ -	$ 88	$ -	$ 89	$ -
Integrated pest mgmt.	595	$250	1	$ 302	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Access control	472	$100	1	$ 121	$ -	$ -	$ -	$ -	$ -	$ -	$ 114	$ -
Brush management (chem)	314	$550	3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	3	$ 266	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Rare habitat monitoring	643	$65	8	$ 78	$ -	$ -	$ -	$ -	$ -	$ -	$ 74	$ -
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Woody residue treatment	384	$250	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	11	$ 266	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Seedlings	342	$5.35	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Critical area planting	342	$275	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Year subtotal:	---	---	---	$ 1,032	$ 117	$ -	$ 125	$ -	$ 88	$ -	$ 277	$ -
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 516	$ 58	$ -	$ 62	$ -	$ 44	$ -	$ 138	$ -
FSP Share:	---	---	---	$ 516	$ 58	$ -	$ 62	$ -	$ 44	$ -	$ 138	$ -
Year 2 Applicant total:	**$**	**818.98**		**Year 2 FSP Total:**		**$**		**818.98**				

Year 3 (2017)													
Fence maintenance	382	$0.25	1	$ 82	$ -	$ 131	$ -	$ 118	$ -	$ 106	$ -	$ -	
Integrated pest mgmt.	595	$250	1	$ -	$ 541	$ -	$ -	$ -	$ -	$ -	$ 285	$ -	
Access control	472	$100	2	$ 121	$ 216	$ -	$ -	$ -	$ -	$ 181	$ 114	$ -	
Brush management (chem)	314	$550	3	$ -	$ 1,190	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Competition control	315	$220	3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Rare habitat monitoring	643	$65	8	$ 78	$ 141	$ -	$ -	$ -	$ -	$ 118	$ 74	$ -	
Brush management (manu)	314	$550	8	$ -	$ 1,190	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Woody residue treatment	384	$250	10	$ -	$ 541	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Competition control	315	$220	11	$ -	$ 476	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Seedlings	342	$5.35	12	$ -	$ 2,315	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Critical area planting	342	$275	12	$ -	$ 595	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Year subtotal:	---	---	---	$ 281	$ 7,205	$ 131	$ -	$ 118	$ -	$ 404	$ 473	$ -	
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Applicant share:	---	---	---	$ 141	$ 3,602	$ 66	$ -	$ 59	$ -	$ 202	$ 236	$ -	
FSP Share:	---	---	---	$ 141	$ 3,602	$ 66	$ -	$ 59	$ -	$ 202	$ 236	$ -	
Year 3 Applicant total:	**$**	**4,305.95**		**Year 3 FSP Total:**		**$**		**4,305.95**					
Year 4 (2018)													
Fence maintenance	382	$0.25	1	$ -	$ 117	$ -	$ 125	$ -	$ 88	$ -	$ 89	$ -	
Integrated pest mgmt.	595	$250	1	$ 302	$ -	$ -	$ -	$ -	$ -	$ 452	$ -	$ -	
Access control	472	$100	2	$ 121	$ 216	$ -	$ -	$ -	$ -	$ 181	$ 114	$ -	
Brush management (chem)	314	$550	3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 627	$ -	
Competition control	315	$220	3	$ -	$ 476	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Rare habitat monitoring	643	$65	8	$ 78	$ 141	$ -	$ -	$ -	$ -	$ 118	$ 74	$ -	
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 627	$ -	
Woody residue treatment	384	$250	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 285	$ -	
Competition control	315	$220	11	$ -	$ 476	$ -	$ -	$ -	$ -	$ -	$ 251	$ -	
Seedlings	342	$5.35	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,219	$ -	
Critical area planting	342	$275	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 313	$ -	
Year subtotal:	---	---	---	$ 501	$ 1,426	$ -	$ 125	$ -	$ 88	$ 750	$ 3,599	$ -	
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Applicant share:	---	---	---	$ 250	$ 713	$ -	$ 62	$ -	$ 44	$ 375	$ 1,799	$ -	
FSP Share:	---	---	---	$ 250	$ 713	$ -	$ 62	$ -	$ 44	$ 375	$ 1,799	$ -	
Year 4 Applicant total:	**$**	**3,244.00**		**Year 4 FSP Total:**		**$**		**3,244.00**					

Year 5 (2019)												
Fence maintenance	382	$0.25	1	$ 82	$ -	$ 131	$ -	$ 118	$ 88	$ 106	$ -	$ -
Integrated pest mgmt.	595	$250	1	$ -	$ 541	$ -	$ -	$ -	$ 293	$ -	$ 285	$ -
Access control	472	$100	2	$ 121	$ 216	$ -	$ -	$ -	$ 117	$ 181	$ 114	$ -
Brush management (chem)	314	$550	3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 251	$ -
Rare habitat monitoring	643	$65	8	$ 78	$ 141	$ -	$ -	$ -	$ 78	$ 118	$ 74	$ 156
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Woody residue treatment	384	$250	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	11	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 251	$ -
Seedlings	342	$5.35	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Critical area planting	342	$275	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Year subtotal:	---	---	---	$ 281	$ 898	$ 131	$ -	$ 118	$ 576	$ 405	$ 974	$ 156
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 141	$ 449	$ 66	$ -	$ 59	$ 288	$ 202	$ 487	$ 78
FSP Share:	---	---	---	$ 141	$ 449	$ 66	$ -	$ 59	$ 288	$ 202	$ 487	$ 78
Year 5 Applicant total:	**$**	**1,769.50**		**Year 5 FSP Total:**		**$**		**1,769.50**				
Year 6 (2020)												
Fence maintenance	382	$0.25	1	$ -	$ 117	$ -	$ 125	$ -	$ 88	$ -	$ 89	$ -
Integrated pest mgmt.	595	$250	1	$ 302	$ -	$ -	$ -	$ -		$ -	$ -	$ 599
Access control	472	$100	2	$ 121	$ 216	$ -	$ -	$ -	$ 117	$ 181	$ 114	$ -
Competition control	315	$220	3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Brush management (chem)	314	$550	3	$ 664	$ -	$ -	$ -	$ -	$ -	$ 994	$ -	$ -
Rare habitat monitoring	643	$65	8	$ 78	$ 141	$ -	$ -	$ -	$ 76	$ 118	$ 74	$ 156
Brush management (manu)	314	$550	8	$ 664	$ -	$ -	$ -	$ -	$ -	$ 994	$ -	$ -
Competition control	315	$220	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Year subtotal:	---	---	---	$ 1,829	$ 474	$ -	$ 125	$ -	$ 281	$ 2,287	$ 277	$ 755
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%
Applicant share:	---	---	---	$ 914	$ 237	$ -	$ 62	$ -	$ 141	$ 1,144	$ 138	$ 378
FSP Share:	---	---	---	$ 914	$ 237	$ -	$ 62	$ -	$ 141	$ 1,144	$ 138	$ 378
Year 6 Applicant total:	**$**	**3,013.24**		**Year 6 FSP Total:**		**$**		**3,013.24**				

Year 7 (2021)													
Fence maintenance	382	$0.25	1	$ 82	$ -	$ 131	$ -	$ 118	$ 88	$ 106	$ -	$ -	
Access control	472	$100	1	$ 121	$ 216	$ 259	$ 214	$ 186	$ 117	$ 181	$ 114	$ -	
Integrated pest mgmt.	595	$250	1	$ -	$ 541	$ -	$ 535	$ -	$ 293	$ 452	$ 285	$ -	
Competition control	315	$220	3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Brush management (chem)	314	$550	3	$ -	$ -	$ -	$ -	$ -	$ 644	$ -	$ 627	$ -	
Rare habitat monitoring	643	$65	8	$ 78	$ 141	$ 168	$ 139	$ 121	$ 76	$ 118	$ 74	$ 156	
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 627	$ -	
Woody residue treatment	384	$250	10	$ -	$ -	$ -	$ -	$ -	$ 293	$ -	$ -	$ -	
Competition control	315	$220	11	$ -	$ -	$ -	$ -	$ -	$ 257	$ -	$ -	$ -	
Seedlings	342	$5.35	12	$ -	$ -	$ -	$ -	$ -	$ 1,252	$ -	$ -	$ -	
Critical area planting	342	$275	12	$ -	$ -	$ -	$ -	$ -	$ 322	$ -	$ -	$ -	
Year subtotal:	---	---	---	$ 281	$ 898	$ 558	$ 888	$ 425	$ 3,342	$ 857	$ 1,726	$ 156	
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Applicant share:	---	---	---	$ 141	$ 449	$ 279	$ 444	$ 212	$ 1,671	$ 428	$ 863	$ 78	
FSP Share:	---	---	---	$ 141	$ 449	$ 279	$ 444	$ 212	$ 1,671	$ 428	$ 863	$ 78	
Year 7 Applicant total:	**$**	**4,565.57**		**Year 7 FSP Total:**		**$**	**4,565.57**						
Year 8 (2022)													
Fence maintenance	382	$0.25	1	$ -	$ 117	$ -	$ 125	$ -	$ 88	$ -	$ 89	$ -	
Access control	472	$100	1	$ 121	$ 216	$ 259	$ -	$ 186	$ 117	$ 181	$ 114	$ -	
Integrated pest mgmt.	595	$250	1	$ 302	$ -	$ 647	$ 214	$ 466		$ 452	$ -	$ 599	
Competition control	315	$220	3	$ -	$ -	$ -	$ -	$ -	$ 257	$ -	$ -	$ -	
Brush management (chem)	314	$550	3	$ -	$ 1,190	$ 1,423	$ 1,178	$ -	$ -	$ -	$ -	$ -	
Rare habitat monitoring	643	$65	8	$ 78	$ 141	$ 168	$ 139	$ 121	$ 76	$ 118	$ 74	$ 156	
Brush management (manu)	314	$550	8	$ -	$ 1,190	$ 1,423	$ 1,178	$ -	$ -	$ -	$ -	$ -	
Woody residue treatment	384	$250	10	$ -	$ -	$ 647	$ 535	$ -	$ -	$ -	$ -	$ -	
Competition control	315	$220	11	$ -	$ -	$ 569	$ 471	$ -	$ 257	$ -	$ -	$ -	
Seedlings	342	$5.35	12	$ -	$ -	$ 2,768	$ 2,291	$ -	$ -	$ -	$ -	$ -	
Critical area planting	342	$275	12	$ -	$ -	$ 711	$ 589	$ -	$ -	$ -	$ -	$ -	
Year subtotal:	---	---	---	$ 500	$ 2,853	$ 8,615	$ 6,720	$ 773	$ 795	$ 751	$ 277	$ 755	
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Applicant share:	---	---	---	$ 250	$ 1,427	$ 4,308	$ 3,360	$ 387	$ 398	$ 376	$ 138	$ 378	
FSP Share:	---	---	---	$ 250	$ 1,427	$ 4,308	$ 3,360	$ 387	$ 398	$ 376	$ 138	$ 378	
Year 8 Applicant total:	**$**	**11,019.41**		**Year 8 FSP Total:**		**$**	**11,019.41**						

