STEEP TERRAIN HAZARDOUS FUELS TREATMENT DEMONSTRATION IN NORTHERN CALIFORNIA

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and CAL FIRE

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Prepared by:
Tad Mason, TSS Consultants
Martin Twer, The Watershed Center
Nick Goulette, The Watershed Center

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TSS Consultants typically conducts assessments and equipment demonstrations with in-house personnel and resources, a business model our firm has utilized since it was founded in 1986. The Steep Terrain Hazardous Fuels Treatment Demonstration project was unique in that a wide ranging list of entities made available an array of knowledgeable individuals and networks that proved invaluable in the course of our work. The authors wish to thank a number of individuals and organizations for their significant efforts in support of this project.

Communications and Outreach Team

- Jennifer Chapman, Eldorado National Forest
- Mark Luster, Sierra Pacific Industries
- Ricky Satomi, UC Cooperative Extension
- Diane Dealey Neill, Amador-El Dorado Forest Forum
- Heather Williams, Cal Fire
- Scott McClean, Cal Fire
- Jeremiah Norrell, Georgetown Fire Department
- Ann Dunsky, USFS Regional Office
- Steve Dunsky, USFS Regional Office
- El Dorado County Fire Safe Council
- Tad Mason, TSS Consultants

Implementation Team

- Rich Wade, Sierra Pacific Industries
- Martin Twer, The Watershed Center
- Nick Goulette, The Watershed Center
- Ricky Satomi, UC Cooperative Extension
- Susie Kocher, UC Cooperative Extension
- Nancy Starr, UC Cooperative Extension
- Tad Mason, TSS Consultants

Field Sampling and Analysis Team

- Martin Twer, The Watershed Center
- Nick Goulette, The Watershed Center
- Tad Mason, TSS Consultants

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EXECUTIVE SUMMARY

USDA Forest Service and Cal Fire, along with other partners, sponsored a steep terrain hazardous fuels treatment demonstration between June 5 and June 9, 2018, in the American River watershed east of Sacramento. In the past several decades, vegetation treatment equipment and techniques have evolved, becoming more versatile and efficient with reduced impacts on the landscape. This demo deployed equipment and techniques that are specifically designed to treat excess vegetation (e.g., brush/small stems) on steep terrain (30%+ slopes).

Target audiences for this demo included fire agencies, natural resource managers, electric utilities, elected officials, water and resource conservation districts, homeowner associations, fire safe councils, county and city planning departments, fuels treatment contractors, private landowners, and other stakeholders. A total of 161 stakeholders participated in the demo. Resource professionals were on site to answer questions and guide participants through the equipment settings.

Both conventional and innovative equipment and techniques were deployed with a total of nine different equipment systems onsite during the demo. Equipment systems were selected for their ability to reduce hazardous fuels including shrubs, brush, and small trees. These systems, broadly grouped, included excavators and skid steer systems, all equipped to masticate excess brush and small stems.

INTRODUCTION

Historically, fuels treatment activities in California have focused on four techniques: 1) prescribed fire; 2) livestock grazing; 3) treatment with hand crews; and 4) mechanical treatment with heavy equipment. Prescribed fire (PF) is typically the preferred and most cost effective technique to treat excessive fuels. However, in many cases, the existing fuel load has accumulated to unsafe concentrations and the landscape cannot be treated safely with PF. Often, a pre-treatment step is needed to reduce standing and down fuels to acceptable levels before PF can be deployed. The use of PF is also constrained by the number of burn days approved by air quality management districts and the number of burn projects competing for approval in the airshed. While livestock grazing and hand crew deployment is relatively light on the land, the costs per acre are significant ($1,700 to $2,700/acre).[1] In many cases, mechanical treatment with ground-based equipment is the next most cost effective technique (behind PF). The costs of mechanical fuel treatment on steep terrain usually cannot be offset by utilization of the vegetation removed because it typically consists of small diameter trees and other non-commercial biomass that is very costly to collect and remove on challenging terrain.

Much of the mechanical fuels treatment conducted in California has only been focused on relatively accessible topography (typically under 30% slope gradient) due to equipment limitations and concerns regarding potential soil impacts, equipment effectiveness, and operator safety. As wildfires have become larger and more frequent, fire agencies and land managers have been seeking alternative fuels treatment methods on steep terrain in order to more effectively protect communities, watersheds, and key infrastructure such as powerlines and communication facilities.

In response to the growing need for fuels treatment on steep terrain, equipment manufacturers have improved mechanical vegetation treatment systems used to manipulate biomass onsite (mastication) in order to mitigate the intensity of wildfire behavior. Improvements include development of equipment carriages and self-leveling cabs that facilitate safe operation on steep slopes (35% plus topography). To assist with increasing mechanical fuel treatment and biomass utilization, the USFS Pacific Southwest Region established a cooperative agreement in 2013 with the Watershed Research Training Center (WRTC) as part of the State and Private Forestry Program. Under this agreement, the WRTC facilitates monthly meetings for the CA Forest Biomass Working Group, the Statewide Wood Energy Team, and the Tree Mortality Task Force Bioenergy Subgroup. Funding for this demo was made available by CAL FIRE and administered through the USFS cooperative agreement with the WRTC.

Mechanized fuels treatment demonstrations were conducted in 2002 and 2015 at seven locations in Idaho, Washington, Oregon, and California. Findings from these demos included cost of operating the equipment, soil impacts, and fuels treatment effectiveness.[2]

[1] 2016 Hazardous Fuels Reduction Demonstration Report, TSS Consultants.
[2] TSS Consultants was the project manager for these studies. The results can be found at: **http://tssconsultants.com/reports-papers/**

Targeted Outcomes

Expected short-term outcomes of the Hazardous Fuels Treatment Demonstration (HFTD) include improved ability of government agencies and partners to assess, plan and budget for future fuels treatment projects, heightened cooperator awareness about equipment options and impacts, and improved ability of local contractors to make informed business decisions about what equipment to buy or lease. Targeted long-term project outcomes include improved wildland and watershed health, enhanced ability to defend communities and other infrastructure from wildfires, mitigation of air emissions impacts (including greenhouse gas releases during wildfires), improved reduction in hazardous fuel accumulation, reduced site impacts, potential increase in acres treated, and local job retention.

Participating Vendors and Contractors

Vendors and contractors that participated in the HFTD demos included:

- BEJAC Corporation
- Fecon
- Global Machinery
- Hamre Equipment
- Pape Machinery

The UC Center for Forestry created a webpage (http://ucanr.edu/HFTD) to provide information regarding registration for the HFTD and also to allow interested parties to view treatment systems and site conditions pre and post treatment.

Project Partners

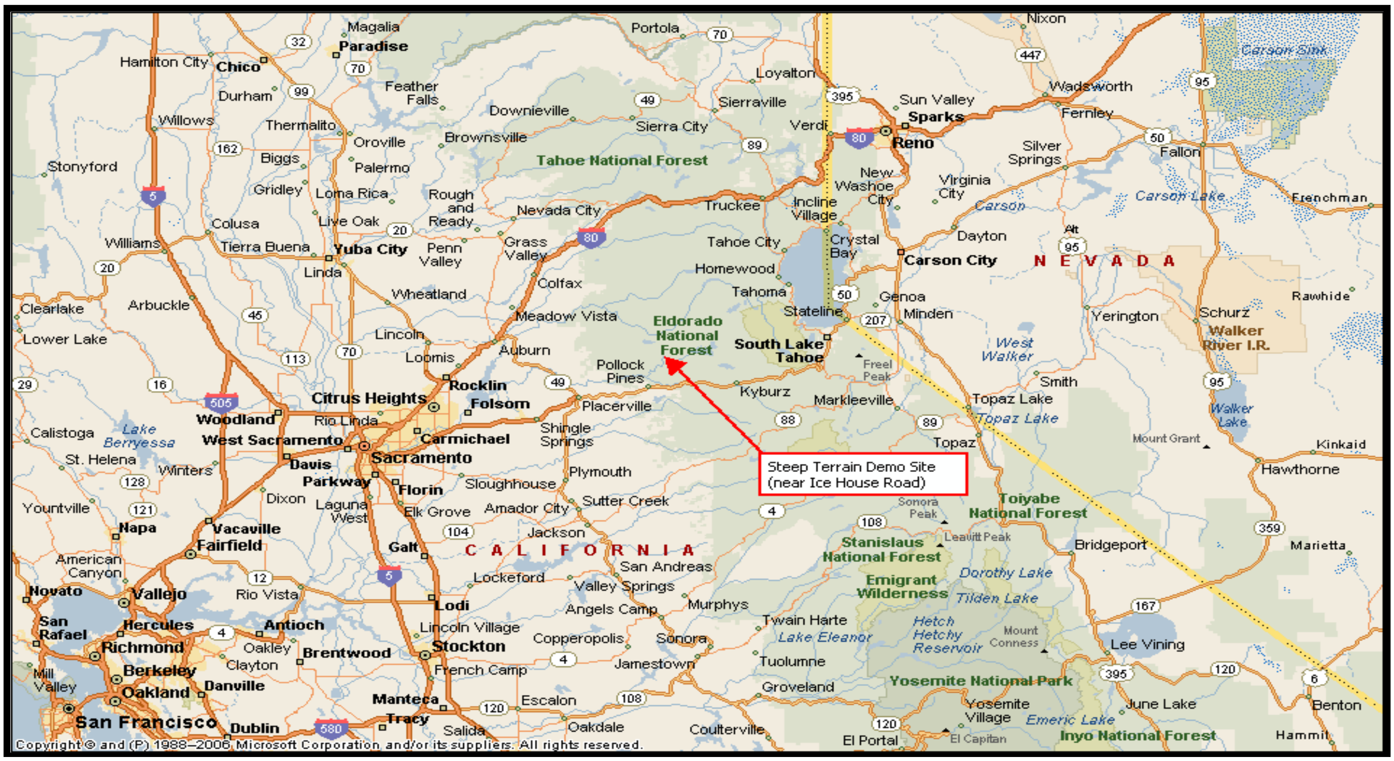
USDA Forest Service and CAL FIRE provided funding and communications support for this project. Sierra Pacific Industries provided the treatment area site and communications support. Significant in-kind services (equipment and staff mobilization, operator support, labor) were provided by all of the treatment system vendors and contractors (noted previously). Listed below are the project partners that provided wide-ranging support including outreach assistance, data collection, guides and docents, serving on the project Steering Committee and data analysis. These project partners were key to the successful implementation of the HFTD demos.

- CAL FIRE
- California Forestry Association
- EL Dorado County Fire Safe Council
- Natural Resources Conservation Service
- Sierra Pacific Industries
- The Nature Conservancy
- The Watershed Research and Training Center
- University of California Cooperative Extension
- USDA Forest Service

ENVIRONMENTAL SETTING

The HFTD was conducted on Sierra Pacific Industries (SPI) land, just northwest of Ice House Resort. Located at 5,400' elevation on a traditionally mixed conifer site, the treatment area was severely impacted by the Cleveland Fire of 1992. The site was planted in 1995 with ponderosa pine spaced at 8 to 10 feet. These pine plantations received pre-commercial thinning (drop and lop technique) using hand crews equipped with chainsaws around 2005. Figure 1 shows the general location of the treatment area.

Figure 1. Steep Terrain Demo Location



The SPI site provided a strategic communication and outreach opportunity due to its location relative to a significant media market and to state and federal resource management agency staff and state legislative staff. In addition, close proximity to the Lake Tahoe Basin facilitated significant participation by regulatory and agency staff conducting forest restoration and fuels treatment work in the Basin.

Figure 2 is an image of the treatment area, showing the average tree size and stocking levels pre-treatment.

