Last Chance Integrated Vegetation Management
Biomass Removal Project

Placer County

Additional funding from:

The Nevada and Placer County Resource Advisory Committee,

The Tahoe National Forest - American River Ranger District,

The Placer County Air Pollution Control District, and

The Sierra Nevada Conservancy

May, 2014

Executive Summary

The Last Chance Integrated Vegetation Management Biomass Removal Project (Last Chance Biomass Project) was one of a series of projects coordinated by Placer County with the overall objective of improving the utilization of excess woody biomass from forest management projects for production of energy - to help make such utilization more economically feasible while contributing to improving air quality and protection of natural resources.

Specifically, this biomass project involved processing, transporting, and utilizing for energy production, the excess biomass - small trees, and limbs and tops of larger trees - that were generated by the Last Chance forest management project on the Tahoe National Forest. The Last Chance forest management project was part of the Sierra Nevada

Adaptive Management Project (SNAMP) - a collaboration between the U.S. Forest Service, the University of California, other state and federal agencies, and the public - to research the effects of fuels reduction projects conducted by the Forest Service on forest health, fire behavior, water quality and quantity, wildlife, and public participation.

Monitoring the biomass project performance included documentation of total biomass processed and removed, fuel used by equipment for processing and transportation, logistics costs of the total project, and comparisons of air emissions from the biomass facility versus air emissions that would have occurred from open burning the biomass. The Last Chance forest management project began in November 2010 and was completed in July 2013. Operations on this biomass removal project began September 5, 2013 and were completed November 28, 2013.

The project resulted in 5,024 green tons (GT) - 3378 bone dry tons (BDT) - of biomass being processed and transported to the Rio Bravo bioenergy facility in Rocklin, California where it was utilized to produce 4,286 Megawatt hours of electricity. Significant reductions in emissions resulted from utilizing the excess biomass for energy generation as opposed to open burning. Carbon dioxide (CO_2), methane (CH_4), and carbon monoxide (CO), all of which are greenhouse gases, were reduced 22 percent, 97 percent, and 99 percent respectively. In addition, particulate matter (PM), of which 10 to 30 percent is in the category of "black carbon" and has significant impact on global warming and human health, was reduced by 97 percent.

This project was funded with contributions from the Nevada and Placer County Resource Advisory committee, the Tahoe National Forest (both actual and in-kind funding), Placer County, and the Placer County Air Pollution Control District.

Project Description

The primary goal of this project was removing biomass waste from the Last Chance forest management and research project on the Tahoe National Forest. The biomass was ground into chips and transported to the Rio Bravo biomass energy facility in Rocklin, California where it was burned to produce electrical energy.

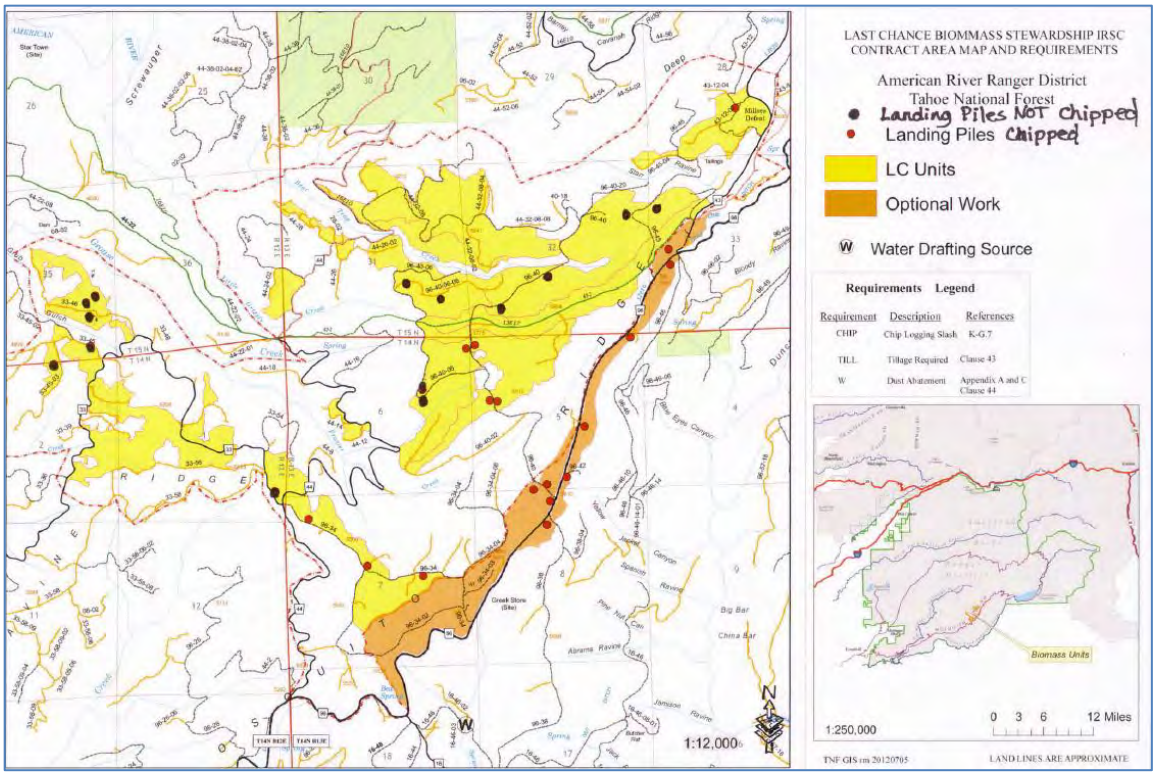
Last Chance forest management and associated activities were carried out and administered through a U.S. Forest Service contract. This included thinning harvest units designed to reduce the effects of wildfire, and various follow up treatments including mastication and prescribed burning. The harvest units produced logs with commercial lumber value but also excess biomass in the form of limbs, tops, and small trees with no commercial lumber value.