Year 9 (2023)													
Fence maintenance	382	$0.25	1	$ 82	$ -	$ 131	$ -	$ 118	$ -	$ 106	$ -	$ -	
Integrated pest mgmt.	595	$250	1	$ -	$ -	$ -	$ -	$ -	$ 293				
Access control	472	$100	1	$ 121	$ 216	$ 259	$ 214	$ 186	$ 117	$ 181	$ 114	$ -	
Brush management (chem)	314	$550	3					$ 1,025		$ 994		$ 1,318	
Competition control	315	$220	3			$ 569	$ 471		$ -		$ -	$ -	
Brush management (manu)	314	$550	8					$ 1,025	$ -	$ 994		$ -	
Integrated pest mgmt.	595	$250	1	$ -	$ 541		$ 535	$ -	$ -	$ -	$ 285	$ 1,318	
Rare habitat monitoring	643	$65	8	$ 78	$ 141	$ 168	$ 139	$ 121	$ 76	$ 118	$ 74	$ 156	
Woody residue treatment	384	$250	10					$ 466	$ -	$ -	$ -	$ 599	
Competition control	315	$220	11			569	$ 471	$ 410	$ -	$ -	$ -	$ 527	
Seedlings	342	$5.35	12					$ 1,995	$ -	$ -	$ -	$ 2,564	
Critical area planting	342	$275	12					$ 513	$ -	$ -	$ -	$ 659	
Year subtotal:	---	---	---	$ 281	$ 898	$ 1,696	$ 1,830	$ 5,859	$ 486	$ 2,393	$ 473	$ 7,141	
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Applicant share:	---	---	---	$ 141	$ 449	$ 848	$ 915	$ 2,929	$ 243	$ 1,196	$ 236	$ 3,571	
FSP Share:	---	---	---	$ 141	$ 449	$ 848	$ 915	$ 2,929	$ 243	$ 1,196	$ 236	$ 3,571	
Year 9 Applicant total:	**$**	**10,528.29**		**Year 9 FSP Total:**		**$**		**10,528.29**					
Year 10 (2024)													
Fence maintenance	382	$0.25	1	$ -	$ 117	$ -	$ 125	$ -	$ 88	$ -	$ 89	$ -	
Access control	472	$100	1	$ 121	$ 216	$ 259	$ 214	$ -	$ 117	$ 181	$ 114	$ -	
Integrated pest mgmt.	595	$250	1	$ 302	$ -	$ 647	$ -	$ 466	$ -	$ 452	$ -	$ 599	
Competition control	643	$65	3	$ -	$ -	$ -	$ -	$ 410	$ -	$ -	$ -	$ 527	
Brush management (chem)	314	$550	3	$ -	$ -	$ -	$ -	$ 186	$ -	$ -	$ -	$ -	
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Rare habitat monitoring	643	$65	8	$ -	$ -	$ 168	$ 139	$ 121	$ 76	$ -	$ -	$ 156	
Competition control	643	$65	8	$ -	$ -	$ -	$ -	$ -	$ -	$ 118	$ -	$ -	
Woody residue treatment	384	$250	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Competition control	315	$220	11	$ -	$ -	$ -	$ -	$ 410	$ -	$ -	$ -	$ 527	
Seedlings	342	$5.35	12	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Critical area planting	342	$275	12	$ 78	$ 141	$ -	$ -	$ -	$ -		$ 74	$ -	
Year subtotal:	---	---	---	$ 501	$ 474	$ 1,074	$ 478	$ 1,593	$ 281	$ 751	$ 277	$ 1,809	
NRCS%	---	---	---	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Applicant share:	---	---	---	$ 250	$ 237	$ 537	$ 239	$ 797	$ 141	$ 376	$ 138	$ 905	
FSP Share:	---	---	---	$ 250	$ 237	$ 537	$ 239	$ 797	$ 141	$ 376	$ 138	$ 904.50	
Year 10 Applicant total:	**$**	**3,618.41**		**Year 10 FSP Total:**		**$**		**3,618.41**					

Table 9. Annual budget totals for Mauka FMU.

Period	Applicant	FSP	Mauka
Year 1	$ 3,145	$ 3,145	$ 6,290
Year 2	$ 819	$ 819	$ 1,638
Year 3	$ 4,306	$ 4,306	$ 8,612
Year 4	$ 3,244	$ 3,244	$ 6,488
Year 5	$ 1,770	$ 1,770	$ 3,540
Year 6	$ 3,013	$ 3,013	$ 6,026
Year 7	$ 4,566	$ 4,566	$ 9,132
Year 8	$11,019	$11,019	$ 22,038
Year 9	$10,528	$10,528	$ 21,056
Year 10	$ 3,618	$ 3,618	$ 7,236
FMU Total:	**$46,028**	**$46,028**	**$ 92,056**

6.1.2. Schedule

Activity	NRCS code	Year	Start month	Field								
				M1	M2	M3	M4	M5	M6	M7	M8	M9
Year 1 (2015)												
Fence maintenance	382	2014	6	■	■	■	■	■	■	■	■	
Integrated pest mgmt.	595	2015	6								■	
Brush management (chem)	314	2014	6	■								
Access control	472	2014	6	■							■	
Rare habitat monitoring	643	2014	8	■							■	
Brush management (manu)	314	2014	8	■								
Woody residue treatment	384	2014	9	■								
Seedlings	342	2014	11	■								
Critical area planting	342	2014	11	■								
Competition control	315	2014	12	■								
Year 2 (2016)												
Fence maintenance	382	2015	1		■		■		■		■	
Integrated pest mgmt.	595	2015	1	■								
Access control	472	2015	1	■							■	
Brush management (chem)	314	2015	3									
Competition control	315	2015	3	■								
Rare habitat monitoring	643	2015	8	■							■	
Brush management (manu)	314	2015	8									
Woody residue treatment	384	2015	10									
Competition control	315	2015	11	■								
Seedlings	342	2015	12									
Critical area planting	342	2015	12									
Year 3 (2017)												
Fence maintenance	382	2016	1	■		■		■		■		
Integrated pest mgmt.	595	2015	1		■						■	
Access control	472	2016	2	■	■					■	■	
Brush management (chem)	314	2016	3		■							
Competition control	315	2016	3									
Rare habitat monitoring	643	2016	8	■	■					■	■	
Brush management (manu)	314	2016	8		■							
Woody residue treatment	384	2016	10		■							
Competition control	315	2016	11		■							
Seedlings	342	2016	12		■							
Critical area planting	342	2016	12		■							

Year 4 (2018)				
Fence maintenance	382	2016	1	
Integrated pest mgmt.	595	2016	1	
Access control	472	2016	2	
Brush management (chem)	314	2016	3	
Competition control	315	2016	3	
Rare habitat monitoring	643	2016	8	
Brush management (manu)	314	2016	8	
Woody residue treatment	384	2016	10	
Competition control	315	2016	11	
Seedlings	342	2016	12	
Critical area planting	342	2016	12	

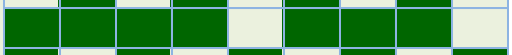
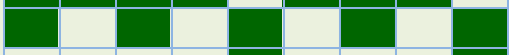
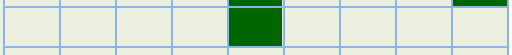
Year 5 (2019)				
Fence maintenance	382	2016	1	
Integrated pest mgmt.	595	2015	1	
Access control	472	2016	2	
Brush management (chem)	314	2016	3	
Competition control	315	2016	3	
Rare habitat monitoring	643	2016	8	
Brush management (manu)	314	2016	8	
Woody residue treatment	384	2016	10	
Competition control	315	2016	11	
Seedlings	342	2016	12	
Critical area planting	342	2016	12	

Year 6 (2020)				
Fence maintenance	382	2016	1	
Integrated pest mgmt.	595	2014	1	
Access control	472	2016	2	
Competition control	315	2016	3	
Brush maintenance (chem)	314	2016	3	
Rare habitat monitoring	643	2016	8	
Brush management (manu)	314	2016	8	
Competition control	315	2016	12	

Year 7 (2021)				
Fence maintenance	382	2016	1	
Access control	472	2016	1	
Integrated pest mgmt.	595	2016	1	
Competition control	315	2016		
Brush maintenance (chem)	314	2016	3	
Rare habitat monitoring	643	2016	8	
Brush management (manu)	314	2016	8	
Woody residue treatment	384	2016	10	
Competition control	315	2016	11	
Seedlings	342	2016	12	
Critical area planting	342	2016	12	

Year 8 (2022)				
Fence maintenance	382	2016	1	
Access control	472	2016	1	
Integrated pest mgmt.	595	2016	1	
Competition control	315	2016	3	
Brush management (chem)	314	2016	3	
Rare habitat monitoring	643	2016	8	
Brush management (manu)	314	2016	8	
Rare habitat monitoring	643	2016	8	
Brush management (manu)	314	2016	8	
Woody residue treatment	384	2016	10	
Competition control	315	2016	11	
Seedlings	342	2016	12	
Critical area planting	342	2016	12	

Year 9 (2023)				
Fence maintenance	382	2016	1	
Access control	472	2016	1	
Brush management (chem)	314	2016	3	
Competition control	315	2016	3	
Brush management (manu)	314	2016	8	
Integrated pest mgmt.	595	2015	1	
Rare habitat monitoring	643	2016	8	
Woody residue treatment	384	2016	10	
Competition control	315	2016	11	
Seedlings	342	2016	12	
Critical area planting	342	2016	12	

Year 10 (2024)				
Fence maintenance	382	2016	1	
Access control	472	2016	1	
Integrated pest mgmt.	595	2014	1	
Competition control	643	2014	3	
Brush management (chem)	314	2016	3	
Brush management (manu)	314	2016	8	
Rare habitat monitoring	643	2016	8	
Competition control	643	2016	8	
Woody residue treatment	384	2016	10	
Competition control	315	2016	11	
Seedlings	342	2016	12	
Critical area planting	342	2016	12	

6.2. Kalahe‘e reforestation area

6.2.1. Budget

Table 10. Management activities at Kalah‘e are prescribed in five fields, K1 – K5.. Fields K4 and K5 are positioned such that separate fences make sense for each field. Fencing, site preparation (brush management), and planting activities (seedlings, critical area planting, competition control) will be focused earlier in the project period. Maintenance activities will continue throughout the decade.

Waimea plans to obtain funds from Hawaii CREP for restoration work in K1 in the Kalahe`e site. FSP is being asked for funds related to fencing for K1. Waimea is also in contract with EQIP to restore 5 acres within K4.

Activity	NRCS code	Cost unit^{-1}	Field	K1	K2	K3	K4	K5
			Area	14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
			Annual	2 ac	2 ac	2 ac	1 ac	2 ac
Year 1 (2015)			**Month**					
Fence construction	382	$7.00	6	$ 33,950	$ -	$ -	$ -	$ -
Brush management (chem)	314	$825	6	$ -	$ -	$ -	$ 825	$ -
Access control	472	$100	6	$ 200	$ -	$ -	$ -	$ -
Rare habitat monitoring	643	$65	8	$ -	$ -	$ -	$ 65	$ -
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ 550	$ -
Woody residue treatment	384	$250	9	$ -	$ -	$ -	$ 250	$ -
Seedlings	342	$5.35	11	$ -	$ -	$ -	$ 1,070	$ -
Critical area planting	342	$275	11	$ -	$ -	$ -	$ -	$ -
Competition control	315	$220	12	$ 440	$ -	$ -	$ -	$ -
Year subtotal:	---	---	---	$ 34,590	$ -	$ -	$ 2,760	$ -
NRCS%	---	---	---	50%	50%	50%	0%	50%
Applicant share:	---	---	---	$ 17,295	$ -	$ -	$ 2,760	$ -
FSP Share:	---	---	---	$ 17,295	$ -	$ -	$ -	$ -
Year 1 Applicant total:	**$**	**20,055.00**			**Year 1 FSP Total:**	**$**		**17,295.00**
Year 2 (2016)			**Month**					
Fence construction	382	$7.00	---	$ -	$ -	$ -	$ -	$ -
Fence maintenance	382	$0.25	---	$ 572	$ -	$ -	$ -	$ -
Access control	472	$100	2	$ 200	$ -	$ -	$ -	$ -
Brush management (chem)	314	$825	3	$ -	$ -	$ -	$ 825	$ -
Competition control	315	$220	3	$ 440	$ -	$ -	$ -	$ -
Rare habitat monitoring	643	$65	8	$ -	$ -	$ -	$ 65	$ -
Brush management (manu)	314	$550	8	$ -	$ -	$ -	$ 550	$ -
Woody residue treatment	384	$250	10	$ -	$ -	$ -	$ 250	$ -
Competition control	315	$220	11	$ 440	$ -	$ -	$ -	$ -
Seedlings	342	$5.35	12	$ -	$ -	$ -	$ 1,070	$ -
Critical area planting	342	$275	12	$ -	$ -	$ -	$ -	$ -
Year subtotal:	---	---	---	$ 1,652	$ -	$ -	$ 2,760	$ -
NRCS%	---	---	---	50%	50%	50%	0%	50%
Applicant share:	---	---	---	$ 826	$ -	$ -	$ 2,760	$ -
FSP Share:	---	---	---	$ 826	$ -	$ -	$ -	$ -
Year 2 Applicant total:	**$**	**3,585.84**			**Year 2 FSP Total:**	**$**		**825.84**

