Midpeninsula Regional
Open Space District

R-26-171
Meeting 26-27
November 10, 2026

AGENDA ITEM 8

AGENDA ITEM

Study Session: La Honda Forest Health Project

GENERAL MANAGER'S RECOMMENDATION

Receive updates on the La Honda Forest Health Project. No Board action required.

SUMMARY

Midpeninsula Regional Open Space District (District) has prepared a draft Timber Harvesting Plan (THP) for the La Honda Creek Preserve Forest Health Project (Project). The goals of the Project are to implement forest health treatments and watershed improvements that restore and promote healthy, resilient mature and old-growth forests; improve watershed health and function; enhance wildlife habitat and carbon storage; and increase the forest's resilience to fire, disease, and climate change. A THP is a detailed operational and environmental document that is functionally equivalent to an Environmental Impact Report (EIR) under the California Environmental Quality Act (CEQA)[1] and will serve as the environmental clearance and permitting document for project implementation. An update on the project is being presented to the Board of Directors (Board) prior to its submittal.

BACKGROUND

Policy Framework
The District's Resource Management Policies guide land stewardship activities, which include the following goals for forest management: "Manage District land to retain and promote biologically diverse, dynamic forest conditions; maintain and enhance high-quality forest and aquatic habitat; encourage and enhance the development of late-seral conifer forest; provide for visitor experiences within diverse forest habitats; and promote District and regional fire management objectives." During forest restoration work, timber that would otherwise be disposed of may be sold. The District's Forest Management Policies state that any revenue from commercial timber sales must be reinvested into resource management activities, such as road improvements, weed abatement, and long-term monitoring.

Timber Harvesting Plans
Prior to implementing forestry operations involving the removal of timber that could have commercial value, the Z'Berg Nejedly Forest Practice Act of 1973 and the California Forest Practice Rules require that a Timber Harvesting Plan (THP) be prepared by a Registered Professional Forester and approved by the California Department of Forestry and Fire Protection

[1] *Sierra Club vs. Board of Forestry (1994)*

(CAL FIRE). Timber harvest operations in California are subject to a certified regulatory program under CEQA. A THP is a detailed operational and environmental document that is functionally equivalent to an EIR, with CAL FIRE serving as the Lead Agency responsible for reviewing and approving the THP, including considering any public input as part of the review process. The District is considered the landowner and the Plan Submitter under the certified regulatory program.

The THP development process includes extensive forest inventorying and monitoring, delineating natural and cultural resources and outlining appropriate protection and hazard reduction measures, preparing silvicultural prescriptions, identifying operational procedures and any requisite road and infrastructural improvements, and conducting pre-consultations with regulatory agencies to receive their concurrence on the plan prior to submittal.

After a THP is submitted to CAL FIRE, CAL FIRE conducts a public and multi-agency review process that satisfies CEQA's requirements, encompassing the following steps:

1. *Submission and notification:* A Registered Professional Forester submits the THP to CAL FIRE. The agency distributes it to relevant reviewing agencies and provides public notices per the Forest Practice Rules, including notifications to nearby landowners as well as individuals who have requested them.
2. *Interagency review:* CAL FIRE coordinates review with agencies, including California Department of Fish and Wildlife, Regional Water Quality Control Boards, and California Geological Survey. Reviewers evaluate the plan's completeness, environmental impacts, and compliance with applicable regulations. A pre-harvest field inspection is generally conducted.
3. *Public comment:* Once the THP is filed, members of the public have an opportunity to review the plan and submit written comments regarding environmental concerns or regulatory compliance. CAL FIRE generally provides at least 30 days following the pre-harvest inspection for public comment, with extensions possible depending on the review process. Public hearings may also occur under specified statutory circumstances.
4. *Decision and oversight:* CAL FIRE considers agency recommendations and public comments before approving or denying the THP. The agency provides written responses to significant environmental issues raised during public review. Following agency and public review, CAL FIRE issues a Notice of Conformance, affirming the THP adheres to the Forest Practice Rules. Project operations may commence following this determination. Approved operations remain subject to inspections, enforcement, and applicable reforestation requirements.

Once approved by CAL FIRE, THPs are valid for three years, with the option to renew for an additional two-year period.

Project Actions to Date

To fulfill the goals set forth by the Board-approved La Honda Creek Preserve Master Plan (R-12-29), the District established the Restoration Forestry Demonstration Project (MAA05-010), later renamed the La Honda Forest Health Project.

In 2019, the District hired Sicular Environmental Consulting LLC to prepare a forest health assessment and management plan for La Honda Creek Open Space Preserve (Preserve). The resulting La Honda Forest Health Assessment and Management Plan (Plan; R-19-84) identified several impairments impeding the health and resilience of the forested portions of the Preserve

following intensive historic logging. These impairments include overly dense redwood regrowth stands exhibiting high fuel loads and stunted growth, Douglas-fir and brush encroachment in hardwood stands, accumulated ladder fuels, Sudden Oak Death, as well as sedimentation and watercourse diversions from legacy industrial logging. The Plan outlines recommended actions to address these impairments, which were subsequently presented to the Board in a Study Session alongside a Project Description (R-23-88). These recommended actions include strategic forest health treatments and watershed improvements to restore and promote healthy, resilient, mature, and old-growth forests; improve watershed health and function; enhance wildlife habitat and carbon storage; and increase the forest's resilience to fire, disease, and climate change. The Project Description also defined the project area, which is separated into two units in La Honda Creek Preserve: the Harmon Unit and the Conservation Management Unit (CMU) (see Attachment 1: Map of La Honda Forest Health Project Areas).

Following the 2023 Study Session, the District hired a Registered Professional Forester, Joe McGuire of Buena Vista Services LLC, to develop a THP as the permitting mechanism for the Project (R-24-03). During THP preparation, several underlying road issues were identified. The District amended its contract with Sicular Environmental Consulting to add a subconsultant, Tim Best, a Certified Engineering Geologist, to assess the internal road network and access routes for the Project area and to develop a road improvement plan, addressing key failures and reducing downstream sedimentation (R-25-42). This contract was amended again to provide additional recommendations for requisite road improvements along the Northside Road (R-26-18).

Throughout the THP development process, the District conducted public and partner outreach, including holding public community meetings and legislative briefings as well as completing pre-consultations with regulatory agencies, to receive feedback and concurrence on the Project. Input received indicated support for the Project, particularly for the enhancement of old-growth forest conditions, as well as habitat, watershed, and wildland fire resiliency improvements. Due to specific feedback received regarding the Project access routes, an alternative access route (the Northside Road) was studied and added to the THP to support Project operations. The Northside Road is an existing patrol and maintenance road that would be upgraded for Project operations in the CMU. Bear Gulch Road and a portion of Allen Road stemming from Bear Gulch to Highway 35 would be used for Project operations in the Harmon Unit. This change from the original access route will help reduce the level of use on Allen Road.

DISCUSSION

Forest Carbon Assessment

To establish baseline conditions prior to implementing the Project, the District completed a comprehensive inventory of carbon stored within the Project areas across major forest carbon pools, including the standing trees, downed woody materials, duff, and soil. The resulting report, the La Honda Forest Carbon Assessment (Attachment 2), describes the collection protocols, data analysis methods, and findings. The total sequestered carbon was 681 metric tons of carbon dioxide per acre, largely held in the standing trees (70.2%), followed by the mineral soil (15.7%), forest floor (7.4%), woody debris (6.1%), and understory (0.7%). By remeasuring carbon stocks following forest health treatments, the District will be able to track how carbon stocks shift across the ecosystem over time in response to forest health management. Comparing baseline carbon stock levels with post-treatment conditions will help evaluate the effects of forest health management activities on carbon storage over time. These findings can inform future

management decisions, support transparent communication with the public, and provide valuable data for pursuing outside grant funding for similar projects in other locations.

La Honda Forest Health Project Timber Harvesting Plan
The THP describes the silvicultural prescription for the forest health treatments, the natural and cultural resources present within the project area, requisite environmental protection measures, and specifications for Project operations. The THP also includes a supplemental roads assessment and improvement plan prepared by Tim Best, a letter from the California Department of Fish and Wildlife (CDFW) regarding marbled murrelet (*Brachyramphus marmoratus*) protections, and the La Honda Forest Carbon Assessment. An early summarized preview of the THP is provided in Attachment 3, and key information is described below.

Marbled Murrelet
As the Project area has the potential to include marbled murrelet, a seabird deemed endangered by the State of California and listed as threatened under the U.S. Endangered Species Act, the District completed a habitat assessment and conducted two years of modified protocol surveys per direction from CDFW. Surveys did not detect marbled murrelet in the Project area. After completing two pre-consultations, which included review of the habitat assessment, survey data, and site visits, ***CDFW deemed the CMU as unsuitable habitat for marbled murrelet and the Harmon Unit as a "potentially suitable, but probable absence" site***. This determination and associated precautionary species protective requirements governing project operations (i.e., working outside of breeding season, retaining medium and high-quality potential nest trees, etc.) are documented in a letter, included as an attachment to the draft THP. Through the interagency review process described above, any additional specific requirements and conditions relevant to CDFW's determination will be incorporated into the THP prior to final approval. By supporting the development of old-growth forest characteristics, the Project will improve habitat suitability for marbled murrelet over time.

Roads
Per regulatory agency guidance, the District completed a supplemental roads assessment and improvement plan to address failures and sources of sedimentation both within the Project areas and along the access routes, including the Northside Road. The proposed road improvements will include eliminating, modifying, and/or replacing roads, as well as addressing stream crossings and gullies, where appropriate to reduce sedimentation and improve watershed conditions. Road improvements will be permitted through the THP and implemented through the Project.

FISCAL IMPACT

None

PRIOR BOARD AND COMMITTEE REVIEW

- **August 22, 2012 –** The Board approved the La Honda Creek Open Space Preserve Master Plan and associated Mitigated Negative Declaration and Mitigation Monitoring Program. (R-12-83; Meeting Minutes)

- **June 26, 2019**: The Board approved an award of contract with Sicular Environmental Consulting to provide forest assessment and planning services for the La Honda Forest. (R-19-84, Meeting Minutes)

- **July 28, 2021**: The Board reviewed and approved the Forest Health Plan and authorized the preparation of an addendum to the Forest Health Plan to include the recently acquired Woodruff Creek-Folger Parcel. (R-21-103, Meeting Minutes)

- **October 12, 2022**: The Board reviewed the Forest Health Plan and next steps for the project, which included developing forest management prescriptions under a forest health THP to improve forest health conditions. (R-22-116, Meeting Minutes)

- **July 26, 2023:** The Board received a study session presentation on the Woodruff Creek-Folger Parcel Addendum to the La Honda Forest Health Assessment and Management Plan as well as the Project Description for the La Honda Forest Health Project. (R-23-88, Meeting Minutes)

- **January 10, 2024:** The Board approved an award of contract with Buena Vista Services to prepare a Timber Harvesting Plan for the Project. (R-24-03, Meeting Minutes)

- **April 9, 2025:** The Board approved a contract amendment with Sicular Environmental Consulting and Natural Lands Management to provide additional technical support for the La Honda Forest Health Project. (R-25-42, Meeting Minutes)

- **January 28, 2026:** The Board approved a contract amendment with Sicular Environmental Consulting and Natural Lands Management to authorize assignment of the contract and provide additional technical support for the La Honda Forest Health Project. (R-26-03, Meeting Minutes)

- **July 8, 2026:** The Board approved a contract amendment with Sicular Environmental Consulting LLC to provide additional technical support necessary to add the Northside Road as a haul route for the La Honda Forest Health Project. (R-26-110, Meeting Minutes)

PUBLIC NOTICE

Public notice was provided as required by the Brown Act. Additional notices were provided to the La Honda Creek Preserve and Resource Management Interested Parties lists via email. A postcard was mailed to project area neighbors. A Notice of Intent, tribal notifications, and printed notices in the town of La Honda will be posted in accordance with the Forest Practice Rules through the THP submittal and review process.

CEQA COMPLIANCE

The Project is subject to a certified regulatory program (Public Resources Code § 21080.5; CEQA Guidelines § 15250-15253). CAL FIRE serves as the Lead Agency for environmental review of the Project and manages the environmental review process, including conducting pre-harvest inspections of the Project site, and coordinating reviews and comments from the general public and other entities, such as counties, California State Parks and Native American tribes. Responsible agencies (e.g., CDFW, California Coastal Commission, Regional Water Quality Control Board), who would need to issue permits for the work, will participate in CAL FIRE's environmental review process and issue permits based on CAL FIRE's approval of the final

THP. As Lead Agency, CAL FIRE determines if the THP conforms with the Forest Practice Rules and may require the District to engage in discussions with CAL FIRE, responsible agencies and other stakeholders, and revise its THP as necessary, to address agency and stakeholder concerns. If CAL FIRE approves the THP, it will issue a written Notice of Conformance to the District, allowing for Project operations to commence. CAL FIRE is also responsible for filing the Notice of Conformance for the THP to CAL FIRE's public portal.

NEXT STEPS

Following this meeting, the RPF will submit the draft THP to CAL FIRE, initiating regulatory agency and public review. CAL FIRE will post the THP on the CalTrees website (https://aca-prod.accela.com/Caltrees/Default.aspx) for public review and send out notices of its availability. Separately, the District will notify our Interested Parties lists and the Board with a courtesy email when the THP is posted and ready for review. Public comments will be submitted directly to CAL FIRE.

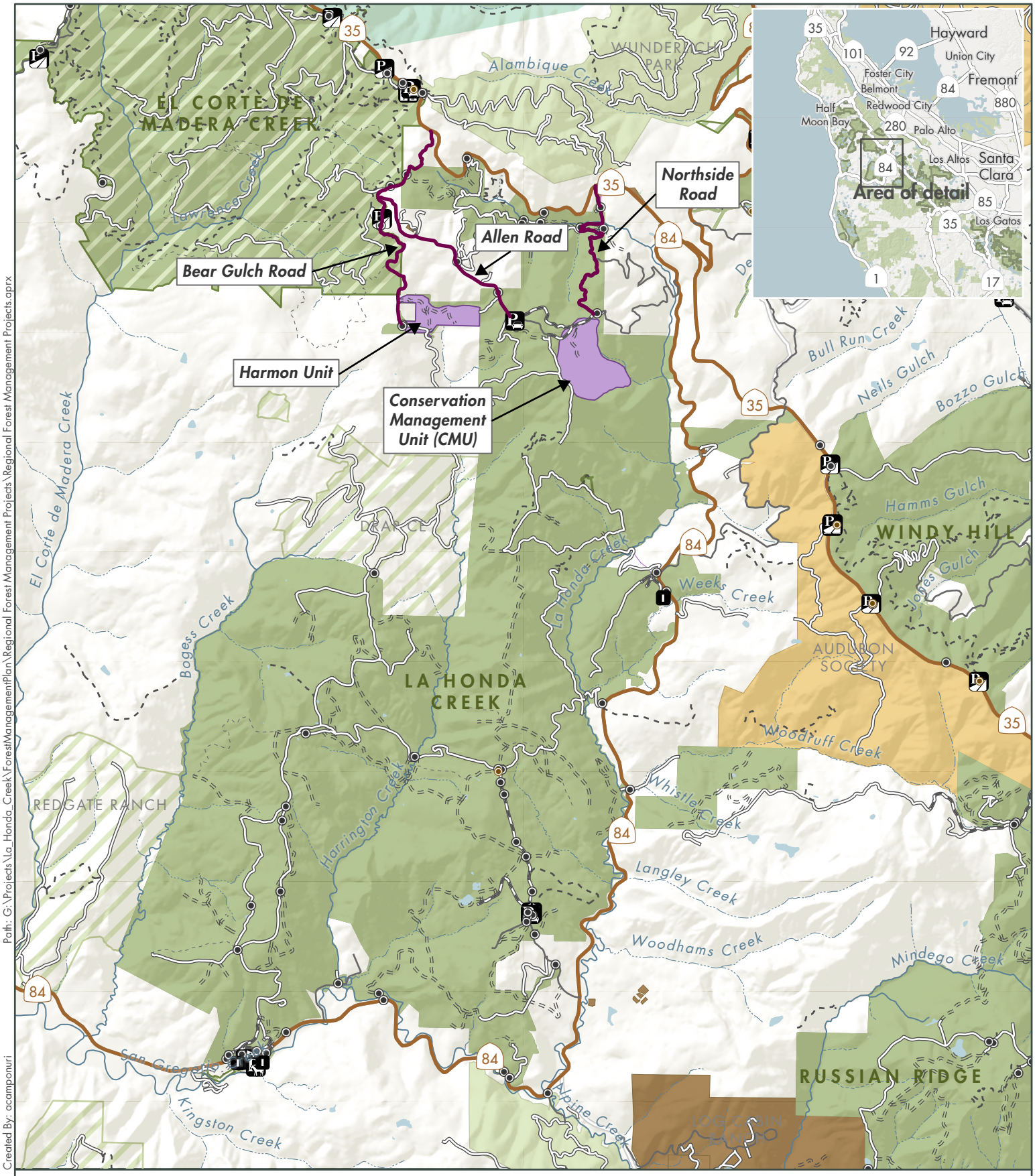
Pending issuance of the Notice of Conformance, staff would return to the Board with an FYI Memo to relay the approval has been issued. If approved, staff would solicit the services of a Licensed Timber Operator and return to the Board for approval of the contract. It is anticipated that Project operations would begin with forest health treatments in the Harmon Unit during fall of 2027.