Figure 2. Dominant Vegetation Cover

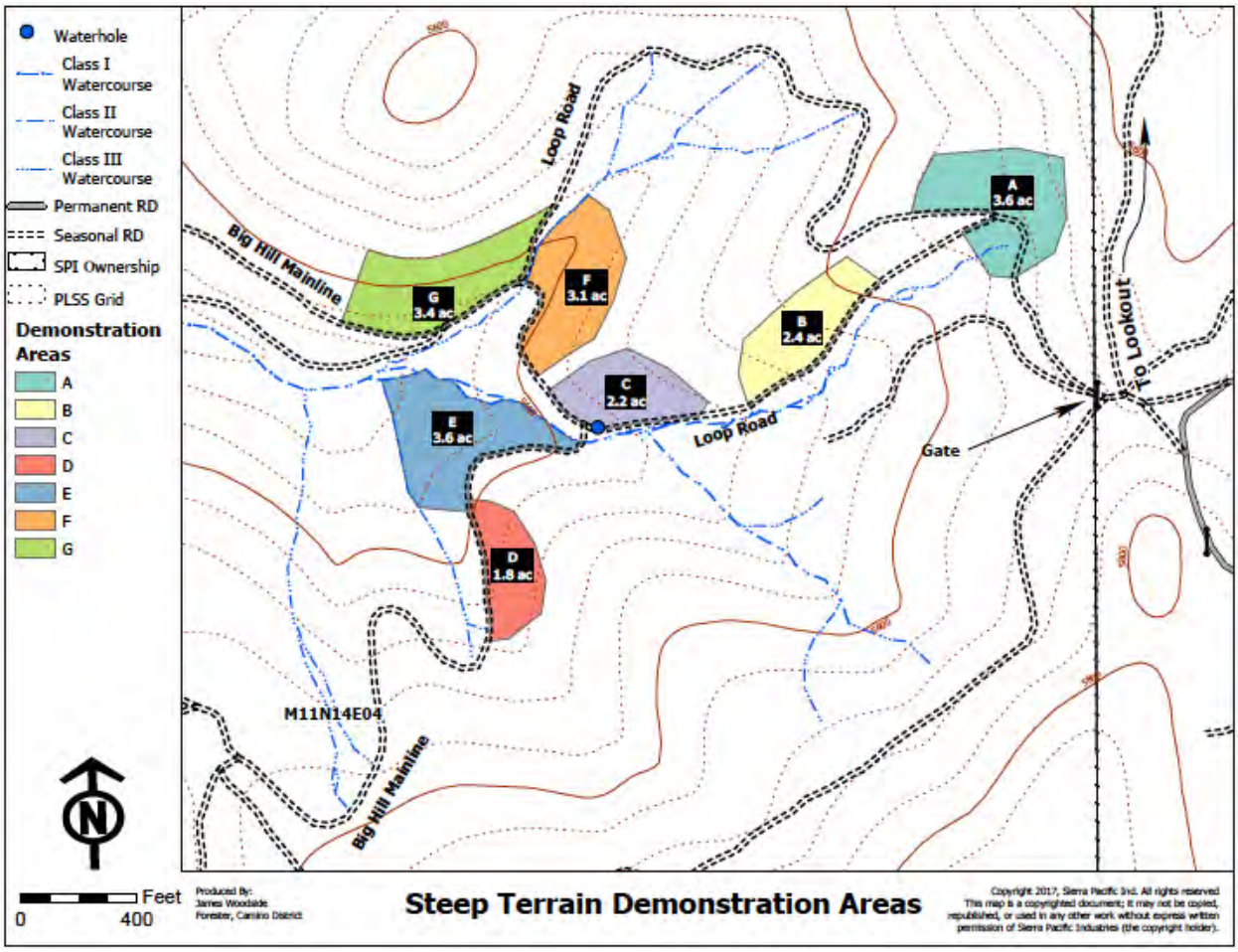
Treatment Prescription

The primary vegetation treatment objective was reduction of understory cover through mastication of brush and conifers that form ladder fuels, creating vertical separation between ground fuels and tree crowns. Generally, trees 12" DBH and smaller were candidates for mastication with residual tree spacing of 21 to 25 feet. The complete treatment prescription is included as Appendix A.

Treatment Units

Units were located on steep terrain with overstocked vegetation conditions along road systems that allowed participants to readily view both treated and untreated stands. Spacing between units allowed the field sampling and analysis team to readily distinguish treatment systems deployed. SPI forestry staff generated a detailed site map with seven distinct treatment units. Figure 3 is the site map.

Figure 3. Treatment Area Map Detail



Treatment Systems Deployed

Table 1 lists treatment systems that were deployed at the HFTD. All systems were designed to masticate excess brush and small stems.

Table 1. Treatment Systems Deployed by Treatment Unit

UNIT	MANUFACTURER	MODEL NUMBER, TYPE OF EQUIPMENT AND ATTACHMENT
A	TimberPro	TL 735C (feller-buncher) with Fecon BH 80 mastication attachment
B	John Deere	JD 210G LC (excavator) with Fecon BH 80 mastication attachment
C	Fecon	FTX 128L (skid-steer) with Fecon BH 85SD-4 mulching attachment
D	ASV	ASV RT 120F (skid-steer) with Fecon BH 74SS mastication attachment
E	Menzi	Menzi Muck M545 (excavator) with Fecon BH 40EXC mastication attachment
E	Menzi	Menzi Muck M220 (excavator) with Fecon FMX50 mastication attachment
F,G	FAE - Prime Tech	PT 175 (skid-steer) with FAE 140/U-175 mastication attachment
F,G	FAE - Prime Tech	PT 300 (skid-steer) with FAE 200/U-210 mastication attachment
F,G	Takeuchi	TB 2150 (excavator) with FAE UML/HY/VT-125 mastication attachment

COMMUNICATIONS AND OUTREACH

The primary objective of the HFTD was to raise awareness about different fuel treatment alternatives and provide key stakeholders with up-to-date information as well as an opportunity to view conventional and innovative fuels treatment equipment deployed in the field on steep terrain. This may lead to more informed decisions regarding the selection of fuels treatment systems and activities, optimized for specific vegetation types and terrain found in central and northern California.

Expected short-term outcomes include improved ability of public agencies, private businesses and non-profit organizations to assess, plan, and budget for fuels treatment projects, heightened awareness about steep terrain equipment options and impacts, and improved ability of local contractors to make informed business decisions about what equipment to buy or lease. Projected long-term outcomes include improved forest and watershed health, enhanced ability to defend communities and other infrastructure from wildfires, mitigation of air emissions impacts (including greenhouse gas releases during prescribed fires or wildfires), improved reduction in hazardous fuel accumulation, reduced site impacts, potential increase in acres treated, and potential employment opportunities.

Communication Plan

Utilizing the communications and outreach team's knowledge, experience, and local media contacts, a communications plan was developed and is included in Appendix B. The communications plan provided a structured approach to outreach that included project objectives, list of target audiences, key messages, implementation plan, communication tools, evaluation tools, key contacts (including media), and contingency plans.

Outreach Objectives

The communications and outreach team agreed on a variety of outreach objectives, both short term and long term.

Short-term objectives of this project include:

- Improved ability of agencies to plan and budget for future fuels treatment projects in steep terrain.
- Development of an informed cadre of local fuels treatment contractors and local stakeholder groups (e.g., fire safe councils, homeowners associations, resource conservation districts).
- Outreach to the general public (e.g., media, homeowners, forest landowners) with regards to fuels treatment opportunities, techniques and latest technology.
- Expanded public support for increasing the pace and scale of ecologically sound fuels treatment activities.
- Promotion of cost effective fuels treatment alternatives in steep terrain.

Long-term objectives include:

- Increase in the number of acres treated to reduce hazardous fuels in steep terrain and improvement of the ecological health of at-risk landscapes.
- Reduction of site impacts from fuels treatment activities.
- Creation of long-term sustainable jobs.
- Promotion of an informed public that more fully appreciates the complexities of fuels treatment efforts and the statewide challenge of creating and maintaining fire resilient landscapes.
- Improved water yields, timing and quality.

Audiences

Key Audiences

1. Independent contractors interested in purchasing equipment.
2. Small woodland associations (forest landowners of California).
3. Professional organizations: Associated California Loggers, California Licensed Foresters Association, Northern California Society of American Foresters.
4. Key state and federal agencies: USDA Forest Service, CAL FIRE, Bureau of Land Management, Natural Resource Conservation Service, National Park Service, California State Parks.
5. Local tribes and Intertribal Timber Council.
6. Other agencies: US Fish and Wildlife Service, California Fish and Wildlife Service, National Marine Fisheries Service, Bureau of Indian Affairs, California Department of Water Resources, California Air Resources Board, Resource Conservation Districts, Resource Conservation and Development Councils, elected officials (federal, state, county).
7. NGOs: watershed councils, advisory councils, conservation organizations (e.g., Sierra Forest Legacy, League to Save Lake Tahoe), California Forestry Association, Fire Safe councils, and land management organizations (The Nature Conservancy, New Forest).
8. Media and general public.
9. Local fire districts (CAL FIRE, El Dorado County Fire Protection District, Georgetown Fire District).
10. Power utilities: Public Utilities Commission, PG&E, SMUD, El Dorado Irrigation District.
11. Local colleges and universities: forestry/natural resource programs (Sierra College, Lake Tahoe Community College, Sierra Nevada College).
12. Local high schools: ecology clubs/vocational students (reach out to Forestry Challenge and Forest Foundation to assist with outreach to local schools).

13. Stakeholder collaboratives: South Fork American River Cohesive Strategy (SOFAR) Collaborative, Amador Calaveras Consensus Group.

Outreach to these target audiences was conducted using a variety of communication tools including email blasts and posting in weekly and monthly newsletters. An HFTD announcement and registration forms were distributed widely and encouraged online registration using a site hosted by the University of California Division of Agriculture and Natural Resources (UCANR). A website[3] was established and maintained by UCANR and the University of California Extension staff that hosted key information regarding the HFTD project including schedule, treatment systems, pre and post-treatment images, and key contact information. This same website will host the final report.

Demo Attendance

Public participation in the HFTD project was significant, with a total of 161 stakeholders in attendance across one and a half days of demos. Most of the participation was concentrated (by design) on Friday (June 8), 9am to 4pm and Saturday (June 9), 9am to 1pm. Appendix C provides a detailed head count showing guest participation by affiliation.

The HFTD demos attracted significant participation from a wide range of affiliations. Overall, the HFTD outreach goal of reaching a variety of target audiences was met.

Media Participation

Media participation included the Sacramento Bee and the Lake Tahoe News. The Bee reporter deployed an aerial drone and produced a video clip[4] that featured an interview with Mark Luster, Community Relations Manager with Sierra Pacific Industries. The Lake Tahoe News generated an article[5] on June 11 that featured equipment images and an interview with Stew McMorrow, Deputy Chief Forestry Assistance, Cal Fire.

In addition, the Georgetown Fire Protection District deployed an aerial drone on Saturday and was able to record equipment actively masticating vegetation. The raw video tape was edited by the USFS communications team[6] and the final version is now available.[7]

Participant Response

Randomly selected participants were asked to fill out a brief, seven question evaluation form. A total of 44 evaluation forms were filled out (representing a 27% sample). Question #7 asked participants to rate their experience on a scale of 1 to 10. Considering all responses, an average rating of 8.8 was received.

[3] http://ucanr.edu/sites/WoodyBiomass/Technical_Assistance/Steep_Terrain_Hazardous_Fuels_Treatment/
[4] https://www.sacbee.com/news/local/article212896259.html%23storylink=cpy
[5] https://www.laketahoenews.net/2018/06/equipment-changing-landscape-of-fire-prevention/
[6] Ann and Steve Dunsky.
[7] https://vimeo.com/307090633

MONITORING PROCEDURES

Monitoring procedures were focused on soil conditions (pre and post treatment) and the cost of treatment ($/productive machine hour) by treatment system.

Monitoring Objectives

The monitoring objectives of the HFTD were to track the cost of each treatment system in achieving the desired stand condition outlined in the treatment prescription (Appendix A). Pre and post-treatment sampling was conducted to monitor the following impacts from treatment.

- Soil condition to identify impact of treatment. Monitoring was implemented using a qualitative assessment using Visual Soil Assessment Class Descriptions (Appendix D).