Year 3 (2017)			Month									
Fence construction	382	$7.00	6	$	-	$	-	$	-	$	-	$	-
Fence maintenance	382	$0.25	6	$	572	$	-	$	-	$	-	$	-
Access control	472	$100	2	$	200	$	-	$	-	$	-	$	-
Brush management (chem)	314	$825	3	$	-	$	-	$	-	$	825	$	-
Competition control	315	$220	3	$	440	$	-	$	-	$	-	$	-
Rare habitat monitoring	643	$65	8	$	-	$	-	$	-	$	65	$	-
Brush management (manu)	314	$550	8	$	-	$	-	$	-	$	550	$	-
Woody residue treatment	384	$250	10	$	-	$	-	$	-	$	250	$	-
Competition control	315	$220	11	$	440	$	-	$	-	$	-	$	-
Seedlings	342	$5.35	12	$	-	$	-	$	-	$	1,070	$	-
Critical area planting	342	$275	12	$	-	$	-	$	-	$	-	$	-
Year subtotal:	---	---	---	$	1,652	$	-	$	-	$	2,760	$	-
NRCS%	---	---	---		50%		50%		50%		0%		50%
Applicant share:	---	---	---	$	826	$	-	$	-	$	2,760	$	-
FSP Share:	---	---	---	$	826	$	-	$	-	$	-	$	-
Year 3 Applicant total:	**$**	**3,585.84**				**Year 3 FSP Total:**		**$**				**825.84**

Year 4 (2018)			Month									
Fence maintenance	382	$0.25	2	$	572	$	-	$	-	$	-	$	-
Access control	472	$100	2	$	200	$	-	$	-	$	-	$	-
Brush management (chem)	314	$825	3	$	-	$	-	$	-	$	825	$	-
Competition control	315	$220	3	$	440	$	-	$	-	$	-	$	-
Rare habitat monitoring	643	$65	8	$	-	$	-	$	-	$	65	$	-
Brush management (manu)	314	$550	8	$	-	$	-	$	-	$	550	$	-
Woody residue treatment	384	$250	10	$	-	$	-	$	-	$	250	$	-
Competition control	315	$220	11	$	440	$	-	$	-	$	-	$	-
Seedlings	342	$5.35	12	$	-	$	-	$	-	$	1,070	$	-
Critical area planting	342	$275	12	$	-	$	-	$	-	$	-	$	-
Year subtotal:	---	---	---	$	1,652	$	-	$	-	$	2,760	$	-
NRCS%	---	---	---		50%		50%		50%		0%		50%
Applicant share:	---	---	---	$	826	$	-	$	-	$	2,760	$	-
FSP Share:	---	---	---	$	826	$	-	$	-	$	-	$	-
Year 4 Applicant total:	**$**	**3,585.84**				**Year 4 FSP Total:**		**$**				**825.84**

Year 5 (2019)			Month									
Fence maintenance	382	$0.25	2	$	572	$	-	$	-	$	-	$ -
Access control	472	$100	2	$	200	$	-	$	-	$	-	$ -
Brush management (chem)	314	$825	3	$	-	$	-	$	-	$	825	$ -
Competition control	315	$220	3	$	440	$	-	$	-	$	-	$ -
Rare habitat monitoring	643	$65	8	$	-	$	-	$	-	$	65	$ -
Brush management (manu)	314	$550	8	$	-	$	-	$	-	$	550	$ -
Woody residue treatment	384	$250	10	$	-	$	-	$	-	$	250	$ -
Competition control	315	$220	11	$	440	$	-	$	-	$	-	$ -
Seedlings	342	$5.35	12	$	-	$	-	$	-	$	1,070	$ -
Critical area planting	342	$275	12	$	-	$	-	$	-	$	-	$ -
Year subtotal:	---	---	---	$	1,652	$	-	$	-	$	2,760	$ -
NRCS%	---	---	---		50%		50%		50%		0%	50%
Applicant share:	---	---	---	$	826	$	-	$	-	$	2,760	$ -
FSP Share:	---	---	---	$	826	$	-	$	-	$	-	$ -
Year 5 Applicant total:	**$**	**3,585.84**				**Year 5 FSP Total:**		**$**				**825.84**

Year 6 (2020)			Month									
Fence construction	382	$7.00	2	$	-	$	24,224	$	-	$	66,542	$ -
Fence maintenance	382	$0.25	2	$	-	$	-	$	-	$	-	$ -
Access control	472	$100	2	$	200	$	200	$	-	$	100	$ -
Brush suppression (chem)	314	$150	2	$	-	$	300	$	-	$	300	$ -
Brush management (chem)	314	$825	3	$	-	$	1,650	$	-	$	825	$ -
Competition control	315	$220	3	$	440	$	-	$	-	$	220	$ -
Rare habitat monitoring	643	$65	8	$	-	$	130	$	-	$	65	$ -
Brush management (manu)	314	$550	8	$	-	$	1,100	$	-	$	550	$ -
Woody residue treatment	384	$250	10	$	-	$	500	$	-	$	250	$ -
Competition control	315	$220	11	$	440	$	440	$	-	$	220	$ -
Seedlings	342	$5.35	12	$	-	$	2,140	$	-	$	1,070	$ -
Critical area planting	342	$275	12	$	-	$	550	$	-	$	275	$ -
Year subtotal:	---	---	---	$	1,080	$	31,234	$	-	$	70,417	$ -
NRCS%	---	---	---		50%		50%		50%		50%	50%
Applicant share:	---	---	---	$	540	$	15,617	$	-	$	35,209	$ -
FSP Share:	---	---	---	$	540	$	15,617	$	-	$	35,209	$ -
Year 6 Applicant total:	**$**	**51,365.50**				**Year 6 FSP Total:**		**$**				**51,365.50**

Year 7 (2021)			Month											
Fence maintenance	382	$0.25	2	$	572	$	865	$	-	$	594	$	-	
Access control	472	$100	2	$	200	$	200	$	-	$	100	$	-	
Brush suppression (chem)	314	$150	2	$	-	$	-	$	-	$	-	$	-	
Brush management (chem)	314	$825	3	$	-	$	1,650	$	-	$	825	$	-	
Competition control	315	$220	3	$	440	$	440	$	-	$	220	$	-	
Rare habitat monitoring	643	$65	8	$	-	$	130	$	-	$	65	$	-	
Brush management (manu)	314	$550	8	$	-	$	1,100	$	-	$	550	$	-	
Woody residue treatment	384	$250	10	$	-	$	500	$	-	$	250	$	-	
Competition control	315	$220	11	$	440	$	440	$	-	$	220	$	-	
Seedlings	342	$5.35	12	$	-	$	2,140	$	-	$	1,070	$	-	
Critical area planting	342	$275	12	$	-	$	550	$	-	$	275	$	-	
Year subtotal:	---	---	---	$	1,652	$	8,015	$	-	$	4,169	$	-	
NRCS%	---	---	---		50%		50%		50%		50%		50%	
Applicant share:	---	---	---	$	826	$	4,008	$	-	$	2,085	$	-	
FSP Share:	---	---	---	$	826	$	4,008	$	-	$	2,085	$	-	
Year 7 Applicant total:	**$**	**6,917.84**					**Year 7 FSP Total:**	**$**					**6,917.84**	

Year 8 (2022)			Month											
Fence maintenance	382	$0.25	2	$	-	$	865	$	-	$	594	$	-	
Access control	472	$100	2	$	200	$	200	$	-	$	100	$	-	
Brush suppression (chem)	314	$150	2	$	-	$	300	$	-	$	300	$	-	
Brush management (chem)	314	$825	3	$	-	$	1,650	$	-	$	825	$	-	
Competition control	315	$220	3	$	440	$	440	$	-	$	220	$	-	
Rare habitat monitoring	643	$65	8	$	130	$	130	$	-	$	65	$	-	
Brush management (manu)	314	$550	8	$	-	$	1,100	$	-	$	550	$	-	
Woody residue treatment	384	$250	10	$	-	$	500	$	-	$	250	$	-	
Competition control	315	$220	11	$	440	$	440	$	-	$	220	$	-	
Seedlings	342	$5.35	12	$	-	$	2,140	$	-	$	1,070	$	-	
Critical area planting	342	$275	12	$	-	$	550	$	-	$	275	$	-	
Year subtotal:	---	---	---	$	1,210	$	8,315	$	-	$	4,469	$	-	
NRCS%	---	---	---		50%		50%		50%		50%		50%	
Applicant share:	---	---	---	$	605	$	4,158	$	-	$	2,235	$	-	
FSP Share:	---	---	---	$	605	$	4,158	$	-	$	2,235	$	-	
Year 8 Applicant total:	**$**	**6,997.06**					**Year 8 FSP Total:**	**$**					**6,997.06**	

Year 9 (2023)			Month											
Fence maintenance	382	$0.25	2	$	572	$	865	$	-	$	594	$	-	
Access control	472	$100	2	$	200	$	200	$	-	$	100	$	-	
Brush suppression (chem)	314	$150	2	$	300	$	-	$	-	$	-	$	-	
Brush management (chem)	314	$825	3	$	-	$	1,650	$	-	$	825	$	-	
Competition control	315	$220	3	$	-	$	440	$	-	$	220	$	-	
Rare habitat monitoring	643	$65	8	$	130	$	130	$	-	$	65	$	-	
Brush management (manu)	314	$550	8	$	-	$	1,100	$	-	$	550	$	-	
Woody residue treatment	384	$250	10	$	-	$	500	$	-	$	250	$	-	
Competition control	315	$220	11	$	-	$	440	$	-	$	220	$	-	
Seedlings	342	$5.35	12	$	-	$	2,140	$	-	$	1,070	$	-	
Critical area planting	342	$275	12	$	-	$	550	$	-	$	275	$	-	
Year subtotal:	---	---	---	$	1,202	$	8,015	$	-	$	4,169	$	-	
NRCS%	---	---	---		50%		50%		50%		50%		50%	
Applicant share:	---	---	---	$	601	$	4,008	$	-	$	2,085	$	-	
FSP Share:	---	---	---	$	601	$	4,008	$	-	$	2,085	$	-	
Year 9 Applicant total:	**$**	**6,692.84**					**Year 9 FSP Total:**	**$**					**6,692.84**	

Year 10 (2024)			Month											
Fence construction	382	$7.00	2	$	-	$	-	$	16,016	$	-	$	26,879	
Fence maintenance	382	$0.25	2	$	-	$	865	$	-	$	594	$	-	
Access control	472	$100	2	$	200	$	200	$	200	$	100	$	200	
Brush suppression (chem)	314	$150	2	$	-	$	300	$	-	$	300	$	-	
Brush management (chem)	314	$825	3	$	-	$	1,650	$	1,650	$	825	$	1,650	
Competition control	315	$220	3	$	-	$	440	$	-	$	220	$	440	
Rare habitat monitoring	643	$65	8	$	130	$	130	$	130	$	65	$	130	
Brush management (manu)	314	$550	8	$	-	$	1,100	$	1,100	$	550	$	1,100	
Woody residue treatment	384	$250	10	$	-	$	500	$	500	$	250	$	500	
Competition control	315	$220	11	$	-	$	440	$	440	$	220	$	440	
Seedlings	342	$5.35	12	$	-	$	2,140	$	2,140	$	1,070	$	2,140	
Critical area planting	342	$275	12	$	-	$	550	$	550	$	275	$	550	
Year subtotal:	---	---	---	$	330	$	8,315	$	6,710	$	4,469	$	7,150	
NRCS%	---	---	---		50%		50%		50%		50%		50%	
Applicant share:	---	---	---	$	165	$	4,158	$	3,355	$	2,235	$	3,575	
FSP Share:	---	---	---	$	165	$	4,158	$	3,355	$	2,235	$	3,575	
Year 10 Applicant total:	**$**	**13,487.06**					**Year 10 FSP Total:**	**$**					**13,487.06**	

Table 11. Annual budget totals for Kalahe'e FMU.