The University of California, through the Sierra Nevada Adaptive Management Project (SNAMP), designed and implemented a research study to measure the effects of the forest management project on forest health, fire behavior, water quality and quantity, wildlife, and public participation. The goal of SNAMP is to provide the U.S. Forest Service with management recommendations integrated across the various disciplines and

scaled up to the fireshed level. The SNAMP was designed to test implementation of the 2004 Sierra Nevada Forest Plan Amendment prepared by the Pacific Southwest Region of the U.S. Forest Service as a supplement to the forest plans of the 10 national forests located in the Sierras.[1]

SNAMP assessed effects of forest management on future fire behavior using data gathered for one year after treatment was completed. Modeling based on collected data was used to identify long-term effects. The American Fire provided additional opportunities for monitoring and research of actual results related to fire behavior and effects - but this would require a new research project and new funding.

Figure 1 – Last Chance Project Area



The Last Chance project involved removal of whole trees (known as "whole-tree yarding") to landing areas where commercial-sized trees were cut into logs and hauled to a lumber mill. Small trees, and the limbs and tops from larger trees, constituted excess biomass and were placed in large piles at near the landings. This piled excess biomass was scheduled for removal to ensure adequate reduction of fire hazard. Removal would normally have been done by open burning the piles during fall or winter months. Instead, this biomass removal project was designed to grind and transport the excess biomass to a

[1] The SNAMP research involves assessing impacts of the project on resources such as wildlife habitat and watershed function and modeling the effects of harvesting on wildfire behavior. The monitoring is ongoing. The SNAMP research included extensive resource inventories in the Last Chance Project area both pre- and post-timber harvest. The final integrated report will be available in December 2014

biomass energy facility, in this case, the Rio Bravo energy generation facility in Rocklin, California. Grinding and utilization were carried out on seventeen landings of the Last Chance forest management project under this biomass project.

Processing and transportation of the biomass was completed under a U.S. Forest Service contract with Brushbuster Inc. (Contractor). The contractor used a Link Belt 290 LX excavator/loader to transfer biomass material from the landing piles into a Bandit 3680 grinder. The grinder ground the biomass into small pieces and transferred those pieces into large chip vans.

Figure 2 – Last Chance Grinding Operation

Figure 3: Chip Van Unloading at Rio Bravo Facility

Three standard chip vans were used to reduce the amount of time the grinder was not operating. The chip vans transported the grindings to the Rio Bravo facility via the Mosquito Ridge Road haul route. Because of the sharp curves along the Mosquito Ridge Road haul route, the Forest Service required a pilot vehicle to avoid safety problems with other road users. Haul distances and times, even utilizing three chip vans, still resulted in some idle time for the excavator and grinder when no chip vans were available at landing sites to be loaded.