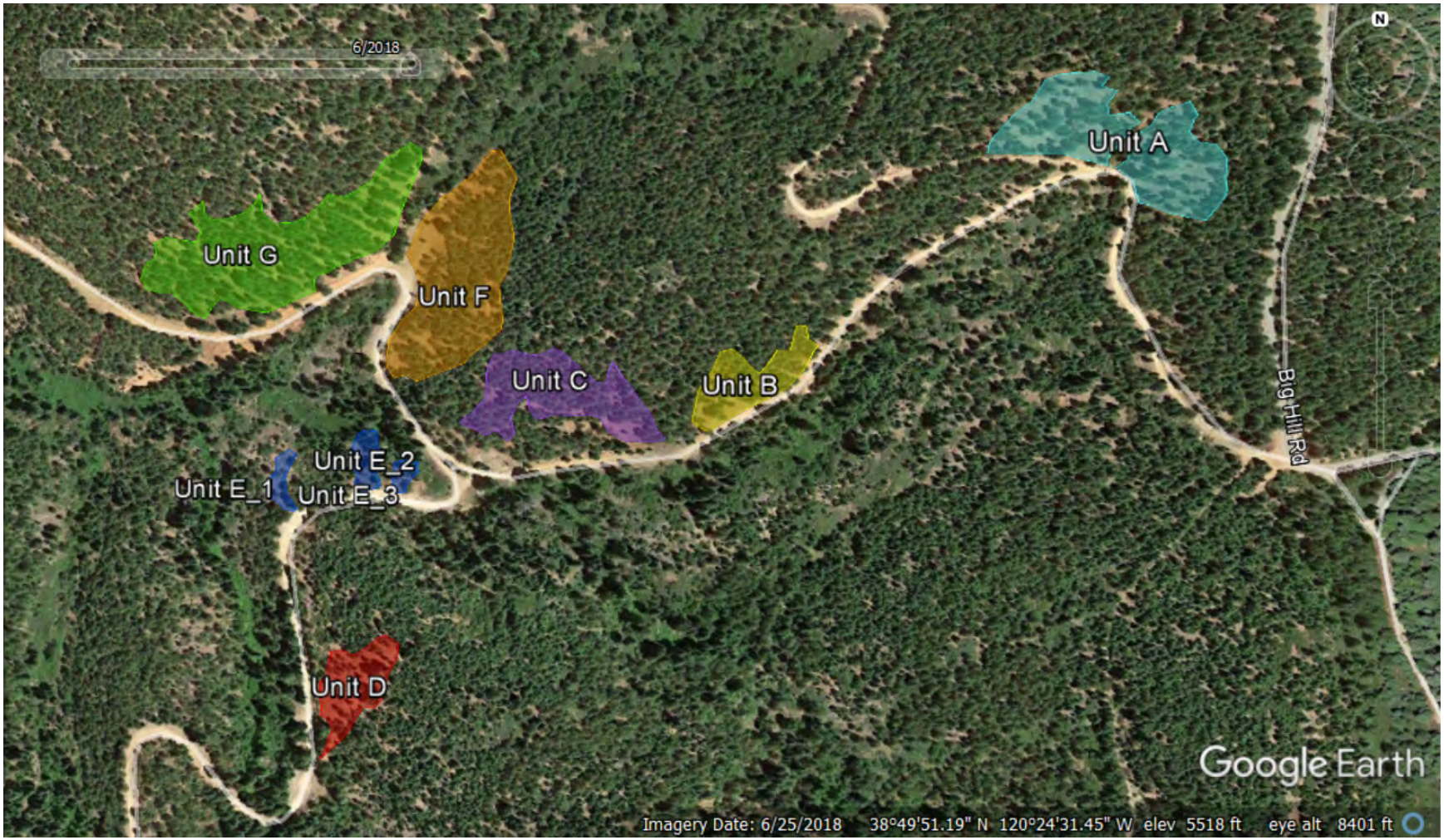
- Visual condition with photographs to identify impact of treatment on qualitative aspects of the ecosystem including, but not limited to, public perception of treatment impact and light availability (Appendix I).

- Cost of treatment was monitored during the treatment process to identify production rates for all treatment options with contractors providing daily shift report template (Appendix E) summarizing hours of machine time per day.

Monitoring Design

A minimum of one randomly located 1/10th acre plot was measured in each treated area. It is important to note that sample plots were laid out to be a representative sample of the vegetative conditions in the treatment unit and were limited by budget, not driven by statistical rigor. Depending upon the vegetation type, equipment, and desired condition, the treatment may have operated on a greater or lesser percentage of the total treatment unit area. Figure 4 is a map showing actual area treated within each treatment unit. Note that Unit E had three distinct treatment areas.

Figure 4. Acreage Treated Map



Each 1/10th acre plot monitored both soil condition and vegetative condition using photographic documentation. To monitor production efficiency of each treatment, (1) economic cost and (2) time was collected for every piece of treatment system included within a treatment unit.

Soil Disturbance

Impact to the soil resources were estimated for each treatment system participating in the HFTD using a Visual Soil Assessment Protocol created by Weyerhaeuser Company and later adapted by Steve Howes, US Forest Service Soils Program Manager for Washington and Oregon, for use by Forest Service units in the Pacific Northwest. This method involves setting up random transects both pre- and post-treatment and recording soil condition at given intervals along that transect. Soil conditions are segregated into seven soil disturbance categories ranging from no soil disturbance to significant, drainage-altering disturbance (Appendix D). Distribution of soil disturbance classes was compared pre- and post-treatment to estimate extent of soil disturbance caused by each treatment system participating in the HFTD.

System Productivity and Cost

Shift level data was collected for each treatment system. Shift level data summarizes time spent in maintenance, repair, breaks (e.g., lunch) or other activities, so these can be separated from the time spent directly conducting fuels treatment operations. Shift reports were submitted by all equipment operators or crew foremen for all shifts (Appendix E Shift Report Template). System productivity was evaluated based on the area treated. Equipment costs were estimated based on standard methods from Miyata.[8] Vendors were asked to provide cost data via an online survey (Appendix F, Equipment Vendor Input Form). Cost data such as initial equipment cost, track or tire replacement cost, economic life, maintenance and repairs, and labor were provided using this online form.

As noted earlier, each equipment operator or crew foreman also completed a shift report estimating the amount of time allocated to various activities during each shift. The shift report is intended to capture time during a work shift interrupted by breaks, service, and repair and other activities not directly relating to its primary forestry purpose.

Shift level production data was collected in terms of acres treated wherein the treatment objective was achieved. For the treatment systems deployed with the HFTD (which do not include extraction of material), production data consists only of acres treated.

Cost Monitoring

Equipment costs were estimated based on methods from Miyata[9] and are reiterated generally here. Treatment costs for the fuels treatment operations include the cost of owning and operating each piece of equipment. Total equipment costs include all costs accrued from buying, owning, and operating equipment. For analysis, equipment costs can be grouped into fixed costs,

[8] Miyata, ES. Determining fixed and operating costs of logging equipment. General Technical Report NC-55. 1980. Available from: http://www.nrs.fs.fed.us/pubs/gtr/gtr_nc055.pdf
[9] Miyata ES. Determining fixed and operating costs of logging equipment. General Technical Report NC-55. 1980. Available from: http://www.nrs.fs.fed.us/pubs/gtr/gtr_nc055.pdf

operating costs, and labor costs. To estimate these costs, we utilized the method presented by Miyata.[10]

Preliminary Data

- Equipment Costs (*P*)**.** This is defined as the actual equipment purchase cost, less the tire or track replacement cost, regardless of whether the equipment is purchased at full price or discounted.

    - Equipment costs with standard attachment
    - Optional attachment cost
    - Sales taxes (state and local)
    - Freight cost
    - Miscellaneous, including installation of attachments or modifications made to equipment.

    Vendors and contractors provided equipment cost (*P*) data.

- Salvage Value (*S*)**.** This is defined as the amount that equipment can be sold for at the time of its disposal. The actual salvage value of equipment is affected by current market demand for used equipment and the condition of the equipment at the time of disposal. However, estimating the future salvage value of equipment is very difficult because it is based on the future market value and the unknown condition of the equipment at the time of its disposal. As a rule of thumb, the salvage value can be considered 20% of the initial investment cost.

- Economic Life (*N*)**.** This is the period over which the equipment can operate at an acceptable operating cost and productivity. The economic life is generally measured in terms of years, hours, or mileages (trucks and trailers). It depends on two factors: physical and functional impairment.

- Scheduled Operating Time (*SH*)**.** Scheduled operating time is the time during which equipment is scheduled to do productive work.

- Productive Time (*H*)**.** Productive time is that part of scheduled operating time during which a machine actually operates.

Fixed Costs

Fixed costs do not vary with hours of operation. They are neither affected by the amount of equipment activity nor output and are incurred regardless of whether a piece of equipment is used or not. Fixed costs include depreciation, interest, insurance, and taxes.

- Depreciation charges were estimated using the straight-line or declining balance method. Straight-line is calculated as:

[10] Ibid.

$$\boxed{D_n = (P - SN)_n}$$

where *n* is the year for which the depreciation charge is to be estimated.

Declining balance method allows equipment owners to depreciate their asset more quickly in the earlier years of its useful life while still arriving at the same total depreciation as the straight-line method at the end of its economic life. Declining balance is calculated using the maximum depreciation rate for this method permitted by the Internal Revenue Service, which is 2 times the depreciation rate derived from the straight-line method. A 40% depreciation is taken annually based on the depreciated value of the asset from the previous year.

Operating Costs

- Maintenance and Repair
- Fuel
- Lubricants
- Tires or Tracks

Labor Costs

- Social Security
- Unemployment Insurance
- Workmen's Compensation Insurance
- Other: other employer contributions may include paid vacation, paid holidays, paid sick leave, health insurance, uniforms, safety equipment.

Photo Tracking

Before and after photos for each treatment unit are displayed in Appendix I. Just prior to the event, several photos were taken from a road adjacent to each treatment unit to document initial stand conditions as a reference. Another set of photos was to be taken from the same locations after the treatment to document site impacts and stocking control. However, since operators rarely treated the entire unit allocated to them, the initial photo points often didn't represent an area that was in fact treated. As such, most post-treatment photos had to be taken from a different location or bearing.

DEMONSTRATION RESULTS

Soil Impacts

As noted earlier, in order to determine the impact of treatment on physical attributes that influence site resilience and hydrologic function, soil condition was monitored using a Visual Soil Assessment Protocol (VSAP). Pre-treatment soil monitoring was captured immediately prior to treatment to establish a baseline to compare with the current study and avoid the influence of any legacy soil impacts.

Soil characteristics were collected as qualitative rankings. Live vegetation and woody material cover provides obstacles to decrease impact pressure from precipitation and overland flow, improving soil stability. Rutting, slash, and compaction can also channelize overland flow, increasing the cutting power of water to erode soil and cause sedimentation of watercourses.

Overall qualitative ranking of soil disturbance classes is as follows: undisturbed (0), slight disturbance (1), some disturbance (2), moderate disturbance (3), high disturbance (4), severe disturbance (5), or altered drainage (6) as defined in the VSAP. This ranking combines the soil characteristic and disturbance indicator metrics into a single relative value for comparison. See Appendix D for a more detailed description of the VSAP criteria.

To avoid operator bias, operators were not informed of plot locations prior to treatment.

Findings

Overall post-treatment soil disturbance rankings indicated that some disturbance occurred from all mastication treatments. The level of visible impacts seemed to be correlated with present soil structure, steepness of the ground, as well as the proficiency of the equipment operator.

Woody material cover increased from some treatment systems due to an increase in masticated vegetative residue being distributed over the treatment area. Most treatments demonstrated insignificant post treatment changes to vegetative cover, suggesting positive benefits from treatment.

Live vegetative cover was reduced in all the treatments. Most treatments had a low impact on existing live vegetative cover. Since post-treatment monitoring surveys were captured shortly after treatment, there is no determination if the loss of vegetation is a short-term or long-term impact from treatment.

Exposed bare soil significantly decreased over the course of most treatments while some treatments showed increases in bare soil cover (see Table 2). Loss of bare soil coverage in these treatments are likely attributed to increases in woody material coverage, while increased bare soil coverage suggests surface scraping from treatment.

Overall, soil disturbance findings are consistent with expected outcome. Significant reductions were made in the live vegetative cover from the treatments but were not correlated with

significant increases in exposed bare soil cover. Similarly, post-treatment soil disturbance rankings did not identify any significant rutting, compaction, or platy soil disturbance indicators. Table 2 summarizes the soil impact results.[11]

Table 2. Soil Impact Analysis Results

TREATMENT SYSTEM	PRE-TREATMENT DISTURBANCE CLASS RANKING	POST-TREATMENT DISTURBANCE CLASS RANKING
ASV RT 120F	2	3
FAE - Prime Tech PT 175	2	3
FAE - Prime Tech PT300	2	3
Fecon FTX 128L	2	3-5
John Deere JD 210GLC	2	2-3
Menzi M220	2	2-5
Menzi M545	2	3
Takeuchi TB 2150	2	3
TimberPro TL 735C	2	2-3

Treatment System Production and Cost Estimates

To determine machine productivity and cost, it was critical to differentiate the effects of machine capability from extraneous environmental variables. To achieve this, we focused on measuring production rate (hours per acre) and cost rate ($/acre) of each treatment system.

Cost Analysis

We requested general treatment system data from participating vendors and contractors. Equipment-specific information was provided via a web-based form (Appendix F). A total of nine treatment systems were deployed. Vendors were asked to provide prices for equipment base system, necessary attachments and miscellaneous setup costs to provision the specific configuration used in the HFTD. Table 3 summarizes these costs.

Table 3. Equipment Purchase and Setup Prices

TREATMENT SYSTEM	BASE COST	ATTACHMENT COST	MISCELLANEOUS SETUP COST	TOTAL COST
ASV RT 120F	$130,000	$12,000		$142,000
FAE - Prime Tech PT 175	$250,000*			$250,000
FAE - Prime Tech PT 300	$385,000*			$385,000
Fecon FTX 128L	$207,000*			$207,000
John Deere JD 210GLC	$250,000	$50,000		$300,000
Menzi M220	$250,000	$15,000		$265,000
Menzi M545	$420,000	$20,000		$440,000
Takeuchi TB 2150	$170,000	$25,400		$195,400
TimberPro TL 735C	$500,000	$115,000	$10,000	$625,000

*Includes cost of attachment.