Period	Applicant	FSP	Kalahe'e
Year 1	$ 11,084.00	$ 8,324.00	$ 19,408
Year 2	$ 3,586.00	$ 826.00	$ 4,412
Year 3	$ 3,586.00	$ 826.00	$ 4,412
Year 4	$ 3,586.00	$ 826.00	$ 4,412
Year 5	$ 3,586.00	$ 826.00	$ 4,412
Year 6	$ 51,366.00	$ 51,366.00	$102,732
Year 7	$ 6,918.00	$ 6,918.00	$ 13,836
Year 8	$ 6,997.00	$ 6,997.00	$ 13,994
Year 9	$ 6,693.00	$ 6,693.00	$ 13,386
Year 10	$ 13,487.00	$ 13,487.00	$ 26,974
Total:	**$ 110,889.00**	**$ 97,089.00**	**$207,978**

6.2.2. Schedule

Activity	NRCS code	Year	Start month	Field				
				K1	K2	K3	K4	K5
				14.6 ac	16.6 ac	11.2 ac	14.7 ac	10.2 ac
Year 1 (2015)								
Fence construction	382	2015	6	■				
Brush management (chem)	314	2015	6				■	
Access control	472	2015	6	■				
Rare habitat monitoring	643	2015	8				■	
Brush management (manu)	314	2015	8				■	
Woody residue treatment	384	2015	9				■	
Seedlings	342	2015	11				■	
Critical area planting	342	2015	11					
Competition control	315	2015	12	■				
Year 2 (2016)								
Fence construction	382	2014	---					
Fence maintenance	382	2016	---	■				
Access control	472	2016	2	■				
Brush management (chem)	314	2016	3				■	
Competition control	315	2016	3	■				
Rare habitat monitoring	643	2016	8				■	
Brush management (manu)	314	2016	8				■	
Woody residue treatment	384	2016	10				■	
Competition control	315	2016	11	■				
Seedlings	342	2016	12				■	
Critical area planting	342	2016	12					

Year 3 (2017)									
Fence construction	382	2014	6						
Fence maintenance	382	2017	6						
Access control	472	2017	2						
Brush management (chem)	314	2017	3						
Competition control	315	2017	3						
Rare habitat monitoring	643	2017	8						
Brush management (manu)	314	2017	8						
Woody residue treatment	384	2017	10						
Competition control	315	2017	11						
Seedlings	342	2017	12						
Critical area planting	342	2017	12						

Year 4 (2018)									
Fence maintenance	382	2014	2						
Access control	472	2018	2						
Brush management (chem)	314	2018	3						
Competition control	315	2018	3						
Rare habitat monitoring	643	2018	8						
Brush management (manu)	314	2018	8						
Woody residue treatment	384	2018	10						
Competition control	315	2018	11						
Seedlings	342	2018	12						
Critical area planting	342	2018	12						

Year 5 (2019)									
Fence maintenance	382	2014	2						
Access control	472	2019	2						
Brush management (chem)	314	2019	3						
Competition control	315	2019	3						
Rare habitat monitoring	643	2019	8						
Brush management (manu)	314	2019	8						
Woody residue treatment	384	2019	10						
Competition control	315	2019	11						
Seedlings	342	2019	12						
Critical area planting	342	2019	12						

Year 6 (2020)								
Fence construction	382	2020	2		■		■	
Fence maintenance	382	2020	2					
Access control	472	2020	2	■	■		■	
Brush suppression (chem)	314	2020	2		■		■	
Brush management (chem)	314	2020	3		■		■	
Competition control	315	2020	3	■			■	
Rare habitat monitoring	643	2020	8		■		■	
Brush management (manu)	314	2020	8		■		■	
Woody residue treatment	384	2020	10		■		■	
Competition control	315	2020	11	■	■		■	
Seedlings	342	2020	12		■		■	
Critical area planting	342	2020	12		■		■	

Year 7 (2021)								
Fence maintenance	382	2016	2	■	■		■	
Access control	472	2021	2	■	■		■	
Brush suppression (chem)	314	2021	2					
Brush management (chem)	314	2021	3		■		■	
Competition control	315	2021	3	■	■		■	
Rare habitat monitoring	643	2021	8		■		■	
Brush management (manu)	314	2021	8		■		■	
Woody residue treatment	384	2021	10		■		■	
Competition control	315	2021	11	■	■		■	
Seedlings	342	2021	12		■		■	
Critical area planting	342	2021	12		■		■	

Year 8 (2022)								
Fence maintenance	382	2016	2		■		■	
Access control	472	2022	2	■	■		■	
Brush suppression (chem)	314	2022	2		■		■	
Brush management (chem)	314	2022	3		■		■	
Competition control	315	2022	3	■	■		■	
Rare habitat monitoring	643	2022	8	■	■		■	
Brush management (manu)	314	2022	8		■		■	
Woody residue treatment	384	2022	10		■		■	
Competition control	315	2022	11	■	■		■	
Seedlings	342	2022	12		■		■	
Critical area planting	342	2022	12		■		■	

Year 9 (2023)								
Fence maintenance	382	2016	2					
Access control	472	2023	2					
Brush suppression (chem)	314	2023	2					
Brush management (chem)	314	2023	3					
Competition control	315	2023	3					
Rare habitat monitoring	643	2023	8					
Brush management (manu)	314	2023	8					
Woody residue treatment	384	2023	10					
Competition control	315	2023	11					
Seedlings	342	2023	12					
Critical area planting	342	2023	12					

Year 10 (2024)								
Fence construction	382	2016	2					
Fence maintenance	382	2024	2					
Access control	472	2024	2					
Brush suppression (chem)	314	2024	2					
Brush management (chem)	314	2024	3					
Competition control	315	2024	3					
Rare habitat monitoring	643	2024	8					
Brush management (manu)	314	2024	8					
Woody residue treatment	384	2024	10					
Competition control	315	2024	11					
Seedlings	342	2024	12					
Critical area planting	342	2024	12					

6.3. Wetland, lama forest, *Eugenia* conservation

6.3.1. Budget

Table 12. In the sixth year of the project, fencing will be constructed to surround the *Eugenia* restoration and the lama forest; the wetland will not be fenced. Planting, competition and access control, and monitoring will occur every year after fencing to continually improve native plant populations in all three areas.

Activity	NRCS code	Cost unit^{-1}	Field	E1	L1	W1
			Area	1.4 ac	1 ac	43.2 ac
			Annual	1.4 ac	1 ac	1 ac
Year 1 (2015)			**Month**			
Fence construction	382	$7.00	6	$ -	$ -	$ -
Brush management (chem)	314	$650	6	$ -	$ -	$ 1,625
Access control	472	$100	6	$ -	$ -	$ 100
Integrated pest mgmt.	595	$250	6	$ -	$ -	$ 250
Rare habitat monitoring	643	$65	8	$ -	$ -	$ -
Seedlings	342	$5.35	9	$ -	$ -	$ 1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400
Competition control	315	$220	11	$ -	$ -	$ 220
Year subtotal:	---	---	---	$ -	$ -	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ -	$ -	$ 2,789
FSP Share:	---	---	---	$ -	$ -	$ 2,789
Year 1 Applicant total:	**$**	**2,788.75**			**Year 1 FSP Total:**	**$ 2,788.75**
Year 2 (2016)			**Month**			
Fence maintenance	382	$0.13	2	$ -	$ -	$ -
Access control	472	$100	2	$ -	$ -	$ 100
Integrated pest mgmt.	595	$250	6	$ -	$ -	$ 250
Brush management (chem)	314	$650	3	$ -	$ -	$ 1,625
Competition control	315	$220	3	$ -	$ -	$ 220
Rare habitat monitoring	643	$65	8	$ -	$ -	$ -
Competition control 2	315	$110	9	$ -	$ -	$ 110
Seedlings	342	$5.35	11	$ -	$ -	$ 1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ -	$ -	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ -	$ -	$ 2,789
FSP Share:	---	---	---	$ -	$ -	$ 2,789
Year 2 Applicant total:	**$**	**2,788.75**			**Year 2 FSP Total:**	**$ 2,788.75**

Year 3 (2017)			Month				
Fence maintenance	382	$0.13	2	$ -	$ -	$	-
Access control	472	$100	2	$ -	$ -	$	100
Integrated pest mgmt.	595	$250	6	$ -	$ -	$	250
Brush management (chem)	314	$650	3	$ -	$ -	$	1,625
Competition control	315	$220	3	$ -	$ -	$	220
Rare habitat monitoring	643	$65	8	$ -	$ -	$	-
Competition control 2	315	$110	9	$ -	$ -	$	110
Seedlings	342	$5.35	11	$ -	$ -	$	1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$	1,400
Year subtotal:	---	---	---	$ -	$ -	$	5,578
NRCS%	---	---	---	50%	50%		50%
Applicant share:	---	---	---	$ -	$ -	$	2,789
FSP Share:	---	---	---	$ -	$ -	$	2,789
Year 3 Applicant total:	**$**	**2,788.75**			**Year 3 FSP Total:**	**$**	**2,788.75**
Year 4 (2018)			**Month**				
Fence maintenance	382	$0.13	2	$ -	$ -	$	-
Access control	472	$100	2	$ -	$ -	$	100
Integrated pest mgmt.	595	$250	6	$ -	$ -	$	250
Brush management (chem)	314	$650	3	$ -	$ -	$	1,625
Competition control	315	$220	3	$ -	$ -	$	220
Rare habitat monitoring	643	$65	8	$ -	$ -	$	-
Competition control 2	315	$110	9	$ -	$ -	$	110
Seedlings	342	$5.35	11	$ -	$ -	$	1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$	1,400
Year subtotal:	---	---	---	$ -	$ -	$	5,578
NRCS%	---	---	---	50%	50%		50%
Applicant share:	---	---	---	$ -	$ -	$	2,789
FSP Share:	---	---	---	$ -	$ -	$	2,789
Year 4 Applicant total:	**$**	**2,788.75**			**Year 4 FSP Total:**	**$**	**2,788.75**

Year 5 (2019)			Month				
Fence maintenance	382	$0.13	2	$ -	$ -	$ -	
Access control	472	$100	2	$ -	$ -	$ 100	
Integrated pest mgmt.	595	$250	6	$ -	$ -	$ 250	
Brush management (chem)	314	$650	3	$ -	$ -	$ 1,560	
Competition control	315	$220	3	$ -	$ -	$ 220	
Rare habitat monitoring	643	$65	8	$ -	$ -	$ -	
Competition control 2	315	$110	9	$ -	$ -	$ 110	
Seedlings	342	$5.35	11	$ -	$ -	$ 1,873	
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400	
Year subtotal:	---	---	---	$ -	$ -	$ 5,513	
NRCS%	---	---	---	50%	50%	50%	
Applicant share:	---	---	---	$ -	$ -	$ 2,756	
FSP Share:	---	---	---	$ -	$ -	$ 2,756	
Year 5 Applicant total:	**$**	**2,756.25**			**Year 5 FSP Total:**	**$**	**2,756.25**

Year 6 (2020)			Month				
Fence construction	382	$7.00	2	$ 8,364	$ 5,824	$ -	
Fence maintenance	382	$0.13	2	$ -	$ -	$ -	
Access control	472	$100	2	$ 144	$ 100	$ 100	
Integrated pest mgmt.	595	$250	6	$ 360	$ 249	$ 250	
Brush management (chem)	314	$650	3	$ 936	$ -	$ 1,625	
Competition control	315	$220	3	$ -	$ -	$ 220	
Rare habitat monitoring	643	$65	8	$ 94	$ 65	$ -	
Competition control 2	315	$110	9	$ -	$ -	$ 110	
Seedlings	342	$5.35	11	$ -	$ -	$ 1,873	
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400	
Year subtotal:	---	---	---	$ 9,898	$ 6,238	$ 5,578	
NRCS%	---	---	---	50%	50%	50%	
Applicant share:	---	---	---	$ 4,949	$ 3,119	$ 2,789	
FSP Share:	---	---	---	$ 4,949	$ 3,119	$ 2,789	
Year 6 Applicant total:	**$**	**10,856.60**			**Year 6 FSP Total:**	**$**	**10,856.60**

Year 7 (2021)			Month			
Fence maintenance	382	$0.13	2	$ 155	$ 108	$ -
Access control	472	$100	2	$ 144	$ 100	$ 100
Integrated pest mgmt.	595	$250	6	$ 360	$ 249	$ 250
Brush management (chem)	314	$650	3	$ -	$ -	$ 1,625
Competition control	315	$220	3	$ -	$ -	$ 220
Rare habitat monitoring	643	$65	8	$ 94	$ -	$ -
Competition control 2	315	$110	9	$ -	$ -	$ 110
Seedlings	342	$5.35	11	$ -	$ -	$ 1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 754	$ 457	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 377	$ 228	$ 2,789
FSP Share:	---	---	---	$ 377	$ 228	$ 2,789
Year 7 Applicant total:	**$**	**3,393.94**			**Year 7 FSP Total:**	**$ 3,393.94**

Year 8 (2022)			Month			
Fence maintenance	382	$0.13	2	$ 155	$ 108	$ -
Access control	472	$100	2	$ 144	$ 100	$ 100
Integrated pest mgmt.	595	$250	6	$ 360	$ 249	$ 250
Brush management (chem)	314	$650	3	$ -	$ -	$ 1,625
Competition control	315	$220	3	$ -	$ -	$ 220
Rare habitat monitoring	643	$65	8	$ -	$ 65	$ -
Competition control 2	315	$110	9	$ -	$ -	$ 110
Seedlings	342	$5.35	11	$ -	$ -	$ 1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 659	$ 522	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 330	$ 261	$ 2,789
FSP Share:	---	---	---	$ 330	$ 261	$ 2,789
Year 8 Applicant total:	**$**	**3,379.36**			**Year 8 FSP Total:**	**$ 3,379.36**