Figure 4: Rio Bravo Facility, Rocklin, California

The contract required the contractor to keep detailed records of the time spent handling and grinding the landing piles and transporting the grindings to the Rio Bravo facility. In addition, the contractor was required to keep accurate records of fuel used in all equipment. Required data collection included: excavator and grinder operation hours; total operation hours, total miles and number of trips for chip vans and pilot vehicles; and total amount of biomass processed and delivered.[2] The Last Chance biomass removal project was delayed by the American Fire and American Fire post-fire work, therefore, biomass processing and removal began September 5, 2013 and was completed November 28, 2013. During the project period, 25 operation days were lost due to weather and government shutdown and closure of the Rio Bravo facility. In addition, there were 4 days during which weather and equipment breakdowns reduced project production.

The Rio Bravo facility is required to have ongoing monitoring of air emissions from combustion of biomass material. In addition, the Placer County Air Pollution Control District (PCAPCD) periodically inspects the facility to ensure accurate monitoring is occurring. Data from typical combustion was used to estimate emissions produced from

[2] See Appendix for spread sheets showing results of contract documentation.

the Last Chance project biomass. This was combined with data from Rio Bravo that shows typical electrical energy generation for a given amount of biomass in order to determine how much energy was generated specifically from Last Chance biomass.

Additionally, the PCAPCD has data showing typical emissions from open burning of a given amount of biomass in piles. This data was used to estimate the amount of emissions that would have occurred from open burning the Last Chance landing piles. Calculations were made to show the comparisons in emissions from open burning versus utilization in the Rio Bravo energy facility.

Figure 5: Typical Pile Burn

Funding for completing the Last Chance Biomass Project came from several sources. Payment for all the contract work related to processing and removing biomass was made possible due to funding from the Nevada and Placer County Resource Advisory Committee, the Sierra Nevada Conservancy, the PCAPCD, the Tahoe National Forest and Placer County. Placer County and the Tahoe National Forest also provided in-kind funding that covered the cost of contract administration and overall project management.

Project Monitoring

The original project plan, as described in the Nevada and Placer County Resource Advisory Committee grant application, called for monitoring and analyzing a number of key metrics:

- Economics of woody biomass material collection, processing and transport.
- Performance of the biomass-to-energy recovery boiler.

- Net air quality impacts from open pile burning and utilizing woody biomass in a biomass power cogeneration facility, including criteria on air pollutants and greenhouse gases.
- Potential benefits to watersheds (water quality, wildlife habitat, recreation).
- Mitigation of wildfire behavior.

The results of the project related to these metrics are discussed in the following "Project Results" section.

Project Results

Biomass Utilized for Energy Generation

The project resulted in 190 loads of biomass being ground into chips and transported to the Rio Bravo energy facility for energy generation - a total of 5,024 green tons (GT). Rio Bravo tested each load for quality and moisture content to determine that the total bone dry weight delivered was 3,378 tons. At the Rio Bravo facility, the chips were burned under controlled conditions to heat a boiler, creating steam that drove a turbine generator to produce electricity. The biomass generated an estimated 4,280 Megawatt hours of electricity, enough to support 500 to 600 households for a year.

Figure 6: Grindings from Last Chance Project

Project Air Quality Impacts and Performance of the Biomass-Energy Recovery Boiler

Emissions modeling based on research studies together with accurate accounting of the tonnage of biomass delivered to the Rio Bravo biomass energy facility indicate that utilization of the excess biomass from the Last Chance project for energy production

versus the alternative of open burning resulted in significant air emissions reductions as shown in Table 1.

Table 1: Comparison of Emissions - Open Burning vs. Biomass Facility

Project emissions								
		NOx	PM	VOC	CO	CO2	CH4	CO2e
No Project								
Open pile burn	metric tons	8.73	18.92	14.56	183.41	5336	8.73	5520
Electricity grid	metric tons	0.34	0.11	0.04	0.6	1646	0	1646
Biomass Project								
Chip van	metric tons	0.34	0.07	0.01	0.8	45	0.02	45
Pilot car	metric tons	0.01	0.00	0.00	0.0	2	0.00	2
Grinder	metric tons	0.27	0.24	0.01	0.3	46	0.03	46
Excavator	metric tons	0.15	0.00	0.01	0.1	9	0.01	9
Biomass boiler	metric tons	2.16	0.30	0.10	0.0	5319	0.24	5325
Reductions	metric tons	6.16	18.42	14.47	182.6	1561	8.43	1738
	%	68	97	99	99	22	97	24

Explanation of Table 1 information:

The "No Project" section of Table 1 shows emissions that would have occurred if the biomass in this project had been open burned ("Open pile burn" row in the table) and the emissions that would have resulted from use of fossil fuels needed to generate an equivalent amount of energy ("Electricity grid" row in the table).