[11] See Appendix D for detailed description of criteria used when assigning class ranking.

To calculate depreciation for each piece of equipment, an expected economic life span is necessary. Vendors were asked to provide an expected economic life span for the equipment. If none was provided, a default of five years was assumed. Salvage value is also necessary to calculate depreciation. If vendors did not provide salvage value at the end of the economic life span of the investment, we assumed 20% of the initial value. Scheduled (planned) and productive time on an annual basis were used to derive a utilization rate for each piece of equipment. If vendors did not provide planned and productive hours, we assumed a utilization rate of 65% based on the average values for equipment presented by Miyata.[12] The utilization rate reflects the percent of scheduled hours during which the equipment was actually used to perform its intended function.

Several basic ownership and utilization metrics were used to calculate equipment costs with the following:

- Salvage value at the end of equipment economic life.
- Economic life in years.
- Scheduled operating time in hours per year.
- Productive time in hours per year.
- Utilization rate.

Table 4 summarizes ownership and utilization metrics by treatment system.

Table 4. Ownership and Utilization Metrics by Treatment System

TREATMENT SYSTEM	SALVAGE VALUE	ECONOMIC LIFE (YEARS)	SCHEDULED HOURS (PER YEAR)	PRODUCTIVE TIME (PER YEAR)	UTILIZATION RATE
ASV RT 120F	$28,400	7	1,872	1,404	75%
FAE - Prime Tech PT 175	$50,000	5	1,872	1,248	67%
FAE - Prime Tech PT 300	$77,000	5	1,872	1,463	78%
Fecon FTX 128L	$41,400	10	1,872	1,310	70%
John Deere JD 210GLC	$60,000	12	1,872	1,404	75%
Menzi M220	$53,000	7	1,872	1,404	75%
Menzi M545	$88,000	7	1,872	1,404	75%
Takeuchi TB 2150	$39,080	5	1,872	1,498	80%
TimberPro TL 735C	$125,000	10	1,872	1,664	89%

Fixed Costs

Depreciation, interest, insurance and taxes are all considered fixed costs, as they do not vary regardless of operating hours. We asked vendors to select between three methods used to calculate depreciation:[13]

- Straight line assumes constant annual depreciation over the life span of the equipment.

[12] Miyata, E.S. Determining fixed and operating costs of logging equipment. General Technical Report NC-55. Houghton, MI: USDA Forest Service, North Central Forest Experiment Station. 1980.
[13] See Miyata for a more detailed discussion of the different methods of estimating depreciation.

- Declining balance weights depreciation toward the early years of the equipment economic life.
- Sum of the years digits which is an alternate way of weighting depreciation toward the earlier years.

We estimate other fixed costs such as interest, insurance, and taxes on the basis of the Average Value of Yearly Investment (AVI). AVI is calculated as follows:

$$AVI = \left(\frac{(P-S)(N+1)}{2N}\right) + S$$

where P = initial Investment
S = salvage value
N = economic life in years

We estimate interest, insurance, and taxes as 5.25%, 3%, and 3% of AVI, respectively, with interest based on the median of vendor submitted rates, and insurance and taxes based on Miyata.[14] Table 5 summarizes depreciation, AVI, interest, insurance and taxes by treatment system.

Table 5. Annual Depreciation and Fixed Cost Data by Treatment System

TREATMENT SYSTEM	DEPRECIATION	DEP. METHOD	AVI	INTEREST	INSURANCE	TAXES
ASV RT 120F	$16,229	straight line	$93,314	$4,899	$2,799	$2,799
FAE - Prime Tech PT 175	$40,000	straight line	$170,000	$8,925	$5,100	$5,100
FAE - Prime Tech PT 300	$61,600	straight line	$261,800	$13,745	$7,854	$7,854
Fecon FTX 128L	$16,560	straight line	$132,480	$6,955	$3,974	$3,974
John Deere JD 210GLC	$36,923	sum-of-years	$190,000	$9,975	$5,700	$5,700
Menzi M220	$30,286	straight line	$174,143	$9,143	$5,224	$5,224
Menzi M545	$90,200	declining balance	$289,143	$15,180	$8,674	$8,674
Takeuchi TB 2150	$31,264	straight line	$132,872	$6,976	$3,986	$3,986
TimberPro TL 735C	$93,125	declining balance	$400,000	$21,000	$12,000	$12,000

Operating Costs

Operating costs, unlike fixed costs, will vary with the number of operating hours the equipment is utilized. Operating costs include fuel, lubricants, and maintenance. Maintenance and repair are calculated based on Miyata as 50% of annual depreciation. Based on prices for off-road

[14] Ibid.

diesel used during the HFTD, we assume a fuel cost of $2.60/gallon. We estimate fully loaded labor costs of $20.06/hour for equipment operators based on US Bureau of Labor statistics for 2017.[15]

Table 6 summarizes hourly operating costs by treatment system.

Table 6. Hourly Operating Costs by Treatment System

TREATMENT SYSTEM	MAINTENANCE AND REPAIR	DIESEL FUEL	LUBRICANTS	TOTAL OPERATING COST
ASV RT 120F	$5.78	$11.46	$0.073	$44.06
FAE - Prime Tech PT 175	$16.03	$15.75	$0.351	$62.22
FAE - Prime Tech PT 300	$21.06	$26.26	$0.493	$73.49
Fecon FTX 128L	$6.32	$12.22	$0.074	$47.27
John Deere JD 210GLC	$13.15	$15.18	$0.095	$55.17
Menzi M220	$10.79	$7.16	$0.046	$44.74
Menzi M545	$32.12	$15.28	$0.094	$74.24
Takeuchi TB 2150	$10.44	$10.88	$0.116	$46.51
TimberPro TL 735C	$27.98	$31.79	$0.188	$82.53

Additional equipment-specific information is necessary to calculate total hourly costs. Table 7 summarizes horsepower and lubricant data for each piece of equipment.

Table 7. Equipment Horsepower and Lubricant Data

TREATMENT SYSTEM	RATED HP	LUBRICANT RESERVOIR (GALLONS)	OIL CHANGE CYCLE (HOURS)
ASV RT 120F	120	3	300
FAE - Prime Tech PT 175	165	66	250
FAE - Prime Tech PT 300	275	87	250
Fecon FTX 128L	128	3.5	500
John Deere JD 210GLC	159	5.5	500
Menzi M220	75	2	300
Menzi M545	160	3	300
Takeuchi TB 2150	114	28	500
TimberPro TL 735C	333	6	500

Total Hourly Costs

Using key economic data presented in Tables 3 through 7, total costs per Productive Machine Hour ($/PMH) were calculated for each treatment system. Table 8 summarizes costs per productive machine hour for each of the treatment systems.

[15] Occupational Employment and Wages, May 2017 45-4029 Logging Workers, All Other. http://www.bls.gov/oes/current/oes454029.htm#(2)

Table 8. Total Hourly Costs for each Treatment System

TREATMENT SYSTEM	TOTAL HOURLY COSTS PER PRODUCTIVE MACHINE HOUR
ASV RT 120F	$63.09
FAE - Prime Tech PT 175	$109.60
FAE - Prime Tech PT 300	$135.74
Fecon FTX 128L	$71.28
John Deere JD 210GLC	$96.69
Menzi M220	$80.26
Menzi M545	$161.65
Takeuchi TB 2150	$77.37
TimberPro TL 735C	$165.54

Findings

Summarized in Table 9 are results from the treatment systems deployment. Treatment production rate (hours/acre) and treatment cost rate ($ per acre) are provided as standard metrics for comparison.

Production rates (hours/acre) differ significantly based on treatment system, application site, and operator skills/familiarity with the equipment.

Table 9. Treatment Cost per Productive Machine Hour

TREATMENT SYSTEM	EQUIPMENT TYPE	HOURS/ACRE	HOURLY RATE ($/PMH)
ASV RT 120F	Skid Steer	14.2	$63.09
FAE - Prime Tech PT 175	Skid Steer	1.4	$109.60
FAE - Prime Tech PT 300	Skid Steer	1.5	$135.74
Fecon FTX 128L	Skid Steer	6.6	$71.28
John Deere JD 210GLC	Excavator	9.7	$96.69
Menzi M220	Excavator	41.3	$80.26
Menzi M545	Excavator	39.5	$161.65
Takeuchi TB 2150	Excavator	1.7	$77.37
TimberPro TL 735C	Feller-Buncher	2.4	$165.54

Hourly cost rates per productive machine hour showed that the TimberPro is the most expensive treatment option, followed by the Menzi M545.

The two Menzi Muck treatment systems were the most expensive treatment systems when calculating cost per acre, at over $3,000 per acre. Field observations confirmed that this high cost per acre is due to operators not being fully conversant with the kind of terrain and forested environment within their assigned treatment unit. Being significantly larger than purpose-built forestry machines, the John Deere had higher ground pressure and required careful operator control to minimize damage to soil and residual trees during treatment, decreasing production rate. The Takeuchi TB2150 and the two FAE-Prime Tech were operating in a “tandem”

configuration. Depending on the stand structure, either the skid steer with mastication attachment would make the first entry into the unit, opening sight lines for the excavator, or the excavator would enter first, removing larger trees to make movement for the skid steers easier. This took advantage of the strengths of each piece of equipment, while reducing the impact of its limitations. Considering the relatively gentle terrain and shrub dominated vegetation cover of the assigned treatment areas, skid steer equipment was the more cost-efficient treatment system. Whereas boom-mounted excavators operate in discrete intervals (and have the ability to "reach-in" with a boom mounted attachment to treat sensitive areas) and are better adapted to treat steep and rugged terrain, skid steer attached masticating heads can treat continuously as they move, boosting productivity.

Due to the range of treatment productivity (hours/acre) and range of operator skills, the cost per acre results were inconsistent and not considered an accurate representation of actual field-based costs.

OBSERVATIONS

Fire/Fuel Impact

In summary, all of the fuel treatment systems significantly altered the fuel profiles consistent with the treatment prescription. The increase in dead woody fuel loading within the treatment units may increase the potential for below ground damage to root systems and other soil heat effects in the event that a smoldering, creeping type of fire were to become established. Research findings regarding post mastication treatment soil impacts due to fire is variable. A 2009 research initiative found relatively low soil heating following mastication on the Okanogan and Wenatchee National Forests.[16] A 2018 research initiative suggests that limiting the depth of masticated fuels will limit soil heating.[17] However, as masticated woody debris decomposes over time and is incorporated into the topsoil, this potential damage from soil heating will be reduced.

Soil Impacts

Different terrain and soil types result in site specific treatment prescriptions, which result in different post treatment results. Field experience confirms that equipment-based treatment systems (as opposed to livestock, hand crews, or prescribed fire) will cause soil disturbance at varying degrees of impact. Key variables are soil type, slope gradient, operator experience and equipment type.

Treatment Efficacy

Production rates differ based on treatment system and operator proficiency. Balancing differences in production and cost rate are important features in contracting decisions, as limited time is available in any given field season to implement fuels treatment activities.

[16] R. Harrod et al, Masticating Fuels: Effects on Prescribed Fire Behavior and Subsequent Vegetation Effects. Fire Science Brief, May 2009.
[17] P. Morgan, et al, Masticated Fuels and Fire Behavior in Forests of the Interior West. Joint Fire Science Project, May 2018.

Demo Attendance

Public participation in the HFTD project was significant, with a total of 161 stakeholders in attendance. A key factor in achieving a successful attendance outcome was the use of a comprehensive communications plan and online registration. Regarding media attendance, past experience (2002 Dry Forest Mechanized Treatment Trials, 2015 Hazardous Fuels Reduction Demo) confirms that attracting media participation can be challenging.

Media Attendance

Two media representatives were in attendance: Sacramento Bee and Lake Tahoe News. The Bee reporter generated a two minute video clip providing an overview of the demo with key interviews:

https://www.sacbee.com/news/local/article212896259.html

The Lake Tahoe News reporter produced an article that appeared on June 11, 2018 (Appendix H).

Drone Video

The Georgetown Fire District deployed a drone on the final day of the demo (June 9, 2018) to document equipment deployed. While not all of the treatment systems were captured on video, the clip does provide a good perspective regarding site conditions and vegetation treated. USFS staff[18] provided post production video editing and formatting. The three minute video clip is available at https://vimeo.com/307090633

LESSONS LEARNED

Summarized below are lessons learned that can be applied to future fuels treatment demonstrations.

Post-Treatment Monitoring Expansion

Future opportunities include monitoring site conditions annually over an extended period of time, such as five or ten years. Soil conditions, vegetative response and woody debris decomposition rates over time are some of the key variables that deserve further study. Due to funding constraints, post treatment site conditions were only measured once.