Year 9 (2023)			Month			
Fence maintenance	382	$0.13	2	$ 155	$ 108	$ -
Access control	472	$100	2	$ 144	$ 100	$ 100
Integrated pest mgmt.	595	$250	6	$ 360	$ 249	$ 250
Brush management (chem)	314	$650	3	$ -	$ -	$ 1,625
Competition control	315	$220	3	$ -	$ -	$ 220
Rare habitat monitoring	643	$65	8	$ 94	$ -	$ -
Competition control 2	315	$110	9	$ -	$ -	$ 110
Seedlings	342	$5.35	11	$ -	$ -	$ 1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 754	$ 457	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 377	$ 228	$ 2,789
FSP Share:	---	---	---	$ 377	$ 228	$ 2,789
Year 9 Applicant total:	**$**	**3,393.94**			**Year 9 FSP Total:**	**$ 3,393.94**
Year 10 (2024)			**Month**			
Fence maintenance	382	$0.13	2	$ 155	$ 108	$ -
Access control	472	$100	2	$ 144	$ 100	$ 100
Integrated pest mgmt.	595	$250	6	$ 360	$ 249	$ 250
Brush management (chem)	314	$650	3	$ -	$ -	$ 1,625
Competition control	315	$220	3	$ -	$ -	$ 220
Rare habitat monitoring	643	$65	8	$ -	$ 65	$ -
Competition control 2	315	$110	9	$ -	$ -	$ 110
Seedlings	342	$5.35	11	$ -	$ -	$ 1,873
SMZ improvement	395	$1,400	11	$ -	$ -	$ 1,400
Year subtotal:	---	---	---	$ 659	$ 522	$ 5,578
NRCS%	---	---	---	50%	50%	50%
Applicant share:	---	---	---	$ 330	$ 261	$ 2,789
FSP Share:	---	---	---	$ 330	$ 261	$ 2,789
Year 10 Applicant total:	**$**	**3,379.36**			**Year 10 FSP Total:**	**$ 3,379.36**

Table 13. Annual budget totals for the wetland, lama forest, and *Eugenia* restoration area.

Period	Applicant	FSP	Lama, *Eug* , Wetland
Year 1	$ 2,789.00	$ 2,789.00	$ 5,578
Year 2	$ 2,789.00	$ 2,789.00	$ 5,578
Year 3	$ 2,789.00	$ 2,789.00	$ 5,578
Year 4	$ 2,789.00	$ 2,789.00	$ 5,578
Year 5	$ 2,789.00	$ 2,789.00	$ 5,578
Year 6	$ 10,857.00	$ 10,857.00	$ 21,714
Year 7	$ 3,393.00	$ 3,393.00	$ 6,786
Year 8	$ 3,379.00	$ 3,379.00	$ 6,758
Year 9	$ 3,393.00	$ 3,393.00	$ 6,786
Year 10	$ 3,379.00	$ 3,379.00	$ 6,758
Total:	**$ 38,346.00**	**$ 38,346.00**	**$ 76,692**

6.3.2. Schedule

Activity	NRCS code	Year	Start month	Field		
				E1	L1	W1
				1.4 ac	1 ac	43.2 ac
Year 1 (2015)						
Fence construction	382	2020	6			
Brush management (chem)	314	2015	6			
Access control	472	2015	6			
Integrated pest mgmt.	595	2015	6			
Rare habitat monitoring	643	2015	8			
Seedlings	342	2015	9			
SMZ improvement	395	2015	11			
Competition control	315	2015	11			
Year 2 (2016)						
Fence maintenance	382	2015	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			
Year 3 (2017)						
Fence maintenance	382	2021	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

Year 4 (2018)						
Fence maintenance	382	2021	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

Year 5 (2019)						
Fence maintenance	382	2021	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

Year 6 (2020)						
Fence construction	382	2021	2			
Fence maintenance	382	2015	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

Year 7 (2021)						
Fence maintenance	382	2021	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

Year 8 (2022)						
Fence maintenance	382	2021	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

Year 9 (2023)						
Fence maintenance	382	2021	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

Year 10 (2024)						
Fence maintenance	382	2021	2			
Access control	472	2015	2			
Integrated pest mgmt.	595	2015	6			
Brush management (chem)	314	2015	3			
Competition control	315	2015	3			
Rare habitat monitoring	643	2015	8			
Competition control 2	315	2015	9			
Seedlings	342	2015	11			
SMZ improvement	395	2015	11			

6.4. Property-wide management

6.5. Management activities that will take place across the entire 1,875-acre Waimea Valley parcel will include incipient weed monitoring and suppression, feral ungulate control, fuel break maintenance, and road (access trail) maintenance. Trail maintenance would occur across the 10 miles of access routes that exist on the property, and would likely be necessary between 2 and 3 times annually; costs on a per-mile basis are thus multiplied by 2.5 repetitions. Fuel break vegetation control and incipient weed management (monitoring and eradication) would occur on an annual basis with no anticipated cost decreases over the length of the project.

Table 14. Schedule of activities for property-wide management of ungulates, fuel breaks, access routes, and incipient weeds.

Activity	NRCS code	Year	Start month	Field		
				WVP	FB	RD
Year 1 (2015)						
Ungulate control	472	2015	8	■		
Trail maintenance	568	2015	8			■
Roadside weed control	315	2015	9			■
Fuel break	383	2015	10		■	
Incipient weed mgmt	643	2015	0			
Year 2 (2016)						
Ungulate control	472	2015	1	■		
Trail maintenance	568	2015	1			■
Roadside weed control	315	2015	1			■
Fuel break	383	2015	6		■	
Incipient weed mgmt	643	2015	6	■		

Table 15. Budget for trail and access maintenance, ungulate control, fuel break maintenance, and incipient weed control for the first two years of the project. Total yearly costs from Year 2 thru Year 10 remain constant at $43,400.

Activity	NRCS code	Cost unit^{-1}	Field Annual	WVP 1875 ac	FB 1.0 mi	RD 10 mi	Property-wide mgmt
Year 1 (2015)			**Month**				
Ungulate control	472	$14.50	8	$ 27,188	$ -	$ -	$ 38,001
Trail maintenance	568	$166	8	$ -	$ -	$ 4,150	$ 43,401
Roadside weed control	315	$333	9	$ -	$ -	$ 3,330	$ 43,401
Fuel break	383	$333	10	$ -	$ 333	$ -	$ 43,401
Incipient weed mgmt	643	$4.48	0	$ -	$ -	$ -	$ 43,401
Year subtotal:	---	---	---	$ 27,188	$ 333	$ 7,480	$ 43,401
NRCS%	---	---	---	50%	50%	50%	$ 43,401
Applicant share:	---	---	---	$ 13,594	$ 167	$ 3,740	$ 43,401
FSP Share:	---	---	---	$ 13,594	$ 167	$ 3,740	$ 43,401
Year 1 Applicant total:	**$**	**17,500.25**		**Year 1 FSP Total:**		**$ 17,500.25**	
Year 2 (2016)			**Month**				
Ungulate control	472	$14.50	1	$ 27,188	$ -	$ -	
Trail maintenance	568	$166	1	$ -	$ -	$ 4,150	
Roadside weed control	315	$333	1	$ -	$ -	$ 3,330	
Fuel break	383	$333	6	$ -	$ 333	$ -	
Incipient weed mgmt	643	$4.48	6	$ 8,400	$ -	$ -	
Year subtotal:	---	---	---	$ 35,588	$ 333	$ 7,480	
NRCS%	---	---	---	50%	50%	50%	
Applicant share:	---	---	---	$ 17,794	$ 167	$ 3,740	
FSP Share:	---	---	---	$ 17,794	$ 167	$ 3,740	
Year 2 Applicant total:	**$**	**21,700.25**		**Year 2 FSP Total:**		**$ 21,700.25**	**$ 428,610**

7. References

Clausnitzer, D. 2007. Ecological Site Description. USDA NRCS FOTG publications.

Flint, M.L., Daar, S., Molinar, R. 2003. Establishing integrated pest management policies and programs: a guide for public agencies. UC Davis. 8093.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte, 2013: Online Rainfall Atlas of Hawai'i. *Bull. Amer. Meteor. Soc.* 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1.

Gon, S., Pool, L., Sumiye, J., 2011. Waimea Valley Conservation Action Plan

Ho, J. 2010. Waimea Valley Plant Collections Policy.

Khan, R., Jarvis, C.E. 1989. The correct name for the plant known as *Pluchea symphytifolia* (Miller) Gillis (Asteraceae). Taxon. 38, 4, 659-661.

Leary, J., Beachy, J., Hardman, A. 2012. Practitioner's guide for effective non-restricted herbicide techniques to control and suppress invasive woody species in Hawai'i. CTAHR.

USDA NRCS Soil Data Viewer. http://soildatamart.nrcs.usda.gov/templates.aspx

8. Maps

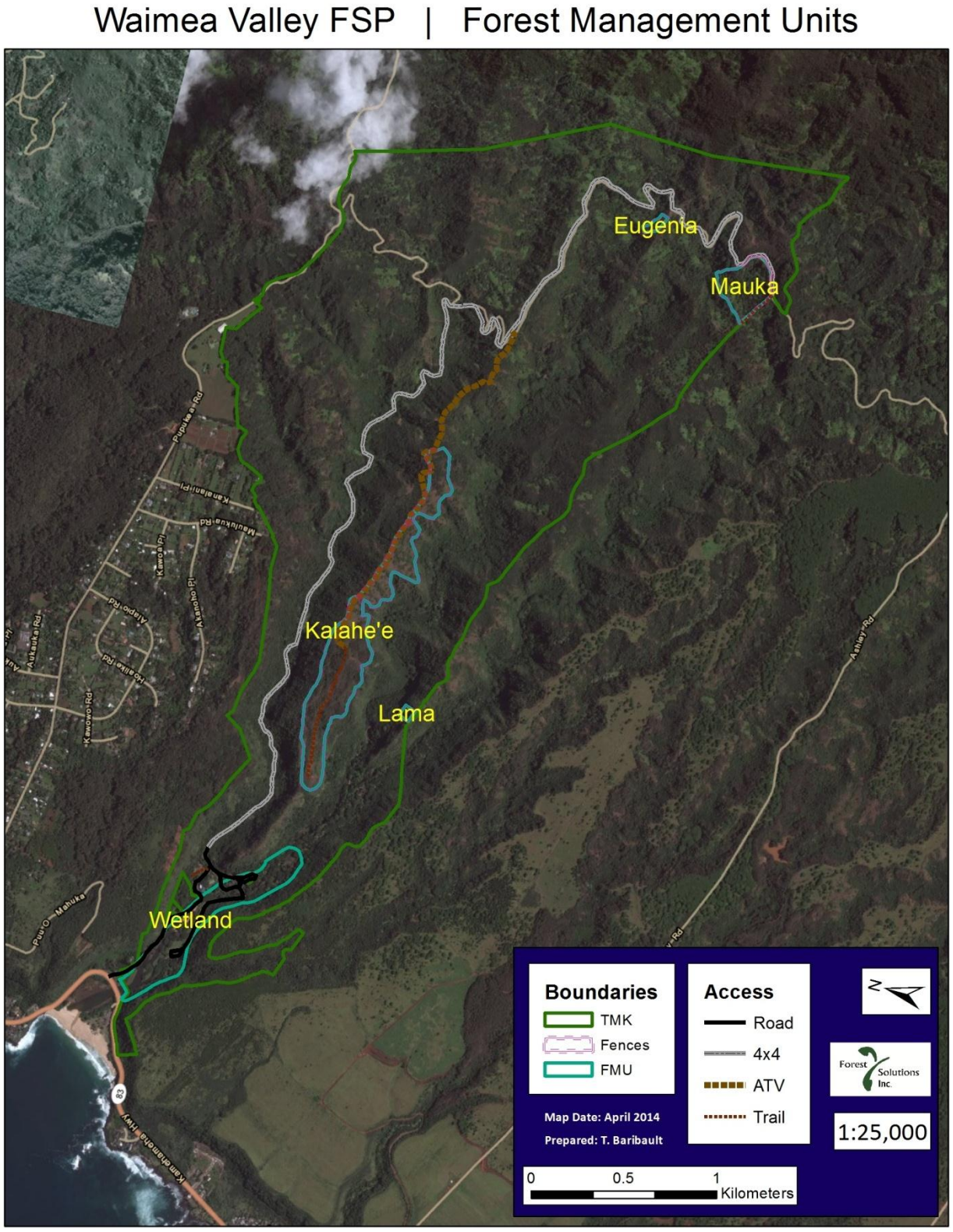


Figure 15. Forest management units at Waimea Valley (blue), with fences (pink), bounded by TMK (green).