The "Biomass Project" section of Table 1 shows the emissions that were actually produced from all aspects of the project. This includes the processing of the biomass ("Excavator" and "Grinder" rows in the table), transport of the biomass to the Rio Bravo energy facility ("Chip van" and "Pilot car" rows in the table), and the actual production of energy at the Rio Bravo energy facility ("Biomass boiler" row in the table). The "Reductions" rows in the table show the metric tons of reduction in emissions resulting from utilization of the biomass for energy production in lieu of open burning and the percentage of total reduction for each specific emission.

The columns in the table show emissions for NOx (nitrogen oxide), PM (particulate matter - shows the weight of particulates that are less than 2.5 microns in diameter), VOC (volatile organic compounds, not including methane), CO (carbon monoxide), CO_2 (carbon dioxide), CH_4 (methane), and CO_2e (carbon dioxide equivalent). CO_2e indicates the total weight of CO_2 and the CO_2-equivalent weight of CH_4, methane, which has a global warming potential factor 21 times that of carbon dioxide by weight.

Significance of Emissions Reductions:

The bottom of Table 1 shows reductions in emissions, some of which have more significance than the amounts might seem to indicate.

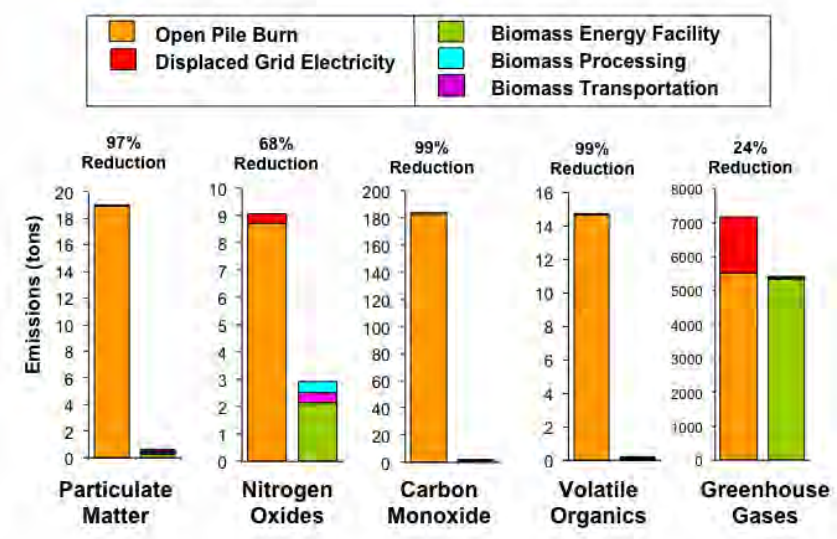
The reduction in PM is significant in terms of reducing particulates that have a tangible documented effect on respiratory-related illness. But the PM reduction may be even more significant in relation to global climate change impact. Preliminary data shows that 10 to 30 percent of PM falls in the category of "black carbon" which research indicates has approximately 900 times the climate change impact of CO_2.

The reduction in CH_4 emissions appears small in terms of tonnage; however, as mentioned above, research has shown that methane has 21 times the effect of CO_2 on climate change, so this reduction is important.

The reduction in CO_2, a major compound connected to climate change, also appears small in terms of percentage; however, this is primarily due to the fact that burning biomass in an energy facility produces essentially the same amount of CO_2 emissions as open burning. The significance of the reduction is increased by the fact that biomass (a renewable energy source) is considered "carbon-neutral" by most experts because the carbon released when biomass is burned was originally sequestered from the atmosphere by the tree that produced the biomass. This is in contrast to the combustion of fossil fuels that are not renewable and are not carbon-neutral, making those CO_2 emissions more impactful.

In summary, the reduction in emissions from the utilization of biomass for energy production in lieu of open burning is very significant in terms of air quality improvements, reduction in human health impacts, and climate change influence beyond what some of the amounts might individually imply.

Figure 7: Comparison of Emissions - Open Burning vs. Energy Facility



Project Economics

Work on the Last Chance Biomass Project was financed from two main sources - payment through the U.S. Forest Service contract that governed the handling, grinding and transportation of the biomass to the Rio Bravo biomass energy facility, and payment from the Rio Bravo facility for the biomass delivered to the facility. The total payment from these two sources, $274,308, equates to a total cost of $81.20 per BDT for utilizing the excess biomass from the Last Chance project. This cost covers all project work such as processing, transportation, moving equipment to and from the project, pilot car operation, fuel, and maintenance.