Active Equipment

Due to safety concerns regarding equipment operating on steep terrain and disbursement of vegetative material, TSS made the conscious decision to allow primarily static display of equipment. Participant evaluations indicated that stakeholders would have preferred live

[18] Ann and Steve Dunsky.

deployment of equipment. Clearly a balance between safety of stakeholders and real time deployment of equipment is required and will impact the guest's experience.

Woody Material Collection and Processing

Fuels treatment activities in California have the potential to provide forest biomass material as feedstock to support the State's renewable energy mandate (Renewable Portfolio Standard) and climate change mitigation goals (California Global Warming Solutions Act of 2006). More information is needed to determine optimized harvest, collection, processing and transport of excess forest biomass sourced from steep terrain. Excess forest biomass collection and removal on slope over 30% gradient have traditionally been considered uneconomical due to high cost of operations on challenging terrain and the need to upgrade road systems accessing that terrain. Changes in the market value of forest biomass (brought on by recent BioRAM and BioMAT power purchase agreements) may provide enough market value to reconsider biomass collection and removal on steep terrain. This is especially the case at locations within economic transport distance of BioRAM and BioMAT compliant facilities.

Saturday Operations

Several volunteer based organizations requested that we include Saturday in our equipment deployment schedule. In past years we have focused demos on a Monday through Friday deployment schedule. However, volunteer based organization (e.g., Fire Safe councils, Resource Conservation districts) members typically are otherwise employed during the work week and are not available to attend field demonstrations. Participation on Saturday morning (about 40 total) was significant enough to justify the Saturday session.

APPENDIX A. TREATMENT PRESCRIPTION

Steep Terrain Demonstration Treatment Specifications (v.1 June 6)

Overall Vision for the Residual Stand: The primary objective will be to reduce understory cover by masticating brush and conifer ingrowth of smaller trees that form fuel ladders, creating vertical separation between ground fuels and tree crowns.

The expectation is that the maximum size of trees to be masticated is 12" DBH. Trees larger than that are considered too big to process efficiently, and may contain a merchantable log of at least 16' to a 6" top diameter.

With this limitation, horizontal separation of crowns is of secondary consideration. Where possible, remove trees less than 12" DBH to space residual trees to 21' to 25' apart.

Stand History and Current Condition: This area was burned in the Cleveland Fire in 1992. This portion of the fire was replanted in 1995. There are scattered residual conifers, particularly in the stream zones, and areas of ingrowth from natural seeding by the residual conifers. Generally, ponderosa pine trees were planted on 10' x 10' spacing, and precommercially thinned to remove about half the trees. It is considered overstocked by today's standards.

There are residual larger trees and ingrowth from seed deposited by the residual trees, particularly white fir and incense-cedar. The ingrowth constitutes much of what is to be masticated.

Operating Boundaries: There is no flagging. Each operator will work within the confines of the shape that is provided by the Avenza map download.

Streams and Stream Zones: Neither watercourses nor protection zone boundaries have been mapped. In general, keep the equipment a minimum of 25' away from watercourses in order to maintain an erosion control buffer and reduce the potential for fuel or fluids being deposited in the watercourse should a hose break. In no case will equipment enter or cross running water. Treat the brush and small trees in the stream zone where there is no running water; leave a 10' wide strip on either side of running water.

Large Downed Logs (greater than 20" diameter): These are considered important wildlife structure and should be retained in place where possible.

Snags: Retain where possible for wildlife purposes.

Black Oak: Retain for wildlife purposes.

Minor Conifer Species: Where species other than ponderosa pine form part of the canopy, retain these species to promote stand diversity.

APPENDIX B. COMMUNICATIONS PLAN

STEEP TERRAIN HAZARDOUS FUELS TREATMENT DEMONSTRATION COMMUNICATION PLAN

June 9, 2018 Update

The USDA Forest Service and CAL FIRE are sponsoring a steep terrain hazardous fuels treatment demonstration in partnership with Sierra Pacific Industries (SPI) on SPI land near Ice House Resort. Target audiences include fire agencies, natural resource managers, electric utilities, water conservation districts, homeowner associations, fire safe councils, county and city planning departments, fuels treatment contractors, and other stakeholders.

This demonstration is administered through a cooperative agreement between the Watershed Research and Training Center (WRTC) and the USDA Forest Service with contributions by the University of California Cooperative Extension, other partners, equipment vendors and operators. Project coordination is provided by TSS Consultants under a contract with WRTC.

DEVELOPMENT AND REVIEW TEAM

Developed and reviewed by:
Tad Mason, TSS, Jennifer Chapman, USFS,
Scott McClean, CALFIRE, Heather Williams, CAL FIRE, and
Mark Luster, SPI

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EXECUTIVE SUMMARY

The Steep Terrain Hazardous Fuels Treatment Demonstration project (HFTD) will demonstrate fuels treatment techniques and equipment used to manage hazardous fuels on sites in steep terrain that represent areas currently at risk of catastrophic wildfire in the Central Sierra Nevada. The project will conduct real time fuels treatment demonstrations on Sierra Pacific Industries land near Ice House Resort, approximately 33 miles east of Placerville, California. Data will be collected during the demonstration (demo) to document the change in fuels, and equipment performance. Once completed, this data will be synthesized and disseminated to target stakeholders.

The treatment demonstration will be approximately four days in duration and will provide vendors the opportunity to showcase conventional and innovative equipment and techniques that are not well known and are not widely utilized. A report on the general effectiveness and cost of the equipment and techniques used during the demo will be publicly available later this year.

This communication plan provides a comprehensive framework for actions that will support successful outreach and communication. The goals are to facilitate appropriate media coverage; ensure interested individuals, organizations and contractors have an opportunity to observe equipment deployed in the field and ask questions; and ensure the results reach interested parties.

The primary target audience includes natural resource professionals, community-based stakeholders (e.g., fire safe councils) and potential contractors interested in mechanized fuels reduction work. The goal is to inform these stakeholders of the demo, engage their interest, encourage their participation, and inform them of the results. They will gain the following:

- More information about fuel treatment technologies including conventional and innovative equipment;
- Treatment capabilities on steep terrain and;
- Treatment costs.

Secondary audiences include forest landowners, media, industry association and non-governmental organizations. The goal is to inform them of the following:

- Hazardous fuels treatment opportunities;
- Techniques;
- Technologies – both conventional and innovative;
- Treatment costs.

Finally, communication with stakeholders interested in natural resource management, in general, will increase their understanding of the complexities of fuel treatment activities, particularly in steep terrain.

The communication goals will be achieved using a variety of methods including media releases, tours, industry contacts and networks, public presentations, and publication/dissemination of results.

BACKGROUND

Throughout many forests in the West, concentrations of hazardous fuels are placing rural communities, critical infrastructure (e.g., roads, power lines), sensitive habitat and entire watersheds at significant risk from wildfire. Wildfire incidence in California has averaged approximately 4,800 fires at 202,786 acres per year over the past five years (2013 – 2017). 2017 was an exceptionally challenging year with 9,133

fires across 1,248,606 acres, almost 12,000 structures destroyed and 46 fatalities. The most destructive fire in California recorded history was the 2017 Tubbs Fire with 5,643 homes destroyed and 22 lives lost.

A primary factor influencing the intensity of these wildfire events is the unnaturally high concentrations of vegetation. As noted in the April 1999 General Accounting Office report (GAO/RCED-99-65) *Western Forests: A cohesive Strategy is Needed to Address Catastrophic Wildfire Threats,* ***"The most extensive and serious problem related to the health of national forests in the interior West is the over-accumulation of vegetation."***

A century of successful fire exclusion efforts have facilitated a serious and unnatural concentration of vegetation - mostly small trees and brush. To restore the health of at-risk landscapes and reduce the risk of wildfire, these dense stands require treatment. This treatment of non-commercial trees and brush – also know as biomass -- is fast becoming a fuel management priority for land managers throughout the West. In many cases the removal or mastication of excess forest biomass is a pre-treatment technique used to prepare the landscape for the introduction of prescribed fire.

Many studies have looked at the mechanical treatment of hazardous fuels. However, very few have included the opportunity to observe an array of different treatment techniques and equipment in the same location, interface with knowledgeable and experienced operators, and obtain a follow-up summary about results and performance. There are several examples of projects involving deployment of equipment to conduct hazardous forest fuels treatment field demonstrations:

Dry Forest Mechanized Fuels Treatment Trials, TSS Consultants/The Yankee Group - 2002.
http://ucanr.edu/sites/WoodyBiomass/newsletters/Woody_Biomass_Related_Publications50962.pdf

Hazardous Fuels Reduction Demontrations, TSS Consultants – 2015
http://ucanr.edu/sites/WoodyBiomass/Hazardous_Fuels_Reduction_Demonstration/ - sec-2.1

These trials earned numerous positive reviews because of their focus on local situations and partner groups, and they provided information not previously available about effectiveness and costs. The demos planned for the Ice House area would be focused on unique site conditions and vegetation management in this region and the ability of the most suitable equipment or processes to address excess fuel buildup on steep terrain.

Results from the HFTD project will be synthesized and distributed to interested parties including natural resource managers, local contractors, community organizations, media, and other interested parties to aid on the ground efforts in the pro-active treatment of hazardous fuels.

Outlined below is a summary of the HFTD project administrative structure:

- **PRIMARY FUNDING SUPPORT:** USDA Forest Service, CAL FIRE
- **ADMINISTRATION:** The Watershed Research and Training Center
- **IMPLEMENTATION - CONTRACTORS:** TSS Consultants
- **IMPLEMENTATION – AGENCY PRIMARY SUPPORT:**

- Eldorado National Forest, CAL FIRE

- **IMPLEMENTATION – NGO/AGENCY ADDITIONAL SUPPORT:**
  - University of California Division of Agriculture and Natural Resources
  - California Society of American Foresters – Sac Tahoe Chapter
  - El Dorado County Fire Safe Council
  - Sierra Pacific Industries
  - Forestry Challenge
  - Forest Foundation

PROBLEM AND OPPORTUNITY STATEMENT

Problem Statement:

1. Throughout much of central and northern California, concentrations of hazardous forest fuels are placing rural communities, sensitive habitat (including threatened and endangered species), entire watersheds and strategic infrastructure at significant risk to catastrophic wildfire events. Hazardous fuels include a high concentration of biomass[1], including many small trees.

2. To aid in restoration of the ecological health of at-risk landscapes, unnaturally high concentrations of biomass requires treatment. Some information exists addressing treatment and removal of biomass. More information needs to be gathered about effectiveness, and cost of treatment, especially in steep terrain.

3. Public perceptions to fuels treatment and tree removal activities are not always positive.

Opportunity Statement:

1. The USDA Forest Service, UC Division of Ag and Natural Resources, Sierra Pacific Industries and other partners are sponsoring a forest fuels treatment demonstration near Ice House Resort in northern California. It is anticipated that information from this work will aid efforts to proactively treat hazardous fuels, in northern California forests.

2. Hazardous fuels reduction projects could potentially contribute additional economic opportunities for local contractors and communities.

3. Reducing excess fuels on at-risk landscapes will alter wildfire behavior, thus protecting communities, habitat, and valuable infrastructure from the impacts of catastrophic wildfire.

4. Reducing excess fuels on at-risk landscapes will alter wildfire behavior thus reducing greenhouse gas emissions associated with wildfire events.

[1] Biomass – the living or dead weight of organic matter in a tree, stand or forest (Dictionary of Forestry, Society of American Foresters, 1998).

5. California's watersheds are at significant risk from wildfire events (e.g., 2013 Rim Fire impacted city of San Francisco's domestic watershed and power generation assets near Yosemite National Park).

6. Field demonstration of conventional and innovative techniques and equipment will contribute to the regional knowledge base regarding steep terrain fuels treatment near communities, sensitive watersheds and other at-risk landscapes.

7. Fire suppression costs (financial and societal costs) are significant. Investing in a pre-fire fuel treatments has proven to be very cost effective.

8. Returning our watersheds to a more fire resilient state will protect them from potential impacts of wildfire. Healthy, functioning watersheds typically yield higher volumes and better quality water.

9. As more tax dollars are allocated to treat fuels and suppress wildfire, the public should have an opportunity to view fuels treatment activities and their effects first hand.

PRIMARY GOAL

Successfully demonstrate to natural resource managers, landowners, contractors, agency personnel, concerned public and other stakeholders, the options available to treat excess biomass material on steep terrain and return landscapes to a more natural and fire resilient condition. This will lead to more public support for ecological restoration on forested landscapes.

OBJECTIVES

Short term objectives of this project include:

- Improved ability of agencies to plan and budget for future fuels treatment projects in steep terrain.
- Development of an informed cadre of local fuels treatment contractors and local stakeholder groups (e.g., fire safe councils, homeowners association, resource conservation districts).
- Outreach to the general public (e.g., media, homeowners, forest landowners) with regards to fuels treatment opportunities, techniques and latest technology.
- Expanded public support for increasing the pace and scale of ecologically sound fuels treatment activities.
- Promotion of cost effective fuels treatment alternatives in steep terrain.