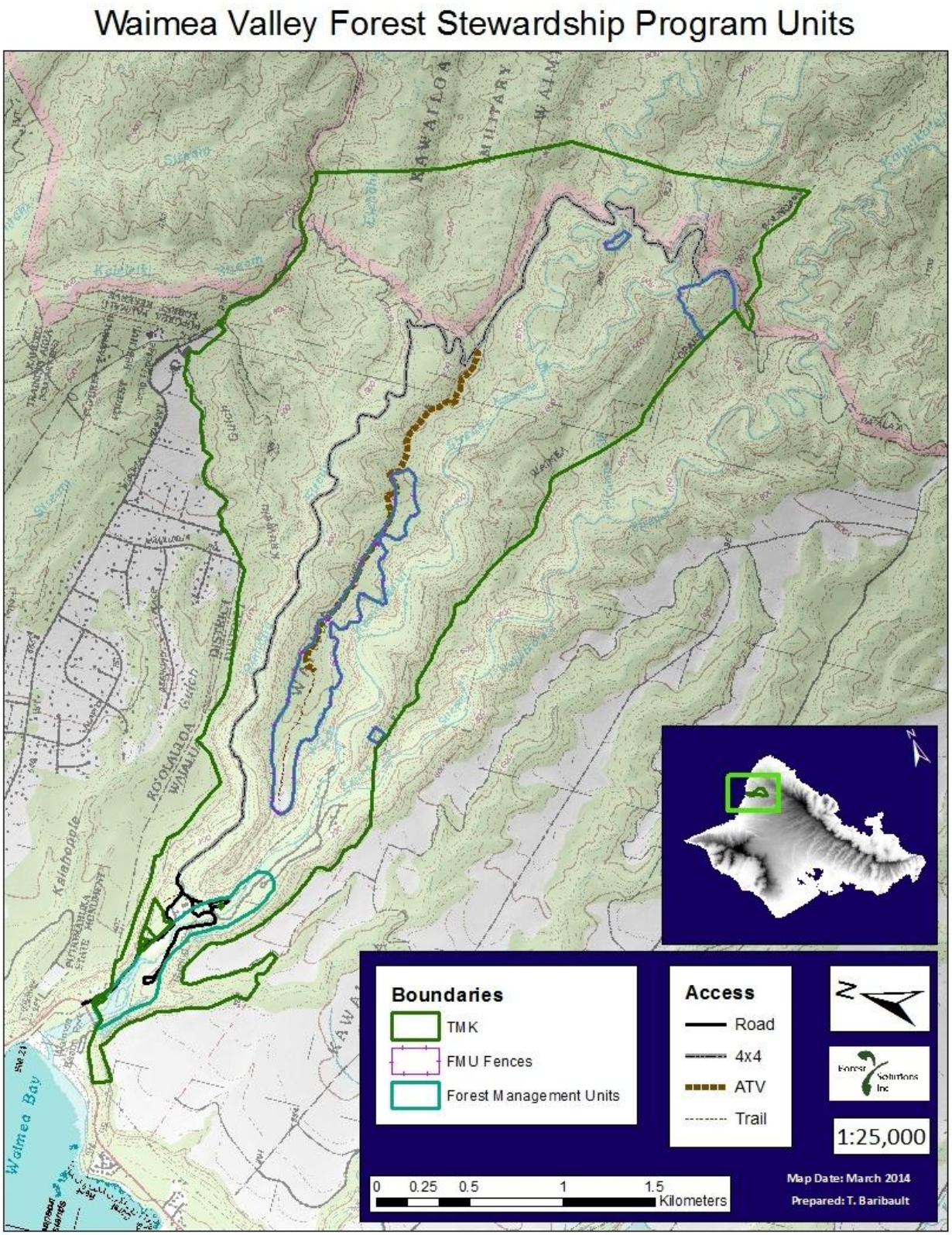


Figure 16. Topographic map of Waimea Valley, with TMK boundary (green), FMU (blue), and access routes.

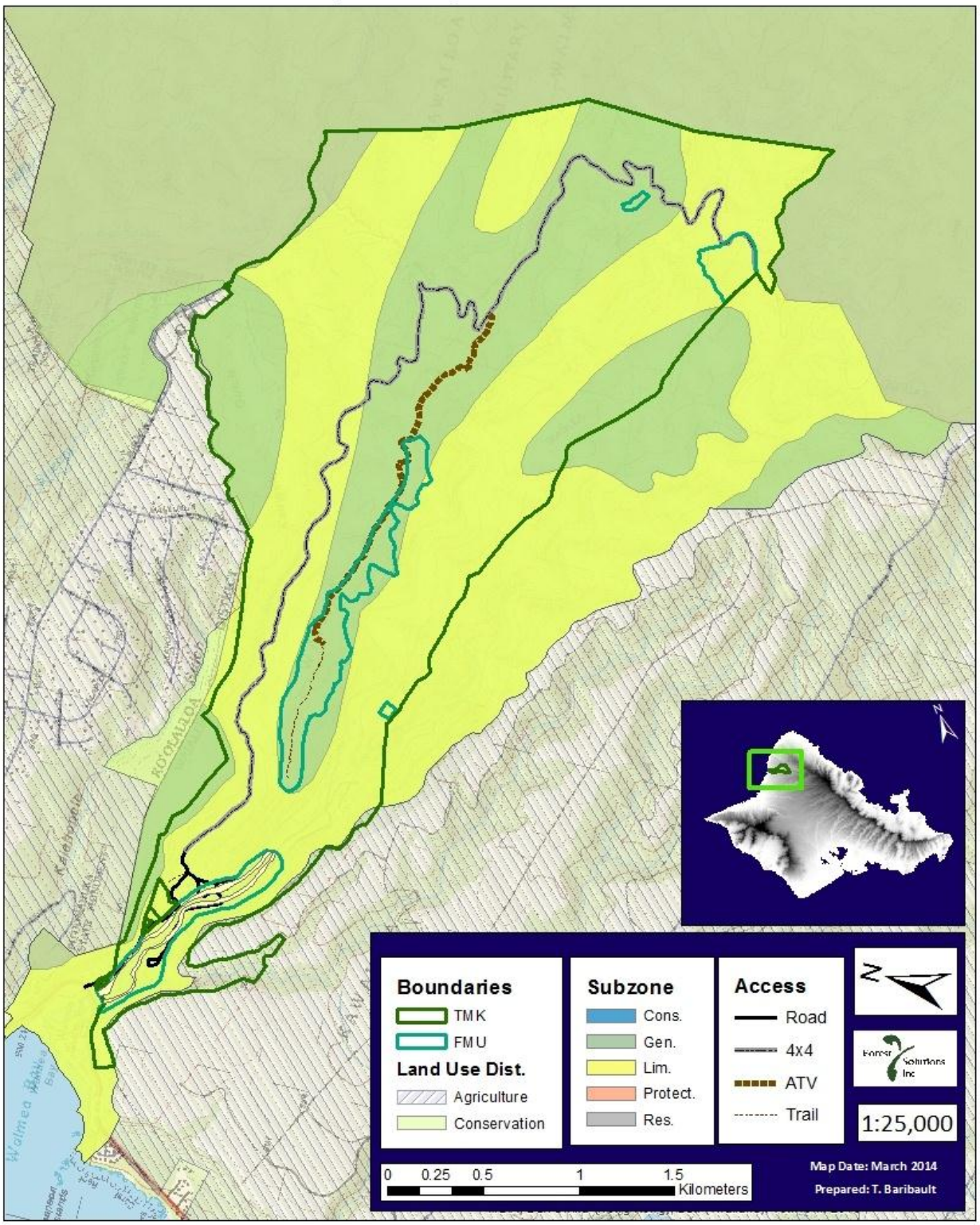


Figure 17. Waimea valley comprises conservation district subzones General (green) and limited (yellow).

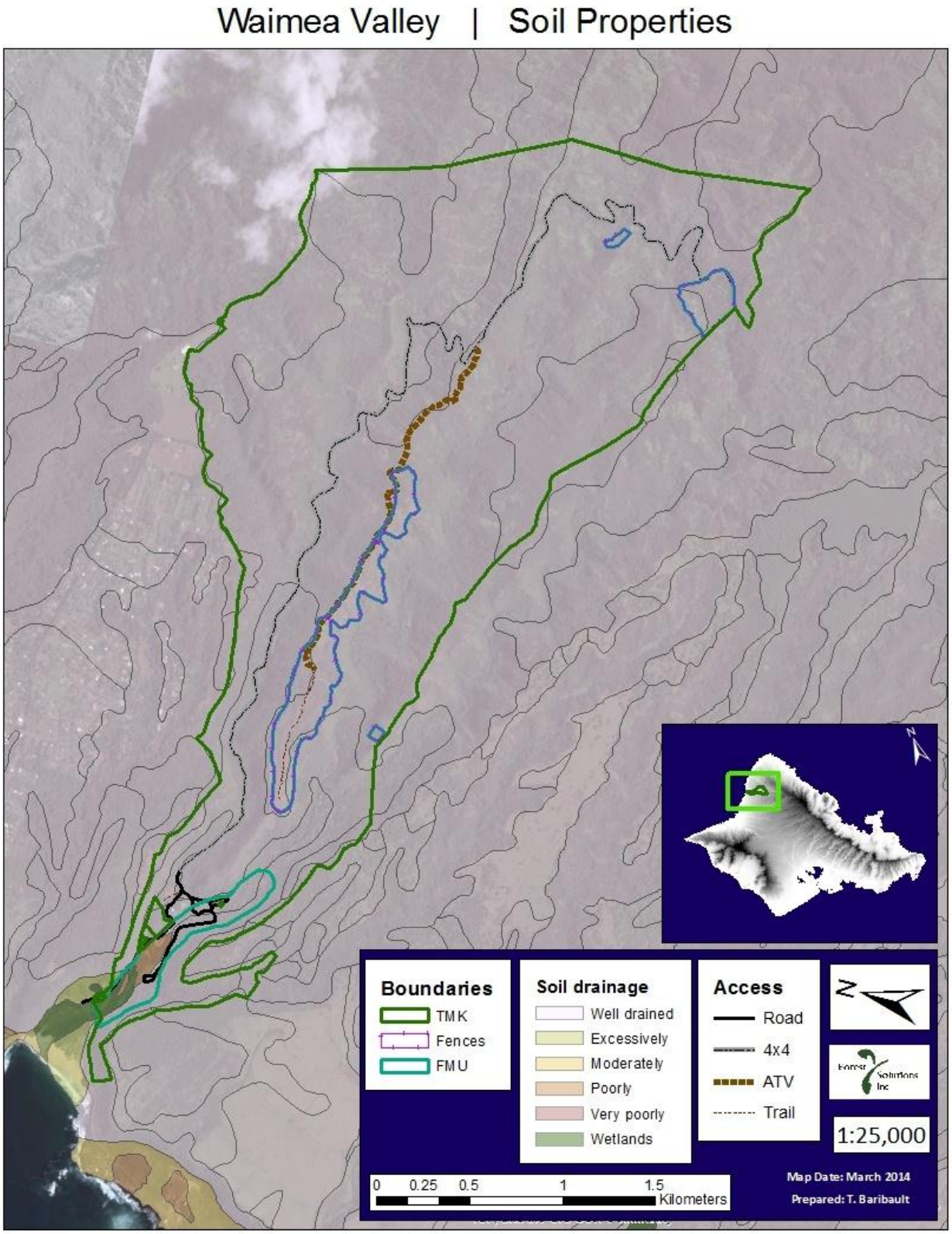


Figure 18. The mauka restoration site, Kalahe'e, lama forest, and *Eugenia* area are situated on well drained soils. The

SMZ and wetland soils are either poorly drained or waterlogged types, but these are constrained to the makai section.