Without this biomass utilization project, the U.S. Forest Service would have burned the seventeen landing piles of excess biomass during the late fall or winter after sufficient rain and/or snow had rendered the area safe from fire hazard. Burning would have cost approximately $450 per landing or a total of $7,650. This figure must be subtracted from the sum of the contract cost and the receipts from Rio Bravo to determine the real cost per BDT for this project. That figure is approximately $2.26 per BDT, making the actual total cost for biomass utilization $78.94 per BDT.

	Total	Per BDT
Contract Cost	$138,162	$40.90
Biomass Receipts, Rio Bravo	$136,146	$40.30
Total: Initial Project Cost	$274,308	$81.20
Deduction: Avoided Burning Cost	$7,650	$2.26
Net Project Cost	$266,658	$78.94

The cost of transporting biomass from the Last Chance area was increased by long haul distances and the requirement for a pilot vehicle to accompany every chip van during delivery and return travel. Having a biomass facility closer to the biomass source would decrease overall transportation cost but would not reduce the cost associated with a pilot vehicle. In addition, since there is a fixed per-hour cost for ownership of equipment and labor, having enough chip vans to allow continuous operation of the excavator and grinder would reduce overall contract time and, thereby, some fixed costs.

The cost of handling the biomass at the chipping sites was increased because the large piles were constructed only to facilitate burning. This necessitated more effort in tearing the piles apart with the excavator and loading the biomass into the grinder. If similar projects are planned for excess biomass utilization, piles can be constructed for more efficient handling.

To be economically feasible, the cost of processing and removal of excess biomass from forest management and hazard reduction projects should preferably not exceed a sum representing the value of the biomass as delivered at an energy facility plus the cost for alternative handling or disposal of the biomass. However, if societal benefits of reducing emissions and protecting watersheds, wildlife habitat, and forest health that accrue from

forest management or hazard reduction projects are considered (as discussed further below), there is an argument to be made that some additional cost is justified even without actual monetization of those societal benefits. In the future, it appears recognition of, and funding for, those societal benefits may be possible through programs being considered by state agencies.

Potential Benefits to Watersheds and Mitigation of Wildfire Behavior

Potential benefits to watersheds (and other forest resources) and mitigation of wildfire behavior are related in that wildfires represent the largest potential for impacts to forest resources. For the most part, assessment of benefits to watersheds and of mitigation of wildfire behavior will require longer-term monitoring. However, the American Fire that occurred in the summer of 2013 offered an opportunity to immediately understand some of the effects of the Last Chance forest management project implementation.

Figure 8: Last Chance Project Area Burned in American Fire

The American Fire occurred prior to this biomass recovery project, and it burned into some of the Last Chance harvest units. The fire missed most of the landing piles - with

one impressive exception where a very large landing well inside a harvest unit did burn. However, the Last Chance harvest did provide benefit to fire suppression efforts. As described earlier, the Last Chance forest management project included removal of whole trees from the forest as a way of reducing fuel load in the harvest area. This resulted in limbs, tops, and small trees being yarded to the landing area and placed in large piles for later disposal. This reduction of excess biomass reduced fuel load sufficiently to allow fire fighting forces to safely ignite a backfire on one edge of a harvest unit to create a wide fire line that was successful in stopping one flank of the fire. The resulting fire line contributed to a reduction in ultimate fire size and thereby reduced potential negative effects on watershed and other resources.

The SNAMP began water monitoring before implementation of the Last Chance timber management project. Monitoring will continue into the future and will provide information about possible effects of forest management on such things as snow pack and both amounts and timing of runoff. This monitoring will be increasingly important due to concerns about the negative effects of climate change on California water supplies and the possibility that different approaches to forest management can help mitigate those effects.

Summary

The Last Chance Integrated Vegetation Management Biomass Project was intended to utilize excess biomass for energy production in lieu of open burning, and to provide information about both resulting emissions reduction benefits and basic economics. Although it was not itself economically self-supporting, the Last Chance Project provided valuable information to help design and improve future biomass utilization projects and programs. In addition, the Last Chance Project provided significant reductions of emissions through utilization of the biomass in the project area.

In the longer-term, developing economically-feasible utilization of excess biomass will benefit forest management programs and projects designed to protect and enhance forests, as well as important forest resources like watersheds, wildlife habitat, forest health, and recreation. This adds to the importance of projects like Last Chance and the information they provide in helping inform and improve future forest management and hazard reduction projects.

Program Documentation:

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