Long-term objectives include:

- Increase in the number of acres treated to reduce hazardous fuels in steep terrain and improvement of the ecological health of at risk landscapes.

- Reduction of site impacts from fuels treatment activities.
- Creation of long-term sustainable jobs.
- Promotion of an informed public, that more fully appreciates the complexities of fuels treatment efforts and the statewide challenge of creating and maintaining fire resilient landscapes.
- Improved water yields, timimg and quality.

AUDIENCES

Key Audiences

1. Independent Contractors – Interested in purchasing equipment and or fiber purchasers (small diameter logs, biomass). Appendix A
2. Small Woodland Associations – Forest Landowners of California
3. Professional organizations – Associated California Loggers, California Licensed Foresters Association, SoCal Society of American Foresters, Sierra Cascade Logging Conference, Redwood Regional Logging Conference.
4. Key State and Federal Agencies – USDA Forest Service, Cal Fire, Bureau of Land Management, Natural Resource Conservation Service, National Park Service, California State Parks.
5. Local Tribes and Intertribal Council.
6. Other Agencies – US Fish and Wildlife Service, California Fish and Wildlife Service, National Marine Fisheries Service, Bureau of Indian Affairs, California Department of Water Resources, California Air Resources Board, Resource Conservation Districts, Resource Conservation and Development Councils, Elected Officials – Federal, State, County.
7. NGO's - Watershed Councils, Advisory Councils, Conservation organizations (e.g., Sierra Forest Legacy, League to Save Lake Tahoe), California Forestry Association, Fire Safe Councils, and land management organizations (the Nature Conservancy, New Forest).
8. Media and general public.
9. Local fire districts. (CAL FIRE, El Dorado County Fire Protection District)
10. Power Utilities: Public Utilities Commission, PG&E, SMUD, El Dorado Irrigation District.
11. Local colleges and universities - Forestry/Natural Resource programs (Sierra College, Lake Tahoe Community College, Sierra Nevada College).
12. Local high schools – ecology clubs/vocational students. (reach out to Forestry Challenge and Forest Foundation to assist with outreach to local schools).
13. Stakeholder collaboratives – South Fork American River Cohesive Strategy (SOFAR) Collaborative, Amador Calaveras Consensus Group

KEY MESSAGES

- A variety of fuels treatment tools and techniques are available to natural resource managers (hand crews, prescribed fire, livestock and mechanical equipment). The HFTD is focused on mechanical equipment capable of operating on slope gradients over 30%.

- Landscape targeted for treatment is located at the 5,400' elevation in mixed conifer vegetation type within the northern Sierra Nevada region. Owned and managed by Sierra Pacific Industries this property was selected due to ready access (close to Hwy 50) and moderate to steep slope conditions (20% to 50%).

- The HFTD is intended to provide interested stakeholders the opportunity to view conventional and innovative equipment operating in the field, thus raising awareness regarding the deployment of mechanical technologies to actively reduce excess forest fuels. The use of mechanical fuels treatment has the potential to increase the pace of fuels treatment while driving down overall cost of treatment. The HFTD will also provide stakeholders with up-to-date information regarding soil resource impacts, equipment efficiencies and cost.

- Mastication reduces ladder fuels and excess vegetation which can carry fire into the forest canopy thus creating an active crown fire. By reducing the potential for crown fire conditions, wildfire behavior is mitigated. Masticated material is left on site and is incorporated into the forest floor eventually adding nutrients to the soil. Collection and removal of ladder fuels and excess vegetation from steep slopes is cost prohibitive.

- USDA Forest Service standards and guidelines in Land Management Plans (e.g., Eldorado NF) typically set 35% slope gradient as the not to exceed threshold for deploying ground based equipment. This slope constraint is in place to protect soil resources and mitigate risk to the workforce. Some of the technologies deployed have been developed since these standards were put in place and are capable of safely operating on slopes exceeding 50%. .

- Information learned from this demonstration, could be utilized by public and private land managers to conduct fuel treatments that reduce impacts on key resources (e.g., soil) and are cost effective. Proactive fuels treatment activities are an important wildfire mitigation technique.

- Equipment deployed at the HFTD is typically owned and operated by independent operators (private contractors) that are retained by utilities, public and private land managers and entities such as Fire Safe Councils, to reduce excess fuels near communities, key watersheds, sensitive wildlife habitat and other at risk landscapes.

- Wildfire incidence in California has averaged approximately 4,800 fires at 202,786 acres per year over the past five years (2013 – 2017). 2017 was an exceptionally challenging year with 9,133 fires across 1,248,606 acres, almost 12,000 structures destroyed and 46 fatalities. The most destructive fire in California recorded history was the 2017 Tubbs Fire with 5,643 homes destroyed and 22 lives lost.

- The Governor's May 10, 2018 Executive Order called out the need to significantly increase the pace of fuels treatment statewide – from the current level of approximately 250,000 acres per year, to 500,000 acres per year by 2023. The use of mechanical fuels treatment is one of the tools available to achieve this level of proactive treatment.

IMPLEMENTION PLAN

Outlined below is the draft implementation plan.

Completion Date	Activity	Purpose	Responsible Parties
12/15/17	Draft Comm Plan	Meet HFTD objectives	Tad Mason Others
2/27/18	El Dorado County Fire Safe Council Presentation	Engage local stakeholders in upcoming demo	Tad Mason
2/28/18	Finalize Comm Plan Generate key contact list	Assure info reaches target audience	Tad Mason Others
3/4/18	SOFAR General Meeting Presentation	Engage local stakeholders in upcoming demo	Tad Mason
3/15/18	Outreach to key target audience (e.g., Fire Safe Councils) to Save the Date – email and social media	Solicit support and participation	Tad Mason UC Extension Others
4/1/18	Issue Project Announcement with registration form.	Assure target audience participation	UC Extension Tad Mason
5/15/18	Make personal contact with Target Audience and Media	Assure target audience participation	Tad Mason Others
5/30/18	Issue News Release (who, what, where, why) Include description of visual possibilities (equipment, landscape, etc). Conduct followup calls (to assure participation).	Assure media and elected official participation	USFS-CALFIRE Public Affairs / Communications
6/4/18	Issue Media Advisory – USFS/CAL FIRE joint release	Assure media participation	USFS-CALFIRE Public Affairs / Communications
6/5+6/18	Equipment is mobilized to Ice House site.	Equipment inspection (all equipment will be power washed before arriving at Ice House.	Tad Mason
6/8+9/18	Demonstration Days	Assure high participation.	Tad Mason Others
6/9+10/18	Equipment is de-mobilized commencing late afternoon 6/9/18		Tad Mason
12/30/18	Report on fuel treatment cost and results	Information sharing and public education	Tad Mason Others

COMMUNICATION TOOLS/PRODUCTS

Communication Tool	Prepared By	Target Audience					
		Independent Contractors	NGO's	Land Management Agencies	Other Agencies	Elected Officials	Media & Public
Talking Points (key messages)	Tad Mason	X	X	X	X		
Talking Points (key messages)	Tad Mason Jennifer Chapman					X	X

Communication Tool	Prepared By	Target Audience					
		Independent Contractors	NGO's	Land Management Agencies	Other Agencies	Elected Officials	Media & Public
	Heather Williams						
Media Alerts/Media Advisories/Press Release	Jennifer Chapman Heather Williams					X	X
Project Overview	Tad Mason	X	X	X	X	X	X
Website Updates (UC Coop Extension)	Rick Satomi	X	X	X	X	X	X
Briefing Paper	Tad Mason					X	X
Powerpoint Presentation	Tad Mason		X	X	X		
Evaluation Form (for guests as they exit the demo)	Tad Mason	X	X	X	X		
Demo Report	Tad Mason Martin Twer	X	X	X	X	X	X

Other Communication Tools

Establish a web site or link showing digital photos of the equipment registration information and final report results:
http://ucanr.edu/sites/WoodyBiomass/Technical_Assistance/Steep_Terrain_Hazardous_Fuels_Treatment/

EVALUATION

Did we accomplish the objectives of plan? There are two ways to evaluate the plan's effectiveness:

Nominal Evaluation

Which communication tools were completed and distributed. Posted below is a check list.

Communication Tool	Completed Tasks
Talking Points	X
News Release	X
Fact Sheet/Project Overview	X
Website updates	X
Briefing Paper	X
Participant Evaluation Form	X
Media Contacts	X

Effectiveness Or Outcomes Evaluation

Include participant evaluation/feedback.

Attitude change, and opinion change

KEY CONTACTS – COMMUNICATIONS PLAN

Summarized below are key contacts

Name	Organization	Email	Office	Cell
Tad Mason	TSS	tmason@tssconsultants.com	916.600.4174	916.600.4174
Jennifer Chapman	PAO, Eldorado NF	jenniferachapman@fs.fed.us	530.621.5280	530.957.9660
Rich Wade	Sierra Pacific Ind	rwade@spi-ind.com	530.644.2311	530.635.5663
Mark Luster	Sierra Pacific Ind	mluster@spi-ind.com	916.645.1631	916.812.4894
Heather Williams	Asst PIO,Cal Fire	Heather.williams@fire.ca.gov		
Daniel Berlant	PIO, Cal Fire	Daniel.berlant@fire.ca.gov		
Larry Swan	Region 5, USFS	lswan01@fs.fed.us	707.562.8917	541.891.7752
Lamont Jackson	Acting PAO, Region 5, USFS	lamontjackson@fs.fed.us	707.562.9105	
Sherri Eng	Acting Deputy Dir, Public Affairs+Communications	sleng@fs.fed.us	707.562.8995	510.414.9397
Rick Satomi	Forest Advisor, UC Cooperative Extension	rpsatomi@ucanr.edu	530.224.4900	626.500.6212
Pat Dwyer	El Dorado County Fire Safe Council	rpd123@att.net		530.391.4493
Rob Griffith	Asst Director, Fire and Aviation, Region 5, USFS	rgriffeth@fs.fed.us	707.562.8695	
Marva Willey	Fuels Program Coordinator, Region 5, USFS	mwilley@fs.fed.us	707.562.8981	
Jamie Tripp	Fuels Operations	jtripp@fs.fed.us		

CONTINGENCY CONSIDERATIONS

- The major variable is weather. Snow conditions or rain will likely force re-scheduling.
- Federal shutdown will force re-scheduling.

REFERENCES

- National Fire Plan – http://www.fs.fed.us/rm/science-application-integration/national-fire-plan/

- GAO Report – "*Western Forests: A Cohesive Strategy is Needed to Address Catastrophic Wildfire Threats"* – http://www.gao.gov/products/GAO/rced-99-65

- GTR 220 An Ecosystem Management Strategy for Sierra Mixed-Conifer Forests http://www.fs.fed.us/psw/publications/documents/psw_gtr220/

APPENDIX A. LIST OF CONTACTS

USDA Forest Service:

- USDA Forest Service – Region 5 staff
- Eldorado, Tahoe and Plumas NF – Supervisor Office and local Ranger Districts. Focus on fire/fuels staff.
- Pacific Southwest Research Station Research Station

Industry Contacts:

- California Forestry Association
- Associated California Loggers
- Sierra Cascade Logging Conf
- Local logging and fuels treatment contractors (Appendix A)

Professional Associations:

- California Society of American Foresters
- California Licensed Foresters Assoc
- California Forest Soils Council
- Other?

Elected Officials Contacts:

- Federal Congressional Offices
- State Legislative Offices
- County Supervisors

Media Contacts: (Include news release, fact sheet, website address, briefing paper)

- *Need input from PAO/PIO*
- Television Stations – Local, PBS
- Radio Stations AM, FM, NPR
- Newspapers: Sac Bee, Tahoe Daily News, others.
- Other – Wildfire Today

Other contacts:

- Cal Poly SLO
- Humboldt State, CSU San Bernardino
- UC Berkeley, UC Riverside
- BLM
- USFWS
- NMFS
- USFWS

Local Agencies/Organizations:

- Resource Conservation Districts
- Resource Conservation and Development Councils
- Local Fire Districts
- Fire Safe Councils
- El Dorado Irrigation District
- Other?

Conservation/Sportsman/Recreation Organizations:

- The Nature Conservancy
- Sierra Club
- National Forest Foundation
- State Parks
- National Park Service
- El Dorado County Parks

Other State/Federal/local Agencies:

- Cal Fire
- CA Air Resources Board
- Dept. of Fish and Wildlife
- US Fish and Wildlife
- NOAA
- NMFS
- Local Air Districts
- County Planning Departments
- Other?

Tribes:

- Me-Wok
- Shingle Springs Band of Miwok
- Others?