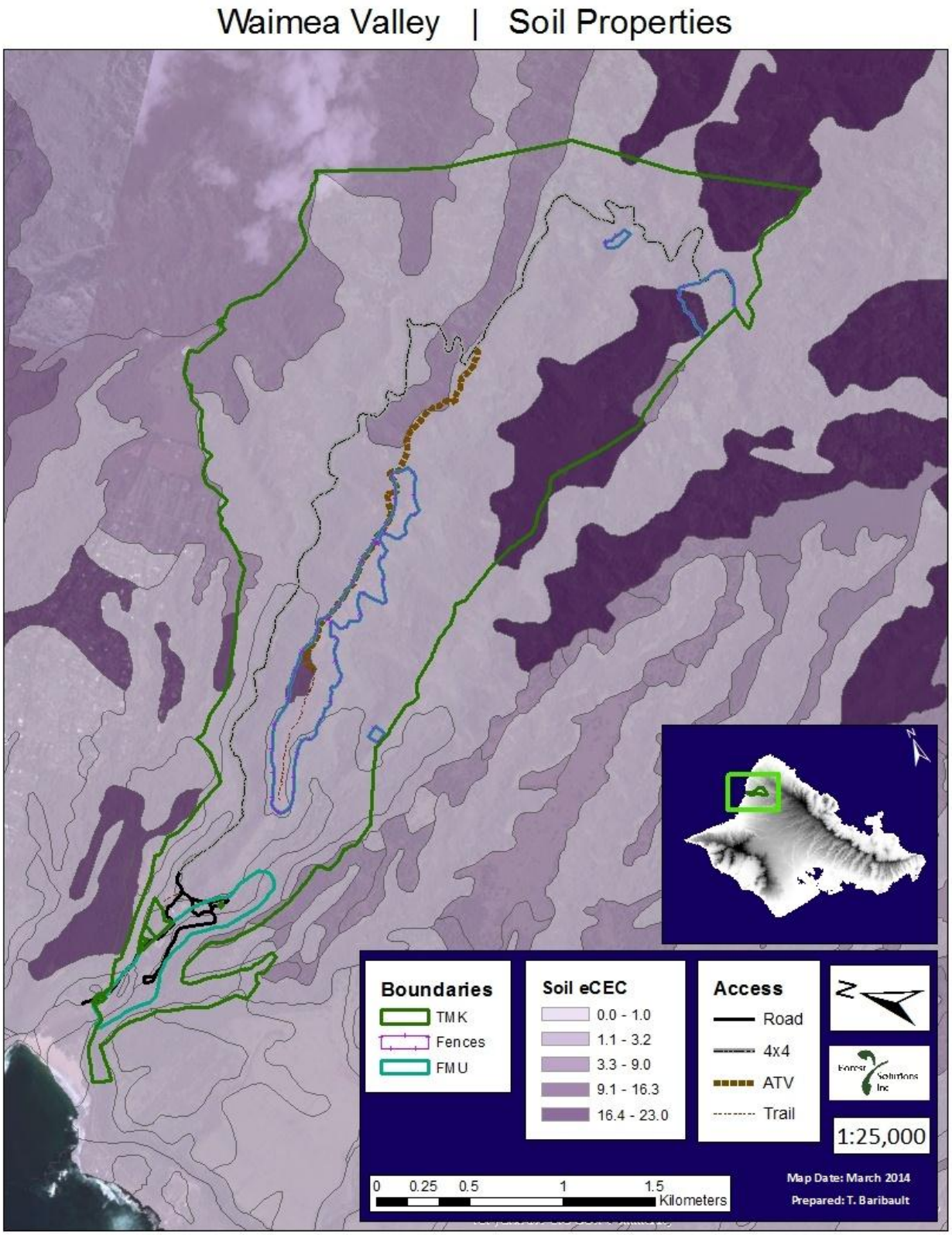


Figure 19. Soil effective cation exchange capacity (eCEC), an integrated measure of soil fertility, is quite low across much of Waimea Valley. Small portions of Kalahe'e and the mauka site have some higher eCEC zones, but fertility is low

overall.

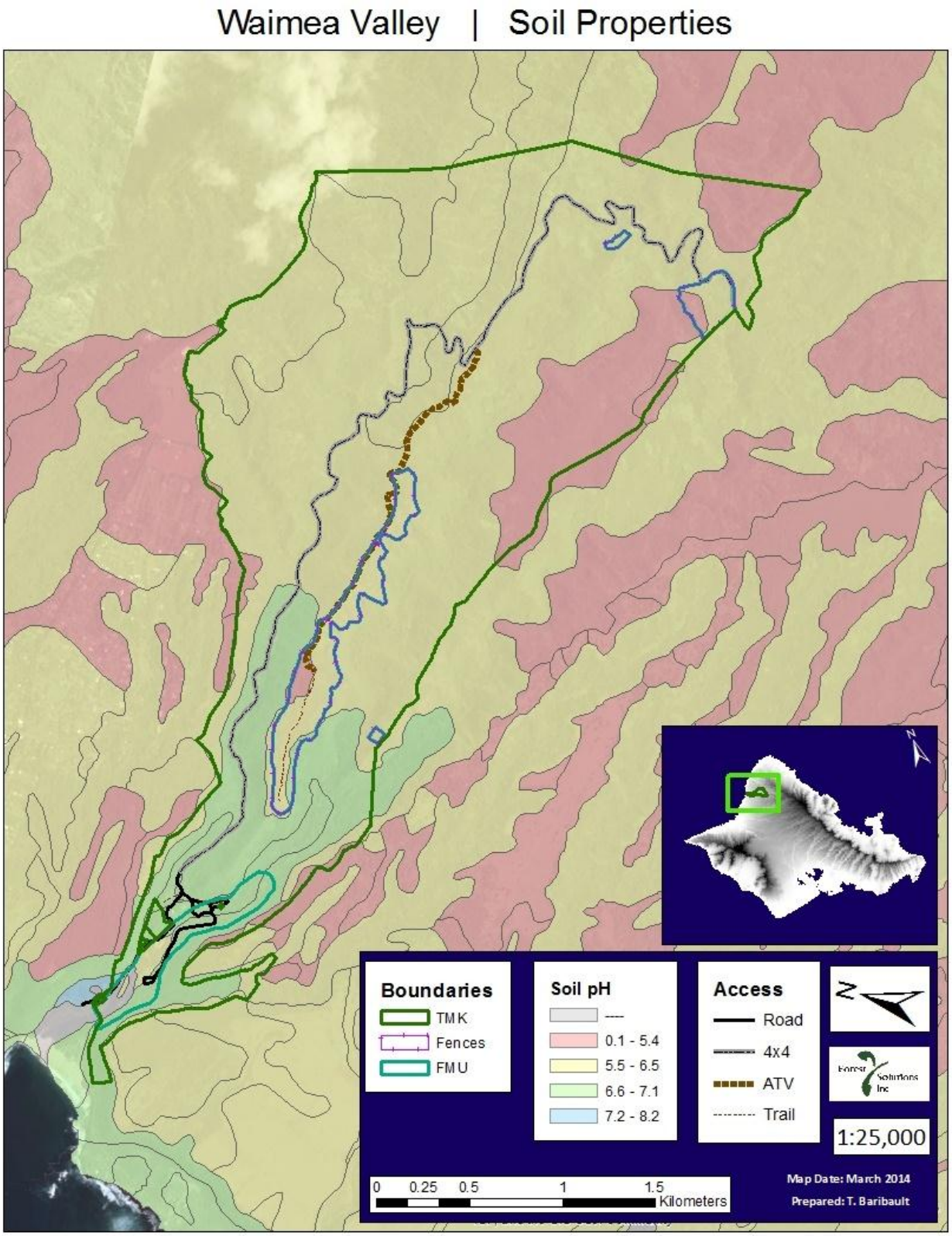


Figure 20. Soil pH across Waimea Valley shows strong variability, from highly acidic soils on the Southern valley walls

near the mauka site to nearly neutral soils toward the makai sections of each stream.

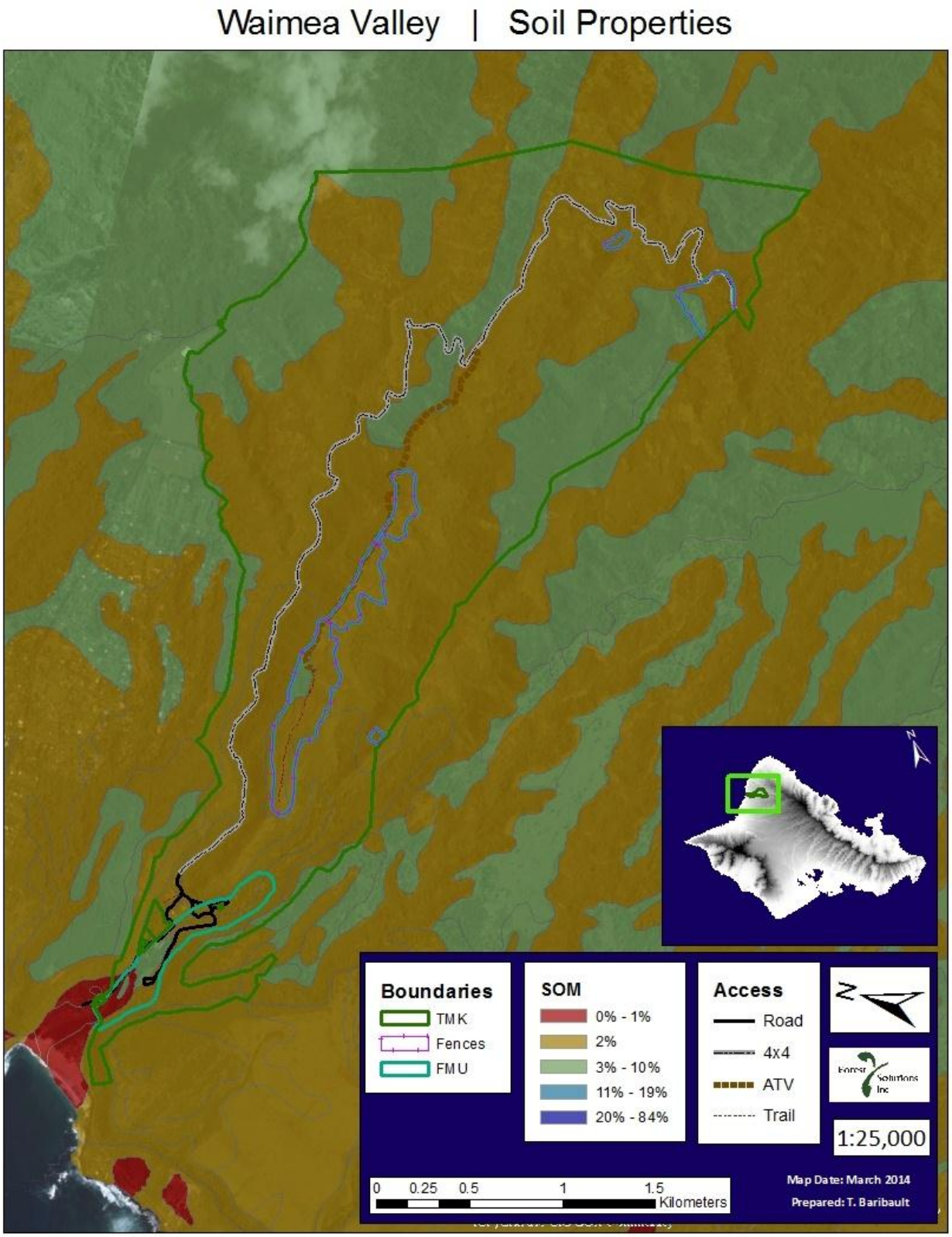


Figure 21. Soil organic matter (SOM) is another integrated soil fertility metric. Most soils in Waimea Valley have very

little SOM, consistent with low fertility as assessed by eCEC.