Attachments

1. Map of La Honda Forest Health Project Areas
2. La Honda Forest Health Project Carbon Assessment
3. La Honda Forest Health Project THP Summary

Responsible Department Head:
Kirk Lenington, Natural Resources Department Manager

Prepared by/Contact Person:
Arianna Camponuri, Forest Ecologist II, Natural Resources Department



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Created By: acamponuri

La Honda Forest Health Project Areas

- Midpen preserves
- Other protected lands
- Private property
- Watershed land
- Land trust
- Other public agency
- Project areas
- Project access roads

Midpeninsula Regional Open Space District
(Midpen)
10/19/2026

Miles
0 0.5 1

While the District strives to use the best available digital data, these data do not represent a legal survey and are merely a graphic illustration of geographic features.

LA HONDA FOREST HEALTH PROJECT

Carbon Assessment



Prepared for:

Midpeninsula Regional Open Space District

By: **Sicular Environmental Consulting and Natural Lands Management**

June 2025

LA HONDA FOREST HEALTH PROJECT

Carbon Assessment

Midpeninsula Regional Open Space District

June 2025

Report preparer:

Dan Sicular, Ph.D.

Cover Photo: Soil sample collection in the La Honda Conservation Management Unit



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LA HONDA FOREST HEALTH PROJECT

Carbon Assessment

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A: Soil Organic Carbon Monitoring: Methods and Protocols
B. Soil Sample Processing Procedures
C. Soil Sampling Field Data Sheet

1. INTRODUCTION

The Midpeninsula Regional Open Space District (Midpen, District) completed the La Honda Creek Open Space Preserve Forest Health Assessment and Management Plan (La Honda Forest Plan) in July 2021 (Sicular et al, 2021). The La Honda Forest Plan characterizes existing forest health, water quality, and wildfire resiliency conditions, identifies impairments, and recommends management actions to improve the health and resilience of the forested areas of La Honda Creek Open Space Preserve (Preserve), known as the "La Honda Forest."

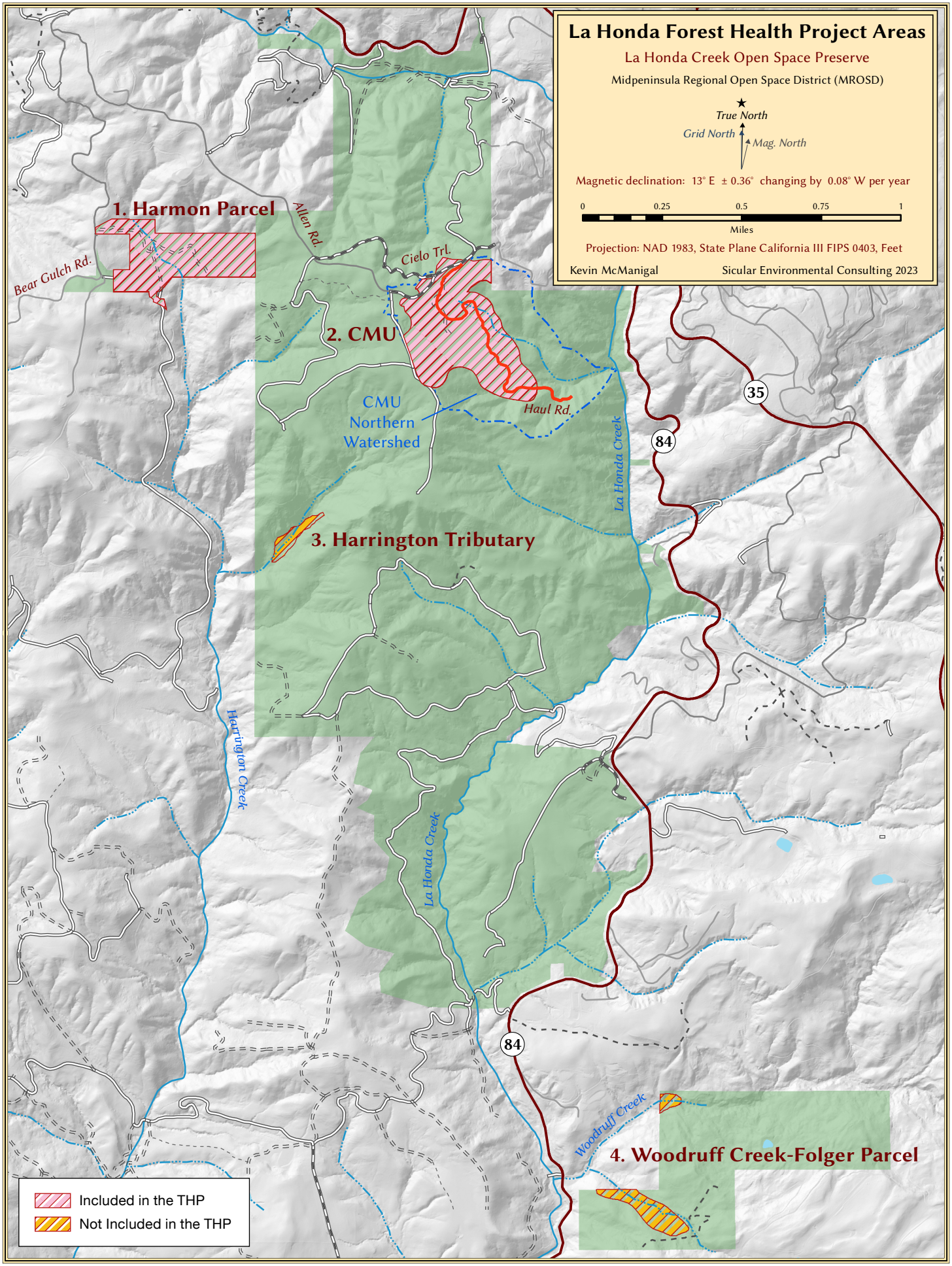
The Midpen Board of Directors (Board) directed the General Manager to begin planning for implementation of certain elements of the La Honda Forest Health Project (Project) on October 12, 2022. The Project will implement several of the recommendations in the La Honda Forest Plan, focusing initially on restoration forestry treatments in the Harmon and Conservation Management Unit (CMU) areas of the Preserve (Figure 1), to be carried out under the permitting authority of a Timber Harvest Plan (THP).[1] Consistent with the District's Resource Management Policies for Forest Management and Wildland Fire Management (Midpen, 2022), the goals of the Project are to:

1. Conserve and restore biodiversity by expediting the acquisition of old growth characteristics in regrowth conifer stands;
2. Preserve existing old growth individuals and stands;
3. Increase resilience to wildfire and climate change;
4. Enhance the forest's capacity for carbon sequestration and long-term, stable carbon storage; and
5. Reduce sediment sources negatively impacting water quality in salmonid-bearing streams (Sicular, 2023).

As a part of the Project planning process, Sicular Environmental Consulting was tasked with conducting a comprehensive assessment of carbon currently sequestered in the Harmon and CMU Project areas. The purpose of the carbon assessment (Assessment) is to inform the Midpen Board, staff, and the public of the mass of carbon stored in the forest, to identify the relative importance, and to estimate the size of specific carbon pools,[2] based on empirical measurements. Published sources of information on the amount of

[1] THPs are prepared pursuant to California's Forest Practice Rules (FPR), the implementing regulations for the Z'berg-Nejedly Forest Practice Act of 1973 administered by the California Department of Forestry and Fire Protection (CAL FIRE). The FPR are the most stringent and comprehensive forest management rules in the nation, and regulations in the Southern Subdistrict where La Honda Preserve is located are additionally protective of sensitive resources. The FPR govern all aspects of the commercial harvest of forest products including the licensing of timber operators, preparation of THPs, cutting intensity, harvest practices, road construction, erosion control, stream and watershed protection, sensitive species, archaeological and cultural resources, hazard reduction, and fire protection. Only single-tree selective harvesting is permitted in the Southern District, allowing just a portion of the standing timber to be cut, which is compatible with and supported by the recommended management options presented for this Project as well as existing District policies.

[2] A "carbon pool" is a reservoir or system within Earth's biosphere that can accumulate, store, and release carbon, such as the atmosphere, the oceans, terrestrial ecosystems, or soil.


La Honda Forest Health Project Areas
La Honda Creek Open Space Preserve
Midpeninsula Regional Open Space District (MROSD)
True North
Grid North
Mag. North
Magnetic declination: 13° E ± 0.36° changing by 0.08° W per year
0
0.25
0.5
0.75
1
Miles
Projection: NAD 1983, State Plane California III FIPS 0403, Feet
Kevin McManigal
Sicular Environmental Consulting 2023
1. Harmon Parcel
2. CMU
3. Harrington Tributary
4. Woodruff Creek-Folger Parcel
Bear Gulch Rd.
Allen Rd.
Cielo Trl.
Haul Rd.
CMU
Northern
Watershed
La Honda Creek
Harrington Creek
Woodruff Creek
35
84
84
Included in the THP
Not Included in the THP

carbon sequestered in redwood forests, especially in the southern portion of their range and in redwood forest soils, are limited (van Mantgem et al., 2013; Hoover et al., 2021; Jones and O'Hara, 2012; De la Espriella, 2019). The Assessment therefore will contribute to our understanding of current carbon sequestration in the redwood forest generally, and in second-growth redwood forests of the Santa Cruz mountains in particular. The Assessment may also point to considerations for management actions to preserve and enhance existing carbon stocks,[3] particularly in the face of climate change and increased potential for wildfire.

The Assessment examines the following pools of organic carbon[4]:

1. Standing live and dead trees, based on the forest inventory completed for the La Honda Forest Plan in 2020 by Buena Vista Services under contract with Sicular Environmental Consulting, and reported in Chapter 2 and Appendix C-3 of the La Honda Forest Plan;

2. Down and dead woody material, based on a 2024-2025 field survey conducted by Spatial Informatics Group for the District (SIG, 2025);

3. Live shrubs and other understory plants, also based on the SIG survey;

4. Forest floor material, consisting of leaves and fine woody material (litter) and partially decomposed organic material (duff or organic soil layer; the soil O horizon)[5] based on a 2024 field survey conducted by Midpen staff and Sicular Environmental Consulting;

5. Mineral soil, including the fine and coarse fractions making up mineral soil, to a depth of one foot (12 inches or 30 cm), also based on the 2024 field survey by Midpen staff and Sicular.

Section 2, Soil Organic Carbon Assessment, focuses on the methodology and results of soil sampling and analysis used to estimate carbon stored in pools four and five listed above. Methodologies and detailed reporting of standing timber (pool one in the list above) and down and dead woody material, and live shrubs and other understory plants (pools two and three) are provided in the original reports (Sicular et al., 2021; SIG, 2025), with the results summarized in Section 3, Summary of La Honda Forest Carbon Stocks.

[3] A "carbon stock" is the amount of carbon stored in a carbon pool.
[4] Inorganic carbon contained in carbonate rocks, and soil derived from them, is not closely related to the present-day atmospheric carbon cycle, and so is not the focus of this study, which focuses instead on organic carbon.
[5] "Soil horizon" is a term used for a layer in the soil in which some or all soil properties have resulted from pedogenic (i.e., soil-forming) processes. Horizons are more or less parallel to the soil surface and each horizon can be distinguished from adjoining horizons by differences in one or more of its properties, such as color and texture. The "O horizon" is the organic layer, consisting of litter and duff on the ground surface. The A horizon underlies the O horizon. It is commonly referred to as topsoil, and is characterized by a high concentration of organic matter (humus) mixed with mineral particles, usually appearing darker in color compared to the layers below it; it is the primary zone where plant roots grow and biological activity occurs. The "B horizon" is next. The B horizon is commonly referred to as "subsoil" and consists of mineral layers which are significantly altered by pedogenesis, mostly with the formation of iron oxides and clay minerals. The "C horizon" is little affected by pedogenesis, and is formed of alluvial deposits or weathered bedrock (Wikipedia: Soil Horizon. Accessed March 13, 2025). Other horizon and sub-horizon designators are also defined, but are not used in this report.

Measurement Systems and Terminology

Field measurements were taken using U.S. customary units. Laboratory results for soil samples, however, were reported in metric units. Typically, carbon emissions and sequestered carbon are reported in metric tonnes of CO_2 equivalence ($MTCO_2e$).

For this report, the following measurement systems, units, and terms are used:

- Field measurements are reported in U.S. customary units, with metric equivalents or conversions provided upon their first use. The symbol ” is used to denote inches.
- Laboratory results and figures derived from them are reported in metric units. For example, concentration of organic carbon in soil samples is reported as grams of total organic carbon per cubic meter of soil (TOC g/m^3).
- Carbon stocks (i.e., the amount of carbon stored in a carbon pool per unit of land area) are reported both as metric tonnes of elemental carbon (C) and as $MTCO_2e$ per acre.
- “Average” and “mean” are used interchangeably to denote the arithmetic mean of a set of values.
- Notation for mean values is sometimes given as plus or minus the confidence interval at 95% confidence level (e.g., 38.3 ± 2.5).
- Confidence interval is always given at the 95% confidence level (α=.05).

2. SOIL ORGANIC CARBON ASSESSMENT

Project Area Soils

Both the Harmon and the CMU Project areas are underlain by Butano sandstone (Best, 2009) and have nearly uniform soil series, consisting of **HyF—Hugo and Josephine sandy loams, very steep** (NRCS, 2023a, 2023b). Both Hugo and Josephine soils are derived from sandstone and shale parent material. Hugo has a typical profile as follows:

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 45 inches: gravelly sandy loam
H3 - 45 to 49 inches: weathered bedrock

Josephine soils are somewhat deeper, with a typical profile as follows:

H1 - 0 to 12 inches: sandy loam
H2 - 12 to 47 inches: loam
H3 - 47 to 51 inches: weathered bedrock

Typical depth to the water table is given as 80 inches or more for both series.

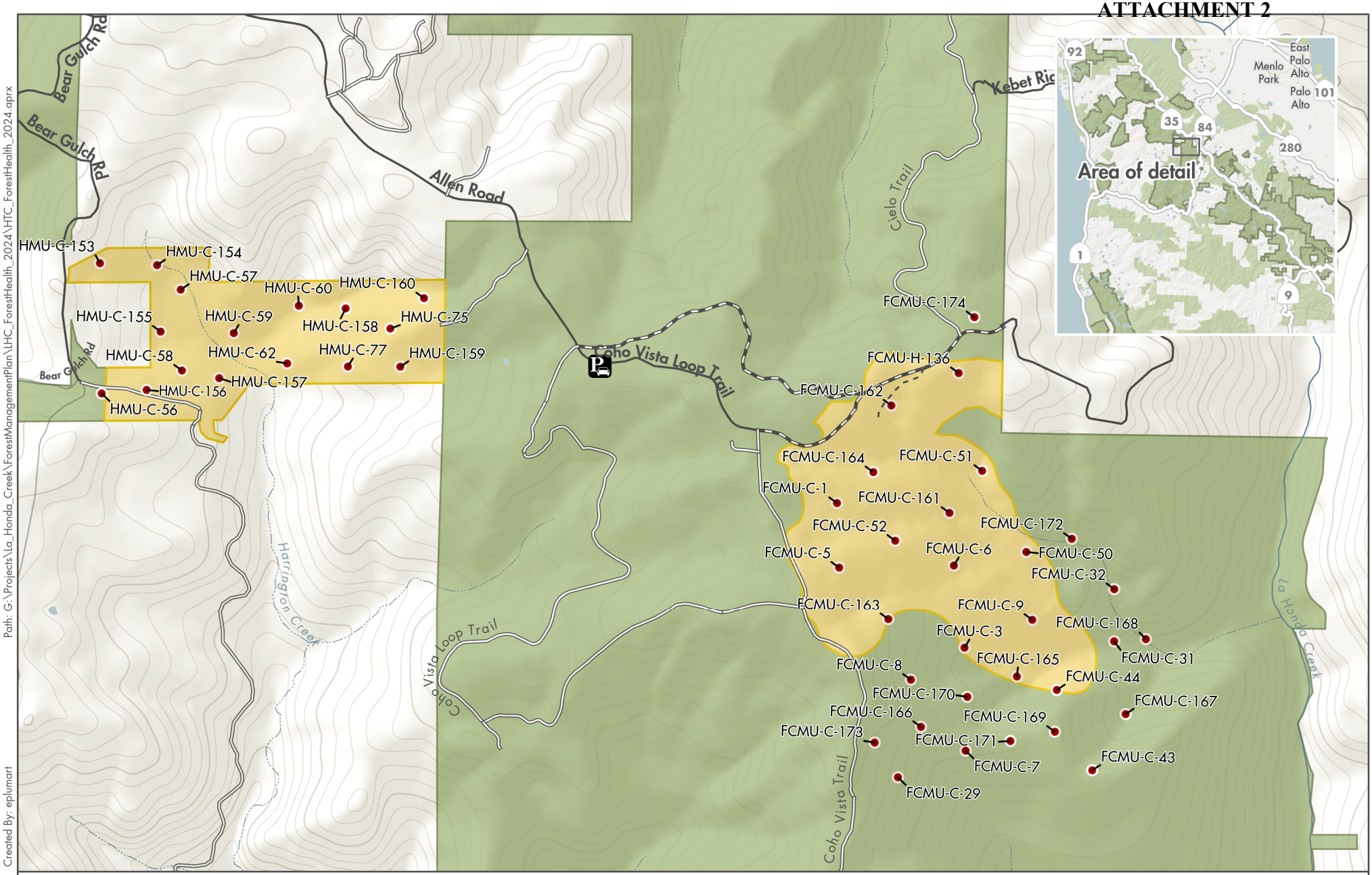
Methods and Materials

In the spring and summer of 2024, Midpen Natural Resources staff and Sicular collected soil samples from the Harmon and CMU Project areas. Sampling design and methods are detailed in Appendix A and summarized here.[6] Soil samples were taken from a total of 45 plots. Twenty-three of the plots were previously established for the forest inventory;[7] 22 plots were added to bring the total to 45. Fifteen plots were located in each of the two Project areas, and another 15 were located in a "control" area within the CMU, but outside of the Project area (Figure 2). The plots were arrayed roughly on a grid as the basis for randomization of samples. Given the near uniformity of mapped soil series, stratification of sampling based on soil survey data was deemed unnecessary and impractical.

The field team located nearly all the previously established plots by monuments placed during the 2020 inventory. For new plots, and the few established plots that could not be found, we monumented plot center and recorded the GIS coordinates. The field team took and recorded a series of observations (slope, aspect, dominant tree cover, canopy density, distance to water, bedrock outcrops, etc.), at each plot center.[8] The field data sheet is included as Appendix C.

[6] Thanks to Deborah S. Page-Dumroese, Ph.D., USDA Forest Service, Rocky Mountain Research Station (retired) and Prof. Mark Bradford, Yale School of the Environment, for their generous assistance in reviewing draft soil sampling and analysis protocols.
[7] See Chapter 2 and Appendix C of the La Honda Forest Plan (Sicular et al, 2021) for methods and results of the forest inventory.
[8] All field data have been entered into an Excel spreadsheet stored on Midpen's server. Scans of field data sheets are also stored on the server.

ATTACHMENT 2



Path: G:\Projects\La_Honda_Creek\ForestManagementPlan\LHC_ForestHealth_2024\LHTC_ForestHealth_2024.aprx

Created By: eplumart

La Honda Forest Health Project Inventory Plots

- Midpen preserves
- Private property
- Vegetation management areas
- Sample plots
- Trail
- Paved road
- Unpaved seasonal road
- Unpaved all-season road
- Abandoned / unmaintained trail

Midpeninsula Regional Open Space District
(Midpen)
3/4/2025

Miles 0 0.1 0.2

While the District strives to use the best available digital data, these data do not represent a legal survey and are merely a graphic illustration of geographic features.

At each plot, two sampling points were established at set distances along a transect starting from plot center and extending along a randomly selected azimuth. At each sample point, we removed woody debris and live plants, if present, to expose the top of the forest floor. We then removed forest floor material from within a one-foot (30 cm) diameter circle to expose the top of the mineral soil layer. We collected a one-liter (1.1 quarts) subsample from the first sample point for laboratory analysis, and measured the depth of the forest floor at four points along the circumference of the circle (Figure 3). We then used a 2" x 12" (5 cm x 30 cm) split-core soil sampler (AMS, Inc., #58599) with a serrated tip, driven into the soil with a slide hammer, to collect a mineral soil sample core (Figure 4). We divided the core into two 6" (15 cm) subsamples, adjusting for compaction of the soil column in the sampler measured during sampling.

Samples were brought to the Midpen Administrative Office and refrigerated until processed. Under the direction of District staff, a Midpen intern prepared samples for lab analysis following protocols described in detail in Appendix B. Mineral soil samples were air- or oven-dried (at 55 degrees Celsius) and sieved using a #10 (2 mm) sieve, to separate the coarse, stony soil fraction and larger pieces of roots and recognizable organic matter from the fine soil fraction. Fine roots were picked out of the fine material by hand. Each of the three fractions — fine soil fraction, coarse soil fraction, and roots/organic matter — were separately weighed, and the volume of the coarse fraction and roots/organic matter were measured.[9] Forest floor samples were not processed.

All fine fraction mineral soil samples (180 total) and forest floor samples (45 total), plus several batched samples of coarse fraction mineral soil (13 total batches), were sent to the University of California at Davis Analytical Laboratory (Anlab) for chemical and physical analysis. The Anlab analyzed all fine fraction mineral soil samples, all coarse fraction mineral soil batches, and 16 of the 45 forest floor samples for carbon content using Method 322.[10] The Anlab reports the following results of Method 322: Total Carbon (C), Total Organic Carbon (TOC), Calcium carbonate ($CaCO_3$) and Total Inorganic Carbon (TIC). Each is reported as concentration in the soil, expressed as a percentage by weight. TOC is the focus of this report. The Anlab also determined bulk density of all fine fraction mineral soil and forest floor samples using Method 480.[11] Bulk density is reported as weight per volume, based on oven-dry weight of the sample and the volume of the core, expressed as grams per cubic centimeter (g/cm^3).

[9] Live roots and dead, undecomposed roots and other organic matter, including woody material, invertebrates, etc., are not considered soil, and so this component of the mineral soil samples was not analyzed for carbon content. Though roots were not directly measured, the equations for converting volume of standing timber to carbon (Sicular et al, 2021, Appendix C-3) include a factor for estimating root volume and carbon content. Estimates of carbon stocks of standing timber presented in Section 3 of this report therefore include roots.

[10] The Anlab's description of Method 322 is as follows: This method quantitatively determines the total amount of organic carbon present in soil. Total carbon (TC) is determined using an instrument that utilizes a combustion system with an induction furnace coupled with an IR detector system. This method is based on the oxidation of the sample by "flash combustion" which converts all organic and inorganic substances into combustion gases (N2, NOx, CO2, and H2O). Total inorganic carbon (TIC) is quantitatively determined by measuring the calcium carbonate content using gravimetric analysis and then using a factor of 0.12 to convert calcium carbon to total inorganic carbon (TIC). Soil total organic carbon (TOC) is calculated as the difference between total carbon and total inorganic carbon. The method has a detection limit of approximately 0.02% carbon (UC Davis Anlab, 2024a).

[11] The Anlab's description of Method 480 is as follows: Soil bulk density is the ratio of the mass of dry solids to the bulk volume of the soil. The bulk volume includes the volume of the solids and of the pore space. The determination of bulk density consists of drying (105°C) and weighing a soil sample, the volume of which is known (core method) or must be determined (UC Davis Anlab, 2024b).



Figure 3: Soil Sample Collection, Midpen Staff and Interns, La Honda CMU



Figure 4: AMS Soil Core Sampler in use. The forest floor has been removed to expose the top of the mineral soil.

Laboratory analysis was completed by December 2024. The Anlab returned uncombusted portions of the samples to Midpen for archiving.

Soil Analysis Results

Field inspection of intact cores indicated highly variable presence and depth of the soil A horizon, typically consisting, when present, of coarsely to finely textured dark loam (Figure 5a).[12] The soil B horizon consisted of coarsely to finely textured, light brown clay or sandy clay (Figure 5b). All samples contained roots. Most samples contained few or no stones or stone fragments (see discussion of Coarse Fraction Mineral Soil, below).

Data compilation and processing were performed by Sicular. Lab results were compiled in an Excel spreadsheet. Anlab results for mineral soil samples were merged with field observations for each sample plot. Bulk density[13] values for mineral soil samples, which the Anlab calculated based on oven-dry weight of the sample and the gross volume of the core ("gross bulk density"), were adjusted by subtracting the volume of each sample occupied by coarse fragments and roots/organic matter, which had been determined during sample processing. The bulk density of the fine fraction (fine fraction bulk density) was derived from the adjusted core volume and the oven-dry sample weight provided by the Anlab.[14]

Descriptive and analytical statistics were performed using Systat v. 13.1[15] and the Microsoft Excel Data Analysis Toolpak add-on, and post-processed in an Excel spreadsheet.

Fine Fraction Mineral Soil

Tables 1 and 2 present descriptive statistics for the fine fraction of the mineral soil samples, including TOC (Table 1) and bulk density (Table 2). Both tables categorize samples by Project area (Harmon, CMU, and CMU Control) and depth (0-6" core depth and 6-12" core depth). As shown in Table 1, the concentration of TOC in fine fraction mineral soil samples ranged from 0.24% to 9.07% by weight, with a mean for all samples of 2.84%. In each of the three Project areas, TOC concentrations in the 6-12" depth samples were about three-fifths the concentration in 0-6" depth samples. TOC values had greater variance than bulk density, with 95% confidence intervals (the confidence interval at the 95% confidence level) ranging from 7.4-17.4% of the mean for TOC, and from 3.2-7.4% of the mean for bulk density. Histograms of the distribution of TOC and bulk density values for 180 samples (90 in each depth category) are shown in Figure 6.

Statistical tests including one- and two-way ANOVA and two-sample T-tests were used to examine whether means for TOC and bulk density were significantly different for different Project areas and

[12] Soil texture descriptions based on field observations, not laboratory analysis.
[13] Bulk density is weight per volume, expressed here as grams per cubic centimeter (g/cm^3).
[14] As described by Jurgensen et al, 2018.
[15] Thanks to François Christen, Ph.D., of Philo, CA for assistance with the statistical analysis, including use of Systat and interpretation of the results, and to Joe McGuire, RPF, Buena Vista Services, for assistance with forestry field methods and statistics. I take sole responsibility for any errors in calculations or interpretation.

Table 1: Descriptive Statistics: Fine Fraction Mineral Soil Samples, Total Organic Carbon % by weight

	0-6" and 6-12" Core Depth Combined				0-6" Core Depth				6-12" Core Depth			
	All Areas	Harmon	CMU	CMU Control	All Areas	Harmon	CMU	CMU Control	All Areas	Harmon	CMU	CMU Control
n	180	60	60	60	90	30	30	30	90	30	30	30
Arithmetic Mean (Average)	2.84	3.14	2.84	2.54	3.54	3.92	3.52	3.18	2.14	2.36	2.15	1.90
Confidence Interval (95%)	0.21	0.40	0.37	0.31	0.30	0.58	0.54	0.42	0.22	0.41	0.37	0.33
CI as % of Mean	7.4%	12.8%	13.0%	12.3%	8.5%	14.7%	15.3%	13.3%	10.1%	17.3%	17.4%	17.2%
Minimum	0.24	1.04	0.24	0.46	1.01	1.35	1.01	1.03	0.24	1.04	0.24	0.46
Maximum	9.07	9.07	7.05	6.05	9.07	9.07	7.05	6.05	5.88	5.88	4.36	4.90
Median	2.68	2.95	2.75	2.30	3.33	3.48	3.61	3.08	2.03	2.18	2.26	1.82
Mode	3.51	2.70	3.13	2.03	3.13	N/A	3.13	N/A	2.28	1.04	N/A	2.03
Standard Deviation	1.45	1.59	1.46	1.23	1.46	1.61	1.50	1.18	1.04	1.14	1.04	0.91
Skewness (g1) (0=normal)	1.02	1.25	0.72	0.74	0.97	1.36	0.54	0.49	0.90	1.17	0.23	1.24
Kurtosis (g2)(0=normal)	1.77	2.39	0.81	0.35	1.84	2.55	0.59	0.27	1.13	1.66	(0.60)	2.93

Note: N/A for Mode = no repeating values

Table 2: Descriptive Statistics, Fine Fraction Mineral Soil Samples, Bulk Density g/cm³

	0-6" and 6-12" Core Depth Combined				0-6" Core Depth				6-12" Core Depth			
	All Areas	Harmon	CMU	CMU Control	All Areas	Harmon	CMU	CMU Control	All Areas	Harmon	CMU	CMU Control
n	180	60	60	60	90	30	30	30	90	30	30	30
Arithmetic Mean (Average)	0.89	0.78	0.97	0.93	0.82	0.73	0.88	0.84	0.97	0.83	1.06	1.01
Confidence Interval (95%)	0.03	0.04	0.05	0.05	0.03	0.04	0.06	0.06	0.04	0.05	0.06	0.06
CI as % of Mean	3.2%	4.7%	4.9%	5.2%	4.2%	6.2%	6.5%	7.4%	4.0%	6.3%	5.7%	6.1%
Minimum	0.31	0.31	0.47	0.48	0.31	0.31	0.47	0.48	0.55	0.55	0.77	0.62
Maximum	1.42	1.40	1.42	1.30	1.24	1.07	1.17	1.24	1.42	1.40	1.42	1.30
Median	0.87	0.77	0.96	0.93	0.82	0.72	0.92	0.84	0.93	0.84	1.05	1.04
Mode	0.84	0.84	0.92	0.72	0.71	0.71	0.92	0.72	0.84	0.84	0.88	1.02
Standard Deviation	0.19	0.15	0.19	0.19	0.17	0.13	0.16	0.17	0.19	0.15	0.17	0.17
Skewness (g1) (0=normal)	0.25	0.86	(0.02)	(0.14)	(0.02)	(0.42)	(0.65)	0.07	0.28	1.71	0.33	(0.43)
Kurtosis (g2)(0=normal)	0.11	6.17	0.43	(0.55)	0.32	4.71	0.62	0.04	(0.38)	7.70	(0.76)	(0.44)



Figure 5a: 12” soil core showing clear distinction between A and B horizons.



Figure 5b: 12” soil core showing less distinction between A and B horizons.

Figure 6: Histograms of Fine Fraction Mineral Soil TOC and Bulk Density Values

For Each Chart, *n* =90

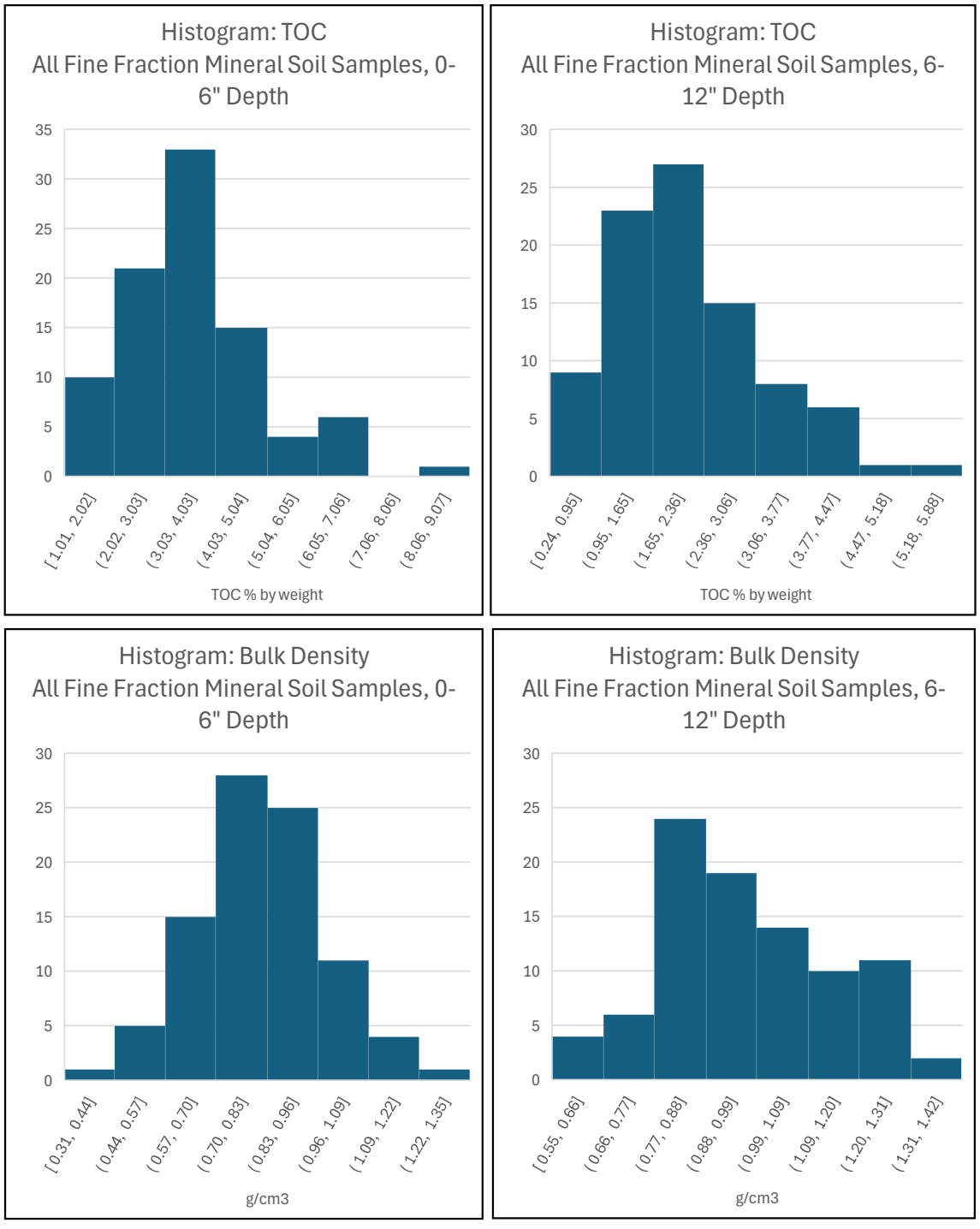


Table 3: Variance of Mean Values for TOC and Bulk Density Between Project Areas

	All Areas		Harmon		CMU		CMU Control		Variance Between Areas[1]	Variance Between Depths[2]
	Mean	95% Confidence Interval	Mean	95% Confidence Interval	Mean	95% Confidence Interval	Mean	95% Confidence Interval	P-Value (two-tail; alpha=.05)[3]	
TOC (% by weight)										
0-6"	3.54	0.30	3.92	0.58	3.52	0.54	3.18	0.42	0.14	
6-12"	2.14	0.22	2.36	0.41	2.15	0.37	1.90	0.33	0.23	**0.0000000000043**
BD (g/cm^3)										
0-6"	0.82	0.03	0.73	0.04	0.88	0.06	0.84	0.06	**0.0006**	
6-12"	0.97	0.04	0.83	0.05	1.06	0.06	1.01	0.06	**0.000001**	**0.000000066**

Notes: 1. P-value for variance of means between areas using single factor ANOVA, H_0 = no significant variance between areas.

2. P-Values for variance of means between depths using two-sample T-test. P-values between the two types of tests are equivalent.

3. P-value <0.05 **(bolded)** indicates there is sufficient evidence to reject H_0; i.e. differences are significant.

Table 4: Variance of Mean Values for Bulk Density Between Project Areas

	P-Values		
Bulk Density Sample Depth	Harmon-CMU	Harmon-CMU Contol	CMU-CMU Control
0-6"	**0.00011**	**0.0039**	0.41
6-12"	**0.00000069**	**0.000047**	0.30

Notes:

P-Values from Two-Sample t-Tests, assuming equal variance.

Bonferroni Correction applied; alpha=0.05/3(tests)=0.0167.

Bolded values indicate significant variance.

sample depths. As shown in Table 3, both TOC and bulk density mean values were significantly different between sample depths (P-value <0.05). TOC mean values were not significantly different between Project areas, but bulk density values were. Two-sample t-tests, using a Bonferroni correction (corrected for three tests, $\alpha = 0.05/3 = 0.0167$), revealed that the mean bulk density value for the Harmon Project area was significantly different from both the CMU Project area and CMU control plots (Table 4).

To calculate the mass of TOC per acre, the mean bulk density values for each core depth and each Project area were used to calculate the total weight of soil per unit area to a depth of 12 inches. The mean values for TOC concentration were then applied to calculate weight of TOC per unit area to 12 inches depth, then converted to the CO_2 equivalent, as shown in Table 5. Adjustments were applied to reduce the area of a given acre occupied by trees, bedrock outcrops, and streambeds, as detailed in Table 6. The results, as shown in Table 5, indicate fine fraction mineral soil organic carbon stocks range from 26.8 metric tonnes of elemental carbon, or 98.4 $MTCO_2e$, per acre in the CMU control plots, to 31.3 metric tonnes of elemental carbon, or 114.9 $MTCO_2e$, per acre in the CMU Project area. The average for the three areas is 28.9 metric tonnes of elemental carbon, or 106 $MTCO_2e$, per acre of fine fraction mineral soil to a depth of 12 inches.

About one third of the fine fraction mineral soil samples contained detectable levels of calcium carbonate ($CaCO_3$; 64 of 180 samples) or total inorganic carbon (TIC; 61 of 180 samples), with no sample containing more than 0.7% $CaCO_3$, or 0.09% TIC.

Correlations

TOC values for each 0-6” core and each 6-12” core were correlated with the corresponding bulk density values as well as ten environmental factors observed at each sample plot (Table 7). TOC values for both core depths are strongly negatively correlated with bulk density (Pearson correlation coefficient = -0.54 for both core depths). TOC was also moderately positively correlated with forest floor depth (PCC = 0.43, 0.45). Other correlations were weak or insignificant.

Mean TOC values by mapped stand type[16] are shown in Figure 7. Mean TOC values by tree cover type observed at plot center are shown in Figure 8. TOC values do not show a clear trend related to stand density or predominant tree species.

Forest Floor

Forest floor samples included the entire profile of the forest floor (litter and duff) to the top of the mineral soil layer. Descriptive statistics for depth, TOC concentration, and bulk density of the forest floor samples

[16] Mapped stand types are shown in the La Honda Forest Plan, Figure 2-3. The stand type labeling system combines age structure, canopy density, and predominant over-story species, in that order, using the following terms:

AGE STRUCTURE	CANOPY DENSITY	PREDOMINANT SPECIES
Y – Young growth	**1 - 70-100%**	**R – Redwood**
YY – Large second growth	**2 - 50-70%**	**D - Douglas-fir**
R – Residual old growth	**3 - 30-50%**	**H – Hardwood**
O - Old growth	**4 - 10-30%**	**B – Shrub**
	5 - <10%	**G – Grassland**

Table 5: Calculation of Fine Fraction Mineral Soil Carbon Stocks

Factor	Unit	All Areas	Harmon	CMU	CMU Control
0-6" Depth					
Mean TOC content	percent by weight	3.54	3.92	3.52	3.18
Mean Bulk Density	g/cc	0.82	0.73	0.88	0.84
TOC per CC	g/cc	0.03	0.03	0.03	0.03
TOC/m^2 to 6"	kg	4.34	4.27	4.65	4.02
TOC/Acre to 6"	mTonne	17.55	17.29	18.80	16.28
$MTCO_2e$/Acre	$mTCO_2e$	64.4	63.5	69.0	59.7
6-12" Depth					
Mean TOC content	percent by weight	2.14	2.36	2.15	1.90
Mean Bulk Density	g/cc	0.97	0.83	1.06	1.01
TOC weight per CC	g/cc	0.02	0.02	0.02	0.02
TOC/m^2 6-12"	kg	3.10	2.94	3.41	2.88
TOC/Acre 6-12"	mTonne	12.53	11.89	13.81	11.65
$MTCO_2e$/Acre	$mTCO_2e$	46.0	43.6	50.7	42.7
0-12" Depth					
TOC Per Acre	mTonne	30.1	29.2	32.6	27.9
CO_2e Per Acre	mTonne	110.4	107.1	119.7	102.5
Adjusted for area occupied by trees, streams, and bedrock outcrops (estimated 4% of area; see Table 6)					
0-12" Depth					
TOC Per Acre	mTonne	28.9	28.0	31.3	26.8
CO_2e Per Acre	$mTCO_2e$	106.0	102.8	114.9	98.4
Conversion factors:					
cc per m^2 per 15 cm depth	150,000				
Acre to Hectare	2.471				
C to CO_2	3.67				

Table 6: Adjustments to Area of Soil per Acre

Square Feet, Unless Otherwise Indicated

Area/Stand Type	Acres	Basal Area of Conifers[1]	Basal area adjusted to ground level[2]	Basal Area of Hardwoods	Total Basal Area	Streams and Rock Outcrops[3]	Total Area Adjustment	Total Area Adjustment (percent)
Harmon								
Y1RD	27	454	835	29	864			
Y3H	2	34	63	75	138			
Y3RD	11	267	491	69	560			
YR4D	1	138	255	56	311			
YR4RD	5	151	278	109	387			
Total/Weighted Avg	46	351	646	50	696	871	1,567	3.6%
CMU								
RY2RD	16	482	888	68	956			
Y2RD	12	486	894	25	919			
YR4D	13	138	255	56	311			
YR3RD	42	319	587	40	627			
Total/Weighted Avg	83	346	638	46	683	871	1,554	3.6%
CMU Control	Plots							
YR3RD	9	319	587	40	627			
Y2RD	3	486	894	25	919			
YR2RD	1	294	541	46	587			
RY2RD	1	482	888	68	956			
YR4D	1	138	255	56	311			
Total/Weighted Avg	15	349	643	40	684	871	1,555	3.6%

Notes

[1]Basal areas of conifers and hardwoods from the 2020 inventory and grown forward to 2024 using growth factors for each stand type reported in Sicular et al, 2021, Table 2-6.

[2]Basal area is calculated based on diameter measurement at breast height (4.5' above ground level). Basal area adjusted to ground level based on Curtis and Arney, 1977, equation 9.

[3]Estimated at 2% of area.

Table 7: Correlations of Fine Fraction Mineral Soil TOC with Environmental Factors

Pearson Correlation Coefficients

	TOC	Bulk Density	Sample Collection Date	Slope	Aspect	Cover Type	Stand Type	Canopy Density	Slope Position	Soil Moisture	Distance to Water	Forest Floor Depth
0-6" Depth												
TOC	1.00											
Bulk Density	(0.54)	1.00										
Collection Date	(0.11)	0.14	1.00									
Slope	0.14	(0.18)	0.23	1.00								
Aspect	(0.12)	0.28	0.20	(0.04)	1.00							
Cover Type	0.02	0.18	0.01	(0.04)	0.28	1.00						
Stand Type	(0.11)	0.06	(0.03)	0.18	(0.31)	(0.28)	1.00					
Canopy Density	0.04	0.20	(0.08)	(0.12)	0.08	0.54	(0.29)	1.00				
Slope Position	0.23	(0.26)	(0.05)	(0.03)	(0.13)	0.20	(0.25)	0.04	1.00			
Soil Moisture	0.19	(0.29)	(0.62)	(0.05)	(0.22)	0.16	(0.13)	0.12	0.31	1.00		
Distance to Water	(0.16)	(0.05)	0.19	0.22	0.05	(0.40)	0.28	(0.09)	(0.59)	(0.23)	1.00	
Forest Floor Depth	0.43	(0.12)	0.11	0.08	(0.17)	(0.02)	(0.11)	0.09	0.21	0.02	(0.16)	1.00
6-12" Depth												
TOC	1.00											
Bulk Density	(0.54)	1.00										
Collection Date	(0.08)	0.29	1.00									
Slope	(0.05)	(0.03)	0.23	1.00								
Aspect	(0.06)	0.26	0.20	(0.04)	1.00							
Cover Type	(0.04)	0.22	0.01	(0.04)	0.28	1.00						
Stand Type	(0.11)	0.15	(0.03)	0.18	(0.31)	(0.28)	1.00					
Canopy Density	0.03	0.21	(0.08)	(0.12)	0.08	0.54	(0.29)	1.00				
Slope Position	0.21	(0.38)	(0.05)	(0.03)	(0.13)	0.20	(0.25)	0.04	1.00			
Soil Moisture	0.10	(0.39)	(0.62)	(0.05)	(0.22)	0.16	(0.13)	0.12	0.31	1.00		
Distance to Water	(0.15)	0.16	0.19	0.22	0.05	(0.40)	0.28	(0.09)	(0.59)	(0.23)	1.00	
Forest Floor Depth	0.45	(0.26)	0.11	0.08	(0.17)	(0.02)	(0.11)	0.09	0.21	0.02	(0.16)	1.00

Key:

Negative values in parenthesis

Weakly correlated (± 0.1 - 0.3)

Moderately correlated (± 0.31 - 0.5)

Strongly correlated (± 0.51 - 0.99)

Repeat of previous table

Figure 7: Carbon Concentration in Fine Fraction Mineral Soil, by Stand Type

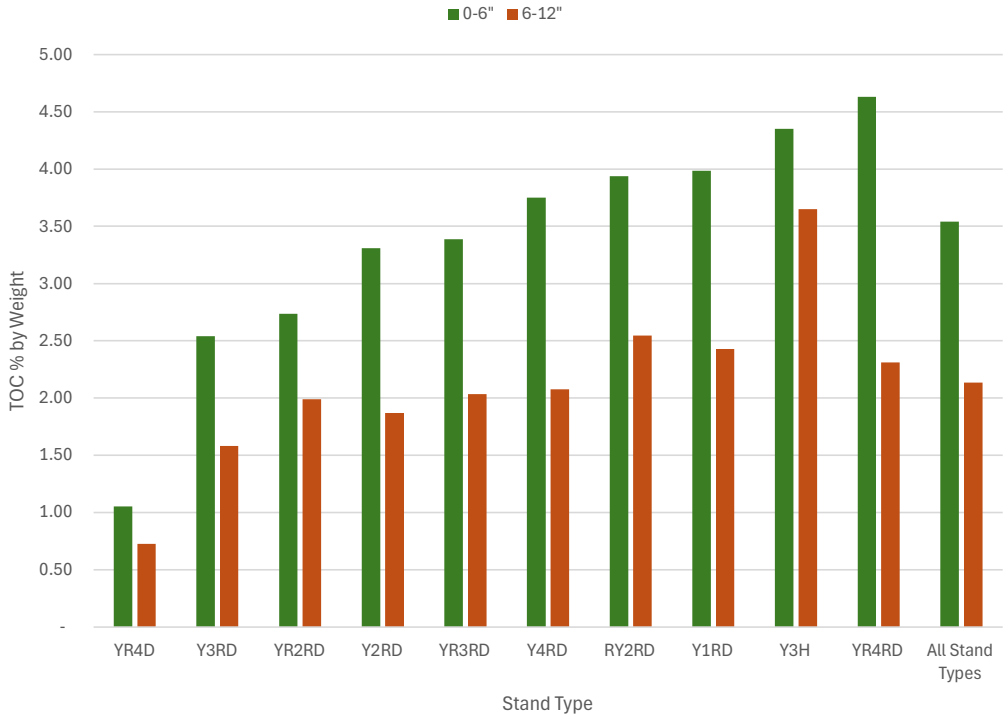


Figure 8: Carbon Concentration in Fine Fraction Mineral Soil, by Cover Type

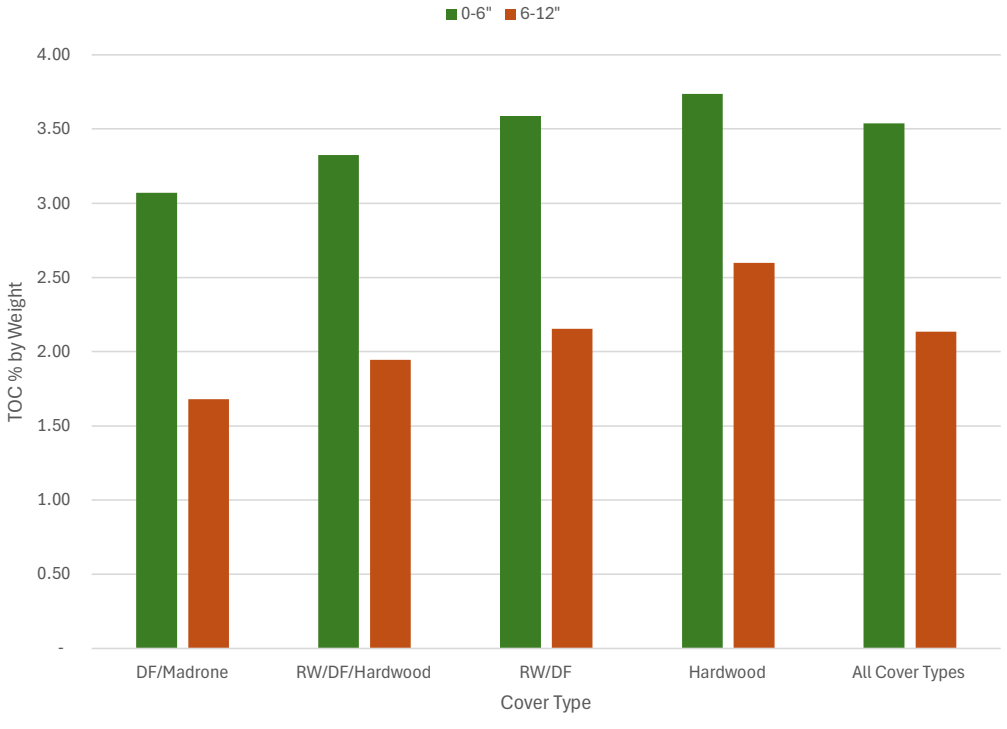


Table 8: Descriptive Statistics for Forest Floor Samples

	Depth (inches)	TOC Content (% by weight)	Bulk Density (g/cm^3)
Mean	2.97	31.5	0.15
Standard Error	0.16	2.2	0.01
Median	2.69	32.8	0.13
Mode	3.00	37	0.12
Standard Deviation	1.55	8.7	0.06
Sample Variance	2.40	75.9	0.004
Kurtosis	0.81	-0.22	1.87
Skewness	0.90	-0.84	1.53
Range	7.31	28.1	0.25
Minimum	0.38	14.1	0.08
Maximum	7.69	42.2	0.33
Count	90	16	45
Confidence Interval (95%)	0.32	4.6	0.02
Confidence Interval as % of Mean	11%	15%	12%

Table 9: Forest Floor Carbon Stocks

Factor	Value	Unit
Mean TOC Content	31.5	percent by weight
Mean Bulk Density	0.15	g/cc
Mean depth of forest floor	2.97	inches
or	7.54	cm
Volume of FF per m^2 to mean depth	75,371	cc
Weight of FF per m^2 to mean depth	11.23	kg
TOC/m^2 to mean depth	3.54	kg
TOC/acre to mean depth	14.3	metric tonnes
TOC/acre adjusted for area occupied by trees, streams, rock outcrops, per Table 6 (-4%)	13.8	metric tonnes
CO_2e per acre	51.7	$MTCO_2e$

are shown in Table 8. TOC concentrations in the 16 samples analyzed ranged from 14.1% to 42.2% by weight, with a mean of 31.5 ± 4.6%. Depth of the forest floor, as measured in the field, ranged from 0.38" to 7.69" with a mean of 2.97 ± 0.32" Calculation of forest floor carbon stocks is shown in Table 9; carbon stocks averaged 13.8 metric tonnes of elemental carbon, or 51.7 $MTCO_2e$, per acre. This represents about one-half of fine fraction mineral soil carbon stocks.

Coarse Fraction Mineral Soil

The coarse fraction of the mineral soil samples consisted of stony fragments that did not pass a #10 (2 mm) sieve during mineral soil processing. In some soils, the coarse fraction is known to contain substantial amounts of organic carbon (Homann et al., 2004; Jurgensen et al., 2018). Thirteen batches of oven-dried coarse fraction samples were submitted to the Anlab for analysis of carbon concentration, using Method 322. Bulk density was determined by measuring weight and volume during sample processing. Descriptive statistics for TOC and bulk density for the coarse fraction mineral soil samples are shown in Table 10. TOC concentrations ranged from .08% to 0.72% by weight, with a mean value of 0.28 ± 0.10%. None of the samples had detectable levels of $CaCO_3$ or TIC. Bulk density values were consistent between batches, averaging 2.3 ± 0.03 g/cm^3. Calculation of carbon stocks contained in the coarse fraction mineral soil is shown in Table 11; the coarse fraction mineral soil carbon pool is significantly smaller than the fine fraction mineral soil and forest floor pools, at an estimated 0.22 metric tonnes of elemental carbon, or 0.81 $MTCO_2e$, per acre.

Discussion of Soil Analysis Results

Total estimated organic soil carbon stocks for all Project areas and control plots was 42.9 metric tonnes of elemental carbon, or 157.3 $MTCO_2e$, per acre (Table 12). As shown in Figure 9, fine fraction mineral soil was the largest contributor, accounting for nearly two-thirds of total soil carbon stocks in this pool. The forest floor, consisting of litter and duff layers, contained about half the carbon as the fine fraction mineral soil. While all coarse fraction mineral soil batch samples had detectable levels of organic carbon, the general paucity of stony fragments in the top 12 inches of soil in the Project areas, and the low concentration of carbon present in this fraction, combined to result in a minor carbon pool.

Statistically significant differences in organic carbon concentration and bulk density were detected between the 0-6" depth and the 6-12" depth fine fraction mineral soil samples (Table 3). In all three Project areas, C concentrations in the 0-6" depth were significantly greater, and bulk density values significantly lower, than the deeper samples. Few 6-12" samples were observed to include any of the A horizon, and nearly all 0-6" samples did contain an A horizon, so the differences in C concentration are not surprising. Differences in organic carbon concentration in the fine fraction mineral soil samples between Project areas were not statistically significant. Bulk density values, however, were significantly different between sample depths and also between Project areas; specifically, the bulk density of both sample depths in the Harmon Project area was significantly lower than either the CMU or CMU control areas (Table 4). This could be explained by a loamier soil texture; both sample depths for the Harmon area had higher (though not statistically higher) C levels than the other areas as well, which would be consistent with a higher content of loam. This could be confirmed with additional laboratory testing.

Table 10: Descriptive Statistics for Coarse Fraction Mineral Soil Samples

	TOC % by Weight	Oven Dry Weight per Sample (g)	Bulk Density (g/cm^3)
Mean	0.28	19.87	2.30
Standard Error	0.05	2.42	0.01
Median	0.25	8.13	2.29
Mode[1]	#N/A	#N/A	#N/A
Standard Deviation	0.17	32.43	0.09
Sample Variance	0.03	1051.95	0.01
Kurtosis	2.58	18.69	7.29
Skewness	1.42	3.77	0.21
Range	0.64	248.92	0.63
Minimum	0.08	0.05	1.99
Maximum	0.72	248.98	2.62
Count	13	180	39
Confidence Interval (95.0%)	0.10	4.77	0.03

Notes: [1]N/A for Mode = no repeating values.

Table 11: Coarse Fraction Mineral Soil Carbon Stocks

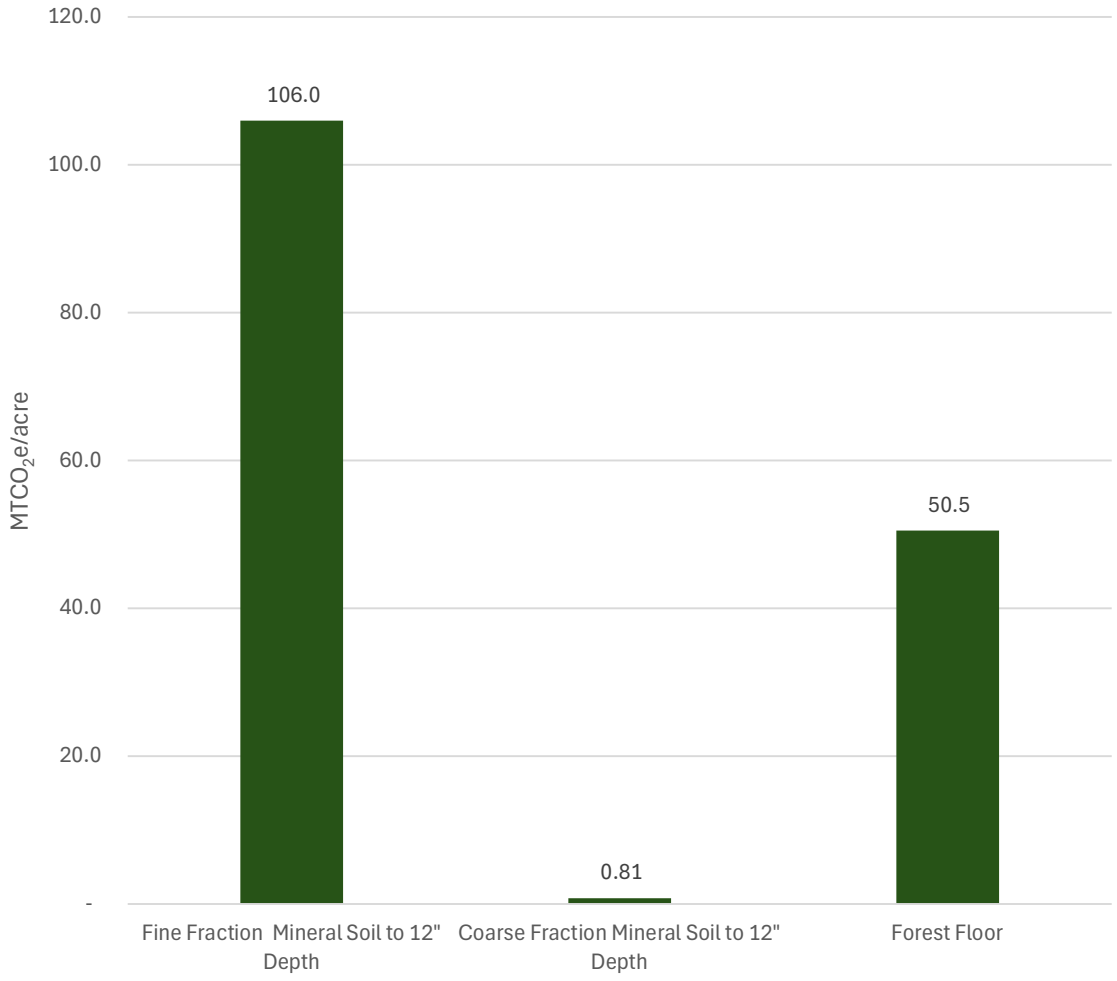
Factor	Value	Unit
Average weight/sample (6" core)	19.87	g
Average TOC Content	0.28%	% by weight
Average weight TOC/12" core (two samples)	0.11	g
Surface area of core	19.63	cm2
or	0.00196	m2
TOC/m2	57	g
TOC/acre	0.23	metric tonnes
TOC/acre adjusted for area occupied by trees, streams, rock outcrops, per Table 6 (-4%)	0.22	metric tonnes
CO_2e/acre	0.81	$MTCO_2e$

Table 12: Summary of Soil Organic Carbon Stocks

Metric Tonnes per Acre

	Elemental C	$MTCO_2e$
Fine Fraction Mineral Soil to 12" Depth	28.9	106.0
Coarse Fraction Mineral Soil to 12" Depth	0.22	0.81
Forest Floor	13.8	50.5
Total	**42.9**	**157.3**

Figure 9: Soil Organic Carbon Stocks



Carbon concentration was strongly negatively correlated with bulk density (Table 7). Here, again, the likely explanation is that loamier soils have lower density and higher organic matter, and thus higher carbon concentrations. Carbon levels in both sample depths were moderately correlated with the depth of the forest floor layer. We had hypothesized that carbon levels in the mineral soil would be positively correlated with higher redwood canopy cover, which is typically associated with deep soils and abundant moisture. Neither cover type, stand type, nor canopy density, however, were strongly correlated with carbon concentration (Table 7, Figures 7 and 8). Note that in Figure 7, the stand type with the highest average carbon concentration for the 0-6" depth samples was YR4RD, a redwood-Douglas-fir stand with a low canopy density. The stand type with the highest average carbon concentration in the 6-12" depth samples was Y3H, a hardwood type with a moderate canopy density.

The coarse fraction mineral soil consisted mostly of pebbles and shards of weak sandstone. None of the sample batches submitted for laboratory analysis contained detectable amounts of inorganic carbon, and all had low levels of organic carbon. Our sample processing procedures included slaking[17] the stony fragments to remove fine soil particles clinging to them and to distinguish between small dirt clods[18] and stones. This was challenging, as the sandstone tended to dissolve into sand particles during the slaking procedure. It is likely that the organic carbon detected in these samples was a combination of residual particles of fine mineral soil, including organic particles, as well as carbon in solution that had adsorbed onto the outer layers of the coarse fragments, or that had been absorbed into the pores between sand grains.

Conclusions and Recommendations

The soil carbon assessment produced a statistically significant snapshot of soil organic carbon stocks in the La Honda Forest, and the relative amount contributed to the total by different carbon pools. The results are considered sufficiently reliable for general reporting and planning purposes.

Comparison to other surveys of soil organic carbon stocks in the redwood region shows similar results. For example, the US Forest Service's *Standard Estimates of Forest Ecosystem Carbon for Forest Types of the United States* (Hoover et al, 2021) estimates mineral soil carbon stocks in redwood stands at 21.8 metric tonnes of elemental carbon per acre; our study yielded an average of 29.1 metric tonnes of elemental carbon in the coarse and fine mineral soil fractions per acre. Our study, however, found much more organic carbon stored in the forest floor pool than estimated by USFS: USFS estimates 2.7 metric tonnes elemental carbon per acre in the forest floor of an 80-year-old redwood stand; our study found 13.8 metric tonnes per acre, or about five times higher. This may be at least partly explained by the lack of fire in recent history in the La Honda Forest, which has resulted in a substantial buildup of litter and duff.

An analysis of the 2008 *Soil Survey for Redwood National and State Parks* found that average carbon content ranged from 4.5 metric tonnes of elemental carbon per acre in floodplain soils with little vegetation cover, to 190 metric tonnes per acre in moist redwood forests, and that overall, soils in the Parks had an average of 86 metric tonnes of elemental carbon per acre (van Mantgem et al., 2013). This is

[17] In Soil Taxonomy, slaking is the disaggregation of coherent soil material when placed in water or another chemical agent to test for cementation. Noncemented materials will mostly slake, or dissolve, while cemented materials will not slake in water (NRCS. 2017). In our processing of stony fragments, we used water in the slake test. See Appendix B, Soil Sample Processing Procedures.

[18] Termed "densic materials" by the USDA Natural Resources Conservation Service (NRCS, 2017).

about three times more than we found at La Honda. The *Soil Survey for Redwood National and State Parks*, however, characterized all soil horizons to bedrock, typically to a depth of four to seven feet (NRCS, 2008). Carbon was present in the deeper B and C horizons, though at substantially lower concentrations than the A horizon.[19] Because the B horizon is typically much thicker than the A horizon,[20] however, the mass of carbon contained in the B horizon may be greater than in the A horizon in some soils.

Because we found few correlations of carbon with environmental factors (Table 7), the study provided few clues for management actions to increase soil organic carbon pools. The one strong positive correlation, forest floor depth with carbon concentrations, suggests that the litter and duff layers could be managed for an increased rate and volume of carbon contained in mineral soil. Periodic, low-intensity prescribed fire may increase carbon concentrations in mineral soils, by converting a portion of the carbon contained in litter, duff, and woody material to more stable forms (Cheng et al., 2023). Prescribed fire and low-intensity fire have been found to have minimal or no negative impacts on deeper soil carbon pools in Pacific Northwest forests, while decreasing, at least in the short-term, carbon storage in the litter/duff layer (Nave et al, 2022). Prescribed fire also reduces surface fuel accumulation and so contributes to decreased intensity of fire behavior in the event of a wildfire; high-intensity wildfire tends to decrease carbon storage at all soil depths (ibid). Further research, and potentially modeling the impacts of prescribed burning on soil carbon stocks, may be useful in determining whether this would be a viable strategy for increasing soil organic carbon stocks in the La Honda forest and other Midpen preserves, in addition to contributing to the attainment of other District management objectives.

While not indicated by any of the study results, an important consideration for management is retention of existing soil carbon stocks through reduction of soil erosion. Of particular concern, and already a focus of the La Honda Forest Health Project, is reducing erosion from old logging roads and other anthropogenic sources within the Project area, especially the CMU. Reducing erosion would help retain existing sequestered carbon, and, by stabilizing the land surface, may also help rebuild soil carbon stocks.

Limitations and Uncertainties

The statistical analysis indicates a 95% chance that the actual mean values for TOC for the major soil carbon pools, fine fraction mineral soil and forest floor, are all within 18% of the mean values given; for bulk density, the confidence intervals are much smaller, within 12% (Tables 1, 2, 8, and 10). A greater number of samples, and further refinement of sample collection and processing methods, would likely increase statistical robustness.

Fifteen of the sample plots were located within the CMU but outside the Project area, with the intent to use these as a control against which to compare future conditions following application of restoration treatments (Figure 2). The statistical analysis indicated no significant difference in fine fraction mineral soil carbon concentration between the control plots and either the CMU or Harmon Project areas, but a

[19] The *Soil Survey for Redwood National and State Parks* reports values for soil organic matter, not carbon (NRCS, 2008, Table 16 - Physical Properties of the Soils). Organic matter is generally considered to contain 58% carbon (UC Davis Anlab, 2025). Based on a review of several of the major soil types where redwood/Douglas-fir forest is given as the dominant vegetation type, organic carbon concentrations in the A horizon are typically about 1-6%, B horizon, 0.3-3.0%, and C horizon 0.0-0.9%.

[20] The Soil Survey's descriptions of the redwood/Douglas-fir soils reviewed indicate A horizon thickness is typically 5-10", B horizon 20-60", and C horizon 10-60" (ibid).

statistically significant difference between Harmon and the CMU areas for fine fraction mineral soil bulk density. The CMU control plots therefore appear to be suitable as a control for the CMU Project area, but may differ too much from the Harmon area to be of use as a control for treatments applied there. Several plots within the Harmon area could be set aside as a control specifically for comparison to the remainder of the Harmon area.

This study limited collection of mineral soil samples to 12" depth only. According to the characterization of the soil series in the Project areas, however, the B horizon is much deeper, up to 45-47" deep, underlain by weathered bedrock (NRCS, 2023a, 2023b). Our 6-12" depth cores were mostly within the B horizon, and we found a substantial amount of organic carbon present there (2.14 ± .22%).[21] Recent studies have identified vast carbon stocks deep in the soil profile in various locations around the world (Harrison et al., 2011; Rossa et al., 2020; Wade et al., 2019). Our sampling methodology limited us to 12" depth, but a different or modified sampling method, even applied to a limited sampling effort to yield a few samples for laboratory analysis, might provide valuable clues to whether a substantially greater amount of organic carbon is contained in these soils than we were able to detect.

[21] The NRCS Web Soil Survey reports that the weighted average of soil organic matter contained in map unit HyF (Hugo and Josephine sandy loams, very steep), which covers nearly the whole of both Project areas, is as follows: A horizon, 2.5%; B horizon, 0.75%; C horizon, 0.75% (https://websoilsurvey.nrcs.usda.gov/app/). Since organic matter is assumed to be 58% carbon (UC Davis Anlab, 2025), organic carbon values would be about half these figures. This would be substantially lower than the mean values for our core samples shown in Table 1. Because the B horizon is much thicker than the A horizon, however, it may contain a substantial amount of carbon, even though the carbon concentration is lower than the A horizon.

3. SUMMARY OF LA HONDA FOREST CARBON STOCKS

This section provides a review of forest carbon pools and estimates of carbon stocks in the Project areas, focusing on non-soil pools: standing timber, down woody debris, and forest understory. A compilation and summary of all carbon stocks surveyed in the La Honda Forest is also provided.

Standing Timber

The forest inventory conducted for the La Honda Forest Plan (Sicular et al., 2021) resulted in an estimate of the volume of standing live and dead timber in the La Honda Forest. Timber volume is readily convertible to carbon content, using broadly accepted equations to extend timber volume to total tree biomass, then applying factors for wood density and carbon concentration. The La Honda Forest Plan estimated the volume of carbon in this pool at 99 metric tonnes of elemental carbon, or 363 $MTCO_2e$, per acre, as of the inventory date in 2020, for the approximately 1,210 forested acres assessed. Using the same methodology and assumptions, this figure was refined for each Project area based on the inventory's estimate of standing timber in the Harmon and CMU areas (Sicular et al., 2021, Table 2-8). The results are shown in Table 13, and include estimates for 2020, the year of the inventory, and 2024, based on an annual growth rate of four percent, as estimated in the La Honda Forest Plan. The estimates for 2024 for the Harmon Project area are 120 metric tonnes of elemental carbon, or 441 $MTCO_2e$, per acre; for the CMU, 140 metric tonnes of elemental carbon, or 515 $MTCO_2e$, per acre.

Down Woody Debris and Herb/Shrub Layer

The 2024 SIG survey (SIG, 2025) used the same plot network that we established for soil sampling to survey down woody debris and forest understory vegetation. For each Project area, SIG estimated the weight of the biomass contained in down woody debris, categorized by diameter class corresponding to the 1-hour, 10-hour, 100-hour, and 1,000-hour fuel classes used for modeling fire behavior (Brown, 1974). From the same survey, SIG estimated biomass contained in the herbaceous and shrub layers of the forest understory, and in the duff and litter layers. The results, converted to carbon using a standard factor of 0.5 (e.g., Pearson et al., 2007), are shown in Table 14. Based on the SIG survey, down woody debris accounted for an average of 11.26 metric tonnes of elemental carbon, or 41.31 $MTCO_2e$, per acre across the three Project areas.

The estimate of carbon in the forest floor layer based on the SIG survey differs from the estimate derived from Midpen's 2024 soil survey. The SIG survey yielded an estimated 21.47 metric tonnes of elemental carbon per acre in the forest floor layer, compared to our estimate of 13.8 metric tonnes. The SIG survey based their estimate of biomass on observed depth of the duff and litter layers and an assumed value for bulk density taken from the literature. In Table 14, biomass is converted to carbon based on a commonly used value of 50% carbon content in woody material, applied to all of SIG's reported biomass values. The Midpen survey, on the other hand, relied on laboratory testing of both bulk density and carbon

Table 13: Standing Timber Carbon Stocks

Metric Tonnes per Acre

	Elemental Carbon	MTCO2e
Harmon		
2020	103	377
2024[a]	120	441
CMU		
2020	120	440
2024[a]	140	515
Average		
2024	130	478

Notes: [a] Assuming 4% annual growth rate.

Source: Sicular et al, 2021

Table 14: Down Woody Debris, Forest Floor, and Understory Vegetation Carbon Stocks

Metric Tonnes Per Acre

	Elemental Carbon				
	Harmon	CMU	CMU Control	All Areas	All Areas: $MTCO_2e$
Down Woody Debris					
1-hr	0.10	0.11	0.15	0.12	0.44
10-hr	0.76	0.97	1.25	0.99	3.63
100-hr	1.05	1.48	1.84	1.46	5.35
1000-hr (sound)	4.95	4.23	5.09	4.76	17.46
1000-hr (rotten)	3.35	2.90	5.54	3.93	14.42
Subtotal: Down Woody Debris	**10.21**	**9.69**	**13.87**	**11.26**	**41.31**
Forest Floor					
Litter	4.10	5.45	7.68	5.74	21.07
Duff	12.59	18.10	16.49	15.73	57.72
Subtotal: Forest Floor	**16.68**	**23.55**	**24.17**	**21.47**	**78.79**
Understory Vegetation					
Live Shrub	0.64	1.50	0.86	1.00	3.66
Dead Shrub	0.05	0.05	0.09	0.05	0.17
Live Herbaceous	0.27	0.09	0.14	0.18	0.67
Dead Herbaceous	-	-	0.05	-	-
Subtotal: Understory Vegetation	**0.95**	**1.63**	**1.13**	**1.22**	**4.49**

Source: SIG, 2025. Biomass converted to elemental carbon using a factor of .5 (50%).

concentration from field samples. The calculated results were then adjusted (discounted) for area estimated to be occupied by standing trees and rock outcrops. The estimates from the Midpen survey therefore are more site-specific and empirically based.

Most of the difference between the two estimates for carbon stocks contained in the forest floor layer is accounted for by the carbon concentration factor. If, for example, the mean carbon (TOC) concentration for the forest floor layer from the Midpen survey (31.5%) were applied to the average biomass estimate for the duff plus litter layers from the SIG study instead of 50%, and the four percent adjustment for non-soil areas applied, the resulting estimate of carbon stocks would be much closer to the results of the Midpen study: 13.0 metric tonnes of elemental carbon per acre for the SIG study, compared to 13.8 metric tonnes for the Midpen study. Bulk density values used for the two studies were about same; the weighted average for duff and litter from the SIG survey was 0.12 g/cm^3 (SIG, 2025, Table 4; figure has been converted from lbs/cubic ft), while the Midpen survey average was 0.15 g/cm^3.

The SIG study separately measured the depth of the duff and litter layers, and found that duff biomass was two to three times greater than litter. The Midpen survey did not separately measure litter and duff.

The SIG survey also estimated biomass of the forest understory, based on measurements of living and dead plants in the shrub and herbaceous layers of the forest. Converted to elemental carbon using the common factor of 0.5, the understory totaled 1.22 metric tonnes of elemental carbon, or 4.49 $MTCO_2e$, per acre.

Summary of all Carbon Stocks

Estimates of all forest carbon stocks are shown in Table 15 and shown graphically in Figure 10. The estimated total, using the value for forest floor from the Midpen survey and the average figure for standing timber from Table 13, is 185.5 metric tonnes of elemental carbon, or 681 $MTCO_2e$, per acre. As shown in Table 15 and Figure 10, standing timber is by far the largest carbon pool, making up over 70% of total carbon stocks, more than four times the second largest pool, the fine fraction mineral soil. Forest floor and down woody debris stocks are about the same size. The understory and coarse fraction mineral soil contribute small amounts to the total.

Table 15 also shows the estimated total organic carbon stock in each Project area.[22] For the 46-acre Harmon Project area, the total carbon stock is estimated at 8,073 metric tonnes of elemental carbon, or 29,629 $MTCO_2e$. For the 83-acre CMU Project area, the estimate is 16,234 metric tonnes of elemental carbon, or 59,578 $MTCO_2e$.

[22] Note that the totals per Project area use the area-specific values for standing timber from Table 13.

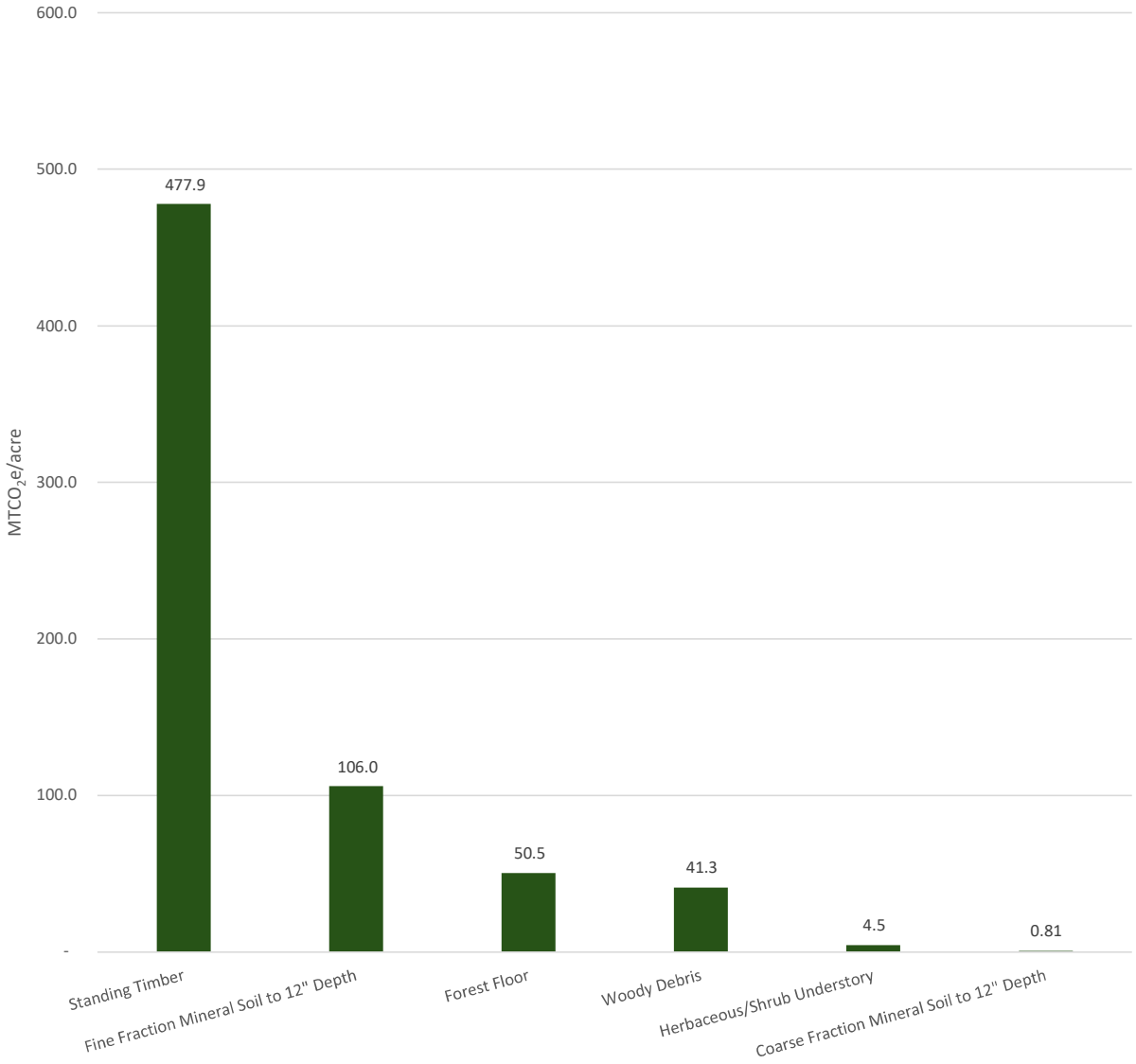
Table 15: Summary of All Forest Carbon Stocks

Per Acre

Carbon Pool	Metric Tonnes C	$MTCO_2e$	Percent of Total
Fine Fraction Mineral Soil to 12" Depth	28.9	106.0	15.6%
Coarse Fraction Mineral Soil to 12" Depth	0.22	0.81	0.12%
Forest Floor	13.8	50.5	7.4%
Woody Debris	11.3	41.3	6.1%
Herbaceous/Shrub Understory	1.22	4.49	0.7%
Standing Timber	130.2	477.9	70.2%
Total	185.5	681.0	100%
Total per Project Area [1]			
Harmon Project Area (46 Acres)	8,073	29,629	
CMU Project Area (83 Acres)	16,234	59,578	

Note: [1]Total for each Project area uses area-specific figure for standing timber from Table 13.

Figure 10: All Forest Carbon Stocks



REFERENCES

Best, Tim, 2007. Road and Trail Erosion Inventory: La Honda Open Space Preserve. Prepared for Midpeninsula Regional Open Space District. Final Draft, August, 2007.

Cheng, Yue; Peng Luo, Hao Yang, Honglin Li, Chuan Luo, Honghong Jia, Yu Huang, 2023. Fire effects on soil carbon cycling pools in forest ecosystems: A global meta-analysis. Science of the Total Environment, Vol. 185, 15 October 2023. https://www.sciencedirect.com/science/article/pii/S0048969723036240

De la Espriella, Lilianne, 2019. Soil Carbon Content of *Sequoia Sempervirens* Forest Habitat. A Senior Thesis submitted in partial satisfaction of the requirements for the degree of Bachelor of Arts in Environmental Studies, University of California, Santa Cruz. June 2019.

Gonzalez, P.; G. P. Asner, J. J. Battles, M. A.Lefsky, K. M. Waring, and M. Palace. 2010. Forest carbon densities and uncertainties from Lidar, QuickBird, and field measurements in California. Remote Sensing of Environment Vol 114 pp. 1561–1575.

Harrison, Robert B., Paul W. Footen, and Brian D. Strahm, 2011. Deep Soil Horizons: Contribution and Importance to Soil Carbon Pools and in Assessing Whole-Ecosystem Response to Management and Global Change. Forest Science Vol 57 No 1.

Homann, P.S.; S.M. Remillard, M.E. Harmon, and B.T. Bormann, 2004. Carbon storage in coarse and fine fractions of Pacific Northwest old-growth forest soils. Soil Sci. Soc. Am. J. 68:2023–2030. doi:10.2136/sssaj2004.2023.

Hoover, Coeli M.; Ben Bagdon, and Aaron Gagnon, 2021, Standard estimates of forest ecosystem carbon for forest types of the United States. Gen. Tech. Rep. NRS-202. Madison, WI: U.S. Department of Agriculture, Forest Service, Northern Research Station. 158 p. https://doi.org/10.2737/NRS-GTR-202.

Jones, D. A., and Kevin A. O'Hara, 2012. Carbon storage in young growth coast redwood stands. In Standiford, Richard et al, eds., Proceedings of coast redwood forests in a changing California: A symposium for scientists and managers. Gen. Tech. Rep. PSW-GTR-238. Albany, CA: Pacific Southwest Research Station, Forest Service, US Department of Agriculture. pp. 515-523.

Jurgensen, Martin F.; Deborah S. Page-Dumroese, Robert E. Brown, Joanne M. Trucked, Chris A. Miller, James B. Pickens, and Min Wang, 2018. Estimating Carbon and Nitrogen Pools in a Forest Soil: Influence of Soil Bulk Density Methods and Rock Content. Soil Science Society of America Journal, vol. 81, pp. 1689-1696.

Midpeninsula Regional Open Space District, 2022. Resource Management Policies. May 2022.

.

Natural Resources Conservation Service, USDA (NRCS), 2008. Soil Survey of Redwood National and State Parks, California. https://archive.org/details/usda-index-to-detailed-soil-map-sheets-soil-survey-of-redwood-national-and-state-parks-cal

Natural Resources Conservation Service, USDA (NRCS), 2017. A Glossary of Terms Used in Soil Survey and Soil Classification, Including Definitions and Brief Commentary. By Dr. Craig Ditzler.

Natural Resources Conservation Service, USDA (NRCS), 2023a. Custom Soil Resource Report for San Mateo Area, California; and San Mateo County, Eastern Part, and San Francisco County, California: CMU Area. November 6, 2023

Natural Resources Conservation Service, USDA (NRCS), 2023b. Custom Soil Resource Report for San Mateo Area, California: Harmon Parcel. November 6, 2023.

Nave, Lucas E., Kendall DeLyser, Grant M. Domke, Scott M. Holub, Maria K. Janowiak, Brian Kittler, Todd A. Ontl, Eric Sprague, Eric B. Sucre, Brian F. Walters, and Christopher W. Swanston, 2022. Disturbance and Management effects on forest soil organic carbon stocks in the Pacific Northwest. Ecological Applications, Vol. 32, No. 6.

Page-Dumroese, D. S.; M. F. Jurgensen, R. E. Brown, and G. D. Mroz, 1999. Comparison of Methods for Determining Bulk Densities of Rocky Forest Soils. Soil Science Society of America Journal, vol. 63, pp. 379-383.

Pearson, Timothy R.H.; Sandra L. Brown, and Richard A. Birdsey, 2007. Measurement Guidelines for the Sequestration of Forest Carbon. USDA Forest Service, Northern Research Station, General Technical Report NRS-18.

Rossa, C. Wade, Sabine Grunwalda, Jason G. Vogel, Daniel Markewitz, Eric J. Jokelac, Timothy A. Martinc, Rosvel Brachoc, Allan R. Bacona, Colby W. Brungard, Xiong Xiong, 2020. Accounting for two-billion tons of stabilized soil carbon. Science of The Total Environment, Vol 703 No 10 February 2020.

Sicular Environmental Consulting and Natural Lands Management, Christopher Keyes, Ph.D., Buena Vista Services, LLC, Timothy Best, CEG, and Orange Peel Cartography, 2021. La Honda Creek Open Space Preserve Forest Assessment and Management Plan (La Honda Forest Plan). Prepared for Midpeninsula Regional Open Space District, July, 2021.

Sicular Environmental Consulting and Natural Lands Management, 2023. La Honda Forest Health Project: Project Description. Prepared for Midpeninsula Regional Open Space District, June 2023.

Spatial Informatics Group, (SIG), 2025. La Honda Open Space Preserve: December 2024 Down Woody Debris Inventory Memo. Prepared for Midpeninsula Regional Open Space District, March 2025.

University of California, Davis, Analytical Laboratory (Anlab), 2024a. Description of method 322 - Total Organic Carbon - Combustion Method. Accessed December, 2024.

University of California, Davis, Analytical Laboratory (Anlab), 2024a. Description of method 480 - Bulk Density. Accessed December, 2024.

University of California, Davis, Analytical Laboratory (Anlab), 2025. Description of method 415 Organic Matter - Loss-On-Ignition Method. Accessed June, 2025.

van Mantgem, Phillip; Mary Ann Madej, Joseph Seney, and Janelle Deshais, 2013. Estimating ecosystem carbon stocks at Redwood National and State Parks. Park Science, Vol. 30, No. 1, Summer 2013.

Wade, Anna M., Daniel D. Richter, Vincent P. Medjibe , Allan R. Bacon , Paul R. Heine , Lee J.T. White, and John R. Poulsen, 2019. Estimates and determinants of stocks of deep soil carbon in Gabon, Central Africa. Geoderma, Vol 341, No 1, May 2019.

APPENDICES

Appendix A: Soil Organic Carbon Monitoring: Methods and Protocols

LA HONDA FOREST HEALTH PROJECT

Soil Organic Carbon Monitoring: Methods and Protocols

Version: 4-17-24

The goal of the Soil Organic Carbon (SOC) monitoring is to determine current carbon stocks sequestered in the soil (including the organic layer), and to establish a baseline against which future conditions can be compared as forest health treatments are implemented over time.

Methods

The methods selected for SOC sampling and laboratory analysis will allow an estimation of carbon stocks (tons per acre, or metric tons per acre or hectare) in the forest floor (duff/litter layer; O horizon) and in the underlying mineral soil layer to a depth of 1 foot. These layers typically contain the majority of SOC contained in forest soils, and are most likely to experience a detectable change in SOC concentration over time as a result of changes in forest management and fire events (Pearson et al, 2007). Sampling also becomes more difficult and time consuming at greater depths (described as "impractical" by Pearson et al, 2007).

Both the Harmon Parcel and the CMU project areas are underlain by Butano sandstone (Best, 2009) and have nearly uniform soil series, consisting of **HyF—Hugo and Josephine sandy loams, very steep.** (NRCS, 2023a, 2023b) Both Hugo and Josephine soils are derived from sandstone and shale parent material. Hugo has a typical profile as follows:

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 45 inches: gravelly sandy loam
H3 - 45 to 49 inches: weathered bedrock

Josephine soils are somewhat deeper, with a typical profile as follows:

H1 - 0 to 12 inches: sandy loam
H2 - 12 to 47 inches: loam
H3 - 47 to 51 inches: weathered bedrock

Depth to water table is given as 80 inches or more for both series.

There is also a limited area in the Harmon Parcel with soil series **HuE2 Hugo and Josephine loams, steep, eroded** (NRCS, 2023b).

Given the near uniformity of mapped soil series, stratification of sampling based on soil survey data is impractical.

The existing forestry plot network will be expanded to a minimum of 15 plots for each of the two project areas and one control area, for a total of 45 plots involved in the monitoring.

Sample Collection

At each plot, three sample types will be collected:

- **Forest Floor:** One (1) sample at each forestry plot, collecting all duff/litter to the top of the mineral soil within a 1 foot diameter circular frame; Sticks >1/4" and green plant material (including moss) will be removed prior to collection.

- **Mineral Soil:** two (2) core samples using a 2" x 12" split core sampler starting at the top of the mineral soil layer, and extending to 12" deep. Each sample will be split into two 2" x 6" cores, to enable separate characterization of the near-surface layer and deeper layer of the mineral soil horizon.

- **Bulk Density:** Bulk density will be determined from the mineral soil cores; no separate samples will be taken for bulk density.

Phytophthora Protocols

All tools, equipment, and footwear will be cleaned at the District field office before arriving at the project site each day and prior to leaving the project site, per the District's *Guidelines for Minimizing Phytophthora Contamination* (MROSD, 2018). Tools, equipment, and footwear will also be cleaned at the end of the sampling day before leaving the site, and when moving from one site to the other (e.g., from the Harmon parcel to the CMU). In the field, tools and sampling equipment that contact soil will be wiped down with 70% isopropyl between samples. Work clothes will be cleaned prior to each field day. (See more on Field Sampling Protocols below).

Lab Analysis

Lab analysis will be by the UC Davis Analytical Lab, using the following methods:

Forest Floor Samples: Dry Matter Determination (method 505) or Bulk Density (method 480) test. Samples will be oven dried at 105ºC for three hours, then weighed. Carbon content is assumed to be 50 percent of oven-dry weight (Pearson et al, 2007). For preliminary test sampling, samples will be analyzed using the Total Organic Carbon-Combustion (method 322) method to confirm carbon content. As described in the following paragraph, method 322 quantitatively measures Total Organic Carbon (TOC) in a sample.

Mineral soil samples: Total Organic Carbon-Combustion (method 322). This method is based on the oxidation of the sample by "flash combustion" which converts all organic and inorganic substances into combustion gases (N2, NOx, CO2, and H2O). The method has a detection limit of approximately 0.02% carbon. Sample material must be ground to a powder fine enough to pass through a 60 mesh screen (<0.25 mm).

Bulk density samples: Bulk Density (method 480) (total and fine fraction). Soil bulk density is the ratio of the mass of dry solids to the bulk volume of the soil. Mass of dry solids is determined by oven drying and weighing of the sample. The volume of the sample is known by the dimensions of the sampling device (in this case, each half core is 2" diameter x 6" long = 18.85 cubic inches). If the mineral soil samples contain a substantial fraction of coarse stones, these should be separated out to determine both total bulk density and fine fraction bulk density (Jurgensen et al, 2018). The lab will therefore be asked to separately weigh and determine the volume of coarse fragments that do not pass a #10 (2 mm) sieve.

Data Analysis

The results of the lab analyses will be used to determine the following:

- mineral soil mean bulk density, both total and fine fraction, for the 0-6" layer and 6-12" layer separately;
- mean percent organic carbon by weight of mineral soil, for the 0-6" layer and 6-12" layer separately; and
- mean weight of organic carbon per unit volume for the forest floor layer.

To calculate carbon stocks within the mineral soil layer, we will calculate the mean fine fraction bulk density for each depth layer, then extrapolate to determine the total mass (dry weight) by unit area (e.g., 1 acre to 6" depth), and multiply this by the Mean TOC content (% by weight, expressed as a decimal) for that layer, using formulas provided by Jurgensen et al, 2018.

To calculate carbon stocks within the forest floor layer, we will determine the mean weight of organic carbon for a given volume, then extrapolate to the mean volume of duff/litter per unit area (derived from depth measurements), reporting the resulting total weight of forest floor layer TOC per acre.

Adding the forest floor + mineral soil calculations gives weight of soil organic carbon by unit area.

We will examine the data to determine the appropriate statistical model to use in data analysis. A parametric model is assumed preliminarily. If bulk density samples contain large stones or a large quantity of stones, the bulk density data may be non-parametric. We will report the statistical confidence interval of results at the 90% confidence level. Post-stratification may be used (for example, by project unit, timber type, slope, slope position) to attempt to reduce the coefficient of variation and narrow the confidence interval.

Field Sampling Protocols

Sample Location and Number of Samples:

2 project areas (Harmon and CMU) and 1 control area (within the CMU).
15 1/5 acre circular plots (52.7' radius) in each project area and in the control area; 45 plots total. A typical portion of the Harmon area (3-5 acres) will be established as a control, and approximately 5 of the plots located there.

One forest floor sample and four mineral soil samples (two each, 0-6" depth and 6-12" depth) in each plot.

Tools, Equipment, and Supplies:

Clean cotton rags
70% (or greater) Isopropyl alcohol in labeled spray bottle
1-gallon and 1-quart heavy zip lock bags (storage or freezer type)
Storage/carrying bag for samples
Medium tip Sharpie pens
5-gallon High Density Polyethylene bucket, graduated in 1-quart increments
1-gallon High Density Polyethylene bucket
Split Core Sampler: AMS #58599 (with hex quick-pin connectors and two 2" x 6" plastic sleeves)
Extra plastic sleeve for core sampler
Crescent wrench
Channel lock pliers
Oil filter wrench
Butter knife
Pruning shears (hand clippers)
Hori-hori knife, graduated, with sheath
Spade
Small rake or cultivator tool
Fire fuel go/no-go gauge
12" inside diameter bicycle tire (size 16" x 2.125")
Medium bristle paint brush – 3" width
Datasheets, printed on Rite-in-the-Rain paper; separate sheet for each plot
Sample labels
Pencils, extra-fine sharpie pens, Rite-in-the-Rain pens
Field maps
GPS with plot coordinates pre-loaded
100' tape
Stake for securing tape at plot center
Pin flags for temporary marking of sample points
Compass
Clinometer
Phone/camera
First-Aid Kit
Special status plant identification guide
Chain of Custody forms
Random number generator (e.g. smart phone app)

Sampling Protocols:

In general: if a sample point is occupied by a tree, LWD, rock, or other object that prevents or hinders access to the ground surface and extraction of sample, move 3 feet 90 degrees to the right of the line used to establish the point (e.g., if line is at 0 degrees azimuth, move 3 feet to the east (90 degrees azimuth). Continue along this 90-degree line in 3-foot increments until you reach an accessible point. Note adjustment on field datasheet.

Equipment cleaning: All tools, equipment, and footwear should be clean when starting the workday, per the District's *Guidelines for Minimizing Phytophthora Contamination*. After each sample is taken, wipe all soil particles from sampling tools and equipment with a clean, dry cloth. After all samples are taken from a plot, and before moving to the next plot, spray sampling tools and equipment with 70% (or

greater) isopropyl alcohol and allow to air dry. All tools, equipment, and footwear should be cleaned at the end of the sampling day before leaving the site and when moving from one project area to another, per the *Guidelines.*

Sample Location Layout: (diagram to be added) Note on datasheet time of arrival at plot. Navigate to plot center. If plot center monuments or flagging cannot be located, establish a new "nominal" plot center at the GPS coordinates for the plot, flag, and note on datasheet. Choose random azimuth (0-360^0) using a random number generator on a smart phone or tablet. Stretch a tape from plot center along this azimuth out to 30 feet. Adjust as necessary to avoid trees and other obstacles and to maintain a straight, non-meandering line and note final azimuth on field data sheet. At 10 and 30 feet from plot center, mark sampling locations with a temporary pin flag. Complete description of plot on the datasheet (one datasheet per plot).

Plot Description:
On the datasheet, record observations from the plot center of the following:

- Current weather conditions;
- Average slope (percent, using the clinometer);
- Average aspect (cardinal points or intermediaries);
- Tree cover type (conifer or hardwood);
- Canopy density (estimate, or use a spherical densiometer);
- Position on slope (upper, mid, or lower);
- Soil moisture current conditions (dry, moist, or wet);
- Closest surface water;
- Note whether there are any bedrock outcrops within the plot. If so, record rock type: sandstone, granite, or other; if rock type is not recognized, collect sample for later identification. Estimate percent of surface area within plot covered in exposed rock.

Organic Layer Sample (taken at 10 feet from plot center – 1 sample per plot): Set the 12" inside diameter bicycle tire on the forest floor, centered on the pin. Identify any plants growing on the surface. If any are special status (endangered, threatened, or rare), relocate sample site per above. Carefully remove any non-special status surface plants, including moss, (cut off at ground level with clippers) and woody material (twigs, branches, etc. ≥ ¼" diameter) from the surface. Cut around the inside of the tire with the hori-hori knife to the mineral soil boundary, being careful not to churn the soil. Remove all litter and duff within the tire to the 5-gallon bucket. Measure depth of litter and duff (separately) and total depth from the surface to the boundary of the mineral soil layer at four locations (12:00, 3:00, 6:00 and 9:00 o'clock, with 12:00 located on the line, at the point farthest from plot center) around the inside of the tire using a ruler or the hori-hori knife (measure to nearest ¼ inch) and note on the datasheet. Level sample material in bucket, compress slightly to approximate in-place density, determine volume to the nearest quart, and record on datasheet. Sample size must equal 1 gallon. If sample as collected is greater than 1 gallon, mix sample well, then measure out sample using the 1-gallon bucket, compressing slightly to approximate in-place density. Place sample in gallon zip lock bag, label (see attached labeling protocol), record label on the datasheet, and discard the remaining organic material. If total sample is less than 1 gallon, add litter/duff from an area adjoining the bicycle tire to bring the sample size up to 1 gallon, taking from the entire depth profile of the litter/duff layer.

Mineral Layer Sample (taken at 10 and 30 feet from plot center; two 12" cores, each split into two 6" cores, four samples total per plot): Assemble the soil core sampler with the slide hammer attachment and two 6" plastic sleeves. The sleeves should be marked with the marking pen "0-6" and "6-12" with the 6-12 sleeve in the lower position in the sampler (closest to the tip). Check that connections are tight, and that the instrument is clean. Double check that all organic matter has been removed from within the

bicycle tire. Select a location within the bicycle tire and collect any small particles of duff with the brush and dustpan, and add to the forest floor sample. Site is ready for collection when surface is free of duff and litter, as determined by a consistent (lighter) color than the duff layer. Drive the sampler to a depth of 12". Remove by reverse hammering or slowly pulling upward. Disassemble sampler. Trim top and bottom of each sleeve with a butter knife or hori-hori knife, cutting off any root filaments with clippers. Remove sleeves, being careful not to dislodge any soil. Push-out all material from each sleeve into a separate quart ziplock bag and label. Add label to datasheet. Clean all soil particles from sampler (including sleeves) with a clean, dry cloth. Pay extra attention to thoroughly cleaning the female threads on the cap and tip of the sampler. Reassemble sampler. Note: if large stones, roots, or other obstacles prevent insertion of core sampler to full depth, try another location within the bicycle tire, or select another sampling point, using the general method above.

Plot Wrap-up: Refill sample holes with any leftover mineral soil and surrounding duff. Check that all tools and equipment are wiped clean and sanitized (with isopropyl). Check that all samples have been taken, and that all samples are properly labeled. Check that the datasheet is complete, and that sample labels match datasheet entries. Place samples into a dry container for storage and transportation. Note on datasheet time ended.

Sample Handling and Delivery to Lab

Each batch of forest floor or mineral soil samples requires a separate "work order" for the lab. A work order may contain up to 100 samples, all one sample type. Once a batch of samples is assembled, assign all samples a sequential order number, starting at "1." Mineral soil and forest floor samples each are assigned their own 1-100 sequence. Write the number on each sample bag, on the field datasheet, and in the excel spreadsheet provided by the lab. Each of these three locations – sample bag, field datasheet, and excel sheet – should include both the descriptive label and lab order number.

Complete an on-line order at the UC Davis Analytical Lab website several days in advance of expected delivery date. Print out completed order forms to accompany each sample batch to the lab. Double check that all sample bags are labeled with both the descriptive label and the lab number. Check that all labels are legible. Complete and print out a Lab Order Description/Chain of Custody form for each work order. If samples are not to be delivered to the lab within 24 hours, they should be kept refrigerated.

References

Best, Tim, 2007. Road and Trail Erosion Inventory: La Honda Open Space Preserve. Prepared for Midpeninsula Regional Open Space District. Final Draft, August, 2007.

Jurgensen, Martin F.; Deborah S. Page-Dumroese, Robert E. Brown, Joanne M. Trucked, Chris A. Miller, James B. Pickens, and Min Wang, 2018. Estimating Carbon and Nitrogen Pools in a Forest Soil: Influence of Soil Bulk Density Methods and Rock Content. Soil Science Society of America Journal, vol. 81, pp. 1689-1696.

Kimble, J.M., Linda S. Heath, Richard A. Birdsey, and R. Lal., 2003. The Potential of U.S. Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect. Lewis Publishers, CRC Press.

Lal, R.; J.M. Kimble, R.F. Follet, and B.A. Stewart, 2001. Assessment Methods for Soil Carbon. Lewis Publishers, CRC Press.

Mid-Peninsula Regional Open Space District (MROSD), 2018. Guidelines for Minimizing Phytophthora Contamination at Midpeninsula Regional Open Space District Preserves.

Page-Dumroese, D. S.; M. F. Jurgensen, R. E. Brown, and G. D. Mroz, 1999. Comparison of Methods for Determining Bulk Densities of Rocky Forest Soils. Soil Science Society of America Journal, vol. 63, pp. 379-383.

Pearson, Timothy R.H.; Sandra L. Brown, and Richard A. Birdsey, 2007. Measurement Guidelines for the Sequestration of Forest Carbon. USDA Forest Service, Northern Research Station, General Technical Report NRS-18.

USDA Natural Resources Conservation Service (NRCS), 2023a. Custom Soil Resource Report for San Mateo Area, California; and San Mateo County, Eastern Part, and San Francisco County, California: CMU Area. November 6, 2023.

USDA Natural Resources Conservation Service (NRCS), 2023b. Custom Soil Resource Report for San Mateo Area, California: Harmon Parcel. November 6, 2023.

Worsham, Luke; Daniel Markowitz, Nathan P. Nibbelink, and Larry T. West, 2012. A Comparison of Three Field Sampling Methods to Estimate Soil Carbon Content. Forest Science, vol. 58 no. 5.

B. Soil Sample Processing Procedures

Soil Sample Processing Procedures

La Honda Forest Health Project

Last Updated: October 31, 2024

Dan Sicular and Gwyn Fritz

Objectives

Soil samples should be prepared by collecting initial measurements, drying, and separating out the organic material and coarse fragments. After sample preparation, the samples will be sent to the laboratory at the University of California Davis, where they will be analyzed for organic carbon content and bulk density. Measurements taken during the preparation procedure will be used to calculate relevant metrics.

Materials

- Balance
- 500g Calibrator weight
- Oven
- Chinet plates
- Sharpies
- Large flexible mat
- Brass 2mm sieve
- Tea strainer
- Paintbrushes: 1”, 2”, 3”
- Metal scrapers
- Cleaning Alcohol
- Rolling pin
- Aluminum weigh boats – 100 ml
- 50mL volumetric flask
- Graduated cylinders: 50mL, 100mL, 250mL
- Sandwich sized Ziploc bags

Setting Up a Workstation

- The workstation is currently set up in the mudroom at the Administrative Office.
- Ensure that the balance is level, stable, and calibrated. Use the 500g weight for calibration at the start of each workday.
- If using the oven for initial drying of samples, set the heat dial between 2 and 3. With this setting, the oven will fluctuate between 50-60℃. 55℃ is the ideal temperature for initial drying. If using the oven for coarse fragments, set the heat dial at 4, which averages at 105℃.
- Wear gloves. Dust or pieces of the samples may attach to them and can be brushed back off, minimizing the amount of sample lost while processing.
- Ensure all tools are cleaned at the beginning of the workday and in-between samples. If processing in an enclosed unventilated space like the AO Mudroom, do not sterilize tools with isopropyl alcohol; clean everything with water only.

Procedure

Initial Drying

1. Weigh the sample in the Ziploc bag it was collected in. **Record weight.** Take note of bag size.
2. For each sample, label a Chinet plate with the sample number (Ex: H-56-MS-1-6). This is the weigh boat for that sample.
3. Over a large mat, remove the sample from the Ziploc bag and add it to the labeled plate. Once most of the sample is out, turn the bag inside out and use scrappers to remove pieces stuck to the bag. Use a clean paintbrush to collected pieces that fall outside of the plate. Spread out the sample thinly across the plate.
4. If bugs are alive in the sample, remove them with tongs into a tared jar. Record their weight and subtract it from the weight of the sample in its bag. Then release the bug outside.
5. Find a place to set samples out to dry over a few days. Generally, 3 days in a well-ventilated area is enough for weights to be accurate, but otherwise water may soak into the paper plate weigh boat and evaporate while sieving which can affect the yield of sieving by 0.5-2g. Drying can be in the mudroom as space allows—tables can be borrowed from Public Affairs or Land and Facilities with permission. It may be possible to dry them upstairs in offices where there's better ventilation but may be in others' way and are more at risk of being disturbed. Samples may also be oven dried in the drying oven set at 55^0 C (between 2 and 3 on the oven dial).
6. Save the Ziploc bags for later use, placing them back into the original bag for their respective plot.
7. Clean work area.

Dry Sieving and Separating Organic Material and Coarse Fragments

1. Weigh the sample on the plate after it has dried. **Record Weight.** Pour the sample into the sieve, then weigh the empty weight boat and **record this as a placeholder tare weight.**
2. Begin a timer for 20 minutes. Separating the organic material and coarse fragments perfectly would take hours otherwise.
3. With the sample in the sieve, shake the sieve with a plate on top to prevent dust escaping. What falls through is the fine fraction. Transfer the pieces from the top of the sieve to the large mat.
4. Pick out any obvious organic material (roots, wood, buried litter) and coarse fragments (rocks). Place the organic material back onto the tare boat plate and have a separate plate for the coarse fragments. The rocks can be hard to differentiate from dried soil clumps, but often have a different color or texture, which sometimes isn't obvious until it breaks. Small pieces of bark may also look very similar to the soil clumps with a thin layer of soil around them. If you're unsure about a piece, it may become more obvious as you continue to roll and sieve the sample. If you do find dead bugs, add them to the organic matter and make a note on the datasheet.
5. Use a rolling pin on the sample with moderate pressure, breaking up the dried soil clumps and charcoal (all charcoal, other than charcoal that is the burnt portion of a piece of wood that can still be distinguished as wood, is included with the fine fraction). You may need to use a good amount of force when rolling, especially if the soil has been drying for over a week and the soil clumps have hardened. Pick out any more obvious organic material/coarse fragments.
6. Sieve the sample again. Lift the mat and use the paintbrush to efficiently brush the sample from the mat to the sieve.

7. Repeat steps 4-6 for the remaining 20 minutes; sieving, picking out organic material/course fragments and rolling the sample until all the soil can pass through the sieve and the organic material/coarse fragments that were too large for the sieve are properly sorted out. If you finish sorting the larger pieces and all the soil can pass through the sieve before the 20 minutes are up, then use the remaining time to pick out organic material from the sample that passed through the sieve.

Table 1. Soil Sample Components

Fine Fraction Components	Soil, charcoal, non-living organic matter <0.2mm excluding woody debris and root hairs
Organic Matter Components	Roots, bark, buried litter, seed casings, dead bugs >0.2mm
Coarse Fragment Components	Rocks and stones >0.2mm
Do Not Include	Alive bugs

Measuring Sample Components

1. Weigh the organic matter and other organic material on the labeled weigh boat. **Record weight.**
2. Transfer the organic matter to a Ziploc bag labeled with the sample number and "Organic Matter". If including a bug, note it on the bag.
3. With the organic matter removed, brush off any dust from the plate back into the sieve and weight the tare boat plate. **Record weight.** This will be the tare weight used in calculations. Check to see how this weight compares to the weight of the plate directly before sieving. If it is off my more than 0.10 grams, then subtract the difference (evaporated water) between the plates from the recorded gross dry weight of the sample—the yield can be substantially inaccurate otherwise.
4. Place the coarse fragments back onto the sieve and sieve lightly to allow any dust that has broken off the rocks after placing them on the plate to fall through.
5. Place the coarse fragments onto the sample plate. **Record weight.**
6. Transfer the coarse fragments to a Ziploc bag labeled with the sample number and "Coarse Fragments."
7. Pour the fine fraction from the pan into the sample plate**. Record weight**.
8. Transfer the fine fraction back into the original labeled sample bag.
9. Keep all the bags from one sample (Fine Fraction, Organic Matter, and Coarse Fragments) together, in the original 2-gallon bag for the plot. Store in fridge before sending to the lab for analysis or additional processing.

Measuring Coarse Fragment Volume and Density

To measure coarse fragment volume and density, individual coarse fragment samples are washed, oven-dried, and weighed, then combined into "batches" typically consisting of 1-10 samples. Each batch is weighed and its volume determined through displacement to derive a density factor, expressed as g/mL.

1. Collect coarse fragment samples in their labeled Ziplocs.

2. Wash individual samples of coarse fragments in the tea strainer. This step is to minimize the amount of fine soil that is stuck to the coarse fragments, and ensures that the volume being measured is that of the coarse fragments only. Many pieces that may have looked like rocks may actually be dirt clumps, and those will be considered lost sample when rubbed and washed away. With a gloved hand, press down on the fragments in the strainer and pay attention to if any of them don't feel completely solid. Use your gloved fingers to rub the clump of dirt until it fully dissolves, making sure any residue on the gloves in is washed back into the strainer. It's unlikely that all the fine soil will come off with washing, and you may still see small amounts of mud when measuring. After washing, lightly dab the underside of the strainer with a towel, which may collect some of the muddy residue.
3. Place the washed coarse fragments into a clean 100-ml aluminum weigh boat labeled with the sample ID. Place in the drying oven at 105℃ for about 2 hours. (Note on drying time: for the first batch or two, test necessary oven time on several samples by removing samples from the oven after 2 hours, weighing, placing back in the oven for 15 minutes, then reweighing. If sample weight has decreased by less than .1 gram, then the sample is considered dry. If weight has decreased by more than .1 gram, return to oven for an additional 15 minutes. Repeat until sample weight stabilizes).
4. When samples are dry, sieve each individual sample in the 2mm sieve before taking their weight. **Record stable oven dry gross weight and weigh boat tare weight**. The spreadsheet will calculate the net weight.
5. After weighing, combine individual coarse fragment samples onto a paper plate weigh boat labeled with the batch number (see below) and **record the paper plate tare weight**. Continue accumulating samples until the net weight is about 80g ±15g (if using the 100mL cylinder) or 150g ±40g (if using 250 mL cylinder when individual sample/rocks are too large for 100mL). This will be considered a batch of coarse fragments. Number batches sequentially, write the batch number on the paper plate, and **record the batch number that each sample was placed in** on the main Sample Processing spreadsheet.

The following measurements are recorded on the "Coarse Fragments" tab in the Sample Processing spreadsheet:

6. **Record the tare weight and gross weight** of the sequentially numbered batches of oven-dried coarse fragments.
7. Measure volume of the batch by displacement: place the batch into a 100 mL graduated cylinder or 250mL cylinder (Use larger cylinder when individual sample/individual rocks are too large for 100mL cylinder). Size reduce any pieces too large to fit into the cylinder with a rubber mallet (large pieces may be placed in a paper bag, to prevent loss of fragments).
8. Measure out 50mL of water in a 50mL volumetric flask and add to the 100 mL graduated cylinder with the batch of coarse fragments. Measuring from the bottom of the meniscus, note the volume of the sample plus the water. Subtract the 50mL of water from the total. Use another 50mL from the volumetric flask if measuring with the 250mL cylinder. **Record the volume of coarse fragments.** The spreadsheet will then calculate bulk density, expressed in grams per mL (or grams pe cm^3), and will automatically copy this figure to the main spreadsheet for each sample in the batch.

9. Over the sink, pour the coarse fragments back into the tea strainer. Add a little bit of water back into the graduated cylinder to remove more of the contents stuck to the bottom and/or sides. Use a small spoon or scraper to collect the rest of the contents from the graduated cylinder.
10. Place the coarse fragments from the strainer back onto the weigh boat for that batch. Place in the 105^0 C oven for 1-2 hours. The batch should be dry and can then be placed into a Ziploc bag labeled with the date, batch number, and "Coarse Fragments". Retain for lab analysis.

Measuring Roots/Organic Matter Volume and Density

To measure the volume and density of roots/organic matter, the process is similar to coarse fragments, but the samples are not oven dried, since oven drying would reduce the volume of the sample, and measuring the volume is not by water displacement, since the materials absorb water and float. As with coarse fragments, individual roots/organic matter samples are combined into "batches" typically consisting of 4-12 samples. Each batch is weighed and its volume measured to derive a density factor, expressed as g/mL. It may be most efficient to process 1-2 batches at a time.

1. Combine roots/organic matter samples together on a paper plate weigh boat to make a batch until the net weight of the batch is 15g±3g. Designate the batch with a letter, in alphabetical order, and label the weigh boat. **Record the batch letter for each sample on the main spreadsheet. Record the weigh boat tare weight on the Roots/Organic Matter tab.**
2. Weigh and **record the gross weight of the batch on the Roots/Organic Matter tab.** The spreadsheet will calculate net weight.
3. Using clippers, reduce the size of larger roots and organic matter so that no pieces are larger than about ¼ inch (about the size of a pencil eraser). Pieces of bark or partially decomposed wood may be broken up by hand.
4. Pack the size-reduced roots/organic matter in an appropriately sized graduated cylinder. Use a scraper/spoon or wooden spoon handle to tamp down the material in the cylinder, eliminating as much empty airspace as is practical, and until the material is reasonably even on top. **Record the volume of the batch on the Roots/Organic Matter tab.** The spreadsheet will calculate the density of the batch, expressed as grams/mL. The spreadsheet will also transfer this density measurement to the main Sample Processing spreadsheet for each sample in the batch.
5. Remove the batch from graduated cylinder and place in a quart or gallon Ziploc bag labeled with the date, batch letter, and "Roots/Organic Matter". Retain for lab analysis.

Lab Order Processing

Every sample in each lab order must receive the same analyses. Number samples accordingly (each lab order starts numbering from 1). Each Midpen sample ID should be associated with only one Lab #, however, Lab #s will be repeated across each shipment because of the multiple orders. Typically, this will be:

- Order 1: Bulk Density and TOC analysis
    - All MS samples and a random subsample of 1/3 FF samples.
- Order 2: Bulk Density only
    - Remaining 2/3 FF samples (these Lab #s will be repeats)

- Order 3: Coarse fragments (if needed)
    - Randomly select 1/3 (?) from batched CF samples (Lab #s will be repeats)

To avoid confusion with repeated Lab #s, separate orders when shipping OR if combining smaller orders into one box, clearly label which order the samples go with, not just the lab #. It may be necessary to pack the largest order in two boxes; if so, include a copy of the COC form in each and circle or highlight which samples are in that box.

Example Labeling for a mineral soil work order with 100 samples:

MS100: TOC + BD

Lab #s: 1-12

Bag 1 of 9

Samples should be shipped overnight via UPS. They do not need to be refrigerated/packed with ice, but it is best to send them in a later shipment (last pickup from UPS store on Showers Drive is 4:45) to minimize daytime heat exposure.

Shipping address:

UC Davis Analytical Lab
Hoagland Annex
110 Hoagland Annex
521 Kleiber Hall Drive
University of California
One Shields Avenue
Davis CA 95616-5270

C. Soil Sampling Field Data Sheet

ATTACHMENT 2

Version: 6-20-24

La Honda Forest Project

Soil Organic Carbon Sampling Datasheet

Date:	Personnel:	Project Area	Plot ID #
		☐ Harmon ☐ Harmon Control ☐ CMU ☐ CMU Control	

GPS Coord:	Time Start:_____ End: _____	Weather:

Plot Characteristics

Slope %	Aspect	Cover Type	Canopy Density
	N NE E SE S SW W NW	RW/DF ☐ Hardwood ☐ Other ☐ Describe if "Other": _____	☐ 70-100% ☐ 10-30% ☐ 50-70% ☐ < 10% ☐ 30-50%

Slope Position	Soil Moisture	Closest Surface Water
☐ Upper ☐ Mid ☐ Lower	☐ Dry ☐ Moist ☐ Wet	_____ feet from plot center

Bedrock outcrop within plot?	If yes, what rock type?	If unknown rock type, collect sample and label with plot ID#	Surface Rock Cover
Y N	☐ Sandstone ☐ Granite ☐ Other: _____		_____ %

Plot:	If Old, Plot center located?	If New, plot center established?	Azimuth for transect (0-360^0)
☐ Old ☐ New	Y N	Y N If Yes, Describe in Notes	

Sample Collection

Labels: **Project Area** (H = Harmon, Hc = Harmon control, C = CMU, Cc = CMU control) - **Plot ID -Sample Type** (FF or MS). For Mineral Soil, add - **Sample Point - Depth**. eg: H-131-MS-1-0. Note: Add Lab # (1-100) when preparing lab order.

Sample Point 1: 10 feet from plot center

Adjustment: _____ ft to the right

Forest Floor Total Vol: _____ Quarts	Forest Floor Sample Label: ____ - ____ - FF	Lab #	Mineral Soil Sample 0-6" Label: ____ - ____ - MS - 1 - 0	0-6" Lab #

Forest Floor Depth: (to nearest 1/4 inch)	12:00	3:00	6:00	9:00

6-12" Label" ____ - ____ - MS - 1 - 6	6-12" Lab #

Sample Point 2: 30 feet from plot center:

Adjustment: _____ ft to the right

Mineral Soil Sample 0-6" Label: ____ - ____ - MS - 2 - 0

0-6" Lab #

Forest Floor Total Volume: _____ Quarts

Forest Floor Depth: (to nearest 1/4 inch)	12:00	3:00	6:00	9:00

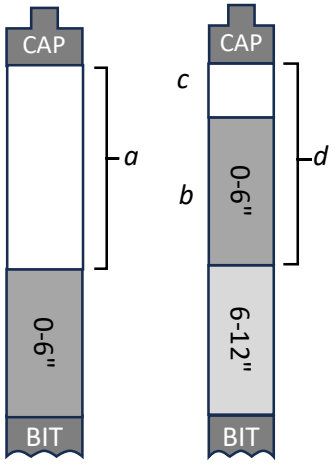
6-12" Label: ____ - ____ - MS - 2 - 6

6-12" Lab #

Notes and Observations:

Core Compression Calculations

Mineral Soil Sample - 10 ft.



12:00 - 3:00 - 6:00 - 9:00

Airspace measurements after sinking 6": _____, _____, _____, _____

a = _____ inches (average or common measurement)

0-6" Core Length

b = 12 - *a* = _____ inches

12:00 - 3:00 - 6:00 - 9:00

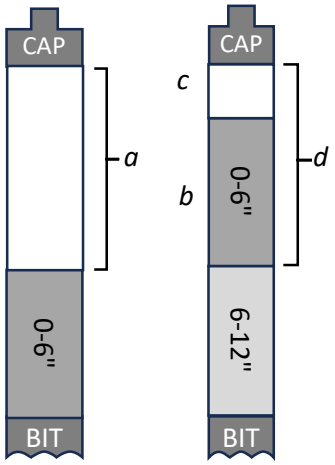
Airspace measurements after sinking 12": _____, _____, _____, _____

c = _____ inches (average or common measurement)

Length from top of cylinder to cut

d = *b* + *c* = _____ inches

Mineral Soil Sample - 30 ft.



12:00 - 3:00 - 6:00 - 9:00

Airspace measurements after sinking 6": _____, _____, _____, _____

a = _____ inches (average or common measurement)

0-6" Core Length

b = 12 - *a* = _____ inches

12:00 - 3:00 - 6:00 - 9:00

Airspace measurements after sinking 12": _____, _____, _____, _____

c = _____ inches (average or common measurement)

Length from top of cylinder to cut

d = *b* + *c* = _____ inches

La Honda Forest Health Project Timber Harvesting Plan Summary

La Honda Forest Health Project Timber Harvesting Plan

The goals of the La Honda Forest Health Project are to implement forest health treatments and watershed improvements that restore and promote healthy, resilient, mature, and old-growth forests; improve watershed health and function; enhance wildlife habitat and carbon storage; and increase the forest's resilience to fire, disease, and climate change in accordance with the La Honda Forest Health Assessment and Management Plan approved by the Midpen Board of Directors (R-21-103). The La Honda Forest Health Project Timber Harvesting Plan is the means of implementing the forest health treatments necessary to achieve these goals.

The La Honda Forest Health Project Timber Harvesting Plan is organized into six sections that collectively provide a comprehensive framework for implementing project operations while ensuring compliance with applicable forestry regulations and resource protection standards, including the Z'berg-Nejedly Forest Practice Act of 1973, the California Forest Practice Rules, as well as Midpen's Resources Management Policies and Best Management Practices. The plan begins with ownership and administrative information, outlines operational requirements and resource protection measures, and incorporates supporting environmental documentation, cumulative effects analysis, required harvest notices, and confidential archaeological information.

Section I: General Plan Information and Operational Requirements

Section I establishes the foundational information for the THP, including land ownership, the project location, operational dates, stocking responsibilities, and environmental statement requirements.

Section II: Timber Harvesting Operations and Resource Protection Measures

Section II addresses the operational details of the project and the measures required to protect forest resources during and after the operation. This includes: the silvicultural methods that will be used to achieve the intended forest management objectives; possible pests and diseases in the project area and management regimes to address them; the yarding method that will be used through the course of project operations; the erosion control measures that will be implemented to minimize soil disturbance and protect water quality; considerations for winter operations; identified forest roads, landing areas, and Watercourse and Lake Protection Zones (WLPZs); notification requirements for domestic water users; hazard reduction measures to manage slash and other residual forest material; descriptions of the relevant biological resources and applicable protection measures; and archaeological resources.

Section III: Additional Information

Section III provides supplemental information, including descriptions of soils and topography, forest stand characteristics, watercourse conditions, and additional silvicultural details, and describes additional resource protection measures in alignment with Midpen's Operations, Site Preparation, and Maintenance of Resources Plan (OSMRP) Best Management Practices.

Section IV: Cumulative Effects
Section IV considers how the proposed project may interact with other past, present, or reasonably foreseeable activities within the surrounding area. The purpose is to evaluate potential combined effects on forest resources and environmental conditions and to identify appropriate measures, where necessary, to avoid or minimize adverse impacts.

Section V: Notice of Intent to Harvest
Section V contains the requisite Notice of Intent (NOI) to harvest timber associated with the project, which is sent to adjacent property owners by CAL FIRE through the THP review process.

Section VI: Confidential Archaeological Addendum
Section VI contains the Confidential Archaeological Addendum (CAA), which describes any potential sensitive archaeological information and applicable protection measures

Attachments
The THP also includes a suite of attachments, including a supplemental roads assessment and improvement plan, a letter from the California Department of Fish and Wildlife (CDFW) regarding marbled murrelet (*Brachyramphus marmoratus*) protections, and the La Honda Forest Carbon Assessment. In addition, as the separate Paulin Crossing Project will be implemented along the Northside Road (one of the La Honda Forest Health Project access routes), supplemental information about the Paulin Crossing, including the basis of design documents and technical specifications, mitigation plan, and project permits, will be attached to the THP alongside its submittal to CAL FIRE per regulatory agency direction.