Power Utilities:

- PG+E
- SDG+E
- SMUD
- NV Energy
- Other?

APPENDIX C. DEMO ATTENDANCE

HFTD Participants

Affiliation	Vendor Reps & Operators	Volunteers & Support	Demo Days (6/8 & 6/9)	Comments
Equipment Vendors & Reps	22			
Sierra Pacific Industries		5		
The Watershed Research & Training Center		2		
Media			2	Lake Tahoe News, Sacramento Bee
Private Landowner			13	
Fuels Treatment Contractor & Equipment Operator			22	
Forestry Consultant			6	
USFS, Regional Office			5	
USFS Local			11	
California Board of Forestry			6	
CAL FIRE			3	
CA Tahoe Conservancy			1	
Lahontan Water Board			4	
CA Air Resources Board			1	
Tahoe Regional Planning Agency			1	
NV Division of Lands & NV Division of Forestry			2	
Natural Resources Conservation Service			3	
Resource Conservation Districts			2	
UC Agriculture and Natural Resources, UC Ext			6	
CSU Chico			1	
California Forestry Association			2	
National Forest Foundation			1	
Sierra Forest Legacy			3	
League to Save Lake Tahoe			1	
Amador Eldorado Forest Forum			4	
Fire Safe Councils			11	
South Fork of the American River Cohesive Strategy Group			4	
PG&E			5	
SMUD			5	
Friends of the West Shore			1	
Blue Forest Conservation			2	
Associated California Loggers			2	
Amador County Board of Supervisors			1	
Educator			1	
Fire Districts			2	
TOTALS	**22**	**7**	**132**	

APPENDIX D. FOREST SOIL DISTURBANCE MONITORING PROTOCOL

Visual Soil Assessment Class Description

Pre-Treatment Soil Condition:

Class 0	**Undisturbed**	No evidence of past equipment operation. Soils are undisturbed or considered to be in a natural state.
Class 1	**Slight Disturbance**	Site is virtually undisturbed. Old litter and duff layers intact. Vegetation present or redeveloping with well-established root systems. Some faint impressions of heel tracks or slight depressions evident. Surface soils (A horizons) intact. Surface soil structure unaffected by past equipment operation. No evidence of platiness developing in surface soils.
Class 2	**Some Disturbance**	Site is virtually undisturbed. Old litter and duff layers intact. Vegetation present or redeveloping with well-established root systems. Some visible indications of past equipment operation. Surface soils (A horizons) intact but may show some signs of compaction (i.e. minor amounts or discontinuous platiness at soil surface). No evidence of surface soil removal.
Class 3	**Moderate Disturbance**	Old litter and duff layer partially intact or missing. New litter layer developing. Vegetation present or redeveloping. Surface soils (A horizons) intact but show evidence of compaction and puddling (surface platiness or lack of structure). Depressions of old wheel tracks evident. Small amounts of surface soil removal.
Class 4	**High Disturbance**	Old litter land duff layer removed. New litter layer may be redeveloping. Surface soils (A horizons) partially or totally removed or mixed with subsoil material. Evidence of surface soil removal. Some pedestalling at base of trees.
Class 5	**Severe Disturbance**	Old litter and duff layer removed. New litter layer redeveloping or absent. Evidence of excessive or extreme surface soil removal. Surface soils (A horizon) absent. Subsoils exposed, compacted, or removed.
Class 6	**Altered Drainage**	Alteration of internal soil drainage characteristics. Results in permanently saturated soils or standing water.

Post-Treatment Soil Condition:

Class 0	**Undisturbed**	No evidence of equipment operation. Soils are undisturbed or are considered to be in a natural state.
Class 1	**Slight Disturbance**	Site is virtually undisturbed. Litter and duff layers intact. Surface soil (A horizons) intact. Impressions of wheel tracks or slight depressions in surface soils may be present. No exposed surface soils (unless natural). No exposed subsoils.
Class 2	**Some Disturbance**	Litter and duff layers generally intact. Surface soils (A horizon) intact but may show some evidence of platiness. No evidence of surface soil removal or deposition
Class 3	**Moderate Disturbance**	Litter and duff layers only partially intact or missing. Surface soil (A horizons) intact but shows evidence of platiness or lack or structure. Equipment tire tracks or cleat marks evident.
Class 4	**High Disturbance**	Litter and duff layers totally removed. Surface soils (A horizons) partially removed or may be mixed with subsoil material. Surface soil structure destroyed (large, thick plates instead of granular or crumb structure). Some shiny or slick appearing soil surfaces may be present.
Class 5	**Severe Disturbance**	Litter and duff layers totally removed. Surface soils (A horizons) nearly all or completely removed. Evidence of topsoil removal and/or gouging. Subsoils partially or totally exposed.
Class 6	**Altered Drainage**	Alteration of internal soil drainage characteristics by equipment operation. Results in permanently saturated soils or standing water.

APPENDIX E. SHIFT REPORT TEMPLATE

HFTD Machine Shift Report

Unit _____
Date _____
Operator _____
Machine _____
Fuel Consumption _____

__:__ Shift Start Time
__:__ Shift End Time

Please fill out a new report for each shift or when changing to a different unit.

For each delay event 10 minutes or longer,
record either the (Start Time and End Time), or the (Total Time).

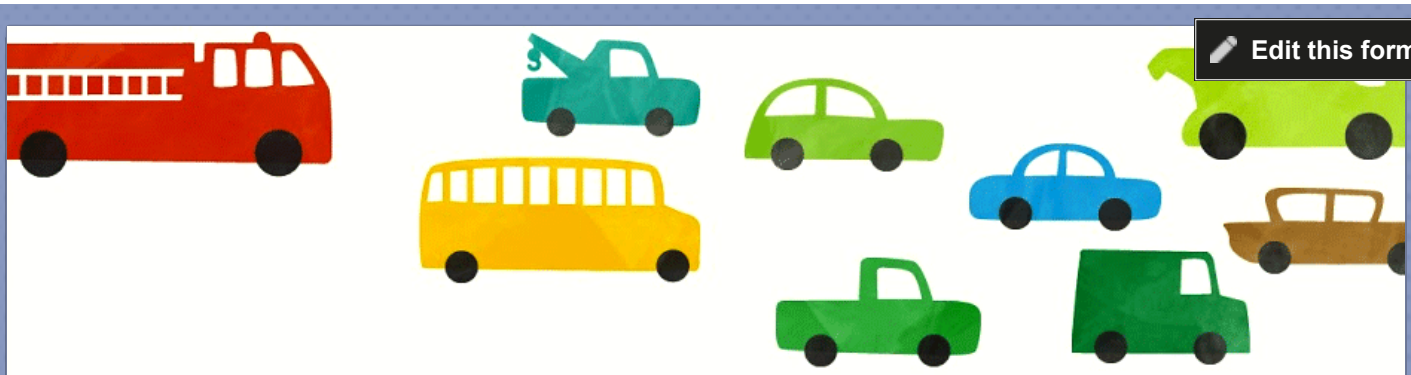
Start Time	End Time	Total Time	Circle Event Type	Comments
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	
:	:	:	Ld Unld Brk Srv Rep Other	

Please explain anything unusual about the shift.
(Example: The engine ran poorly which made the machine slow.)

(Write on back of page if needed.)

Start Time Time of day when event started (Hour : Minute)
End Time Time of day when event ended (Hour : Minute)
Total Time Total time of event (Hours : Minutes)
Ld Loading (including any disassembly)
Unld Unloading (including any assembly)
Brk Break (lunch, coffee, smoke, etc.)
Srv Service (any routine maintenance or service: fuel, lubrication, etc.)
Rep Repair (any breakdowns or problems with machine: broken hose, etc.)
Other Other (describe event: talked to supervisor, etc.)

APPENDIX F. VENDOR INPUT FORM



Edit this form

Equipment Cost

This form should be filled out by equipment vendors for specific pieces of equipment that will be used in the demonstration. Several key fields are required. If you do not feel you can provide accurate estimates for one or more of the optional fields, leave them blank. Keep in mind these numbers will be used to estimate hourly cost on the HFTD site.

* Required

Contact

Please fill this out so we can follow up if necessary

Name *

First and last

Affiliation

Who you work for

E-mail address *

Phone # *

Equipment information

Descriptive information.

Equipment Mfg. *

Please give manufacturer name

Equipment model number *
Model number for the equipment

Equipment description *
Brief description of the equipment including any non-standard attachments

Rated Horsepower *
combined horsepower of the equipment

Lubricant reservoir *
Size of engine oil reservoir (gal)

Lubricant hours *
Reccomended hours between oil change

Sites *
At which sites will this equipment be deployed?

- [ ] Shaver Lake (October 3-10)
- [ ] San Bernardino NF (October 12-17)
- [ ] Santa Rosa Indian Reservation (November 16-21)

Preliminary Data

Total equipment costs include all costs accrued from buying, owning, and operating equipment. For analysis, equipment costs can be grouped into fixed costs, operating costs, and labor costs. To calculate these costs, the user needs preliminary information and understanding of the following definitions.

Equipment cost with standard attachments *
Not including tires. FOB factory price

Optional attachment.
Optional attachment for equipment (eg: masticating head for skid steer)

Optional attachment cost.

Optional equipment attachment cost (falling head for feller-buncher, masticating head for skid steer)

Miscellaneous

such as for installation or adaptation of the equipment to the logging system, should be included in the initial investment cost.

Salvage Value

The amount that equipment can be sold for at the time of its disposal. If not estimated this will be calculated as 20% of the initial investment cost.

Economic life

This is the period over which the equipment can operate at an acceptable operating cost and productivity (years)

Scheduled operating time

Scheduled operating time is the time during which equipment is scheduled to do productive work. The time during which a machine is on standby is not considered scheduled operating time. (hours/year)

Productive Time

Productive time is that part of scheduled operating time during which a machine actually operates (hrs/year). This can be caculated easily by multiplying an estimate of the percentage of the scheduled operating time that the machine is productive.

Fixed costs

Fixed costs do not vary with hours of operation. They are neither affected by the amount of equipment activity nor output and are incurred regardless of whether a piece of equipment is used or not. Fixed costs include depreciation, interest, insurance, and taxes.

Depreciation method

A piece of equipment loses its value with time and possesses only salvage value (or trade-in value) at the time of trade-in. The basic objective of the depreciation schedule is to recover the initial investment cost of equipment each year over its estimated economic life. The method for calculating depreciation is ordinarily determined by its planned or desired effect on profit and income taxes through the economic life of equipment. The three common methods generally used to compute depreciation are: (1) straight line: value decreases at a constant rate, (2) declining balance: depreciates at a higher rate in the early years, and lower rate later, (3) sum-of-years-digits depreciation decreases at a decreasing fraction each year

- ◯ strait line
- ◯ declining balance
- ◯ sum-of-years digits

Interest rate

On borrowed captial for purchase, percent (eg: 0.04)

Insurance

Annual cost to insure equipment ($/year)

Taxes

Annual property or usage taxes ($/year)

Operating Cost

Operating costs, unlike fixed costs, change in proportion to hours of operation or use. They depend on a host of factors, many of which are under control of the operator or the equipment owner to a certain extent.

Maintenance and repairs

Includes everything from simple maintenance to the periodic overhaul of engine, transmission, clutch, brakes, and other major equipment components. Storage costs and preventive maintenance are also included ($/year)

Fuel

$/hour

Lubricants

$/hour

Tires

$/hour

Labor Cost

Labor cost is the cost to keep an operator on the job on an hourly basis. Includes Social Security, Federal Unemployment Insurance, State Unemployment Insurance, Workmen's Compensation, etc.

Wages

$/hour

Social Security

$/hour

Unemployment insurance

$/hour

Workmens compensation

$/hour

Other

Sum of any other condtibutions (401k, uniform, etc.) on an hourly basis ($/hour)

Submit

Never submit passwords through Google Forms.

APPENDIX G. TREATMENT SYSTEM DESCRIPTIONS

System: **ASV RT 120F**

Attachment: Fecon BH 80 mulching attachment

Description: The ASV RT 120F is a compact skid steer track loader that features a suspended undercarriage for lower ground pressures and superior traction. The ergonomic operator station and easy-to-use pilot operated joystick controls facilitate operation throughout the workday. The advanced hydraulic system accommodates a range of attachments. The Fecon BH 80 attachment used for the HFTD demo features fixed teeth that are easily serviced.

Price: ASV 120 RT 120F - $115,000
Fecon BH 80 mulching attachment - $25,000

Vendor: Hamre Equipment
3930 Esplanade, Chico, CA 95973
530-895-8955
www.hamreequipment.com

System: **FAE – Prime Tech PT-175**

Attachment: FAE 140/U-175 mulching head

Description: The Prime Tech PT-175 is the smallest purpose-built track carrier by FAE. It is designed to operate on steep terrain up to 100% slope. The PT-175 is a compact size tracked carrier with 160 HP Cummins QSB4.5 engine. The PT-175 is mainly used for vegetation management, for cleaning undergrowth, cutting and eliminating bushes and shrubs and for cutting fire lines. It has a D3 undercarriage available with either a standard single grouser or LGP (3.65 psi) single grouser pad.