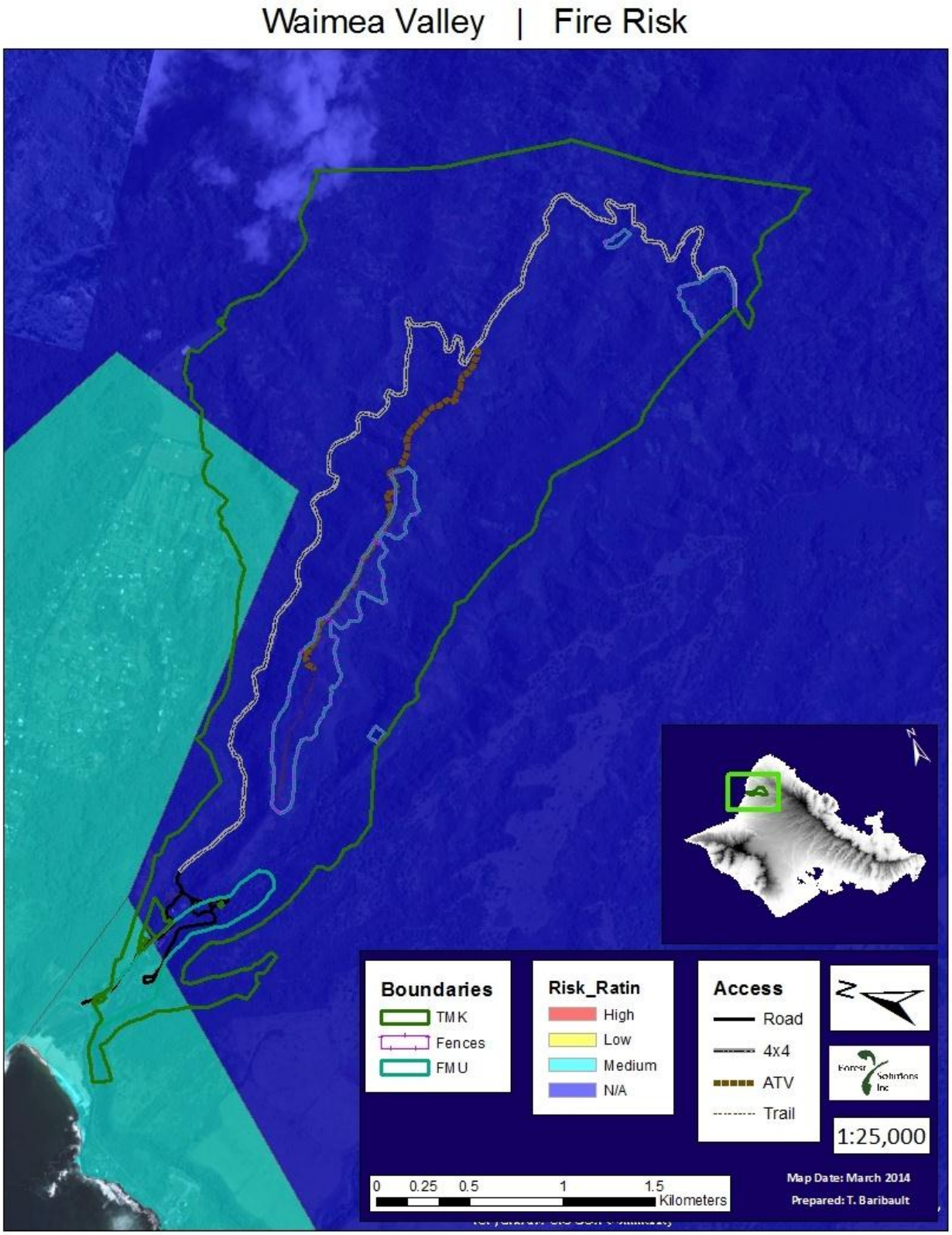


Figure 22. Fire risk zones in Waimea Valley.

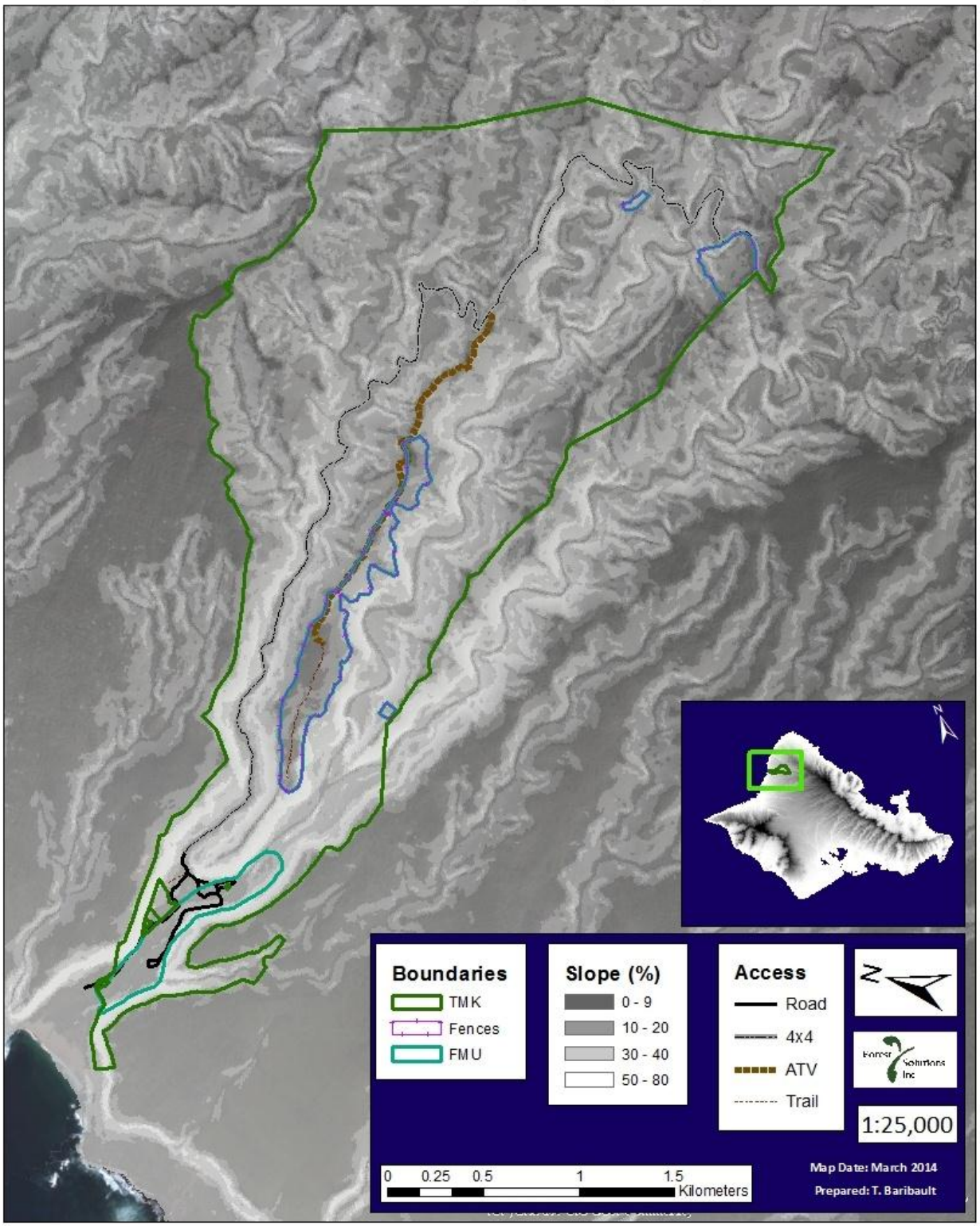


Figure 23. Waimea Valley topography is highly variable, with extremely steep slopes (>80%) on the valley walls and

some flat areas in stream beds and on ridge tops.

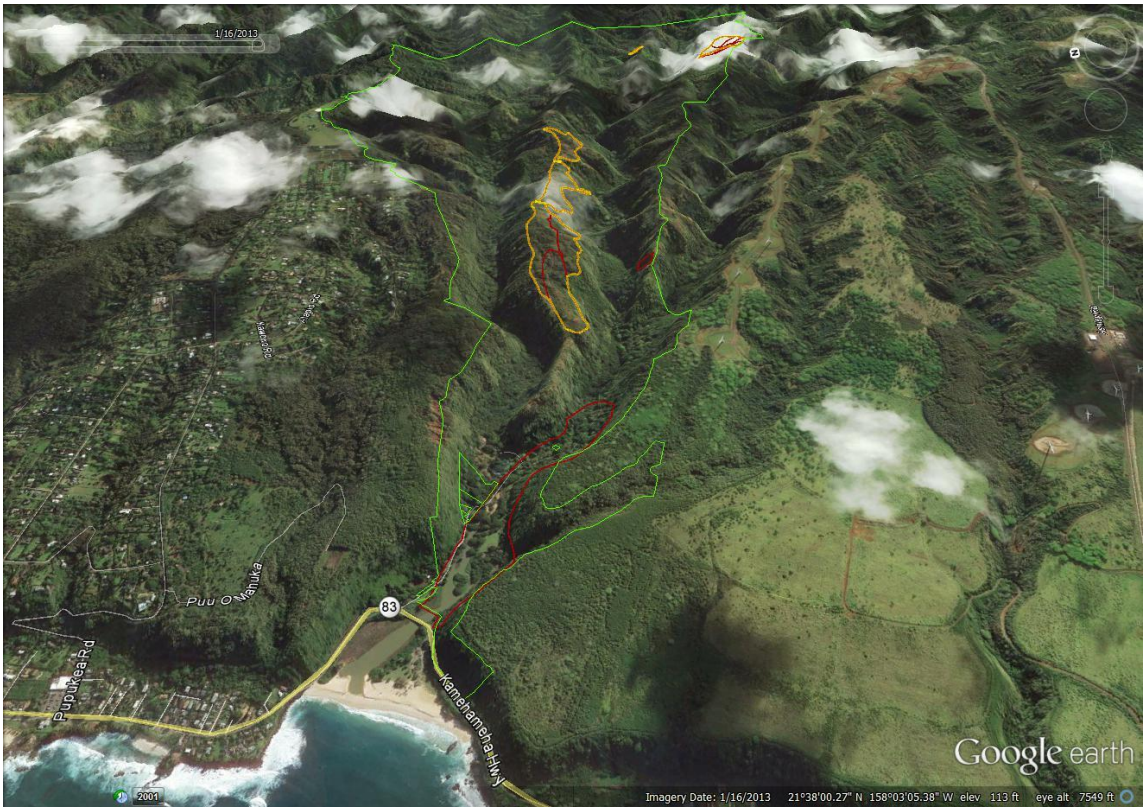


Figure 24. Perspective map of the entire Waimea Valley parcel, view to East.

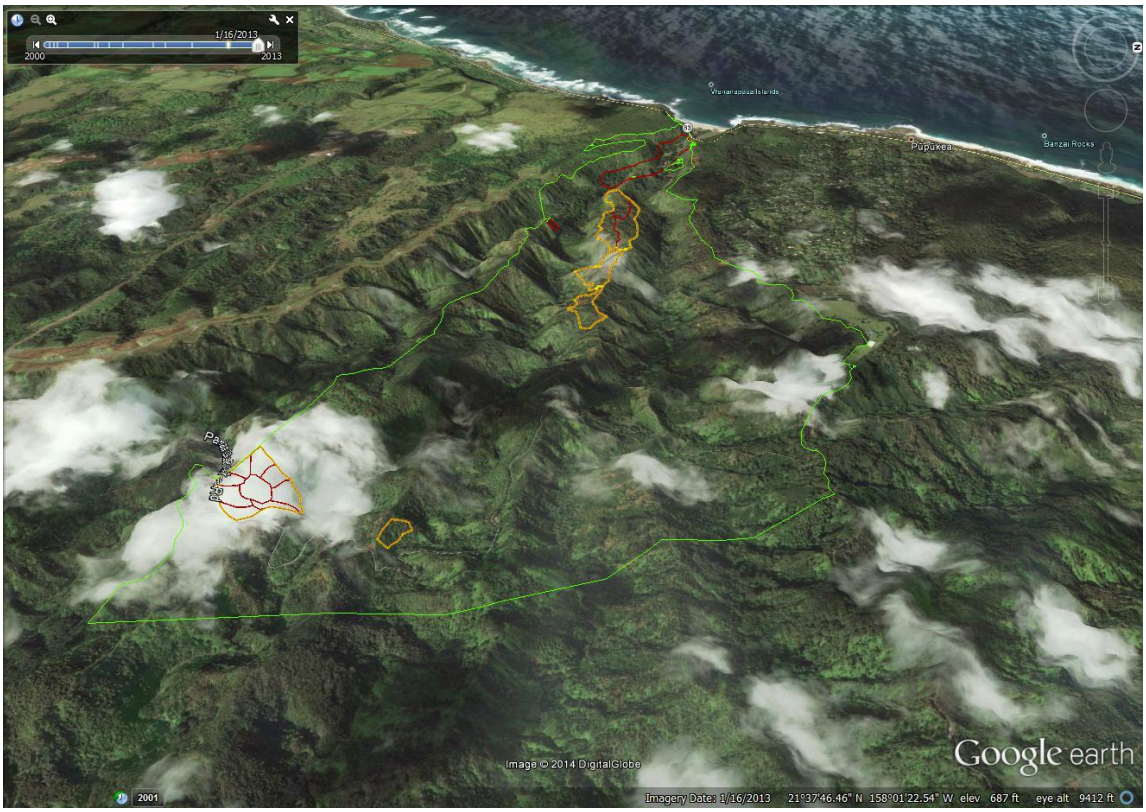


Figure 25. Perspective map of the mauka restoration site, view to West.