Price: FAE – Prime Tech PT-175 - $258,000.00
FAE 140/U 175 mulching attachment
(cost is included in equipment purchase)

Vendor: Global Machinery
3321 Airport Road
Sacramento, CA 95834
877-541-6702
www.Globalmachinery.com

System: **FAE – Prime Tech PT-300**

Attachment: FAE 200/U-210 mulching head

Description: The Prime Tech PT-300 is a medium, low ground pressure (only 0,23 kg/cm² - 3.65 psi!) tracked carrier with 275 HP, designed and built by FAE.
It is designed to operate on steep terrain, up to 100% slope. The robust frame and the oscillating undercarriage with sealed and lubricated track chains and dozer-style rollers, guarantee an extended lifetime of the machine, thus reducing maintenance and operating costs. The operator's cab is very comfortable with excellent visibility, while the ordinary maintenance is easy and fast thanks to the perfect access to all components.

Fields of applications:

One of PT-300's main characteristics is its versatility: depending on the job you want to do, it can be equipped with a mulching head, soil stabilizer, rock crusher, asphalt grinder and stump cutter.
All the attachments, made by FAE, can be switched easily and quickly, allowing you to use PT-300 for land clearing and mulching applications (right-of-way, utility lines, fire breaks, vegetation management, etc.), as well as for land conversion (removal of stumps and roots) and for road construction/maintenance.

Price: FAE – Prime Tech PT-300 - $315,000.00
FAE 200/U-210 mulching attachment - $71,400.00

Vendor: Global Machinery
3321 Airport Road
Sacramento, CA 95834
877-541-6702
www.Globalmachinery.com

System: **Fecon FTX 128L**

Attachment: Fecon BH85SD-4 mulching head

Description: The Fecon FTX128L is a dedicated steel track mulching tractor with loader arms to reach up to 10 feet in the air. It comes equipped with a severe duty Fecon BH85SD-4 mastication head with FGT double carbide tools for durability in rocky environments. The oversized coolers with reversing fans allow it to operate in high ambient temperatures continuously. It can run a variety of skid steer attachments as well.

Price: Fecon FTX128L - $166,400.00
Fecon BH85SD-4 mulching attachment $40,950.00

Vendor: Fecon Inc.
3460 Grant Drive
Lebanon, OH 45036
513-696-4430
www.Fecon.com

System: **John Deere 210G FT4**

Attachment: Fecon BH80 mastication head

Description: The combination of a traditional John Deere 20 ton excavator with a Fecon BH80EXC severe duty mulcher offers the benefit of a versatile machine that has extended reach and mobility for work along roadsides, steep banks, and waterways. The power offered by the John Deere 210 is matched to the BH80 mastication attachment with variable displacement motors for optimum performance and a 56" cutting width.

Price: John Deere 210G FT4 Excavator $215,000
Fecon BH80 mastication attachment - $52,000

Vendor: Pape Machinery
2850 El Centro, Sacramento, CA 95833
916-922-7181
https://construction.papemachinery

System: **Menzi Muck M220**

Attachment: Fecon BH FMX40 mastication attachment

Description: The Menzi Muck M220 is a compact all terrain excavator designed to operate a wide range of attachments on challenging landscape. The Menzi can climb over large obstacles and the flexible chassis adapts to uneven terrain. This equipment features unique high engine and hydraulic power for its weight class, which allows operation of power-hungry attachments (such as mastication attachments). The Menzi is especially suited to operations on sensitive terrain (riparian area) that requires a light touch. The Fecon BH 40EXC attachment used for the HFTD demo features fixed teeth that are easily serviced.

Price: Menzi Muck M220 - $250,000

Fecon BH FMX50 mastication attachment - $20,000

Vendor: Hamre Equipment
3930 Esplanade, Chico, CA 95973
530-895-8955
www.hamreequipment.com

System: **Menzi Muck M545**

Attachment: Fecon BH 40EXC mastication attachment

Description: The Menzi Muck M545 is a compact all terrain excavator designed to operate a wide range of attachments on challenging landscape. The Menzi can climb over large obstacles and the flexible chassis adapts to uneven terrain. This equipment features unique high engine and hydraulic power for its weight class, which allows operation of power-hungry attachments (such as mastication attachments). The Menzi is especially suited to operations on sensitive terrain (riparian area) that requires a light touch. The Fecon BH 40EXC attachment used for the HFTD demo features fixed teeth that are easily serviced.

Price: Menzi Muck M545 - $450,000
Fecon BH 40EXC mastication attachment - $30,000

Vendor: Hamre Equipment
3930 Esplanade, Chico, CA 95973
530-895-8955
www.hamreequipment.com

System: **Takeuchi TB 2150**

Attachment: FAE UML/HY/VT-125 mastication head

Description: The TB2150 is the largest, most capable excavator in the Takeuchi line-up. The Takeuchi TB2150 excavator is a 35,000 lbs. hydraulic excavator with a Final Tier 4 TCD 3.6 liter, turbocharged 114 hp engine. The engine utilizes a DOC+SCR diesel exhaust after-treatment system and has no DPF! The TB2150 has a maximum reach of just over 28 feet, which gives it the capability of working roadside or reaching into sensitive areas being treated for fuels reduction. The FAE UML/HY/VT-125 mastication head has fixed teeth, either carbide or blade style. The optional front hood allows the operator to control the size of the finished product and helps control the direction of material leaving the head. The UML/HY head is rated for treatment of material up to 5" in diameter.

Price: Takeuchi TB 2150 - $170,000.00
FAE DML/HY 125 - mastication head - $30,000.00

Vendor: Global Machinery
3321 Airport Road
Sacramento, CA 95834
916-453-2780
www.globalmachinery.com

System: **Timberpro TL 735C**

Attachment: Fecon BH 80 mastication head

Description: The Timberpro TL 735C is a purpose built track mounted excavator that incorporates an operator controlled leveling cab and upper chassis. This provides stability when performing on steep terrain and allows treatment roadside or along sensitive areas such as creeks or sensitive habitat. The masticating head is mounted on the end of a boom giving the machine a working radius of 25 feet.

Price: Timberpro TL 735C - $465,000.00
Fecon BH 80 attachment - $55,000.00

Vendor: Bejac Corporation
With locations throughout
California, Nevada, and Arizona
800-772-3522
www.bejac.com

APPENDIX H. LAKE TAHOE NEWS ARTICLE

Equipment changing landscape of fire prevention

Published: June 11, 2018

The Spider looks like a Transformer ready to tromp through the forest. Photo/Susan Wood

By Susan Wood

POLLOCK PINES – Relying heavily on prescribed burns as fuel reduction among forest officials may be steeped in tradition – but the practice isn't enough to fight the types of raging infernos the West is seeing year after year.

Much of the challenge often lies in fire prevention over steep terrain requiring a cross between the old and the new. It takes oversized Tonka trucks and Transformer-type heavy equipment.

California is coming off a series of drought years, then one of the worst seasons ever for wildland blazes on the 25th anniversary of the Cleveland Fire. The mega blaze burned more than 24,000 acres in 30 hours, closed a 50-mile stretch of Highway 50, killed two people and injured

72. The hot fire that roared eight miles east of Pollock Pines along the Peavine Ridge north of Riverton at Ice House Road presents a painful reminder of what could be.

Another more recent blaze nearby — the King Fire of 2014 — scorched more than 97,000 acres in El Dorado County and destroyed 80 structures. The fire's cause was arson, but the damage is still visible from the highway and restoration is ongoing.

The terrain is thick, steep and unforgiving to get to off the roads.

CalFire Deputy Chief Stewart McMorrow looks at the chewing teeth of the TimberPro attachment. Photo/Susan Wood

"We've spent $6 million to restore 11 Pines Road, and it's still closed," Eldorado National Forest Supervisor Laurence Crabtree told *Lake Tahoe News* preceding a tour last week from the Ice House Resort 10 miles up from Riverton.

The U.S. Forest Service spends over half its budget on fighting fires, knowing prevention is where the emphasis needs to be.

Forest managers were joined to view the equipment and results up close by small groups of residents, Sierra Pacific Industries and CalFire officials, who declared a suspension to burning starting today in El Dorado, Amador and Alpine counties. Some see the declaration as the official start of fire season. Others would agree fire season has turned into a yearlong event.

Crabtree estimated at least 35 percent of the burn area with a mix of conifer trees such as fir, pine and cedar from the King Fire is steep, posing a hazard to property owners – especially as more build in the wildland interface. In the last five years, Forest Service officials have negotiated agreements with private property owners to establish firebreaks on their land.

Among them is Sierra Pacific Industries – which manages the resources on 1.8 million acres in California.

The excavation machine made by Pacific Tech handles the steep terrain of the Eldorado Forest. Photo/Susan Wood

“We need to manage fire; we don’t need it to manage us,” Sierra Pacific spokesman Mark Luster summarized about the tree-clearing demonstration.

Take an overgrown forest with mass pockets of dead trees in timber-dry conditions, an excess of fuel following wet winters while throwing in windy conditions, and California is ripe for a no-

win perfect storm of fire capable of producing the kind of huge complexes that ripped through the Wine Country last year.

Firefighters regionwide are quite aware of how vulnerable the rugged, woody Sierra Nevada Mountain Range is – especially in hard-to-get-to, steep terrain.

Fire science proves flames burn faster up steep slopes. Unfortunately, this terrain makes it difficult for firefighters to cover the ground necessary to build a perimeter to contain and control fires that hop from low-lying brush, to ladder fuels up to the crown.

That's one reason managing the resources ahead of the worst time of year in fire season may seem like a never-ending task when other forces like drought and bark beetle stack on the obstacles.

Sometimes it's just as hard to manage the people doing the work of clearing the debris.

Contractor Jeff Holland quipped that his company of 30 machines and 25 people said his company has grown increasingly busy since 1983 since the forest has been "mismanaged."

To that, Luster countered that the job is overwhelming anyway.

"If you look at how much acreage, there's so much volume, it's hard to keep up with the amount of volume," he said.

CalFire Deputy Chief Steward McMorrow, who works out of Sacramento, agreed.

"What we're doing here is rearranging the fuels on the lower forest floor," McMorrow said as he glanced over a cleared segment of acreage where the Timberpro harvester had gone through. He contends that environmentally chewing the trees and leveling the land also helps to stimulate the fungal process.

The goal of the equipment demonstration: To witness how the latest and greatest in excavating, skidding, moving and mulching equipment can clear a fire prone region in steep terrain by digesting woody debris in ways unheard of decades ago. The key is in the equipment attachments assembled to address the job, the level of fineness and the terrain.

Some of these heavy-equipment machines look like something out of an animated space film – such as one called the "spider." The walking excavator made by Menzi of Switzerland essentially crawls down the hills with the use of four independently-operated mega wheels, front stabilizers and a loader appendage that helps it crawl up and down a slope of at least 40 degrees with ease. The 30,000-pound machine looks like a living thing when it lays flat or arches its back.

"It can collapse down to 7-feet wide," said equipment operator Eric Monson, whose Atascadero-based Stroles Tri Service company contracts with Sierra Pacific and the U.S. Forest Service to clear the thick forest in hard-to-treat fuel reduction regions.

CalFire Deputy Chief Stewart McMorrow surveys the land cleared by a tree harvester. Photo/Susan Wood

Down the road, Brian Kile, the western regional manager of Fecon, explained how his agile track mulcher can handle steep slopes of 45 degrees. The finished byproduct looked like something homeowners might be happy with in their own back yard. The mulcher was put to the test during the West Yellowstone fires, serving as an emergency fire break.

“This thing can blow dirt and can (at times) put a low-ground fire out,” Kile said with pride.

Bruce Jackson, displaying ASV’s skid steers and track loaders, noted to the tour group how pleased he is with the performance of his equipment in the steep terrain of the Eldorado Forest.

“You have to do something drastic to flip it,” he said.

Jackson also insisted the cooling system makes his machine superior in that it can work for prolonged periods without overheating.

All in all, the heavy equipment of today isn’t your grandfather’s and plays a more important role in human survival than dirt excavation.

APPENDIX I. PRE AND POST TREATMENT IMAGES

UNIT A

Before:

After:

UNIT B

Before:

After:

UNIT C

Before:

After:

UNIT D

Before:

After:

UNIT E_1

Before:

After:

UNIT E_2

Before:

After:

UNIT E_3

Before:

After:

UNIT F

Before:

After:

UNIT G

Before:

After: